date is crucial in the following format:

we need to consider the whole week's data , but the recent 3 days play a huge role

Burnout typically develops gradually over an extended period of time, rather than happening suddenly. It's a process where chronic workplace stress accumulates, leading to emotional, physical, and mental exhaustion. The symptoms of burnout can start subtly and worsen over time if not addressed. Recovery from burnout can also take weeks, months, or even years, depending on the severity and how proactively the individual addresses the underlying causes. so we cant completely eliminate it such that burnout today means no burnout tomorrow at the same time burnout today need not necessarily mean burnout tomorrow.

Stress vs. burnout

Don’t confuse burnout with stress, though. Stress is having too much on your plate — too much work to handle, too many responsibilities, too many hours spent working. Burnout is the opposite. You typically feel like you don’t have enough — not enough motivation, not enough  energy, not enough care.

The same can be said for misinterpreting depression for burnout. Certain depression-related symptoms, such as exhaustion and difficulty performing tasks, can masquerade as burnout. In most cases, burnout is work-related and doesn’t affect your day-to-day life. Depression, on the other hand, impacts every aspect of your life with persistent feelings of hopelessness, worthlessness or helplessness.

Burnout isn’t a sudden onset of feelings. Instead, your thoughts, feelings and actions progress through a series of stages. The initial stages may not feel like much, but they can eventually lead to a habitual phase that makes it hard to carry out your occupational duties.

Honeymoon phase

Like a honeymoon phase in a marriage, this stage comes with energy and optimism. Whether it is starting a new job or tackling a new task, it’s common to experience satisfaction that leads to periods of productivity and the ability to tap into your creative side.

Onset of stress phase

Eventually, the honeymoon phase dwindles, and you begin to experience stress. Not every second of your day is stressful, but there are more frequent times when stress takes over. As this stage begins, take notice of any physical or mental signs. You may start to lose focus more easily or be less productive when completing tasks. Physically, fatigue can start to set in, making it more difficult to sleep or enjoy activities outside of work.

Chronic stress phase

You’ll reach a point where the stress becomes more persistent, or chronic. As the pressure mounts, the stress is likely to consistently affect your work. Examples include feelings of apathy, not completing work on time, being late for work or procrastinating during tasks. Socially, you may withdraw from normal work-related conversations. In other cases, you may become angry and lash out at coworkers. Sometimes, these feelings follow you home and can affect relationships with friends and family.

Burnout phase

This phase is when you reach your limit and can no longer function as you normally would. Problems at work begin to consume you to the point where you obsess over them. At times, you may also feel numb and experience extreme self-doubt. Physical symptoms will become intense, leading to chronic headaches, stomach issues and gastrointestinal problems. Friends and family members may also notice behavioral changes.

Habitual burnout phase

If left untreated, burnout can become a part of your everyday life and eventually lead to anxiety or depression. You can also begin to experience chronic mental and physical fatigue that prevents you from working. Your job status may be put in jeopardy if you continue on this path.

What are symptoms of burnout?

Burnout symptoms vary depending on which phase of burnout you’re in. In general, there are three symptoms to be aware of: exhaustion, depersonalization and reduced personal accomplishment.

Exhaustion: This fatigue presents itself both mentally and physically. The energy you typically have is zapped by persistent exhaustion.

Depersonalization: This is a feeling of indifference. In other words, you start to feel numb. For example, you may become more cynical in your inner workings or lack the ability to communicate effectively with people.

Reduced personal accomplishment/performance: This tends to manifest when you feel your work is insufficient and you’re incapable of performing your work. For example, you may lose pleasure in work you previously received joy from. Your usual creativity may wane, and it can become harder to concentrate.

Symptoms may also present as physical, emotional or behavioral.

Physical symptoms include:

Feeling tired

Having difficulty sleeping

Experiencing a change in appetite

Dealing with headaches or muscle pain

Emotional symptoms include:

Lacking motivation

Experiencing feelings of self-doubt

Failure or loneliness

An overall feeling of dissatisfaction

Behavioral symptoms include:

Social isolation

Not performing your responsibilities

Work-related anger outbursts

now this is working professional related , same can be applied for students. for students , emotional levels plays an extremely huge role too as until 20years of age , emotions are heightened and developing.

Physical symptoms of burnout

Chronic fatigue: An overwhelming sense of tiredness or energy depletion, even after rest.

Insomnia: Difficulty falling asleep or staying asleep, despite feeling exhausted.

Frequent illnesses: A weakened immune system leading to increased susceptibility to colds, flu, and other infections.

Headaches and muscle pain: Unexplained physical health symptoms, including headaches, backaches, and muscle tension.

Changes in appetite: Significant changes in eating habits, which could include loss of appetite or overeating.

Emotional symptoms of burnout

Increased cynicism: A negative, cynical attitude towards work and the people involved, often extending to other areas of life.

Detachment: A feeling of detachment or alienation from work, colleagues, and even from personal relationships.

Loss of enjoyment: Activities that were once pleasurable no longer bring joy, both at work and in personal life.

Lack of accomplishment: Feelings of ineffectiveness and a lack of achievement or satisfaction in one’s achievements.

Depression: In severe cases, burnout can lead to feelings of hopelessness, sadness, or depression.

Behavioural symptoms of burnout

Withdrawal from responsibilities: Avoiding work tasks, calling in sick frequently, or coming in late and leaving early.

Isolation: Withdrawing from social contacts and activities, leading to reduced social interaction.

Procrastination: An increased tendency to procrastinate, leading to decreased productivity and avoiding work tasks.

Use of coping mechanisms: Increased use of unhealthy coping mechanisms, such as alcohol, drugs, or excessive engagement in television, internet surfing, or other escapist activities.

Irritability: Increased irritability or short temper, especially in situations that wouldn’t normally provoke such a response.

The 12 Stages of Burnout

The term “burnout” was coined in 1974 by American psychologist Herbert Freudenberger, who later worked with psychologist Gail North and developed the 12 stages of burnout in 1992. Their model laid the groundwork for how we assess, address, and understand burnout. It outlines a progression of symptoms that can lead to burnout, particularly in high-stress professions.

Stage 1 – Compulsion to prove oneself

At this initial stage, individuals may attempt to establish themselves by demonstrating their worth and capability, often taking on high workloads to prove their value. This can lead to setting unrealistic goals and overcommitting.

Stage 2 – Working harder

In an effort to meet the high expectations they’ve set for themselves, individuals begin to work harder and increasingly longer hours. They may become obsessed with and only focus on work to the exclusion of other aspects of life.

Stage 3 – Neglecting own needs

As work takes precedence, self-care starts to fall by the wayside. People might skip meals, reduce their sleep, and abandon social and recreational activities, leading to a neglect of physical and emotional needs.

Stage 4 – Displacement of conflicts

At this stage, individuals may start to experience conflict between their personal needs and work demands but may not recognise or confront these issues. Instead, they might dismiss or ignore them, leading to unresolved internal conflicts.

Stage 5 – Revision of values

Values begin to shift, with work becoming the sole or primary focus. Values related to personal life, like family and hobbies, are downgraded or lost. Personal identity increasingly becomes tied to work performance and achievements.

Stage 6 – Denial of emerging problems

Individuals might start to deny that the problems they’re experiencing are significant, often blaming external factors for any stress or difficulties they’re facing. There might be a tendency to become intolerant or dismissive of others.

Stage 7 – Withdrawal

As the strain continues, individuals may withdraw from social contacts and activities, leading to isolation. This can manifest as avoiding social gatherings, relying on substances like alcohol or drugs for relief, or using escapism as a coping mechanism.

Stage 8 – Behavioural change

Changes in behaviour become noticeable to others at this stage. The individual’s behaviour may become odd or uncharacteristic, leading to strained personal and professional relationships.

Stage 9 – Depersonalisation

There’s a loss of connection and detachment from oneself and others. Individuals might start to see themselves and others as objects or functions rather than people, leading to a lack of empathy and diminished personal connections.

Stage 10 – Inner emptiness

Individuals may experience feelings of emptiness or anxiety, which they might try to overcome through heightened activity or, conversely, through escapism activities such as overeating, sex, alcohol, or drugs.

Stage 11 – Depression

This stage is characterised by feelings of hopelessness, exhaustion, and indifference. The individual may feel lost, unsure of their purpose, and uncertain about the future, leading to depressive symptoms.

Stage 12 – Burnout syndrome

The culmination of the preceding stages leads to burnout syndrome, where individuals feel overwhelmed by the demands on them and unable to cope. This can result in a significant mental, physical, and emotional breakdown, requiring professional intervention to recover.

Not everyone will experience all these stages or follow this sequence exactly.

now , we cant just look at the link between each feature to burnout we also need to consider that most features are interdependent on each other and affect each other in a way

so what I'm gonna do is focus on each individual feature and provide all info based on it.

AGE:

link between age and burnout :

refer to : Age and Burnout: The Mediating Role of Emotion-Regulation Strategies

by Bianca Mendes 1,\* andIsabel Miguel 2

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Palabras clave

Emotional labour strategies

Original

DOI: 10.1016/j.rpto.2017.09.001

Open Access

Age, emotion regulation strategies, burnout, and engagement in the service sector: Advantages of older workers

Edad, estrategias de regulación emocional, burnout e implicación laboral en el sector servicios: ventajas en los trabajadores mayores

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Do age and gender contribute to workers’ burnout symptoms? Free

A Marchand , M-E Blanc , N Beauregard

Published: 15 June 2018

1. Age and Burnout: The Mediating Role of Emotion-Regulation Strategies

Authors: Bianca Mendes & Isabel Miguel

Institutions: University of Coimbra & CINTESIS.UPT, Portucalense University, Portugal

DOI: 10.1016/j.rpto.2017.09.001

Overview

This study investigates how age influences burnout through the mediating role of emotion regulation strategies. The focus is placed on emotional labor in service professions, where workers frequently manage their emotional expressions to meet organizational demands.

Key Findings

Emotion-Regulation as a Mediator: The study confirms that age impacts burnout levels indirectly by influencing the emotional regulation strategies workers adopt.

Older Workers: Tend to engage in more adaptive emotion regulation strategies, such as cognitive reappraisal, which helps them reinterpret stress-inducing events more positively.

Younger Workers: Are more likely to use surface acting (displaying emotions not genuinely felt), which is more strongly associated with emotional exhaustion and burnout.

Conclusion

Age is not a direct predictor of burnout, but the way individuals regulate emotions in the workplace significantly affects burnout risk. As such, fostering adaptive emotion-regulation strategies across all age groups could be a powerful intervention.

2. Age, Emotion Regulation Strategies, Burnout, and Engagement in the Service Sector: Advantages of Older Workers

Authors: Sheena J. Johnson, Sabine Machowski, Lynn Holdsworth, Marcel Kern, Dieter Zapf

Institutions: University of Manchester, UK & Goethe-University, Frankfurt, Germany

Overview

This paper extends the understanding of how age relates to burnout and job engagement in the service sector by focusing on the positive role of age and emotion regulation.

Key Findings

Burnout vs. Engagement: Older workers not only experience lower levels of burnout but also report higher work engagement, especially when they employ deep acting (genuinely modifying inner emotional states) instead of surface acting.

Experience & Emotional Intelligence: With age, workers tend to develop emotional intelligence and resilience, helping them manage emotionally demanding interactions better.

Job Autonomy: Older workers often have more job control, which buffers the negative effects of emotional labor.

Conclusion

The study presents a compelling argument for the advantages of older employees in emotional labor-intensive jobs. By relying more on deep acting and drawing on life experience, older workers are better protected against burnout and more engaged in their roles.

3. Do Age and Gender Contribute to Workers’ Burnout Symptoms?

Authors: A. Marchand, M-E Blanc, N. Beauregard

Published In: Occupational Medicine, 2018

Overview

This research explores how age and gender influence the occurrence of burnout symptoms in a wide range of occupational settings, going beyond just emotional labor contexts.

Key Findings

Age: A U-shaped relationship was observed—burnout levels were higher among younger and older workers, with a dip in mid-career employees.

Gender: Women were slightly more likely to report emotional exhaustion, though men reported higher depersonalization. However, these differences were not very large.

Job Characteristics Matter: Regardless of age or gender, high job demands and low social support were strong predictors of burnout.

Conclusion

While age and gender do play a role, workplace conditions (e.g., workload, support) are more impactful in determining burnout. Thus, organizational interventions should target structural improvements rather than demographic-specific strategies alone.

Synthesis Across Studies

Common Threads

Emotion Regulation is Central: All three studies highlight emotion regulation—particularly the difference between surface acting and deep acting—as key to understanding burnout across age groups.

Older Workers Show Resilience: Both the Mendes & Miguel and Johnson et al. studies emphasize that older workers are generally less prone to burnout, often due to more developed emotion regulation strategies and workplace experience.

Contextual Factors Remain Critical: The Marchand et al. study cautions against over-reliance on demographic factors and urges attention to job design, workload, and social support.

Research Gaps & Future Work

Cross-cultural validation is limited; these findings may vary across industries and countries.

More research is needed on training emotion regulation strategies in younger workers.

Gendered differences in emotional labor strategies could be further explored in conjunction with intersectional identities.

Burnout can affect students of all ages, but its manifestation and contributing factors can vary. Younger students may experience burnout due to academic pressures and the transition to new educational settings, while older students might face burnout related to increased academic demands, career planning, or the accumulation of stress over time.

Here's a more detailed look:

Younger Students:

Transition Stress:

Moving from elementary to middle or high school can be a stressful period, leading to burnout.

Increased Academic Pressure:

Demands for higher grades and increased workloads can contribute to burnout.

Focus and Attention Issues:

Students with learning and thinking differences may struggle to focus, requiring extra effort and potentially leading to burnout.

Older Students:

Compounded Stress:

Older students may experience burnout as a result of prolonged stress from academic demands, extracurricular activities, and social pressures.

Career Concerns:

As they approach graduation, older students may feel increased pressure related to career planning and future prospects, contributing to burnout.

Emotional Regulation:

Older students may be better at regulating their emotions through strategies like cognitive reappraisal, but they may also utilize maladaptive strategies like expressive suppression, which could exacerbate burnout.

Specific Burnout Dimensions:

Research suggests that age can be linked to specific burnout dimensions, such as exhaustion, cynicism, and inefficacy.

Overall:

General Trend:

Burnout can increase gradually as students age, but some studies indicate that younger students, particularly those in Generation Z, may also experience high levels of burnout.

Individual Differences:

It's important to remember that age is just one factor influencing burnout. Individual personalities, coping mechanisms, and support systems play a crucial role.

Burnout Prevention and Recovery:

Strategies like managing stress, seeking support, and setting boundaries can help prevent and recover from burnout, regardless of age.

this for students

Abstract

Background: Despite mounting evidence on the association between work stress and burnout, there is limited knowledge about the extent to which workers' age and gender are associated with burnout.

Aims: To evaluate the relationship between age, gender and their interaction with burnout in a sample of Canadian workers.

Methods: Data were collected in 2009-12 from a sample of 2073 Canadian workers from 63 workplaces in the province of Quebec. Data were analysed with multilevel regression models to test for linear and non-linear relationships between age and burnout. Analyses adjusted for marital status, parental status, educational level and number of working hours were conducted on the total sample and stratified by gender.

Results: Data were collected from a sample of 2073 Canadian workers (response rate 73%). Age followed a non-linear relationship with emotional exhaustion and total burnout, while it was linearly related to cynicism and reduced professional efficacy. Burnout level reduced with increasing age in men, but the association was bimodal in women, with women aged between 20-35 and over 55 years showing the highest burnout level.

Conclusions: These results suggest that burnout symptoms varied greatly according to different life stages of working men and women. Younger men, and women aged between 20-35 and 55 years and over are particularly susceptible and should be targeted for programmes to reduce risk of burnout.

Burnout's relationship with age among working professionals (20+) is complex and often non-linear, with different age groups exhibiting varying levels of susceptibility. Younger professionals may face burnout due to work-family conflicts and less experience managing stress, while older professionals might experience burnout due to declining adaptation to stressors or new challenges like eldercare. However, some studies suggest that older workers, especially those over 50, may experience lower levels of burnout due to increased work mastery and better coping mechanisms.

Here's a more detailed breakdown:

Younger Professionals (20-35):

May experience higher burnout due to increased work-family conflicts, juggling career and personal life, and potentially facing more pressure to prove themselves.

Mid-Career Professionals (35-55):

Burnout can be influenced by factors like career stagnation, work-life imbalance, and increased responsibilities both at work and home (e.g., childcare).

Older Professionals (55+):

While some older workers may experience burnout due to decreased adaptability to stressors or new challenges, they may also benefit from increased work mastery, better coping mechanisms, and potentially more supportive work environments.

Non-Linear Relationship:

Burnout isn't a simple, linear progression with age. Some research suggests a U-shaped relationship, with younger and older professionals potentially experiencing higher burnout than those in mid-career.

Gender Differences:

Gender can also play a role, with women potentially facing different stressors and experiencing burnout differently than men.

Key Factors Influencing Burnout by Age:

Work-Family Conflicts:

Younger professionals often struggle to balance work and family life, which can contribute to burnout.

Stress Management:

Older workers may have developed better coping strategies and resilience over time, while younger workers may need to learn how to manage stress effectively.

Work Environment:

The work environment, including workload, support, and work-life balance policies, can significantly impact burnout levels across all age groups.

Personal Factors:

Individual personality traits, coping mechanisms, and personal circumstances also play a role in how individuals experience and manage burnout.

In conclusion, while younger and older professionals may face different challenges related to burnout, it's important to remember that it's not solely age-dependent. A variety of factors, including work environment, personal characteristics, and coping strategies, all contribute to burnout at any age.

Background: Despite mounting evidence on the association between work stress and burnout, there is limited knowledge about the extent to which workers' age and gender are associated with burnout. Aims: To evaluate the relationship between age, gender and their interaction with burnout in a sample of Canadian workers. Methods: Data were collected in 2009-12 from a sample of 2073 Canadian workers from 63 workplaces in the province of Quebec. Data were analysed with multilevel regression models to test for linear and non-linear relationships between age and burnout. Analyses adjusted for marital status, parental status, educational level and number of working hours were conducted on the total sample and stratified by gender. Results: Data were collected from a sample of 2073 Canadian workers (response rate 73%). Age followed a non-linear relationship with emotional exhaustion and total burnout, while it was linearly related to cynicism and reduced professional efficacy. Burnout level reduced with increasing age in men, but the association was bimodal in women, with women aged between 20-35 and over 55 years showing the highest burnout level. Conclusions: These results suggest that burnout symptoms varied greatly according to different life stages of working men and women. Younger men, and women aged between 20-35 and 55 years and over are particularly susceptible and should be targeted for programmes to reduce risk of burnout.

High-pressure jobs, academic  working stress, and the relentless hustle culture are significant contributors to early-onset burnout among young adults.

Is the post-covid world burning you out? Many women today struggle with burnout, juggling work, family, working stress and self-care. Dive deeper and discover solutions to reclaim your thriving, balanced self! This guide explores the challenges women face, from mental health to work-life balance.

The risk of burnout is highest for employees aged between 31 and 40. This is shown by a new study from Germany.

"We need age-appropriate work in order to maintain performance. Mental health is becoming an increasingly important competitive factor, especially in the face of a shortage of skilled workers," says Dr Amelie Wiedemann, Managing Director of DearEmployee. According to this year's edition of the German employee study on mental health in the workplace, "Workplace Insights 2025", the risk of burnout is not an exceptional phenomenon, but systematically peaks in middle working age.

Employees between the ages of 31 and 40 rate their risk of burnout as the highest. The results show which challenges in everyday working life this is linked to - and that everyday working life changes significantly with age. The study is based on data from 79,416 employees from 357 companies and was conducted by the software company DearEmployee.

Maximum exposure in midlife

18 percent of employees aged between 31 and 40 consider themselves to be at risk of burnout - more than any other age group. By comparison, only 6 percent of young professionals under the age of 21 consider themselves at risk. The risk is therefore three times as high among 31 to 40-year-olds. At 13 percent, the figure for 21 to 30-year-olds is already twice as high as for career starters. In the age groups over 41, the risk of burnout decreases slightly and is 16 percent among the over-60s.

Pressures such as time pressure, emotional demands and work interruptions are described as stressful significantly more often by people aged between 21 and 40 than by younger people. What is striking is that, according to the analyses, these three stress factors are not only among the most frequently mentioned, but also among the top 5 with the greatest influence on mental health.

At the same time, important protective factors decline. With increasing age, employees report less appreciation from their employer and experience a declining work-life balance - especially around the fourth decade of life.

Categorisation of the results

Other studies also confirm that the risk of burnout is highest in middle age. In this phase of life, career advancement, family commitments and increasing workloads often come together. The "Workplace Insights Report 2025" now makes it clear that it is not only the phase of life that is decisive, but also how employees at this age experience their working conditions - and these are increasingly viewed more critically between the ages of 21 and 40.

The study shows that preventive health protection must be adapted to life phases and stress profiles. This is an opportunity for companies: by taking age-differentiated measures, they not only strengthen the resilience of their employees, but also their own future viability in the face of a shortage of skilled labour.

Introduction

Feeling like your 20s are hurtling toward your 40s? Exhausted yet expected to excel at everything? Is the post-covid world or working stress leaving you burnt out? Dive deeper into the challenges faced by modern women, from pre-aging anxieties to mental health struggles. We explore why burnout is affecting so many and what you can do to reclaim your thriving, balanced self.

The Juggling act: Balancing expectations and exhaustion

In the whirlwind of modern life, women often find themselves at the intersection of societal expectations and personal ambitions. Juggling the demands of work, family, and self-care can lead to burnout, anxiety, and an overwhelming sense of exhaustion. It’s not uncommon for a woman in her 20s to feel decades older, as she experiences hormonal phases, pre-menopause in her 40s, financial worries, and prejudicial views at work.

But in the middle of all of this  working stress, self-care shows us a way forward. Burnout is an increasingly prevalent issue among young adults, particularly affecting women aged 20 to 34. Reports from the Future Forum reveal that over 40% of , with women and those under 30 being especially vulnerable. This exhaustion manifests in negative attitudes, irritability, and resorting to unhealthy coping mechanisms.

Key findings

Many women struggle to maintain a work-life balance, juggling professions or working stress with parental obligations. This can cause significant anxiety and  working stress (Source: ).

Women often face discrimination and prejudice at work, hindering career growth and well-being. (

The struggle to maintain a , including motherhood, is a common source of  working stress and fatigue.

Modern overcoming working stress for women in the modern workplace

Beyond the immediate pressures of daily life, modern women face unique challenges of working stress that contribute to burnout and a sense of “pre-aging.” Here are some of the key factors:

Age-Related Fatigue: The cumulative stress of balancing numerous tasks can leave women in their 30s and 40s feeling a decade older than their actual age.

Balancing Career and Motherhood: Being a primary caregiver and succeeding professionally can be a heavy burden, leading to constant fatigue.

Lack of Support: Without adequate support at work or home, women struggle to find space for self-care, perpetuating the burnout cycle.

The need for balance: Reclaiming your vitality

Additional tips for self-care

Find Time for Yourself: Even 20 minutes a day dedicated to self-care can make a big difference.

Build Support Systems: Create support networks at work and home to alleviate stress.

Power Naps: A 15-minute power nap can rejuvenate your mind and body.

Positive Affirmations: Take a few minutes daily to affirm your worth and strength.

Hydration: Proper hydration is crucial for skin health and energy levels.

Simple Skincare Routine: Invest a few minutes in a basic skincare routine to feel refreshed.

Prioritize Values: Focus on tasks that align with your values and goals.

Embrace Laughter: Watch a funny clip – .

Learn to Say No: Protect your time and energy by setting boundaries.

The burnout epidemic among young women highlights the need for organizational and societal changes to address their specific challenges. By tackling these issues, we can create fairer and healthier environments where women can flourish, both personally and professionally. Remember, self-love is essential. Taking small yet meaningful steps toward self-care allows you to reclaim your vitality, embrace your unique path, and face life’s obstacles with grace and courage. Let’s break the silence and empower women to prioritize their well-being. It’s time for women to truly thrive in all aspects of their lives.

Whether you’re facing physical or mental health concerns, life hurdles, or simply aiming to enhance your overall well-being, we’re here to provide the support you need. Get in touch with us to explore the possibilities and embark on your journey towards holistic therapy and improved heal

Age, burnout and physical and psychological work ability among nurses Free

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Occupational Medicine, Volume 68, Issue 4, June 2018, Pages 246–254,

Published:

26 March 2018

Abstract

Background

The ageing of the US labour force highlights the need to examine older adults’ physical and psychological ability to work, under varying levels of occupational burnout.

Aims

To examine how age and burnout interact in predicting physical and psychological work ability.

Methods

Using a cohort of actively working nurses, we assessed factors on the Work Ability Index at 12-month follow-up and determined how these were related to age and exhaustion-related burnout at baseline.

Results

The study group consisted of 402 nurses aged 25–67 (mean = 41.7). Results indicated age by burnout interactions in which decrements in physical work ability with greater age were observed at all but the lowest level of burnout (1.5 SD below mean: β = −0.14, 95% CI −0.36, 0.07; 1 SD below: β = −0.23, 95% CI −0.39, −0.06; mean: β = −0.39, 95% CI −0.50, −0.29; 1 SD above: β = −0.56, 95% CI −0.70, −0.42; 1.5 SD above: β = −0.64, 95% CI −0.83, −0.46). In contrast, we observed decrements in psychological work ability with age at higher levels of burnout only (1 SD above: β = −0.20, 95% CI −0.35, −0.05; 1.5 SD above: β = −0.30, 95% CI −0.49, −0.11); at lower levels of burnout, older age was associated with improvements in this (1 SD below: β = 0.19, 95% CI 0.03, 0.35; 1.5 SD below: β = 0.29, 95% CI 0.08, 0.50).

Conclusions

Findings indicated physical and psychological dimensions of work ability that differed by age and occupational burnout. This emphasizes the need for interventions to reduce burnout and to address age-related strengths and vulnerabilities relating to physical and psychological work ability.

, ,

Topic:

Subject

Issue Section:

Refer to : Age, Sex, and Profession Difference Among Health Care Workers With Burnout and Metabolic Syndrome in Taiwan Tertiary Hospital—A Cross-Section Study

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Age as a Risk Factor for Burnout Syndrome in Nursing Professionals: A Meta-Analytic Study

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First published: 16 November 2016

Citations:

Effect of Age on Job Satisfaction and Emotional Exhaustion of Primary School Teachers in Greece

by

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Eur. J. Investig. Health Psychol. Educ. 2020, 10(2), 644-655;

Prevalence of burnout among healthcare professionals: a survey at fort portal regional referral hospital

volume 3, Article number: 16 (2024)

31k Accesses

18 Altmetric

Original Article

Authors

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Abstract

Background: Working life today is characterized by acceleration and intensification due to social, and particularly technological, acceleration affecting the whole of society. These phenomena also affect working life by intensifying job demands, possibly imposing new job stressors on the workforce. At the same time workforce is aging, raising a question how older employees manage to cope with these work life changes.

Methods: This study examined intensified job demands and their effects on occupational well-being from the age perspective utilizing Finnish survey data from upper white-collar workers (N = 2,200). Data was analyzed using multivariate analysis of covariance and hierarchical regression analyses.

Results: The findings show that older employees experienced more work intensification and intensified knowledge- and skill-related learning demands, whereas younger employees experienced more intensified career-related planning and decision-making demands. Intensified job demands were related to occupational well-being (job burnout, work engagement), but were rarely age-specific.

Conclusion: Aging does not necessarily mean higher intensified job demands, yet work intensification and intensified learning demands can be more common among older employees. However, more research is needed concerning the relationships between aging, intensified job demands and occupational well-being as empirical evidence is still scarce.

Keywords:

Year: 2019

Page/Article: 3

Submitted on May 28, 2018

Accepted on Jan 31, 2019

Published on Mar 19, 2019

Peer Reviewed

3,269

Views

381

Downloads

19

Citations

6

Tweets

According to many scholars, current working life is characterized by acceleration and intensification (; ; ; ) due to technological acceleration pervading the whole of society (). The work-related implications of this development include increased work pace and intensified cognitive job demands due to a wider use of digitalization, artificial intelligence and robotization in production and services (; ; ; ). We approach these work-related implications via the concept of intensified job demands (henceforth IJDs), imposing new job stressors on employees (; ). Besides acceleration and intensification, another major challenge in contemporary working life is the rapidly aging workforce (+50 years) in industrialized countries. For instance, in Europe 45.6 percent of the workforce are aging (), and older employees may be more susceptible to job stressors.

In spite of an increasingly aging workforce, we lack research evidence on how older employees appraise IJDs, referring to (1) work intensification, (2) intensified planning and decision-making demands, and (3) intensified learning demands at work (defined below, see also ). This study addresses this unexplored issue by comparing IJDs in employees in different age-groups with a particular focus on older employees (+50 years). As IJDs are stressors with harmful well-being implications (; ; ), we deemed it crucial to examine whether older employees suffer more from IJDs by investigating age as a moderator in the relationships between IJDs and occupational well-being (job burnout, work engagement). Research evidence concerning age differences in the appraisal of job stressors is somewhat scarce, as are studies examining the age-specific outcomes of job stressors (; ; ; ). This shortcoming concerns also IJDs and their outcomes, which we focus on. To fill these gaps our study investigates age-specifically new and recently identified job demands, that is, IJDs and their outcomes. The findings can be utilized in planning and implementing age-tailored job stress interventions focusing on these new job demands.

Defining IJDs and their relation to occupational well-being

According to social acceleration theory (), acceleration is endemic in modern life manifesting across three inter-related processes: technological acceleration, acceleration of social change and accelerated pace of life. Technological development hastens social change, which, in turn, accelerates the pace of life, thereby increasing the need for more effective technological performance (). This self-acceleration circle permeates working life, raising concerns about IJDs (; ). Specifically, IJDs cover five aspects (see more in ): (1) work intensification, (2) intensified job-related planning and decision-making demands, (3) intensified career-related planning and decision-making demands, (4) intensified knowledge-related learning demands, and (5) intensified skill-related learning demands.

Work intensification (WI) implies that the requirements of work, especially quantitative workload, have increased over time. WI includes increased time-related demands during the working day, such as intensified pace of work and multitasking attributable to accelerated technology use at work, e.g., in a form of digitalization (; ). Intensified job-related planning and decision-making demands (JPD) refers to the increased extent to which employees need to autonomously plan and pursue their work goals and daily tasks (; Wood, 2011). Employees may experience this increased autonomy as a requirement to make individual decisions on setting and achieving certain goals and accomplishing their work. Intensified career-related planning and decision-making demands (CPD) entail greater individual responsibility for career development and employability (Pongratz and Voß, 2003). Freedom to make self-directed choices in one’s career may be positive, but simultaneously also pose career management demands on employees compelled to take more personal responsibility in order to maintain competitiveness on the labor market (). In modern society knowledge constitutes an important competitive advantage for organizations, but may also imply a need to continuously update old information and acquire new work-relevant knowledge (e.g. because of rapid technological innovations and changes). Such pressures to adopt the latest professional knowledge fall under intensified knowledge-related learning demands (KLD). Finally, there is not only a need to constantly update one’s work-relevant knowledge, but also one’s skills, such as learning new competencies, enabling effective job performance. Maintaining personal skill level becomes challenging as different skills will be needed and need to match changing work practices. These demands are called intensified skill-related learning demands (SLD) (; ). Here, we apply the multi-dimensional scale developed by Kubicek and co-researchers () to assess these five aspects of IJDs.

IJDs have mostly been conceptualized as job stressors, and as such are expected to be detrimental to employees’ well-being/health (). WI, which has already gained some attention, has been associated in earlier studies with increased psychosomatic complaints and job dissatisfaction (; ). Thus, empirical research supports the role of WI as a job stressor. However, other dimensions of IJDs, namely JPD, CPD, KLD and SLD, have so far been scarcely studied (cf. ). These demands may not only be harmful job stressors (causing negative outcomes), but may also pose positive challenges to employees, such as opportunities to learn new things at work (learning demands, KLD and SLD), to attain greater job-related autonomy (JPD), or to improve career prospects and employability (CPD). If IJDs are experienced as positive challenges, they could also have positive, mostly motivational, implications. In line with this idea, contemporary job stress research has divided job demands into hindrance and challenge demands (; ); the former typically interferes with job tasks and performance, whereas the latter poses some positive challenges for employees, e.g., in terms of improved learning and opportunities for growth. Moreover, hindrance demands are hypothesized to cause negative ‘distress’, with negative outcomes, whereas challenge demands should cause positive ‘eustress’, with positive outcomes ().

Here, we combine these approaches and ascertain whether IJDs are associated with positive well-being outcomes (as challenge demands) in addition to, or in contrast to negative outcomes (as hindrance demands). We also investigate whether the level of IJDs makes a difference by testing the curvilinear effects of IJDs on well-being outcomes. This would mean that the effects of IJDs on well-being are not necessary linear, but differ in low, moderate and high levels of IJDs. In this respect work engagement is particularly interesting as a positive outcome because it describes positive motivational states at work (e.g., vigour, dedication, and absorption) (), which might be improved, if an employee experiences challenging job demands. We also perform age-specific analyses by investigating whether there are differences between older and younger employees in the curvilinear associations between IJDs and well-being.

Theoretical foundations and empirical findings on aging and job stress

There are conflicting theoretical views regarding the linkages between aging, job stressors and strain. Some researchers have proposed that aging employees are likely to experience more job stressors/strain because aging causes inevitable decline in cognitive abilities (e.g., in working memory and information processing pace) and in physical strength (; ; ). Reductions in physical and cognitive functioning, in turn, are expected to have negative implications at work, causing older employees to experience more job stress (e.g., higher job demands) and strain (e.g., more job burnout). However, recent research evidence has partly contradicted this assumption, as older employees have not shown a significant cognitive impairment at work, suggesting that this probably occurs later in life (; ).

Different views have also been presented by developmental psychologists and stress-coping researchers, who have approached stress and coping from a life course perspective. Life management models (; ) and coping theories (; ) propose that individuals’ life management and coping strategies develop over the life course, and become more flexible and mature with aging. Accordingly, research has indicated that the use of primary coping strategies/problem-focused coping (trying to change stressful situations) and secondary coping strategies/emotion-focused coping (trying to influence one’s emotions and mental representations of stressful situations) both improve with age (; ). Emotion regulation and emotion control also improve with chronological aging, providing more resources for an individual’s stress management and adjustment (). Moreover, older employees tend to have more work experience and accumulated job-relevant knowledge (), and these resources may improve their stress resilience at work. Thus, older employees may have a better coping repertoire to manage job stress. However, it should be noted that we have relatively limited understanding and little empirical evidence of how employees of different ages perceive job stressors/demands, concerning also IJDs.

To summarize, there are two conflicting approaches to aging and job stress. On the one hand, aging causes certain cognitive and physical impairments that are hypothesized to render the employee more susceptible to job stressors and less stress-resilient. On the other hand, because of normal human development, including knowledge accumulation and work experience, older employees should be more stress-resilient and better ‘copers’ than younger employees. We now present some research evidence on the age-specificity of job stressors and their negative outcomes for well-being/health/strain.

Some studies on age variation in ‘more traditional’ job demands (age as a predictor) and on the associations between job demands and employees’ well-being/health (age as a moderator) have been conducted. Overall, these previous findings reveal a rather inconsistent picture of age differences. Some studies have suggested that experiencing cognitive job demands or job complexity is not more stressful for older employees (), although some impairment may occur in cognitive capabilities when an employee is aging (; ). Concerning other, more traditional job demands, such as role overload/workload, job insecurity and emotional labor/demands at work, studies have drawn an inconsistent picture regarding the role of age. Ng and Feldman () showed in their meta-analysis that older employees reported less workload (particularly role conflict and role ambiguity) than younger employees. By contrast, a Finnish study suggested that older employees perceived higher role overload (quantitative workload) than younger employees (). However, in this same study, aging was found to be a buffering factor against high workload in relation to job satisfaction. Thus, older employees were less negatively affected by high role overload than were younger employees. Finally, Rauschenbach and Hertel () found no age differences in perceived workload (quantitative job demands) in a German sample, but in their study middle-aged workers reported higher strain and emotional reactivity to workload than did the other age groups.

Some evidence can also be found concerning age in relation to perceived job insecurity. In Finnish samples, Mauno and co-researchers () found that although job insecurity was more common among younger employees, it was more stressful for older employees; when their job insecurity was high their well-being was more negatively affected than among younger employees. Finally, a few studies have tested age-related differences in experiences of emotional labor (social stressor caused by facing emotional load at work) as a job demand. For example, one recent Finnish study showed that even though emotional labor was more common among younger employees, poor recovery from job stress was more detrimental to middle-aged employees than to other age groups if they experienced high emotional labor (). Scheibe and co-researchers (), using a German sample, showed that emotional dissonance and sensitivity requirements at work (two core components of emotional labor) were more stressful for older employees; if older employees experienced these job demands at a high level, their well-being was poorer than that of younger employees in comparable stressful situations.

To conclude, earlier research evidence on age differences in experiencing job demands/stressors (age as a predictor) and on their effects on well-being/health (age as a moderator), is rather scarce and does not provide a coherent picture of age-related relationships. To the best of our knowledge, there are no systematic comparative studies on age differences in IJDs or in their effects on employees’ well-being, the question of which we focus on. Due to the lack of earlier research concerning IJDs and conflicting theoretical views and earlier findings concerning other job demands/stressors, we pose no specific hypotheses on age differences in IJDs or in their relationships to occupational well-being (burnout, engagement); we approach age differences exploratively. However, finding age differences would provide valuable knowledge for job stress prevention and interventions, e.g., if certain IJDs need special attention among certain age groups.

Research questions

We examine four research questions in this study:

Are there age-differences in perceptions of five IJDs (WI, JPD, CPD, KLD, and SLD), and if so, how do employees of different ages perceive them?

Does age moderate the associations between IJDs and occupational well-being (burnout, engagement)? A moderator effect would indicate that the relationship between IJDs and occupational well-being is stronger or weaker at certain ages. Scale-based variation may emerge as IJDs describe different job demands and burnout and engagement are also diverse indicators of occupational well-being.

Are IJDs related to occupational well-being irrespective of age (i.e., direct effects of IJDs on well-being)? Regarding this question, we hypothesize that IJDs, as job stressors, are related to poorer occupational well-being (i.e., higher burnout, lower engagement). Again, there may be some scale-based variation in these direct relationships due to the reason mentioned above.

Are (some) IJDs related to better well-being and are these relationships age-specific? Curvilinear associations in particular would show that some dimensions of IJDs may act as challenge demands, which could relate to positive employee outcomes, especially higher engagement in this present study. Age-specificity would mean that these curvilinear effects show age variation.

Methods

Statistical analyses

We used two statistical approaches to analyze the research questions: multivariate analysis of covariance (MANCOVA) and hierarchical regression analyses. MANCOVA is a suitable method to analyze statistically significant mean differences among groups in the case of several dependent variables and covariates (). MANCOVA was executed to study age differences in the perceptions of IJDs. Five dimensions of IJDs (WI, JPD, CPD, KLD and SLD) were used as dependent variables and five age groups (Group 1 = 18–34, Group 2 = 35–44, Group 3 = 45–54, Group 4 = 55–64, Group 5 = over 65 years old) were used as independent variables (fixed factors) in order to compare their effects on IJDs. We used as many age groups as possible in terms of sample sizes in order to explore age differences comprehensively. If age variation was found to be significant in the multivariate test, paired differences (to examine which age groups differed from each other) were analyzed using the Bonferroni test. In reporting MANCOVAs parameter estimates for covariates and the explanatory rates were also checked and reported.

Second, hierarchical regression analyses were conducted to test whether the five dimensions of IJDs (WI, JPD, CPD, KLD and SLD) explained occupational well-being (burnout, engagement). More importantly, we also investigated whether these relationships were age-specific by analyzing age as a moderator between IJDs and well-being. The moderator effects were examined by computing the following interaction terms for the five dimensions of IJDs and age: WI\*age, JPD\*age, CPD\*age, KLD\*age, SLD\*age. We also examined the curvilinear effects of IJDs on well-being by testing the so-called challenge vs. hindrance hypothesis. These effects were also tested age-specifically to be consistent in the analysis procedure. Specifically, we computed two new interaction terms in which each dimension of IJDs was multiplied by itself, resulting altogether in five multiplied interaction terms: WI\*WI, JPD\*JPD, CPD\*CPD, KLD\*KLD and SLD\*SLD. In addition, these interaction terms were then multiplied by age (i.e. WI\*WI\*age, JPD\*JPD\*age, CPD\*CPD\*age, KLD\*KLD\*age and SLD\*SLD\*age) in order to examine whether curvilinear effects were age-specific. Both these interaction terms were entered into the regression equations in the fifth (two-way interaction terms) and in the sixth step of analysis (three-way interaction terms). Significant interaction effects were plotted into figures if the effects were consistent with the respective correlation coefficients. Two-way interaction effects were plotted into figures by placing standardized values of –1 and +1 standard deviation for both variables in the same figure. Curvilinear effects were plotted into figures by giving multiply standardized values between –2 and +2 standard deviation for the variable in order to visualize the effect.

Specifically, the hierarchical regression analyses included the following six steps: (1) control variables, (2) age (as a standardized continuous variable), (3) IJDs (WI, JPD, CPD, KLD and SLD as standardized continuous variables), (4) IJDs\*age interaction term, (5) IJDs\*IJDs interaction term, and (6) IJDs\*IJDs\*age interaction term. In order to avoid multi-collinearity caused by analyzing the dimensions of IJDs simultaneously in one regression model (as the IJDs showed significant inter-correlations), we estimated separate regression models for each of the five dimensions of IJDs. This approach would better reveal the actual effects of each dimension of IJDs on well-being without any suppression effects due to multi-collinearity.

Data

The data was collected by means of an online survey in 2017. The sample was derived from the membership registers of four Finnish trade unions: The Finnish Union of University Researchers and Teachers, the Finnish Union of University Professors, the Finnish Business School Graduates, and the Academic Engineers and Architects in Finland. Altogether, 2,200 subjects responded to the questionnaire and over half of them (61%; n = 586 professors, n = 773 researchers/teachers) were academics (i.e., professors, researchers, university teachers) typically working in universities or research institutes. The rest of the participants (39%) worked either in technical/architectural occupations (n = 373) or in business (n = 486). Thus, the sample represents upper white-collar occupations. The response rate was 31% among the academics and 19% among the others. In this study we were not interested in differences between occupational groups, and for this reason we recoded a new variable including two occupational categories (1 = academics, 2 = business and technical occupations), which was used in subsequent analyses.

The overall mean age in the sample was 48.7 (SD = 10.57) years. Nearly all participants had either a master’s (48%) or doctoral level (47%) university education. Moreover, almost half of the participants (44%) worked in management/leadership positions. Half of the participants were women (52%) and the vast majority (69%) did not have children under the age of 17. The participants were divided into the following age groups: 18–34 (12%, n = 242), 35–44 (23%, n = 472), 45–54 (32%, n = 648), 55–64 (28%, n = 581), and over 65 (5%, n = 96) years old.

Dependent and independent variables

IJDs were used as dependent variables in MANCOVA (research question 1) and independent variables in the hierarchical regression analyses (research questions 2–4). IJDs were measured using the recently validated Intensification of Job Demands Scale (). In order to capture the increased intensity of IJDs, the respondents are requested to compare the last five years in their work (or less, if a participant had been working less than five years) to their current work. Specifically, the scale is designed to measure five dimensions of IJDs: 1) WI (5 items; e.g., ‘…ever more work has to be completed by fewer and fewer employees’), 2) JPD (5 items; e.g., ‘one increasingly has to check independently whether the work goals have been reached’), 3) CPD (3 items; e.g., ‘one is increasingly required to maintain one’s attractiveness for the job market, e.g., through advanced education, networking’, 4) KLD (3 items, e.g., ‘one has to update one’s knowledge level more frequently’), and 5) SLD (3 items; e.g., ‘one increasingly has to familiarize oneself with new work processes’). The response scale ranges from 1 (not at all) to 5 (completely), higher values indicating more frequent/higher intensified job demands. The respective Cronbach’s alpha coefficients of the five IJD sub-dimensions were 0.88, 0.84, 0.79, 0.87 and 0.89. The experiences of IJDs were relatively common in the whole data: more than half of the respondents reported that IJDs were often increased (WI 58.9%, JPD 54.7%, CPD 52.5%, KLD 58.8%, and SLD 59.7%).

Occupational well-being indicators served as dependent variables in the hierarchical regression analyses. Specifically, well-being was operationalized via job-related burnout and engagement. Burnout was assessed with the nine-item Bergen Burnout Indicator (; see also ), which includes three sub-dimensions of burnout (exhaustion, cynicism and professional efficacy were each measured with three items). All the items were rated on a 6-point Likert-type scale ranging from 1 (completely disagree) to 6 (completely agree). We used a total score of burnout, including all nine items. Cronbach’s alpha for the burnout scale was 0.87. Engagement was measured by the Utrecht Work Environment Scale (UWES)-Short Form (see e.g., ), including three sub-dimensions of engagement (vigour, dedication and absorption were each measured with three items). All items were rated on a 7-point scale ranging from 1 (never) to 7 (every day). A total score of engagement was used, containing all nine items. Cronbach’s alpha for the engagement scale was 0.94.

We used certain control/covariate variables in the statistical analyses. These variables included gender (women/men), parenting status (yes/no), management/leadership position (yes/no), and occupational group (academics vs. technical/business professionals). Only these control variables were identical across the sub-samples and were therefore usable as covariates. The same control variables were included in the MANCOVA and hierarchical regression analyses.

Correlations between the study variables are presented in Appendix 1. Inter-correlations between the dimensions of IJDs show that they are not exceptionally high (r = 0.28–0.81) except for SLD and KLD (r = 0.81), and therefore we treated IJDs as separate sub-scales in the subsequent analyses. The original validation study () has also shown that the dimensions of IJD can be used separately.

Results

Comparing IJDs between different age groups: results of MANCOVA analysis

We examined mean differences in IJDs by age groups via MANCOVA analysis where IJDs (five inter-correlated dimensions) served as dependent variables and five following age groups as independent variables/fixed factors: 18–34 (n = 242), 35–44 (n = 472), 45–54 (n = 648), 55–64 (n = 581), and over 65 (n = 96) years old. Covariates included gender (women/men), parenting status (yes/no), management/leadership position (yes/no), and occupational group (academics vs. technical/business professionals). In reporting the results of these mean comparison analyses, we next concentrate on (1) multi-variate test (for the total model), (2) tests of between-subjects effects (for each dimension of IJDs) and paired comparisons results for the age groups in different dimensions of IJDs (computed via Bonferroni tests). Noteworthy is that tests of between-subjects effects and paired comparisons are interpreted only if the multivariate test is significant as significant multivariate effects form a precondition to interpret other effects. Means and standard deviations of IJDs across the age groups can be found in Table  and will not be repeated in the text, whereas other parameter values (i.e., F-, df-, p-values, ηp2, and β-coefficients for parameter estimates concerning the covariates) are reported below in relation to the multivariate test and for the tests of between-subjects effects.

Table 1

Means and Standard Deviations in Intensified Job Demands across the Age Groups.

A multi-variate test of MANCOVA showed that the age groups differed significantly in their perceptions of IJDs (F (20 000, 5174,885) = 5.58, p < 0.001, ηp2 = 0.018). More detailed between-subjects tests for five dimensions of IJDs (WI, JPD, CPD, KLD, and SLD) showed that the age groups differed on all dimensions of IJDs (parameter values reported in a greater detail below) except JPD (F (4, 1573) = 1.35, p = 0.248, ηp2 = 0.003).

Work Intensification (WI, for means see Table ): Older employees reported higher WI than did younger employees (tests of between-subjects effects F (4, 1573) = 6.26, p < 0.001, ηp2 = 0.016). Paired comparisons (via Bonferroni test, p-values ranged from p < 0.01 to p < 0.001) confirmed that the youngest age group differed from the three older age groups (35–44, 45–54, 55–64 years old) by reporting less WI. In addition, 35–44 year-olds differed significantly from 55–64 year-olds. Concerning covariates, we found that women (F (1) = 37.28, p < 0.001, β = –0.32, p < 0.001 ηp2 = 0.023), supervisors (F (1) = 20.64, p < 0.001, β = –0.24, p < 0.001, ηp2 = 0.013), and academics (F (1) = 36.89, p < 0.001, β = –0.32, p < 0.001, ηp2 = 0.023) reported higher WI than men, non-supervisors or those working in the technical/business field.

Career-related planning and decision-making demands (CPD, for means see Table ) showed a declining trend with aging (tests of between-subjects effects F (4, 1573) = 8.06, p < 0.001, ηp2 = 0.020). Means presented in Table  indicate that these demands were highest among the two youngest age groups (18–34 and 35–44 years) and lowest among the two older age groups (45–54 years, 55–64 years) and showing a further decline in the oldest age group (over 65 years). Paired comparisons also confirmed that 18–34 and 35–44 years old differed significantly from all older age groups by showing higher CPD (via Bonferroni test, p-values ranged from p < 0.01 to p < 0.001). Only the two oldest age groups (55–64 and over 65 years old) did not differ from each other in paired comparisons. Moreover, women (F (1) = 38.32, p < 0.001, β = –0.29, p < 0.001, ηp2 = 0.024) and non-supervisors (F (1) = 12.56, p < 0.001, β = 0.18, p < 0.001, ηp2 = 0.008) reported higher CPD than did men and supervisors.

For knowledge- (KLD) and skill-related (SLD) learning demands an increasing trend with aging was found. Regarding KLD (tests of between-subjects effects F (4, 1573) = 4.50, p < 0.001, ηp2 = 0.011) and SLD (tests of between-subjects effects F (4, 1573) = 6.92, p < 0.001, ηp2 = 0.017) we observed significant age variation. Means for age groups in KLD and SLD are presented in Table . Paired comparisons (via Bonferroni test) concerning KLD showed that the second oldest group (55–64 years) differed significantly (p < 0.001) from the two younger groups (18–34, 35–44 years) by showing higher KLD than the younger age groups. Paired comparisons (via Bonferroni test) for SLD showed also various significant paired differences across the age groups: 18–34 year-olds reported less SLD than 45–54, 55–64 and over 65 year-olds (p-values ranged from <0.05 to <0.001). Furthermore, 45–54 year-olds reported more SLD than 35-44 year-olds (p < 0.05) and 55–64 year-olds more than 35–44 year-olds (p < 0.001). Furthermore, parameter estimates for covariates indicated that women experienced higher KLD (F (1) = 35.97, p < 0.001, β = –0.28, p < 0.001, ηp2 = 0.022) and SLD (F (1) = 38.17, p < 0.001, β = –0.29, p < 0.001, ηp2 = 0.024) than men. Moreover, non-supervisors perceived higher SLD than did supervisors (F (1) = 16.26, p < 0.001, β = 0.18, p < 0.001; ηp2 = 0.010).

In job-related planning and decision-making demands (JPD), even though the perceptions of JPD did not vary significantly by age group (tests of between-subject effects, p = 0.248), two covariates were significant: gender (F (1) = 21.89, p < 0.001, β = –0.21, p < 0.001, ηp2 = 0.014) and occupational group (F (1) = 8.37, p < 0.01, β = 0.14, p < 0.01, ηp2 = 0.005): women and those working in technical/business occupations experienced higher JPD than men and those working as academics.

To summarize, we found significant differences in the perceptions of IJDs by age groups. Specifically, older employees reported higher work intensification (e.g., intensified working pace, multitasking) and higher learning demands at work (KLD, SLD). In contrast, younger employees reported higher intensified pressures to manage and plan their career-related tasks and actions (CPD) more often than older employees. Age group explained 0–2% of the variance of IJDs depending on the dimension of IJDs (1.6% for WI, not significant for JPD, 0.2% for CPD, 1.1% for KLD, and 1.7% for SLD. Although the predictive power of age group was not very strong, it was significant (except JPD).

Predicting burnout and engagement: results of the regression analyses

The results of the regression analyses are presented in Table . We first report the direct effects of IJDs on well-being as they were estimated before the moderator effects. As can be seen from regression coefficients (β) and explanation rates (ΔR2), all five dimensions of IJDs were related to higher burnout, and WI had the greatest amount of explained variance regarding burnout (12%). However, IJDs explained engagement less decisively: WI and CPD did not significantly predict engagement and JPD, KLD and SLD explained only 1–2% of the variation of engagement. Furthermore, JPD, KLD and SLD were related to higher (not lower) engagement, but these same job demands showed a positive relationship with (higher) burnout, thus suggesting that they may be simultaneously hindrance and challenge demands.

Table 2

Predicting Burnout and Engagement by Age, IJDs (WI, JPD, CPD, KLD, and SLD), IJDs\*Age, and IJDs\*IJDs Interaction Terms.

Note: \*\*\* p < 0.001; \*\* p < 0.01; \* p < 0.05.

1 Control variables (gender, parenting status, management/leadership position, and occupational group) entered at Step 1 not shown for clarity. β-coefficients derived from the final (5th) step after entering all variables. Only those regression coefficients which are consistent with the correlation’s coefficients are underlined and reported.

2 This interaction effect is artificial and unreliable as the correlation coefficient points in a different direction, the result is not reported.

Abbreviations: WI = work intensification, JPD = intensified job-related planning and decision-making demands, CPD = intensified career-related planning and decision-making demands, KLD = knowledge-related learning demands, SLD = skill-related learning demands.

Age predicted neither burnout nor engagement directly. However, we found two significant interaction effects concerning age as a moderator. These moderator effects were consistent with the correlation coefficients and therefore reliable. Age moderated (a) the association between JPD and burnout (interaction effect β = –0.06, p < 0.01), and between (b) CPD and burnout (interaction effect β = –0.05, p < 0.01). Graphical illustrations of these interaction effects are presented in Figure  (JPD) and Figure  (CPD). Figure  shows that JPD was more strongly related to higher job burnout among younger than among older employees and younger participants also reported a sharper increase in burnout if the level of JPD was high (compared to low a level of JPD). CPD (Figure ) was also more stressful for younger employees as they reported a more marked increase in burnout if the level of CPD was high (compared to a low level of CPD). It is noteworthy that younger and older respondents differed more in a low demand situation, i.e., when CPD was low, regarding burnout.

Figure 1

An interaction effect of JPD and age (JPD\*age) on burnout.

Figure 2

An interaction effect of CPD and age (CPD\*age) on burnout.

Three-way interaction effects (IJD\*IJD\*age computed individually for each of the five IJDs) were all non-significant, signifying that curvilinear effects were not age-specific, and therefore we excluded these three-way interaction terms from the final regression models. However, analyses of two-way curvilinear effects indicated that KLD (KLD\*KLD) and SLD (SLD\*SLD) showed curvilinear interaction effects in relation to burnout and engagement. However, a detailed inspection of these interaction effects revealed that only three of them resulted in a significant change in explanatory rate (see columns for ΔR2), and are therefore reported in more detail. A graphical inspection of the interaction effect of SLD\*SLD on burnout showed that burnout increased linearly with increased SLD, and no clear curvilinear effect was observable (figures available from the first author upon request). However, two other interaction effects, i.e., KLD\*KLD and SLD\*SLD, on engagement showed a clear reversed curvilinear pattern. Furthermore, the curvilinear pattern was most visible in the SLD\*SLD effect and is graphically shown in Figure  (the interaction effect of KLD\*KLD on engagement is available from the first author upon request). Employees experiencing very high SLD reported lower engagement, whereas employees reporting moderately high SLD reported the highest level of engagement. Moreover, a low level of SLD was also associated with lower engagement.

Figure 3

A curvilinear interaction effect of SLD (SLD\*SLD) on engagement.

Discussion

The aim of this study was to examine age differences in intensified job demands (IJDs) and in their relationships with occupational well-being (burnout, engagement). We also analyzed direct (non-age-specific) relationships between IJDs and well-being. This study has two major strengths. First, we focused on new and so far understudied job demands arising from contemporary social and technological acceleration (; ; ; ), that is, IJDs. Second, we paid particular attention to age differences, which is important as there is no empirical evidence on age differences in experiences of IJDs or in their relationships to well-being. In studying age differences, we were particularly interested in the experiences of older employees as workforce aging is a major challenge in Europe (). Moreover, age differences, if emerging, would also provide a basis for tailored job stress interventions planned for and targeted at different age groups.

Age-specific findings

The results showed various age differences in perceived IJDs and some of these differences favored older, and some younger employees. Such mixed findings are nevertheless consistent with those of earlier studies on age differences in job stress research (e.g., ; ; , ; ). Specifically, we found that work intensification, intensified skill- and knowledge-related learning demands were reported more often by older employees, particularly those aged between 55–64 years. However, intensified career-related planning and decision-making demands were more prevalent among younger employees (aged between 18–44 years). Interestingly, we found no age differences in intensified job-related planning and decision-making demands.

There are two explanations for the finding, which indicated that the older employees report more certain IJDs. First, older employees may experience more work intensification and intensified learning demands at work because aging implies certain losses in cognitive (e.g., in working memory) or in physical capacity factors of which may affect work ability (; ; ). However, it should be taken into account that we did not measure employees’ physical or cognitive functioning and therefore this interpretation remains speculative. Future studies should focus on such explanatory mechanisms between aging and IJDs.

Second, cohort effect may also explain these findings: older generations may have been used to a slower working pace and performing one task at time rather than multi-tasking. Overall, the pace of work was slower a few decades ago (e.g., ; ). In addition, older employees may be more used to a ‘stable working life’, where learning requirements have not been so intense, and not required continuous updating. It should also be recalled that older employees typically have different developmental goals and tasks as well as different coping skills compared to younger employees and that such factors may function as mechanisms explaining the age differences found here (see e.g., ; Baltes and Baltes, 2010; ; ). Also, these explanatory mechanisms deserve more attention in future studies as we did not assess them in our survey.

Finally, one interesting finding was that the oldest age group (65+ years) in some cases reported less IJDs than younger age groups. Health selection may explain this finding: these oldest employees might be healthier and more motivated as they have continued working despite of retirement age. In contrast, those oldest employees who have some health issues or/and lower work motivation are no longer in working life but probably retired. As our study was not longitudinal, we were not able to test this health selection hypothesis.

Concerning implications, we propose that employers should be aware that older employees may encounter difficulties if the pace of work, multi-tasking and learning demands they face in their daily work are too intense. This would need particular attention today, when the workforce is aging and many organizations employ older employees. Furthermore, our findings point to the conclusion that employees aged between 55 and 65 years would need particular attention in ongoing technological revolution, causing an intensification of work, concerning also IJDs (; ; ; ).

However, it should be recognized that some effects disfavored younger, not older, employees. Namely, we found that younger employees reported more intensified career-related planning and decision-making demands than older employees, a finding which suggests that employers should pay attention to younger employees’ career management and development issues. This could be of particular relevance in today’s working life, which is characterized by instability and job insecurity, which are detrimental to all employees () but could be even more problematic for younger employees who are establishing their careers. A related aspect might be to consider younger employees’ work-family balance as many of them also have family obligations likely to cause extra stress if accompanied by intensified career-management requirements. One way to help younger employees would be to provide family-friendly organizational arrangements, which may reduce their stress levels and allow more resources for advancing their careers ().

Even though we found various age differences in the prevalence of IJDs, as described above, the relationships between IJDs and well-being (burnout, engagement) were seldom age-specific. Furthermore, certain IJDs (planning and decision-making demands) were not experienced as more stressful among the aging employees, but among the younger ones. Specifically, age moderated the relationship between job- (JPD) and career-related (CPD) planning and decision-making demands and burnout. We found that younger employees reported more burnout than did older employees, if they perceived a high level of planning and decision-making demands in relation to job or career. Thus, younger employees seem to be more vulnerable to burnout if they experience high pressures to plan and perform in their work too independently (JPD component) or to plan and advance their careers very intensively (CPD component). Such pressures could be alleviated if employers were willing to pay more attention to younger employees’ overall life situations, also considering their family obligations (see discussion above). Moreover, younger employees could benefit, for example, from mentoring or supervised practice, which might reduce the stressfulness of job- and career-related planning and the decision-making demands they experience. Competence-related support (e.g., giving professional advice, sharing expertise) from more senior employees would be helpful for younger employees. This could be extremely relevant, particularly in mentally demanding white-collar occupations, which were our focus.

Non-age-specific findings

We also examined non-age-specific relationships between IJDs and well-being and found that not all tested relationships were age-specific but that many of them were robust across the sample. First, we found that all IJDs were related to higher burnout regardless of employees’ age. Thus IJDs are clearly job stressors, or hindrance demands (; ), as they associated with poorer occupational well-being. Similar results have been reported also previously (e.g., ; ; ; ). Of the IJD dimensions, work intensification had the strongest relationship with burnout. This finding has clear implications; if employers would like to reduce the risk of personnel burnout, particularly work intensification, i.e., excessive pace of work, multi-tasking requirements, and inability to take breaks at work, needs to be reduced. Job resources, e.g., job control and social support, could be useful resources against work intensification (). Moreover, when aiming continuously at more effective and productive organizations, it should be recalled that employees’ perceptions of work intensification tend to have negative implications for their well-being.

Second, we found that IJDs showed weaker relationships with engagement than with burnout across the entire sample. Only three IJD dimensions (i.e., job-related planning and decision-making, and skill- and knowledge-related learning demands) were associated with engagement but with a relatively low explanatory power (1–2%). More importantly, these relationships were all positive, implying that the more employees experienced these job demands, the more they experienced engagement at work. Furthermore, both knowledge- and skill-related learning demands showed a curvilinear effect: both low and high levels of learning demands were associated with lower engagement, whereas moderately high level was associated with higher engagement. Thus certain dimensions of IJDs, that is, learning demands at work, can be described as both negative hindrance demands (causing poorer well-being) and as positive challenge demands (causing improved motivation/growth at work) (; ). However, it is good to recall that when work-related learning demands become too high, the effects will be negative, also for engagement. Thus, the level of learning demands is a crucial factor determining their consequences particularly in relation to work motivation (e.g., engagement).

Concerning implications, a challenge for organizations and employers would be to identify the optimal level of learning demands, because not experiencing them at all could be detrimental to personnel work motivation (here engagement), while an excess has negative implications for motivation. The optimal level of an employee’s IJDs could be negotiated between the employee and the supervisor, and these demand levels should also be (re-)evaluated on a regular basis. However, it must be born in mind that in spite of personal variation in employees’ preferences for seeking challenging job demands, it is likely that very low or very high levels could cause negative motivational side effects for all employees. Lifelong learning is nowadays presented as one weapon against dramatic changes inevitably occurring in future working life with the advance in technological acceleration. Lifelong learning will be needed to lengthen careers and cope with working life changes but simultaneously it should be realized that excessive learning demands are harmful for employees’ motivation, a result of which we also found in this study.

Limitations and future directions

Even though this was a pioneer study focusing on age-differences in IJDs and their age-specific relationships with occupational well-being, the study also has few noteworthy limitations.

First, the design was cross-sectional, and we were not able to test cause-effect relationships reliably. However, on the basis of stress theories (e.g., ; ), we expected that IJDs would function as stressors leading to stress reactions (more burnout, less engagement) but future longitudinal studies should confirm this expectation.

Second, all data were collected via self-reports, which is sensitive to common method variance bias. Thus, concerning IJDs, for example, we measured employees’ appraisal of such demands and not objective job demands/environment. However, psychological stress research often emphasizes individuals’ appraisals of their environments (e.g., ) and we followed this tradition.

Third, time-frame in assessing IJDs is not without problems. We requested our participants to use five years in comparing their present and past work experiences but some other time-lag (e.g., shorter) could be more appropriate. A five-year time-frame was used in the original IJDs scale () and we relied on that. On the one hand, so long time-frame may cause retrospective bias particularly in self-reports which we used. On the other hand, longer time-frame is sensible considering the processes of social and technological accelerations which occur more slowly in society and are stated to form the ground for IJDs (see e.g., ; ; ; ).

Fourth, some relationships were relatively weak or even non-significant, e.g., relationships with IJDs and engagement as well as the interaction effects. It has to be acknowledged that the effects found may also be sample-specific; we sampled upper white-collar workers and more research evidence on this topic is needed in blue-collar samples. Some effects may be stronger in different samples than those found here.

Fifth, the response rate in the online survey was low but this is also a more general challenge in contemporary survey research. Luckily, our sample size was large enough to enable age-specific analyses and reasonably good statistical power.

Sixth, even though some relationships were age-specific, we did not examine mechanisms likely to explain or mediate the associations studied. For example, employees at different ages typically face different developmental tasks, life situations, and may also have different coping skills (see e.g., ; ; ; ). Consequently, future studies could focus more on explanatory mechanisms between age(ing), IJDs and occupational well-being.

Additional File

The additional file for this article can be found as follows:

Correlations (Pearson) between study variables. DOI:

Competing Interests

The authors have no competing interests to declare.

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E-ISSN: 2002-2867

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Article

Published: 06 May 2024

Prevalence of burnout among healthcare professionals: a survey at fort portal regional referral hospital

volume 3, Article number: 16 (2024)

31k Accesses

18 Altmetric

Abstract

The work environment in most hospitals is characterised by activities that are strenuous both physically and mentally. These can result in physical and mental exhaustion, which can lead to burnout if not adequately addressed. Burnout among healthcare professionals can negatively affect their clinical decision-making, quality of communication with patients and colleagues as well as their ability to cope with work-related pressure, and ultimately affect the quality of care and patient outcomes. The inclusion of burnout in the 11th revision of the International Classification of Diseases (ICD-11) as an occupational phenomenon indicates that it is an issue of concern in the workplace for which people may need professional attention. This descriptive cross-sectional survey aimed to determine the point prevalence of burnout among healthcare professionals at Fort Portal Regional Referral Hospital and the factors contributing to burnout. The study also evaluated the linear relationship between the age of workers, their work duration at the hospital, and their burnout score, in addition to the possible impact on patient care. Participants were selected from the hospital WhatsApp group and invitations to participate were sent to their individual accounts. Burnout was assessed using the Copenhagen Burnout Inventory. Generally, burnout scores ranged from 16% to 86%, with an overall mean burnout score of 57.4%. The notable factors contributing to burnout included imbalances in duty allocation, physically strenuous work, and resource constraints. Burnout of varying levels was found to be prevalent across all carders in the hospital, although the results indicate that most healthcare professionals experience moderate burnout. Most of the factors contributing to burnout are within the scope of hospital leadership to address. The possible impact on staff performance and patients’ clinical outcomes is speculative, and additional studies are required.

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Introduction

The healthcare work environment is characterised by strenuous activities which can predispose healthcare professionals to burnout, and negatively affect their work performance. This is made worse by a heavy workload which is a major problem for many healthcare systems with significant adverse effects on efficiency and patient safety.

In most developing countries, the work environment in healthcare facilities is characterized by understaffing, excessive workload, and highly demanding tasks which undermines access to and provision of quality health services. In Africa, for example, the ratio of 1.55 health workers (physicians, nurses and midwives) per 1000 people is below the WHO threshold density of 4.45 health workers per 1000 people needed to deliver essential health services,. While most developed countries have better health worker-to-patient ratios, understaffing is still a challenge. In Europe For example, the shortfall of health workers was estimated at 1.6 million in 2013 and is predicted to grow to 4.1 million by 2030.

These staffing shortfalls expose health professionals to overwhelming workloads which increase the risks of stress, illness, and absenteeism. The resulting physical and mental exhaustion can affect the worker’s clinical decision-making, quality of communication with patients and colleagues as well as the ability to cope with work-related pressure. While burnout among health professionals and its impact on healthcare systems has been studied historically, it is not extensively documented in the African context where work in healthcare settings is often characterized by understaffing, resource limitations and excessive workload, which are known risk factors for work-related stress.

In the context of healthcare, studies on burnout emerged in the late 1960s to describe the emotional and psychological stress experienced by clinic staff caring for structurally vulnerable patients in free clinics. Over time the scope of burnout has evolved to include job-related stress in any health practice environment. However, variations in definition and assessment methods make it difficult to standardize assessment within the hospital environment.

A systematic review of the prevalence of burnout among physicians found substantial variability in prevalence estimates of burnout among practising physicians and marked variation in burnout definitions, and assessment methods. Another systematic review identified 88 unique definitions of burnout. The marked variation in burnout definitions, assessment methods, and study quality highlights the need for developing a consensus definition of burnout and standardizing measurement tools to assess the effects of chronic occupational stress on healthcare professionals.

Attempts to expound the definition of burnout have broken it down into three components; personal burnout, work-related burnout, and client-related burnout.

According to Kristensen et al., each component is explained as follows:

1.

“Personal burnout is the degree of physical and psychological fatigue and exhaustion experienced by the person”.

2.

“Work-related burnout is “The degree of physical and psychological fatigue and exhaustion that is perceived by the person as related to his or her work”.

3.

“Client-related burnout is the degree of physical and psychological fatigue and exhaustion that is perceived by the person as related to his or her work with clients”.

These components enable the assessment of burnout from different perspectives and can be used to shed light on the possible factors contributing to overall burnout. They enable attribution of an individual’s symptoms to their work, and the extent to which they see a connection between their fatigue and their work, regardless of their age, gender, or professional status, all of which can influence their perception of exhaustion.

Recent attempts at harmonizing the definition of burnout have resulted in a simplified version which is believed to respond to the fundamentals of definition formation. The definition is as follows: “In a worker, occupational burnout or occupational physical AND emotional exhaustion state is an exhaustion due to prolonged exposure to work-related problems”

Furthermore, the WHO describes burnout as a syndrome characterized by three dimensions: feelings of energy depletion or exhaustion, increased mental distance from one’s job, feelings of negativism related to one’s job, and reduced professional efficiency resulting from chronic workplace stress that has not been successfully managed,. Although not classified as a mental disorder, burnout is still regarded as one of the reasons for which people may seek health services and is included in the 11th revision of the international classification of diseases (ICD-11) as an occupational phenomenon,. Its inclusion in the ICD-11 is an acknowledgement that burnout is an occurrence of concern at the workplace.

The lack of standard tools for assessing and documenting burnout means that many organizations including hospitals which are expected to be the custodians of health promotion do not assess burnout among their staff. It, therefore, remains undocumented, and its burden on the staff and the overall impact on service delivery remain a subject of speculation. Standardization of the definition and assessment methods of burnout is necessary if the assessment of burnout among healthcare professionals is to be integrated into the healthcare work environment to support health professionals.

With the evolution of the general view of burnout, several studies have been conducted among health professionals. Burnout syndrome has been reported among health professionals across all stages of their careers, with symptoms of emotional exhaustion and depersonalization considerably prevalent particularly among nursing staff. One study among primary healthcare professionals found a high risk for burnout syndrome in 10.6% of the participants. The study also found a 29.8% prevalence estimate of high-level symptoms of emotional exhaustion, and 22.3% of depersonalization. The symptoms of burnout observed among healthcare professionals include emotional exhaustion, the dehumanization of interpersonal relationships, and loss of motivation or loss of self-fulfilment. Dehumanization refers to the loss of one’s sense of what it means to be human and may be characterised by lacking emotions, warmth, and flexibility as well as treating patients and colleagues as immature, unintelligent, uncivilized, or irrational,. Other common symptoms include chronic exhaustion, reduced performance, and alienation from work activities.

Among health professionals symptoms of burnout result from regular exposure to emotionally draining situations such as caring for patients with distressing symptoms, fatalities, as well as resource constraints that make certain patient treatments inaccessible. Working in such a stressful environment for long periods with little time for recovery impacts the mental health of healthcare professionals and is a risk factor for burnout.

Studies show that exposure to emotionally draining situations like caring for a high proportion of elderly patients and exposure to high fatality rates in inpatient units is associated with high levels of stress and emotional exhaustion among nurses,.

A recent study among nurses and student nurses at FPRRH examined the relationship between direct exposure to potentially traumatic events and symptoms of burnout. The results indicated that exhaustion symptoms of burnout are associated with secondary traumatic stress. Although this study did not estimate the extent of emotional exhaustion and burnout among the staff at the hospital, it highlighted its presence among the nurses at FPRRH and informed the need for further research.

Work-related stress is particularly prevalent among medical trainees. In a study evaluating moral distress and burnout in internal medicine residents, 21% reported experiencing a high level of burnout. Female residents in particular reported experiencing high levels of emotional exhaustion. Burnout rates for medical residents ranged from 27% to 75% across various medical subspecialties, with the highest reported levels among obstetrics-gynecology trainees and the lowest levels among family medicine trainees.

However, health professionals at various career stages also experience considerable levels of burnout. One study suggests that emergency physicians experience the highest levels of burnout with 57% of emergency physicians experiencing burnout. In a systematic review of burnout among physicians, the prevalence estimates of overall burnout ranged from 0% to 80.5%. These estimates were reported by 67.0% (122/182) of the studies. The prevalence estimates of emotional exhaustion ranged from 0% to 86.2% for Maslach Burnout Inventory (MBI)-derived emotional exhaustion. These were reported by 72.0% (131/182) of the studies included in the review. In addition, the review found that the prevalence estimates of a diminished sense of personal accomplishment ranged from 0% to 87.1%, as reported by 63.2% (115/182) of the studies.

Burnout among the staff at FPRRH has previously been highlighted by a report of the auditor general on the financial statements of FRRH for the year ended 30th June 2016. The report acknowledged understaffing at the hospital and indicated that burnout of health workers was a possible consequence. The report, which indicated a staffing rate of 76%, suggests that understaffing potentially overstretches the available staff beyond their capacity and negatively affects the quality of service delivery to the patients.

Unfortunately, hospitals often lack adequate avenues for health professionals to report and address work-related stress and to manage the consequent burnout which results in increased staff turnover. The individual healthcare worker often has the responsibility to recognize and manage their own stress and symptoms of burnout, with few avenues or tools institutionally available to assist them. Mental health conversations in hospital work environments are also usually informal, yet if encouraged at an institutional level, and not stigmatised could help in minimizing burnout among healthcare professionals,. Additionally, healthcare workers have poor healthcare-seeking behaviour, particularly mental health support. A study to investigate the prevalence of mental help-seeking among public health workers, during covid 19 outbreak found that only 12.7% reported professional mental health-seeking. Therefore, burnout among health workers is often undocumented and underreported.

Several factors have previously been identified as contributing to or worsening physical and mental exhaustion among health professionals, thereby leading to burnout.

A systematic review of burnout about specific contributing factors among nurses identified several factors and confirmed the relationship between work-related stress and burnout. Work environment-related stressors such as poor peer relationships, poor nurse-patient relationships, lack of professional recognition or reward feedback clarity, and supervisor leadership style were related to one or more burnout dimensions. The study also found that work content-related stressors such as nursing role, patient care, job demands, job complexity, work overload, and working overtime were also related to burnout. Additionally, nurses who reported inadequate communication with doctors about patients, as well as fear of not completing tasks, also reported high burnout.

Other studies also suggest that burnout (including all three dimensions) may be associated with time of work shift although there is no consensus on whether day or night duties are more stressful for health professionals. Some studies indicate that burnout is most frequently associated with recurrent night duty among nurses, while others suggest that burnout is significantly higher among those working the day shift,.

Age and career demands have also been reported as potential contributing factors. One study found the distribution of burnout among community psychiatric nurses displayed two slow peaks: one for the 30 s age group; and the other for the 50 s age group. Differences in burnout prevalence between psychiatric and control groups were most noticeable for nurses in the 30 s age group. Nurses in this age bracket often have high expectations and heavy work demands heaped on them by both superiors and subordinates. These levels of expectation and work demands may prove excessive, causing extreme mental and physical exhaustion. The burnout peak in the 50 s age group may be associated with reduced physiological functioning and the associated increasing development of illness.

Another study points to prolonged stay in the same job as another possible contributing factor. Staying too long in the same job without career progression can lead to long-term exposure to stressors. However, some health professionals believe that some level of work-related stress is unavoidable and acceptable. The study found that most participants agreed that some degree and type of stress was acceptable and unavoidable in healthcare. Working night shifts and on public holidays, treating patients who are in pain, and sharing distressing moments with patients and caregivers were some of the acceptable stressors.

The causes of burnout are complex, multifactorial and may be interconnected. For example, it is difficult to separate general life stressors and job-related stressors as these are often overlapping and interconnected. The imbalance between the demands of the job, income, and family demands can be both personal life and job-related stressors. Additionally, the interpersonal relationship with patients and co-workers, including superiors, could either be a stressor or a protector. A positive and harmonious work relationship with co-workers can help handle stressors, while a negative relationship can exacerbate work-related stress,.

Burnout significantly affects the well-being of workers and their productivity. This effect can be transferred to clients directly or indirectly. While burnout has been well-studied among healthcare professionals, few studies have focused on its impact on the patients they serve.

It is suggested that overwhelming exhaustion can create feelings of cynicism, detachment from the job, and a sense of ineffectiveness among health workers. A study on the impact of burnout on self-reported patient care among emergency physicians indicated that emergency physicians with high levels of burnout were more likely to report performing suboptimal care practices such as admitting or discharging patients early, not answering patients’ questions, not treating patients pain, ordering more tests, not communicating important handoffs, and not discussing plans with other colleagues. A qualitative study among practising general practitioners (GPs) indicated that the GPs believed that poor well-being and burnout affect the quality of care patients receive by reducing doctors’ abilities to empathize, reducing the ability to display positive attitudes and listening skills, and increasing the number of inappropriate referrals. Another study also concluded that poor relations with patients, difficulty meeting patients’ needs, and high workload are all associated with burnout. This is in line with the findings of a study among nurses which indicated that all burnout dimensions of the Copenhagen Burnout Inventory (CBI) were related to the outcome of patient safety grade and that healthcare organizations could reduce negative patient safety ratings by reducing nurse burnout. The findings of these studies imply that in the hands of burnt-out health professionals the patient’s safety is considerably compromised, yet the patient is powerless about it.

In the presence of a high workload in a stressful environment, health professionals may struggle to maintain composure, which can affect their ability to listen to patients’ concerns and address them with empathy. This directly affects patient care and clinical outcomes. It can also affect their ability to communicate with kindness to colleagues and patients. The result is a toxic work environment with low staff morale and broken channels of communication between staff and patients, which can worsen stress and lead to poor patient outcomes and patient satisfaction.

Additionally, poor health and moderate to high levels of burnout among health professionals can result in increased medical errors and poorer patient safety. A survey among medical residents in Ireland showed levels of burnout correlated with an increase in medical errors. Sixty-four percent (64%) of the residents who experienced symptoms of burnout also reported making a medical error compared with 22% of those who did not experience symptoms. Therefore, studies to evaluate the impact of health worker burnout on patient care are necessary.

The goal of the study was to determine the point prevalence of burnout among a sample population of health professionals at FPRRH. The study sought to estimate the extent of burnout among the health professionals at FPRRH, to identify workplace factors contributing to burnout at FPRRH and to examine the impact of burnout among health professionals on patient care.

The study examined the phenomenon of burnout in the healthcare work environment in the African setting and its impact on patient care and service delivery. It was expected to highlight the magnitude of the problem and present a basis for additional research into work-related stress among healthcare professionals. The results were expected to inform policy and hospital managers regarding implementing measures to address workplace stress. It was also expected to highlight the growing need for healthcare professionals to actively seek mental health support and improve staff welfare.

Methods

Study design and setting

The study was a descriptive cross-sectional survey to determine the point prevalence of burnout among healthcare professionals at Fort Portal Regional Referral Hospital (FPRRH) which serves the Rwenzori region of western Uganda. The region has a population of 2,868,000 people as of 2019. The population is expected to grow at a rate of 3% per year with a projected population of 3,355,437 by 2024. The region is comprised of 8 districts namely, Kabarole, Kamwenge, Kasese, Ntoroko, Bundibugyo, Bunyangabu, Kyenjojo, and Kyegegwa districts as well as a regional city called Fort Portal Tourism City. The hospital was projected to have 34,000 admissions and 120,000 outpatients in 2021/2022 with a bed occupancy rate of 85%. The hospital had an approved staff structure of 428 positions in 2016 although only 324 positions were filled, leaving 104 positions vacant. The auditor general’s report details the staff as follows; 17 doctors (5%), 130 nurses (40%) and 62 allied health professionals (19%). This staffing structure had not changed significantly by 2022, although a new structure was in the plan for all regional referral hospitals.

Study population

The study was conducted among health workers of different carders broadly categorized into the following groups: Doctors, Nurses, and Allied Health Professionals. All health professionals working as full-time employees at FPRRH were eligible for inclusion in the study. Employees with a total work duration of less than one year (recently recruited) were excluded.

The sample size was determined using the Krejcie and Morgan table. Population size (N) = 324. Sample size (S) = 175. A proportionate non-random sample of participants was computed for each group using the formula:

$${Sample}\,{size}\,{of}\,{each}\,{layer}\,({\rm{s}})\,{\boldsymbol{=}}\,({size}\,{of}\,{layer}{\boldsymbol{/}}{size}\,{of}\,{population}){\bf{X}}({size}\,{of}\,{the}\,{whole}\,{sample}).$$

Therefore, the number of participants from each group was determined as follows: Doctors = (17/324) X175 = 9, Nurses = (130/324) X175 = 70, and Allied health professionals (62/324) X175 = 33.

Study outcomes

The primary outcome was the prevalence of burnout among the health professionals at FPRRH. The secondary outcomes were factors contributing to burnout, impact on patient care, and a correlation between the age of the health workers, duration of work at FPRRH and burnout burden. The extent of burnout was measured using the Copenhagen burnout inventory (CBI). Data from client-related burnout was used to assess the impact of burnout on patient care.

Data collection instruments

Data was collected using self-administered digital questionnaires prepared using Google Forms. The questionnaire incorporated questions from the Copenhagen Burnout Inventory (CBI) and followed the format of the CBI inventory. The CBI is a questionnaire with three sub-dimensions: Personal burnout, work-related burnout, and client-related burnout. This enabled the assessment of burnout from different perspectives. The questionnaire which used multiple-choice questions included four sections namely; Participant demographics with 5 questions, Personal burnout with 6 questions, Work-related burnout with 12 questions, and Client-related burnout with 8 questions. The section on participant demographics captured data on age, sex, duration of work at FPRRH, and employment category.

Data collection procedure

A convenience sample of healthcare professionals at FPRRH was selected from the hospital WhatsApp group and invitations to participate were sent to their individual accounts. A link to the data collection tool was sent to the participants’ individual WhatsApp accounts alongside the invitation to participate. The data collection tool was pre-tested before actual data collection to ensure usability. The participants were free to fill out and submit the questionnaire at their time of convenience. The completed questionnaires were then stratified into three broad categories namely, Doctors, Nurses, and Allied Health Professionals.

Data management and analysis

The questionnaires were checked for completeness, the data was sorted and summarized using Google Sheets and Microsoft Excel (Microsoft 365 MSO (Version 2308). Each response was assigned a score as guided by the Copenhagen Burnout Inventory (CBI) as follows: Always: 100. Often: 75. Sometimes: 50. Seldom: 25. Never: 0. A score for each section of the data collection tool was computed as the average of the scores on the items. A total burnout score was computed as the average score from all three sections.

Burnout was categorized as low, moderate, and high burnout according to Kristensen’s criteria for burnout levels. A score of 0-49% represented low burnout, 50-75% represented moderate burnout and ≥ 76% represented high burnout.

Descriptive statistics including percentages, means and standard deviations, as well as Pearson correlation coefficients, were computed using IBM SPSS statistical package version:29.0.0.0(241) as well as Microsoft Excel 365 MSO (Version 2308). 2-tailed 95% confidence intervals for the correlations and statistical significance were estimated based on Fisher’s r-to-z transformation with bias adjustment. The data was then presented in frequency charts and tables.

The factors contributing to burnout were identified from participant responses to specific questions in the CBI as part of the data collection questionnaire. Any of those questions was considered a potential contributing factor if the majority of the participants rated it 50 or higher on the Likert scale (To a very high degree: 100; To a high degree: 75; Somewhat: 50; To a low degree: 25; To a very low degree: 0). The impact of burnout on patient care was assessed by examining responses in the client-related burnout section of the CBI. Responses of those who scored low, moderate, or high burnout were compared in terms of frequencies.

Ethical consideration

The study was reviewed by the Fort Portal Regional Referral Hospital Research and Ethics Committee (FPRRH-REC) and approved by the FPRRH administration. To ensure confidentiality, the questionnaires were anonymized, coded, and kept securely in a password-protected folder on Google Drive accessed only by the researcher.

All participants were required to give written consent before participating in the study. The study was not expected to pose any physical or psychological risk to the participants. However, participation may have caused minimal disruption to their work routine.

Results

Over 2 weeks in June 2022, A total of 31 (n = 31) healthcare professionals at Fort Portal Regional Referral Hospital participated in the study as per the inclusion criteria, representing an overall response rate of 28%. This response rate was acceptable for a web-based survey where no follow-up or incentives were provided, and sample representativeness was given primary importance. Based on sample size estimates, the response rate for doctors was 44.4%, the response rate for nurses was 22.8%, and that for allied health professionals was 33.3%.

Participant characteristics

Most of the participants, 19 (61.3%) were females, while 12 (38.7%) were males.

In terms of age, 12 (38.7%) participants were in the range of 40–49 years, 10 (32.3%) were in the range of 20–29 years, and 9 (29%) were in the age range of 30–39 years. There were no participants in the age group of 50 to 60 years. The majority, 16 (51.6%) were nurses, 11 (35.5%) were allied health professionals and 4 (12.9%) were doctors.

In terms of work duration, 12 (38.7%) participants had worked at FPRRH for more than 10 years, 9 (29%) had worked at the hospital for 4 to 6 years, 7 (22.6%) had worked for 1 to 3 years, while 3 participants (9.7%) had worked for 7 to 10 years. The mean duration of work at the hospital was 6.32 years (SD = 4.308) as shown in Table .

Table 1 Summary of demographic characteristics of the participants

Extent of burnout among the health professionals at FPRRH

Burnout scores ranged from 16% to 86%, with an overall mean burnout score of 57.4% (SD = 16.083). The distribution of overall burnout is shown in Fig. . The majority, 19 (61.2%) scored moderate burnout, 9 (29%) participants scored low burnout, while only 3 (9.6%) scored high burnout.

Fig. 1

Distribution of burnout scores among staff at Fort Portal Regional Referral Hospital. Most of the staff scored moderate burnout.

The male participants had an average burnout score of 59.94% with an average age of 28.33 years, while female participants had an average burnout score of 55.92% with an average age of 32.10 years. Participants in the age range 30–39 had the highest average burnout score compared to the other age groups, while those of 20–29 years had the lowest average burnout score as shown in Table .

Table 2 A: Average Burnout score by Average age and gender. B: Average Burnout score by age group

Burnout rate by age and duration of work

Pearson correlation indicated a weak positive correlation between the age of the health workers and burnout score, r(29) = 0.16, p =0.387. (95% CI [-0.208,0.485]).

There was also a weak positive correlation between the duration of work at Fort Portal Regional Referral Hospital and burnout score, r(29) = 0.11, p = 0.955. (95% CI [−0.345,0.365]).

Table 3 Possible causes of burnout identified out of participant responses in the three components of the CBI

Burnout rate among doctors

All doctors who participated in the study were male. Of these, 3 (75%) scored low burnout. Only 1 doctor (25%) had a score of high burnout as shown in Fig. . The doctor who scored high burnout was in the age range of 20–29 years, with a work duration of 1–3 years.

Fig. 2

Estimates of burnout burden among doctors at FPRRH.

Of the doctors who scored low burnout 1 (33.3%) was in the age range of 20–29 years with 1–3 years of work duration. The other 2 (66.6%), were 40–49 years of age. Fifty percent (50%) of these had a work duration between 4 and 6 years, and the other 50% had worked for more than 10 years (Figs. –).

Pearson correlation was computed to assess the linear relationship between doctors’ age, and burnout score, as well as doctors’ duration of work and burnout score. There was a strong negative correlation between doctors’ age and burnout score, r(2) = −0.66, p = 0.341. (95% CI [−0.990,0.856]). There was also a negative correlation between doctors’ duration of work at FPRRH and burnout score, r(2) = −0.58, p = 0.417. (95% CI [−0.987,0.883]).

Burnout Rate among Allied Health Professionals

All allied health professionals who participated in the study were between 30 and 49 years of age with at least 4 years of work duration. Of these, 6 (55%) were 40–49 years of age, while 5 (45%) were between 30 and 39. The majority, 7 (63%) were females, and 4 (37%) were males.

Among the allied health professionals, 2 (18.1%) scored low burnout, 8 (72.7%) scored moderate burnout. Only 1 (9%) had high burnout as shown in Fig. . The allied health professionals who scored low burnout were all female, between 40 and 49 years of age. Fifty percent (50%) of them had worked at the hospital between 4 and 6 years, and the other 50% had worked longer than 10 years. The allied health professional who had high burnout was male in the age range of 40 to 49 and had worked for more than 10 years at the hospital.

Fig. 3

Estimate of burnout burden among allied health professionals.

Of the allied health professionals who scored moderate burnout, 3 (37.5%) were between 40 and 49 years of age, and 5 (62.5%) were between 30 and 39 years of age. Of these, 3 (37.5%) were male, while 5 (62.5%) were female.

Pearson correlation indicated a weak negative correlation between duration of work at FPRRH and burnout score, r(9) = −0.12, p = 0.718. (95% CI [−0.670,0.519]). There was a weak negative correlation between their age and burnout scorer (9) = −0.13, p = 0.695. (95% CI [−0.676,0.512]).

Burnout rate among nurses

The nurses who participated in the survey were aged 20 to 49 years. The majority, 11 (68%) were females while 5 (32%) were males. Of these, only 1 nurse (6%) scored high burnout, 11 nurses (68.7%) scored moderate burnout, and 4 nurses (25%) scored low burnout as shown in Fig. . The nurse who scored high burnout was between 40 and 49 years of age and had worked at the hospital for longer than 10 years. Of those who scored moderate burnout, 3 (27.2%) were males while 8 (72.7%) were females. The majority, 5 (45.4%) were between 20 and 29 years of age, 3 (27.2%) were between 30 and 39 years and 3 (27.2%) were between 40 and 49 years of age. 4 (36.3%) had worked at the hospital between 1 and 3 years, 5 (45.4%) had worked between 4 and 10 years and 2 (18.1%) had worked for more than 10 years.

Fig. 4

Estimate of burnout burden among nurses at FPRRH.

Of the nurses who scored low burnout 3 (75%) were females and 1 (25%) were male. All were in the age range of 20 to 39 years. Fifty percent (50%) of them had worked between 4 to 10 years, 25% percent had worked between 1-3 years, and the other 25% had worked more than 10 years.

A Pearson correlation coefficient was computed to assess the linear relationship between nurses’ duration of work at FPRRH and burnout score, as well as nurses’ age and burnout score. There was a weak positive correlation between the duration of work and burnout score, r(14) = 0.20, p =0.452. (95% CI [−0.332,0.630]). There was a statistically significant positive correlation between nurses’ age and burnout score r(14) = 0.56, p =0.025. (95% CI [0.067,0.819]).

Workplace factors contributing to burnout

Unbalanced duty allocation

The majority, 15 (48.4%) of the participants indicated that duty allocation in their ward was somewhat frustrating. Four (4) of the participants (12.9%) indicated that duty allocation was frustrating to a high degree, and 4(12.9%) reported duty allocation was frustrating to a low degree. Fourteen (14) participants (45.2%) indicated that duty allocation in their ward needed to change for them to enjoy their time at work.

Of those who scored high burnout 1 (33.3%) reported that they always felt duty allocation on their ward needed to change for them to enjoy their time at work. 1 (33.3%) reported that they often felt duty allocation needed to change, and 1 (33%) reported that they sometimes felt duty allocation on their ward needed to change for them to enjoy their time at work.

In comparison, of those who scored moderate burnout, 10 (52.6%) indicated that they sometimes felt duty allocation on the ward needed to change for them to enjoy their time at work, 6 (31.5%) indicated that they always felt duty allocation needed to change, 1 (5.2%) indicated that they often felt duty allocation needed to change, 1 (5.2%) indicated that they seldom felt duty allocation needed to change and another 1 (5.2%) indicated that they felt duty allocation never needed to change for them to enjoy their time at work.

Physically exhausting procedures

Another factor identified was physical exhaustion from medical procedures, with 11 (35.5%) of all the participants indicating that their work was physically exhausting to a very high degree. Ten (10) participants (32.3%) indicated that work was physically exhausting to a high degree, and 3 (9.7%) said it was exhausting to a low degree. Only 1 (3.2%) reported that their work was physically exhausting to a very low degree.

Of those who scored high burnout, 2 (66.6%) reported that their work was physically exhausting to a very high degree while the other 1 (33.3)% felt their work was physically exhausting to a high degree.

In comparison, of those who scored moderate burnout, 8 (42.1%) indicated that their work was physically exhausting to a very high degree, 7 (36.8%) indicated that their work was physically exhausting to a high degree, 3 (15.7%) indicated that their work was somewhat physically exhausting, and 1 (5.2%) indicated that their work was physically exhausting to a low degree.

Emotional exhaustion

The other factor was emotional exhaustion associated with emotional attachment to patients. Seventeen (17) participants (54%) reported that they were emotionally attached to patients to a high degree. Five (5) participants (16.1%) indicated they get emotionally attached to patients to a very high degree, while 6 (19.4%) reported they somewhat get emotionally attached to patients.

Ten (10) participants (32.3%) indicated that they found their work to be emotionally exhausting to a very high degree, and another 10 (32.3%) reported that work was emotionally exhausting to a high degree. Seven (7) participants (22.6%) indicated their work was somewhat emotionally exhausting, while 4 (12.9%) indicated that it was exhausting to a low degree.

Of those who scored moderate burnout, 9 (47.4%) indicated that their work was emotionally exhausting to a high degree. Seven (7) participants (36.8) indicated that their work was emotionally exhausting to a very high degree, and 3 (15.8%) indicated that their work was somewhat emotionally exhausting. In contrast, all those who scored high burnout 3 (100%) indicated that their work was emotionally exhausting to a very high degree.

Getting blamed for other people’s mistakes

Eleven (11) participants (35.5%) reported that they sometimes get blamed for other people’s mistakes. Another 8 (25.8%) indicated that they get blamed for other people’s mistakes often. Additionally, 4 (12.9%) indicated that they seldom get blamed for other people’s mistakes, and another 4 (12.9%) indicated never get blamed for other people’s mistakes. Only 2(6.5%) indicated that they always get blamed for other people’s mistakes.

Resource limitations

Limitation in patient care was also identified as a potential factor. The majority, 18 (58.1%) of the participants reported that finding that there isn’t much they can do for a patient was frustrating to a very high degree. And, 6 (19.4%) indicated that it was frustrating to a high degree. Four (4) participants (12.9%) reported that it was somewhat frustrating, while 3 (9.7%) reported that it was frustrating to a low degree.

Of those who scored moderate burnout, 12 (63.1%) reported that finding that there isn’t much they can do for a patient was frustrating to a very high degree, 4 (21%) found it frustrating to a high degree, 2 (10.5%) found it somewhat frustrating, and 1 (5.2%) found it frustrating to a low degree. In contrast, all those who scored high burnout (100%) reported that finding that there isn’t much they can do for a patient was frustrating to a very high degree.

Impact on patient care

Regarding the impact on patient care, 14 (45.2%) participants indicated that they somewhat found it hard to work with patients, 4 (12.9%) indicated that they found it hard to work with patients to a high degree, 7 (22.6%) indicated that they found it hard to work with patients to a low degree, while 5 (16.1%) reported that they found it hard to work with patients to a very low degree.

Of those who scored moderate burnout, 15 (78.9%) reported that their work with patients was somewhat frustrating. Only 2 (10.4%) indicated that it was frustrating to a high degree or a very high degree. And 1(5.2%) indicated that it was frustrating to a low degree. Twelve (12) participants (63.1%) of those who scored moderate burnout indicated that they felt they were sometimes tired of working with patients. 2 (10.5%) reported they often felt they were tired of working with patients. 2 (10.5%) reported they never felt they were tired of working with patients, 1 (5.2%) always felt they were tired of working with patients, and 1 (5.2%) reported they seldom felt they were tired of working with patients.

In comparison, of the participants who scored high burnout, 2 (66.6%) indicated they sometimes found it frustrating to work with patients, and 1 (33.3%) reported frustration to a high degree. Of the participants who scored high burnout 2 (66.6%) indicated they often felt they were tired of working with patients. 1 (33.3%) reported they were sometimes tired of working with patients.

In contrast, 5 (55%) of the participants who scored low burnout indicated that it was frustrating to work with patients to a low degree, while for the other 4 (44.4%), it was frustrating to a very low degree. Six(6) of the participants (66.6%) who scored low burnout indicated that they never felt tired of working with patients, and the other 3 (33.3%) indicated that they rarely felt tired of working with patients.

Discussion

The results of this survey are consistent with previous studies indicating that burnout is prevalent among health professionals, although its severity varies across different age groups and different categories of health professionals, namely, Doctors, Nurses, and Allied health professionals. This study is among the few that included allied health professionals and compared findings in the three categories of health workers. Although allied health professionals constitute a large percentage of staff in most hospitals globally, there is limited published data on burnout in this group with most of the studies focusing on doctors and nurses.

The findings of this study indicate that the majority of health professionals at FPRRH, regardless of category, experience moderate burnout with burnout scores ranging from 16% to 86%. This is consistent with other studies which found burnout scores among physicians to range from 0% to 80%, and that the prevalence of burnout and its related problems was high among allied healthcare staff,. Similarly, a systematic review of estimates of burnout revealed prevalence estimates of overall burnout reported by 67.0% (122/182) of studies that provided data on overall burnout to range from 0% to 80.5%.

This study found males to have a higher average burnout score, compared to females which is in contrast with previous studies which found that female health professionals had higher burnout scores possibly because women have disproportionate responsibilities outside work,.

The positive correlation between the age of the health workers and burnout score suggests that generally, as health professionals grow older, they are more likely to experience higher burnout scores. Similarly, the positive correlation between duration of work at FPRRH and burnout score, also suggests that the longer the health care professionals work, the more likely they are to experience burnout. However, these correlations were not statistically significant, and analysis of each category of health professionals separately showed somewhat contradictory findings for doctors and allied health professionals in terms of the linear relationship between their age, their duration of work, and burnout scores.

Among doctors, this study found low burnout was most prevalent (75%). This contrasts the findings of a systematic review among health care providers in sub-Saharan Africa which concluded that high burnout was prevalent among doctors. The strong negative correlation between doctors’ age and burnout score suggests that as doctors grow older, they experience less burnout. The negative correlation between doctors’ duration of work at FPRRH and burnout score also suggests that doctors who have worked longer experience less burnout. This finding is consistent with previous studies showing higher burnout rates among residents and junior doctors,. This could suggest that older doctors have developed better mechanisms of coping with work-related stress. Alternatively, it could indicate that the younger doctors bear most of the workload compared to older doctors. The 25% rate of high burnout among doctors in this study was among younger doctors with shorter duration of work and is consistent with the 21% rate of high burnout among internal medicine residents found in an earlier survey.

Similarly, among the allied health professionals, the negative correlation between duration of work at FPRRH and burnout score, suggests that allied health professionals who have worked longer at the hospital experience less burnout. The negative correlation between age and burnout score also suggests that older allied health professionals experience less burnout.

In contrast, among the nurses, the statistically significant positive correlation between nurses’ age and burnout score indicates that burnout is likely to increase with age. The positive correlation between the duration of work at FPRRH and burnout score also indicates that nurses who have worked longer at the hospital experience more burnout. This finding is consistent with previous studies showing significant levels of burnout among nurses,. One study found the distribution of burnout among community psychiatric nurses displayed two slow peaks: one for the 30 s age group; and the other for the 50 s age group suggesting that age and career demands can contribute to burnout.

This contrast between nurses and the other categories of health workers could indicate that factors associated with burnout are more prevalent among nurses. Nurses bear a big portion of workload in patient care and various studies report imbalances in workload as a significant factor contributing to burnout among nurses,. Although this study did not examine workload for each category – which necessitates additional studies – the findings are consistent with previous studies that indicate higher burnout rates among nurses in comparison to other categories of health professionals,.

Burnout is a multifactorial phenomenon whose causes can involve individual, interpersonal and organizational stressors. This survey, however, focused on identifying workplace factors potentially contributing to burnout among health professionals. Several factors were identified.

A significant proportion of participants indicated that duty allocation on their ward needed to change for them to enjoy their time at work. This is consistent with the findings of other studies identifying workload imbalances as a source of work-related stress,,. Careful allocation of duties within hospitals is critical for balancing workloads and together with adequate staffing may lower distress and improve work experience,, which can minimize stress and improve staff performance and efficiency in the functioning of health care systems.

However, balancing the workload equitably is not always possible and can be challenging in cases of inadequate staffing versus workload. Other factors like illness, maternity leave, and absenteeism affect the distribution of workload among the staff, which can lead to burnout among those available for work. Healthcare managers need to address staffing levels, as well as absenteeism of health professionals in hospitals, to achieve the recommended patient-staff ratios. Further studies are needed to obtain an in-depth understanding of duty allocation and workload imbalances.

Many of the participants indicated that their work was physically exhausting to a high degree or a very high degree. Most of the tasks involved in patient care are physically strenuous, yet they must be done routinely. Over time, this can result in physical exhaustion and negatively affect the physical and mental health of health professionals,.

The majority (64.6%) of the participants in this study reported that their work was emotionally exhausting to a high degree or a very high degree of CBI-derived work-related burnout. This is consistent with previous prevalence estimates of emotional exhaustion reported by 72.0% (131/182) studies which showed scores ranging from 0% to 86.2% for Maslach burnout inventory (MBI)-derived emotional exhaustion. Work-related emotional exhaustion therefore has a significant association with burnout.

Health professionals are constantly exposed to highly emotional situations involving patients and caregivers, especially when the illness is chronic or life-limiting. In situations of lengthy hospital stays, some health workers tend to get attached to patients for several reasons such as having a previous experience with a certain illness or circumstance. In this study, 54.8% of the participants indicated they get emotionally attached to patients to a high degree. This is similar to a study which concluded that physicians frequently experience intense emotions when dealing with patients and that the emotions can be long-lasting and affect the patient-physician relationship. The study also found that most physicians tried to control their reactions, and coping strategies included behavioural and cognitive approaches such as touching, smiling, crying, etc.

Most of the participants reported that finding that there isn’t much they can do for a patient was frustrating to a very high degree. Having little to do for patients can result from resource limitations, especially in a low-resource setting. Resource limitations can include drug and sundries stockouts, a lack of appropriate investigation modalities and an absence of specialists to manage illnesses.

Like many hospitals in developing countries, Fort Portal Regional Referral Hospital is faced with resource constraints. For many patients, certain diagnostic and therapeutic interventions are absent and inaccessible. Such patients require referral to the national referral hospital but often can’t afford to travel. This can cause health professionals to feel like there isn’t much more they can do for the patient. When such patients accumulate on the wards, frustration can build up among the healthcare team. This is because such patients are perceived to occupy hospital beds with little to no progress in their clinical care, or clinical outcomes.

There is a considerable impact on patient care, as well as on the overall healthcare system. Burnout syndrome is characterized by negative attitudes towards work and life and reduced personal accomplishment.

In this study, the majority of those who scored moderate burnout, which was most prevalent, reported that their work with patients was somewhat frustrating and that they were sometimes tired of working with patients. In contrast, participants who scored low burnout indicated that working with patients was frustrating to a low degree or to a very low degree. And that they rarely or never felt tired of working with patients.

These findings suggest that in comparison to those with low burnout, health professionals with moderate burnout can sometimes have a negative outlook on working with patients and could sometimes perceive it as a burden. This can negatively impact the quality of patient care in several ways.

For example, in times when they feel frustrated or tired of working with patients, communication with patients and colleagues may be less courteous. This can impair the doctor–patient relationship and create a barrier against patients expressing their concerns. This is supported by a recent study, which found that doctors with burnout were twice as likely to receive low satisfaction ratings from patients. It is also in agreement with the suggestion that increasing levels of burnout among health professionals can increase medical errors and affect patient safety.

Health professionals experiencing physical exhaustion and frustration with work may be less enthusiastic to take up elective or semi-elective physically demanding procedures. It can also hinder their willingness to offer extra care or support to the patients and caregivers. Previous studies indicate that physical and mental exhaustion impact health workers’ clinical decision-making, quality of communication with patients and colleagues, as well as the ability to cope with work-related pressure, and that emotional exhaustion contributes most to increases in the turnover intention of health professionals,.

Additionally, studies show that doctors with burnout are more likely to be involved in patient safety incidents,. Therefore, burnout among health professionals has a direct impact on patient care and needs to be effectively addressed to preserve patient safety and clinical outcomes.

Physically demanding work also causes physical health issues. For example, low back pain is common among health workers due to bending and lifting activities associated with patient care. This can affect longevity in care delivery and could contribute to a high turnover of medical professionals in practice,,. It can also lead to increased employee absence and reduced productivity in the workplace, which negatively affects the organization’s overall performance.

Although it is difficult to quantify the impact of burnout on patient care and clinical outcomes, there is evidence that it can affect staff performance. Health care organizations therefore need to invest in mechanisms to address burnout among health professionals as a means of ensuring patient safety.

The sudy had a number of limitations. It was restricted to FPRRH, and the small number of participants means that the results may not be generalizable. The small sample size also means that the statistics are generally weak, particularly in determining the linear relationship between age and burnout, or duration of work and burnout among healthcare professionals. The staffing structure used for sample size determination was a pre-COVID-19 structure and did not reflect the changes in staffing due to the COVID-19 pandemic. The study was a web-based survey, which could have excluded some of the potential participants, who may have had difficulties with internet connection and access. Additionally, the lack of a qualitative component in the survey did not allow the respondents to expound on their experiences of burnout. This limited the study’s in-depth exploration of the factors contributing to burnout among the staff at FPRRH.

In conclusion, burnout is prevalent across all carders and age groups among health professionals at FPRRH although the observed linear relationship between the age of healthcare professionals, their duration of work at the hospital and burnout score is not statistically significant. Moderate burn is the most prevalent, and the major associated factors are imbalances in duty allocation, physically exhausting work, and resource limitations. Most of the possible causes of burnout identified are within the scope of hospital leadership to address. The possible impact on staff performance and patient clinical outcomes is speculative, and additional studies are required. A larger possibly mixed-methods study is recommended to provide more insight on the qualitative component of the factors that contribute to burnout.

To mitigate the potential impact on patient care, measures to address the causes of burnout should be developed and implemented at the hospital. This may include formulating and availing platforms for healthcare staff to express concerns about work-related stress and devising means to address such concerns in a supportive environment where mental health conversations are encouraged and not stigmatised. Such measures should be formulated in consultation with the staff who are the beneficiaries, as this may improve their utilization. Additionally, healthcare managers may include mandatory periodic breaks for all staff in the governing policies of healthcare institutions, and lead by example in fostering a culture of openness, empathy and support, to reduce stigma associated with mental health issues among healthcare professionals. Mechanisms to address staff absenteeism also need to be enforced to minimize unfair duty coverage. For example, work monitoring tools such as cameras and computer software in addition to financial incentives like bonuses or fines according to attendance have been found to reduce staff absenteeism by 21 percentage points relative to the nonmonitored groups.

Data availability

The datasets used and analyzed during this study are available from the corresponding author upon reasonable request.

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Competing interests

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Additional information

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About this article

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Received06 December 2023

Accepted29 February 2024

Published06 May 2024

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ISSN 2731-4251 (online)

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Article

Burnout as a multidimensional phenomenon: how can workplaces be healthy environments?

Original Article

Published: 20 March 2024

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Abstract

Purpose

Burnout was already a significant problem before the pandemic, but in the aftermath became a serious concern and a public health and occupational health priority. This study had two aims. First, we investigated how different healthy workplace dimensions and other health individual-level variables are related to burnout. Second, we examined differences in terms of presenteeism, absenteeism, and quality of life between employees who report burnout symptoms and those who do not.

Methods

Participants were 1702 Portuguese employees from various organizations; 69.68% were female, age ranged from 18 to 72 years (mean = 43.25 years, SD = 10.40). Almost half of the participants (49.9%; 851 participants) reported having at least one burnout symptom.

Results

Participants reported that they have felt exhausted (43.7%), irritated (34.5%) and sad (30.5%) always or very often in the last 4 weeks. Regression analysis revealed that the global score on burnout symptoms was negatively related to leadership engagement, psychosocial work environment, personal health resources, health behaviours, and satisfaction with salary. In addition, the global score on burnout symptoms was positively related to worker involvement, enterprise community involvement, perceived stress, and screen time at work. Furthermore, females tend to report a higher level of burnout symptoms compared to males. In addition, burnout has an impact on sickness absenteeism, presenteeism, and quality of life.

Conclusions

Our findings have an important contribution to understanding and promoting a healthier work environment, and reinforce the need for measures and policies to promote mental health, manage stress, and prevent burnout in the workplace.

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Introduction

Common ground

The COVID-19 pandemic brought about a climate of fear, uncertainty, and death, associated with changes in family and work patterns, namely linked to remote work or teleworking, instability, unemployment, or low income. If burnout was a reality before the pandemic, a significant problem for many modern-day workers (Rapp et al. ), now it should be considered a serious public health and occupational health priority (Gabriel and Aguinis ; Gaspar et al. ).

Complications

The research on the impact of telework on health outcomes is scarce. In an attempt to the assess the evidence for associations between telework from home and health-related outcomes in employed office workers, Lunde et al. () found that this research could not be meta-analyzed, as few studies, with many having suboptimal designs and/or other methodological issues, investigating a limited number of outcomes, resulted in the body of evidence for the detected outcome categories being graded either as low or very low.

Course of action

To overcome the existing gaps, the aim of this study was two-fold. First, it investigated how different healthy workplace dimensions and other health individual-level variables are related to burnout. Second, it examined differences in terms of presenteeism, absenteeism, and quality of life between employees who report burnout symptoms and those who do not.

Contributions

A robust model for assessing, monitoring (Gaspar et al. ), and reporting on the benefits of organisational investment in health and wellbeing can improve understanding of the importance of this investment for employers and society as a whole (Adlakha ).

Theoretical framework

Burnout is a disorder that results from continuous and chronic stress in the workplace, associated with psychosocial risks at work. The following conceptual framework characterises burnout and defines a healthy work environment and its various dimensions, namely the psychosocial environment and mental health. Next, factors emerging from the work environment and associated with health and performance at work are characterised, such as teleworking, presenteeism, absenteeism, and salary satisfaction.

Burnout

The World Health Organization () included burnout in the 11th Revision of the International Classification of Diseases (ICD-11) as an occupational phenomenon. In this classification, burnout is considered a syndrome conceptualized as resulting from chronic workplace stress that has not been successfully managed. This syndrome is characterized by three dimensions: (1) feelings of energy depletion or exhaustion, (2) increased mental distance from one’s job, or feelings of negativism or cynicism related to one's job, and (3) reduced professional efficacy (Maslach and Jackson ; Maslach ; Leiter and Maslach ).

Professionals with burnout feel emotionally exhausted, pessimistic, and withdrawn from work and other important aspects of their lives. Burnout syndrome is likely to occur in employees who feel overwhelmed and impaired with stress in the workplace, and especially in professions with relational contact with others, such as teachers, doctors, nurses, and people in the police force (Schaufeli and Enzmann ; Shirom and Ezrachi ).

Burnout has symptoms and consequences for physical, psychological, social, and environmental health (Ahola et al. ). Past research reveals that burnout hinders personal and organizational performance (e.g., Bakker et al. ; Cropanzano et al. ; Parker and Kulik ; Wright and Cropanzano ), teamwork, and working relationships (e.g., Mijakoski et al. ). Furthermore, it is associated with physical symptoms such as hypertension, muscle problems, and gastrointestinal problems (Salvagioni et al. ). Consistently, burnout has been closely linked to physical illness, mental health, presenteeism, and absenteeism (Ahola et al. ; Gabriel and Aguinis ; Glise et al. ).

Psychological symptoms such as emotional exhaustion, anxiety, irritability, sleep problems, and depression are also well documented (Goh et al. ; Renfrow ).

Emotional exhaustion is variably associated with absenteeism, intention to quit profession, and personal and family deterioration (Suner-Soler et al. ), and is the most studied dimension of the burnout syndrome (Mäkikangas et al. ; Salvagioni et al. ).

Besides emotional exhaustion, according to Maslach's Model, cynicism and lack of efficacy are the other two components of burnout. Leiter and Maslach () propose patterns related to different profiles: Burnout (high on all three components), engagement (low on all three components), and then three more profiles in which the person is affected only on one of the components, that is overextended (high on exhaustion only), disengaged (high on cynicism only), and ineffective (high on inefficacy only).

Burnout and engagement are largely overlapping concepts due to the same underlying phenomena: energy, involvement, and efficacy (Maslach and Leiter ). The relationship between burnout and engagement can be explained to a great extent in terms of similar patterns of associations with job demands and job resources (Taris et al. ). Bakker and Costa () show that chronic burnout is an important moderator of daily employee functioning. Chronic burnout strengthens the loss cycle of daily job demands, daily exhaustion, and daily self-undermining, whereas chronic burnout weakens the gain cycle of daily job resources, daily work engagement, and daily job crafting. Employees with high levels of burnout need help to implement deep changes in their working conditions and health status. A meta-analysis by Glandorf et al. () concluded that burnout was associated with athletes' health, with increases in negative mental health outcomes and decreases in positive mental health outcomes.

In the work context, there are risks referring to social, organizational, and work management aspects that can cause burnout (European Center for Disease Prevention and Control ), and consequently a detrimental impact on the organizations and the economy (Bailey ; Gaspar et al. ).

Healthy workplace

Workers' health and the healthy workplace environment in the organisation should be understood from an ecological and systemic perspective (Gaspar et al. ). A comprehensive appraisal should include organizational factors, psychosocial work environment associated with factors of the relationship between the professional and the organisation, and individual worker biopsychosocial factors, as well as factors external to the workplace (Gaspar , ; Gaspar et al. ; Otto et al. ). One of the comprehensive frameworks and models that considers these factors is the WHO healthy workplace framework and model (Burton ).

In this perspective, a healthy workplace is “one in which workers and managers collaborate to use a continual improvement process to protect and promote the health, safety and well-being of workers and the sustainability of the workplace by considering the following, based on identified needs: health and safety concerns in the physical work environment; health, safety and well-being concerns in the psychosocial work environment including organization of work and workplace culture; personal health resources in the workplace; and ways of participating in the community to improve the health of workers, their families and other members of the community”. In short, the physical work environment refers to the part of the workplace facility that can be detected by human or electronic senses, including the structure, air, machines, furniture, products, chemicals, materials, and processes that are present or that occur in the workplace, and which can affect the physical or mental safety, health, and well-being of workers. If the worker performs his or her tasks outdoors or in a vehicle, then that location is the physical work environment. The psychosocial work environment includes the organization of work and the organizational culture — the attitudes, values, beliefs, and practices that are demonstrated on a daily basis in the enterprise/organization, and which affect the mental and physical well-being of employees. These are sometimes generally referred to as workplace stressors, which may cause emotional or mental stress to workers. Personal health resources in the workplace means the supportive environment, health services, information, resources, opportunities, and flexibility an enterprise provides to workers to support or motivate their efforts to improve or maintain healthy personal lifestyle practices, as well as to monitor and support their ongoing physical and mental health. Enterprise community involvement comprises the activities, expertise, and other resources an enterprise engages in or provides to the social and physical community or communities in which it operates, and which affect the physical and mental health, safety, and well-being of workers and their families. It includes activities, expertise, and resources provided to the immediate local environment, but also the broader global environment (Burton ).

This model includes both content and process. Specifically, it comprises two core principles that are ongoing circumstances that must be tapped into at every stage of the process for implementing a healthy workplace programme (i.e., leadership engagement based on core values and ethics, and worker involvement), four avenues that define the content of a healthy workplace programme (i.e., the physical work environment, the psychosocial work environment, personal health resources in the workplace, and enterprise community involvement) and an eight-step iterative process for implementing a healthy workplace programme.

A healthy workplace is linked to higher job satisfaction, motivation, and job performance, as well as reduced turnover and healthcare costs for companies (Gaspar , ; Gaspar & Faia-Correia ).

Workplace factors associated with burnout

Telework

The accelerated development and widespread use of information and communication technology (ICT) produced in organizations a tremendous switch towards different business approaches. Especially with the occurrence of the Covid-19 global pandemic, the acceleration of the usage of ICT-based working tools offered the possibility for organizations and employees to adopt telework to enforce the social distancing needed to minimize the spread of the virus. Teleworking implies that employees work outside their professional office spaces in their home while keeping in touch with colleagues and managers by way of new information and communication technologies (Beauregard et al. ).

Although the COVID-19 pandemic has ended, previous studies suggest telework is here to stay on its own and as a part of a hybrid model of working. For instance, in 2021, Hensher et al. () found that many employees and organizations are likely to choose to work from home even after the pandemic. In addition, in the "Future trends in remote work worldwide from 2020 to 2022" global survey data released by Statista, telework is still one of the work arrangements in place for almost half of 1200 participants in 2022 (45%) and 29% of the participants stated that they are currently working in a hybrid model. More importantly, 36% of the respondents considered that they will be working in a hybrid model permanently.

Previous research on the impact of teleworking has given conflicting results. On the one hand, meta-analyses revealed that teleworking, especially before the onset of the COVID-19 pandemic, had positive individual- and organizational-level relevant outcomes such as perceived autonomy, (lower) work–family conflict and turnover intentions, job satisfaction, job performance, low role stress (Gajendran and Harrison ), productivity, organisational commitment, and retention (Harker Martin and MacDonnell ). Gajandran and Harrision’s meta-analysis () found that these beneficial consequences of the telework appeared to be at least partially mediated by perceived autonomy. On the other hand, telework has been linked to some negative outcomes, particularly in the case of employees teleworking the majority of their time. Also, high-intensity teleworking (more than 2.5 days a week) accentuated teleworker's beneficial effects on work–family conflict, but harmed relationships with coworkers.

Before the COVID-19 pandemic, teleworkers’ health, including burnout, was not the primary focus of the empirical research; nowadays, it is a priority. Previous studies, many of them with cross-sectional designs, provide mixed results on the relationship between telework and burnout (Lunde et al. ). In addition, recent empirical research tends to provide mixed support for the relationship between telework and burnout or its dimensions. For instance, Lippens et al. () found that notwithstanding the exceptional time of sudden, obligatory, and high-intensity telework imposed by COVID-19 measures, the respondents mainly attributed positive characteristics to telework, such as increased efficiency and a lower risk of burnout. Stempel and Siestrup () found in a sample of 599 teleworkers that a higher level of age, autonomy, adequate work environment, and a low level of overtime and information deficit are related to low emotional exhaustion.

Hoffmann et al. (), using a sample of 573 radiation oncology, radiation physics, and experimental radiation oncology professionals, found that the rate of burnout across the cohort was 32%, that the majority of employees working from home at least part of the time reported the experience was positive (74%), and that feeling positive about working from home was associated with reduced burnout. However, qualitative data review suggested the main drivers of unfavorable work-from-home responses were child/family care issues and information technology issues. Thus, having negative experiences with telework from home was associated with burnout. Similar results were found by Brault et al. () in a sample of 220 female healthcare workers. Overall, reported burnout was low, with only 32.7% of respondents scoring in the moderate-burnout category and no respondents scoring in the high-burnout category. In particular, this sample included younger women. In the same line, in a study conducted during COVID-19 pandemic, Arenas et al. () revealed no difference between Brazilian workers working from home/telework and those working face-to-face in terms of burnout symptoms. Clinically significant levels of burnout were associated with being female, increased childcare load, and living with children under 12 years old. Employees who felt the pressure to overwork were more likely to have a more permeable family boundary when working from home, and appeared to experience a much higher psychological cost in terms of emotional exhaustion. Gender differences in mental health are often identified, with women more often showing symptoms of anxiety, lower psychological well-being, and a lower quality of life (Gaspar et al. ; Gurvich et al. ; Hou et al. ; Eurofound ). With regard to burnout, the gender differences are not so clear and linear. In some studies, there are no gender differences and in others the factors that explain gender differences differ depending on whether you are a man or a woman (Gaspar et al. ; Zhang et al. ).

There are different forms of teleworking. For example, teleworking can be fixed hours and highly regulated by leadership, or it can be based on trust, with set tasks and time and task management carried out by the worker themselves. Teleworking can be carried out in a hybrid way; some days the worker is teleworking and on others they are in person at the company, or they can be entirely teleworking. Some studies revealed that the type of program used during telework is a moderator of the relationship between telework and burnout. For instance, Trogolo et al. () found in a sample of 1049 Argentinian workers that home-based telework under fixed schedules, but not that under flexible schedules, impacts negatively on mental health considered in terms of burnout, life satisfaction, anxiety, and depressive symptoms. In addition, a low level of the ability to freely determine the work schedule and location and the involuntariness in telework was found to increase emotional exhaustion (Giauque et al. ; Lopes et al. ). Furthermore, it seems that the motives for telecommuting present different relationships with exhaustion. In this sense, Vanderstukken et al. () found that telecommuting because one has to (the job requirement class) was not related to exhaustion measured 6 months later, while telecommuting to cope with deadlines and pressure (the efficiency class) and telecommuting to have a healthy balance between work and family/leisure (the work–life balance class) were related to less emotional exhaustion.

Screen time at work

To date, no studies have explicitly linked workplace screen time to occupational burnout or its dimensions. However, this relationship can be informed by the previous research on the use of information and communication technology and occupational burnout and other health outcomes such as virtual meetings fatigue (Gallo ), screen time use, and digital burnout. In this sense, previous research reveals that the use of information communication technology (i.e., technostress) increases burnout in older, middle-aged, and younger workers (Berg-Beckhoff et al. ). Recent studies reveal that it is not the use of ICT per se which negatively impacts mental health and burnout, but digital work intensification (i.e., working at very high speed or to tight deadlines; Leitner & Stöllinger ). Using a within-person experience sampling study in which the use of the camera was manipulated, Shockley et al. () found that using the camera is fatiguing and this effect not attributable to time spent in or number of virtual meetings. Moreover, this effect is higher in the case of employee voice and engagement in meetings, women, and newer employees. Furthermore, prolonged screen time can cause digital burnout. For instance, Durmuş et al. () found that nursing students who spent more than 5 hours a day online had higher digital burnout than those who spent less than 5 hours a day online.

Perceived pay fairness

Perceived pay fairness refers to the perceptions of internal and external pay fairness or reactions to pay relative to referents inside and outside the organization. Shaw and Gupta () found that unfair pay results in greater psychological and physical problems when employees report a high need for money.

Demerouti et al. () established a relationship between remuneration and the prevention of burnout and other work psychosocial risks. The authors found that salary is the most successful strategy in buffering the negative associations of disengagement with supervisor-rated task performance and both disengagement and exhaustion with supervisor-rated adaptivity to change.

In contrast, other studies highlight that satisfaction with salary did not have a significant effect on burnout. For instance, Kader et al. () found that psychiatrists’ high levels of satisfaction with co-workers, work, supervision, opportunities for promotion, and the job in general reduce emotional exhaustion and depersonalization. Satisfaction with salary was not related to burnout. In the same direction, Pikó and Mihálka () found that satisfaction with salary was not related to Hungarian teachers’ burnout.

Sickness presenteeism

According to the WHO (Burton ), presenteeism is defined as the reduced productivity of someone who is present at work, but either physically or mentally unwell, and therefore not as effective, efficient, or productive as they would normally be. In a comprehensive analysis of the literature, Ruhle et al. () identified three main lines of understanding the concept of presenteeism: (a) the act of attending work while ill, as the outcome of a complex decision-making process by the ill person to either attend work or stay at home, (b) the measurable loss of productivity due to attending work with health problems, and (c) the act of not fully engaging in work due to illness as well as non-illness-related reasons. In our study, we adopt the second perspective on presenteeism.

Previous research showed a positive relationship between burnout or its dimensions and perceived productivity loss due to presenteeism (Ferreira and Martinez ). While some studies examined presenteeism as a consequence of the burnout (Demerouti et al. ; Ferreira et al. ), others investigated the predictive role of presenteeism. These studies reveal that emotional exhaustion seems to be more strongly related to presenteeism compared to other dimensions of burnout, such as professional efficacy and cynicism. In a systematic review on the antecedents and associations of sickness presenteeism and sickness absenteeism in nurses, Brborović et al. () found that burnout is an antecedent of sickness presenteeism. One of the negative outcomes of employee presenteeism is sickness absenteeism (Dietz et al. ; Nielsen and Daniels ).

Sickness absenteeism

Sickness absenteeism refers to health-related absence from work (Halbesleben et al. ). Research evidence shows that burnout has a positive impact on the individual- and team-level sickness absenteeism. For instance, Schaufeli et al. () found that burnout positively predicted registered sickness duration. Other studies reveal that global burnout and emotional exhaustion were significant predictors of short-term (but not long-term) (Anagnostopoulos & Niakas ) and mental but not musculoskeletal or other somatic long-term sickness absenteeism (Roelen et al. ). Similarly, Peterson et al. () found that four burnout categories (non-burnout, disengaged, exhausted, and burnout) related in different ways to sickness-related outcomes. The proportions of respondents with overtime, sickness absence, and sickness presence were higher in the burnout and the exhausted groups compared with the disengagement and non-burnout groups. In contrast, Salvagioni et al. () found that depersonalization and not emotional exhaustion or low professional efficacy positively predicted long-term sickness absence (≥ 30 consecutive days). In addition, Consiglio et al. () found that in teams with high levels of burnout the level of sickness absenteeism is also high.

Burnout is one of the biggest problems in terms of health and safety at work. The lack of appreciation of psychosocial risks at work, particularly burnout, will have an impact on the physical, mental, and social health of professionals and on the organisation's health indices related to absenteeism, productivity, job satisfaction, and turnover. This has an impact on society and the global economy.

This study is innovative in that it allows the WHO healthy workplaces model to be operationalised with a special focus on burnout (Burton ). It uniquely allows burnout to be studied from a systemic and ecological perspective. Other studies have delved into burnout in a segmented way. This study looks at burnout in relation to the culture and ethics of the organisation, in relation to leadership, professional involvement, the psychosocial work environment, the physical environment, external relations, and social responsibility, as well as professional health resources. It also allows us to understand burnout taking into account the sociodemographic and health characteristics of the professional. This integrated view is not found in other studies, at least to our knowledge. The present study was designed In line with these situations, aiming at investigating how different healthy workplace dimensions and other individual-level health variables are related to burnout, and secondly examining differences in terms of presenteeism, absenteeism, and quality of life between employees who report burnout symptoms and those who do not.

Method

Study design and participants

This study employed a cross-sectional research design and used a national convenience sample comprising 1702 employees. Most of the participants were female (1186: 69.68%). The participants' age ranged from 18 to 72 years (mean = 43.25 years, SD = 10.40).

More than half of the participants (61.4%) reported being married or living with a partner, while 27.1% were single, 10.6% divorced or separated, and 0.9% widowed. Almost 66% reported that they have children. In terms of education, 38.9% have completed secondary education (mandatory schooling, 12 years), 38.8% have a bachelor degree, and 22.3% have a Master or PhD degree.

Regarding their health condition, 1206 participants (70.9%) reported not having chronic diseases while 494 (29.1%) reported having a chronic disease.

Instruments

The instrument used comprises sociodemographic questions and items from the Management and Quality of Health Organizations instrument (Gaspar , ; Gaspar et al. submitted) and the Healthy Workplace Ecosystems instrument (EATS) developed based on the healthy workplaces model proposed by the World Health Organization (Burton ).

In this study, only eight scales from the EATS were used: (1) the ethics and values (eight items, α = 0.91), 2) the leadership engagement (six items, α = 0.95), (3) the workers' involvement (seven items, α = 0.89), (4) the psychosocial risks at work related to work content and relationships with leadership (12 items, α = 0.91), (5) the physical environment (five items, α = 0.92), (6) teleworking (three items, α = 0.82), (7) community involvement (12 items, α = 0.90), and (8) resources for personal health (four items, α = 0.83). All questions have a 5-point Likert-type scale.

The global healthy workplace was measured with one item: “How would you rate the work environment of your organisation—on a scale of 0 to 10”. Participants indicated their extent of satisfaction using a Likert scale from 0 (total dissatisfaction) to 10 (total satisfaction).

Burnout symptoms were assessed with three items from Gaspar et al. (). These items were: "I felt exhausted", "I felt irritated" and "I felt sad". Participants rated how they felt in the last 4 weeks on a 5-point Likert-type scale (from 1  = to 5 = , α = 0.89). From this, two groups were created: one consisting of workers who have at least one of the symptoms of burnout (exhaustion, sadness, and irritation) and another group without any symptoms of burnout.

Health behaviours were measured with four items (Gaspar et al. ). Items regarded eating behaviours, stress levels, sleep habits, and physical activity (α = 0.70). We considered both the individual score on each item and the global score on the scale.

The four-item version of the Perceived Stress Scale (PSS; Cohen et al. ; Pais-Ribeiro and Marques ) was used to assess the degree to which an individual evaluates their life situations as stressful (α = 0.77).

Screen time at work was measured through the following question: “How many hours a day, on average, do you usually use electronic devices with a screen at work?”. Participants had to choose only one from five possible answers: never, up to 2 h, 3 to 7 h, 8 to 11 h and 12 h or more. The time was considered excessive for the professionals who answered 8 or more hours.

Perceived pay salary was measured with the following question: "Do I consider my remuneration to be fair in relation to my responsibilities, my function, and in comparison, to the amounts paid in the sector where I work?". Participants provided their answer on a five-point Likert-type scale (from 1 =  totally disagree to 5 =  totally agree).

Health and quality of life variable was assessed with two items from WHOQOL-Bref (WHOQOL-1998): “To what extent are you satisfied with your quality of life” and “To what extent are you satisfied with your health”.These two items were on a five-point Likert-type scale (1 = ; 5 =). The minimum possible score was 2 and the maximum score 10 (α = 0.84).

Sickness presenteeism was measured with one question: "How often do health problems hinder the performance of your work?". Sickness absenteeism was measured with the following question "How often do you miss a full day, or part of a day, of work due to physical or mental health problems?". Both questions use a five-point Likert scale ranging from 1 = never/almost never to 5 = always/almost always.

Procedure

The permission to conduct this study was requested from and approved by the Ethics Committee of Hospital Professor Doutor Fernando Fonseca (18.03.2021./No 031/2021.).

Several organisations from different activity sectors, spread throughout the country, were invited to participate in this study. A meeting was held with the companies/organisations to explain the study and clarify issues. Those that agreed to participate received an online version of the instrument. A contact person from the organization spread the link internally among their workers. The sample was by convenience. We included large- and medium-sized organizations from various sectors of activity. Public, private, and social organizations were invited to participate.

The first page of the online version of the instrument included an explanation of the study, the contact details of the researchers for further queries and details on the project, as well as information on confidentiality and anonymity. The participant only had access to the instrument items only after they voluntarily signed the informed consent. At the end of the data collection, each organisation involved received an individual report with the organisation's aggregate results, risk index in the different dimensions, and recommendations for promoting a healthier working environment.

Results

Descriptive statistics for the variables included in this study are presented in Table .

Table 1 Descriptive statistics of healthy workplaces dimensions and comparison analysis according to burnout symptoms

Results of the multiple linear regression revealed that the model comprising socio-demographic characteristics (i.e., age and gender), healthy workplace dimensions, perceived stress, health behaviours, screen time at work, and satisfaction with salary is significant [F(14, 867) = 40.54, p < 0.001; Table ]. This model explains 39% of the burnout symptoms variance.

There are significant differences in burnout symptoms in terms of gender. Females tend to report a higher level of burnout symptoms compared to males (β = 0.06, p < 0.05). A high level of global burnout is related to a low perception of leadership engagement (β = -−.18, p < 0.01), psychosocial work environment (β = -−.24, p < 0.001), personal health resources (β = -−.06, p < 0.05), health behaviours (β = -−.13, p < 0.001), and satisfaction with salary (β = -−.14, p < 0.001). In addition, the global score on burnout symptoms is positively related to worker involvement (β = 0.15, p  < 0.001), enterprise community involvement (β = 0.12,  p < 0.01), stress (β = 0.38,  p < 0.001), screen time at work (β = 0.09,  p < 0.01). The global score on burnout symptoms was not significantly related to age (β = 0.01, p  > 0.05), ethics and values (β = 0.06, p  > 0.05), physical work environment (β = 0.02, p  > 0.05), and telework (β = 0.02, p  > 0.05).

Table 2 Linear regression for explaining the global burnout by the sociodemographic characteristics, dimensions of healthy work environments, perceived stress, health behaviours and satisfaction with salary

In order to perform the comparison between employees who report burnout symptoms and those who not.

We found that almost half of the participants (49.9%) reported having always or often at least one of the burnout symptoms (Table ). The symptom with the most intensity was exhaustion (mean = 3.24, SD = 1.24), followed by irritability ( mean = 2.99, SD = 1.20) and sadness (mean = 2.82, SD = 1.24). Data revealed that 43.7% of the participants reported feeling exhausted always or often, while 34.5% reported feelings of irritation and 30% sadness.

Table 3 Descriptive data for burnout symptoms and global burnout (n = 1702)

Burnout symptoms are associated with high presenteeism and more often associated with higher absenteeism. More than 60% of the participants with global burnout reported high presenteeism (62.5%). In addition, a similar percentage of the participants who reported global burnout also reported high levels of absenteeism (62.3%).

Table  shows a comparison of quality of life between professionals with and without burnout symptoms. Professionals with burnout symptoms present higher risk behaviours and excessive screen time at work when compared to professionals without burnout symptoms.

Table 4 Participants’ characteristics and health indicators by burnout symptoms

Workers with burnout are the ones who show higher dissatisfaction with salary and the ones who make a more negative overall assessment of the organisation with Healthy Workplace when compared to workers not reporting burnout symptoms.

Discussion

The objective was to examine the relationship between the different dimensions of the healthy work environment ecosystem and burnout, and to compare professionals with and without burnout in terms of absenteeism and presenteeism, health behaviours, and stress management strategies.

Our findings reinforce the need to understand the burnout phenomenon in a multidimensional and systemic way. Although it is considered an occupational phenomenon (World Health Organization ), burnout is influenced by and influences different components and contexts of the worker's life.

We found that what best explains the burnout symptoms is workers' perceived stress, followed by psychosocial risk factors at work related to leadership and work content, satisfaction with salary, and health behaviours. We have found that the healthy workplaces dimensions that are strongly related and better explain burnout symptoms, are psychosocial risk factors at work related to leadership and work content, and employee Involvement followed by commitment of ceadership.

We identified a positive relationship between perceived stress and burnout. This is in line with previous research that showed that burnout has a relationship with health from a biopsychosocial perspective, given that a healthier lifestyle is associated with fewer burnout symptoms Gabriel and Aguinis ; Goh et al. ; Renfrow ). Effective work stress management is one of the protective factors, and promotes burnout prevention. Mental health promotion and burnout prevention programs should include the promotion of socio-emotional skills that allow for a better management of work stress (Pijpker et al. ; Wu et al. ).

Consistently with previous research, we found that satisfaction with salary was negatively related to burnout. Demerouti et al. () identified a relationship between remuneration and the prevention of burnout and other work psychosocial risks.

In our sample, almost half of the workers reported at least one of the symptoms of burnout. The symptom with greatest ntensity was exhaustion, followed by irritability and sadness. This finding is consistent with those of the previous studies. Although burnout can manifest itself in different ways — through exhaustion, sadness, cynicism, irritability, and affective withdrawal, among others — exhaustion is the most frequent characteristic (Bakker and Costa ; Goh et al. ; Mäkikangas et al. ; Renfrow ; Suner-Soler et al. ).

Burnout is a serious, physically-, psychologically-, socially-, and occupationally-incapacitating phenomenon. Although affecting professionals even before the pandemic, it becomes more prevalent in face of the changes, challenges, and stress associated with the COVID-19 pandemic (Gabriel and Aguinis ; Gaspar et al. ).

We found that more than half of the employees with high levels of presenteeism and absenteeism reported a high level of global burnout. Our findings consist with previous research that underlines the deleterious effect of burnout or its components in terms of productivity loss due to presenteeism (Ferreira et al. ). Thus, in addition to the consequences on physical and psychological health, burnout is also reflected in the performance and quality of work associated with presenteeism, as well as it may contribute to sick leave by increasing absenteeism (Bakker and Costa ; Gabriel and Aguinis ; Suner-Soler et al. ).

Limitations and strengths

Our study has several limitations. The data was collected through a cross-sectional design, which prevents us from concluding about cause–effect relationships. Future studies could adopt research designs that could provide information about causal relationships, such as longitudinal designs.

The data collection took place after a more acute moment of the pandemic, so it would be interesting to include the professionals' perception of the comparison before and after the pandemic. The study will be replicated every year, which will make it possible to monitor the variables, particularly burnout, over the years.

The generalization of our findings is reduced as, although very large, the sample was not representative for the Portuguese employee population. Future studies should consider representative samples and other cultures too. Furthermore, most of our participants were females (69.68%). Furthermore, we did not control for the sector of activity, profession, or hierarchical status of the participants. While burnout can happen in any profession, some of the professions, such as healthcare workers or psychotherapists, are more vulnerable to burnout or have a lower mental well-being (Rus et al. ; Yang and Hayes ) or are prone to presenteeism (Ferreira et al. ). In addition, previous studies support the necessity for targeted interventions for different groups within organizational hierarchies, such as leaders, health professionals, and customer service professionals, among others who show a higher risk of chronic work stress and burnout, in order to reduce psychological distress and burnout (Wallis et al. ), but also presenteeism (Eurofound ), or to ensure that attending work is the most appropriate course of action considering both the health condition and the nature of the work (Whysall et al. ).

Our variables were measured with self-reports that may be subject to biases (e.g., social desirability) and to common method variance (Podsakoff et al. ). Future studies may use objective data, for instance, to measure absenteeism.

Implications and future developments

Nowadays, workers are the most important asset of any organisation. Thus, policies and practices promoting the employees’ well-being should be a priority (Gaspar , , ; Otto et al. ; Wu et al. ). Given the impact and costs that burnout has on a large array of individual- and organizational-level outcomes, it is important to have policies and practices in place to promote interventions to prevent burnout occurrence, to reduce its incidence, and to mitigate its impact on these outcomes. Our findings reveal that avenues of influence for a healthy workplace are the psychosocial work environment implied by leadership and work content, and the personal health resources in the workplace. As the relationship with leadership, associated with communication, autonomy, and appreciation, is one of the most important factors for the employees’ well-being, and the prevention and rehabilitation of workers with burnout (Adlakha ; Harvey et al. ; Suner-soler et al. ), interventions in these avenues should adopt a multi-component approach, as previous research showed that when combined in a comprehensive programme, the practice of promoting healthy work environment leads to favourable health-related outcomes and well-being of workers and organisational health (Wu et al. ).

To prevent and reduce burnout, action only of one type (individual or organisational) may not be enough. In a recent study, Vleugels et al. () found that there are two independent pathways associated with employee health and well-being, one under the direct control of the organization (occupational stressors) and one under the direct control of the person (healthy lifestyle behaviors). The authors emphasised that both pathways need to be separately attended to in order to attain the best outcomes in terms of reducing stress complaints. As our study found that perceived stress had the strongest association with burnout symptoms, individual-focused relaxation and cognitive interventions could be used effectively to reduce perceived stress (Estevez Cores et al. ).

Our present study focused only on individual-level outcomes. We need to fully understand also the factors that influence outcomes of burnout at other levels such as teams and organizations.

Our findings highlight the need for clear recommendations and guidelines both for employees with regard to self-care, and for organizations and policy makers pointing out directions for practices and public policies to be “worker friendly”.

Furthermore, it is necessary not onl;ly to apply systematic and continued interventions to prevent and reduce burnout, but also to promote health in the workplace (Suner-Soler et al., 2014). These interventions may be integrated in the culture of the organization with the support of occupational health professionals and psychologists as literature suggests that they have a key role to play in effective workplace wellness promotion and illness prevention programmes (Pijpker et al. ).

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Acknowledgements

This study was integrated in grant UIDB/05380/2020 funded by the Foundation for Science and Technology – FCT (Portuguese Ministry of Science, Technology and Higher Education).

To Laboratório Português dos Ambientes de Trabalho Saudáveis (LABPATS)

(Portuguese Healthy Workplaces Laboratory) team and partners

Funding

Open access funding provided by FCT|FCCN (b-on). The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

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Contributions

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Tania Gaspar, Fábio Botelho-Guedes, and Ana Cerqueira. The first draft of the manuscript was written by Tania Gaspar and Margarida Gaspar-Matos; Claudia Rus and Adriana Baban reinforced the discussion and carried out a global revision. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Ethics declarations

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Hospital Professor Doutor Fernando Fonseca (18.03.2021./No 031/2021.).” The study was approved by several ethics committees, academic and hospital ethics committees. Statement regarding the welfare of animals — not applicable.

Consent to participate

Informed consent was obtained from all individual participants included in the study. Informed consent was obtained for all participants before completing the instrument. Consent includes information about the study, voluntary, the anonymous and confidential nature of the study, and data.

Consent to publish

Not applicable.

Competing interests

The authors have no relevant financial or non-financial interests to disclose.

Additional information

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Key messages

1. What best explains the burnout symptoms is workers' perceived stress, followed by psychosocial risk factors at work related to leadership and work content, satisfaction with salary and health behaviours.

2. There is a positive relationship between perceived stress and burnout: effective work stress management is one of the protective factors that prevents burnout and promotes mental health.

3. Satisfaction with salary was negatively related to burnout.

4. The symptom with greatest intensity was exhaustion, followed by irritability and sadness, and became an even more serious public health concern after the pandemics.

5. In addition to physical and psychological health problems, burnout is also reflected in the (lack of) quality of work associated with presenteeism, and it may contribute to sick leave, increasing absenteeism.

6. Our findings reinforce the need to understand the burnout phenomenon in a multidimensional and systemic way, as it is influenced by and influences different components and contexts of the worker's life.

This work is framed within project UIDB/05380/2020 under support of FCT—Fundação para a Ciência e a Tecnologia, I.P.

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About this article

Cite this article

Received03 August 2023

Accepted22 February 2024

Published20 March 2024

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Effect of Age on Job Satisfaction and Emotional Exhaustion of Primary School Teachers in Greece

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Eur. J. Investig. Health Psychol. Educ. 2020, 10(2), 644-655;

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Abstract

The level of occupational burnout (OB) and job satisfaction (JS) was investigated in primary school teachers (n = 125) in the region of Epirus in Northwestern Greece. Teachers exhibited a high level of emotional exhaustion (EE), a medium level of depersonalization (DP), and a lack of personal accomplishment (PA). In our study, EE, which is a significant component of OB, varied according to intrinsic and extrinsic JS parameters. Teachers were less satisfied and more stressed with extrinsic job characteristics of their job, such as working conditions and working hours. Female teachers were more likely to exhibit increased satisfaction from intrinsic job characteristics, whereas male teachers were more likely to exhibit increased emotional exhaustion and lack of personal accomplishment. Job satisfaction had a significant negative impact on emotional exhaustion. Job satisfaction accounted (EE = 47.173 − 3.527\*JS) for 35.1% of the total variation in the dependent variation of EE (F(1124) = 66.094, p < 0.001), indicating that job satisfaction had a significant negative effect on EE, such that an additional unit in job satisfaction will lower EE by 3.527. A Pearson correlation analysis revealed that age correlated negatively with emotional exhaustion (r = −0.204, p = 0.023). Proactive human resources policies may be required to protect the newly hired and less experienced teachers from exposure to stressful working conditions.

Keywords:

; ; ;

1. Introduction

Occupational burnout and job satisfaction are important and crucial parameters for successful human resource management for modern organizations. Job satisfaction refers to the attitude of employees toward various aspects of their work [] and can have a positive effect on several parameters of their job, including productivity, efficiency, reduced absenteeism, staff turnover rate, and well-being in general (e.g., reduced risk for occupational burnout of employees) [,]. The significance of job satisfaction and occupational burnout has been reported in several professions. There is a plethora of evidence which suggest that satisfied employees are likely to exhibit increased productivity and more positive attitudes towards their assigned task [,,,,].

Teachers’ job satisfaction is generally associated with different work features such as motivation, productivity, turnover rates, quality of work, and job efficiency. Teachers’ job satisfaction is a crucial parameter for both teaching efficiency and school performance. Satisfied teachers can be motivated and can work harder to achieve the set goals and objectives. On the contrary, dissatisfied teachers may exhibit increased levels of occupational stress and reduced performance [,,,,].

Teachers’ commitment and satisfaction are affected by several extrinsic and intrinsic parameters, including personality traits, school leadership, working conditions, and social and economic factors. School leadership, emotional support, management feedback, and participation in decision making can improve the prospects of teachers’ job satisfaction [,].

Teachers tend to be satisfied more by the nature of their job and less by other parameters associated with work conditions and environment [,]. School leadership and organizational factors also contribute to teachers’ job satisfaction. School conflict, role ambiguity, work overload, bureaucracy, numerous law reforms, poor working environment, poor remuneration, low advancement prospects, and lack of adequate institutional management have been frequently reported as negative factors [,,].

Job satisfaction depends on a wide range of variables, and it reflects the general attitude of an individual for their job, as well as how they view their profession, the working environment, and the wider general perspectives of the working environment. The overall level of job satisfaction reflects employees’ perceptions for the general job characteristics of their work (e.g., for teachers, they may enjoy working with children, inspiring students, and interacting with parents) as well the specifics of their work (e.g., their current school unit, current students, current school leader). A smaller but also significant effect of “social comfort” job characteristics can also contribute to shaping the overall level of job satisfaction. Wages, job security, and safety are considered as social comfort job characteristics that may affect job satisfaction []. For example, a teacher may like the nature of their job but may dislike some school parameters such as leadership, and may enjoy support from their fellow teachers or enjoy the feeling of social comfort from positive stimuli by the wider society for their job and the recognition of their job by the society [].

The various components of job satisfaction can be grouped into intrinsic and extrinsic job characteristics. Intrinsic job satisfaction parameters are the attitudes of individuals towards their jobs, while extrinsic job satisfaction parameters entail the factors that relate to the environment at work []. Satisfaction refers to the positive feeling of a person to their job []. Therefore, the feelings are intrinsic if one looks at variables such as the job type, while extrinsic looks at the working condition such as supervisors, coworkers, and pay. Distinguishing between extrinsic and intrinsic elements in work contentment helps to determine the degrees of satisfaction [].

Many factors influence work fulfillment of school teachers in Greece [,,,,,], and they can be categorized into some primary categories. The first category includes those factors that relate to the work settings, and the second category are factors associated with a particular job aspect. An effect of other factors was also reported for leadership, personality traits, experience, and age [,,,,,].

When considering gender as a personal factor, it is not easy to determine the difference between females and males concerning job satisfaction levels, considering no studies have found any significant difference. For instance, gender as a variable was a significant determinant only in the working condition aspect. As for age, experience, the status of marriage, education level, and the number of children, studies have reached contradictory conclusions on how they relate to work contentment. In the study conducted by Koustelios [], about 40 schools were studied, of which 20 were primary schools. In this study, questionnaires were used to collect data, and the response rate was 49.2% of the 720 surveys. The instruments for evaluating job fulfillment included an Employee Satisfactory Inventory (ESI). The ESI measured six aspects of satisfaction: the job itself, conditions of work, organization, promotion, and pay. The five-point scale ranged from 1 to 5, with one being a strong disagreement and five being a strong agreement. Based on the results, the teachers seem to have a higher job satisfaction with the supervision and the job itself []. As for the pay and opportunities relating to promotion, teachers felt dissatisfied. While pay had the lowest variance, working conditions had the highest.

The significance of intrinsic job characteristics of teachers in Greece was also observed in other studies. For instance, Saiti and Papadopoulos [] conducted a study in 2013 that was exclusively on primary school teachers in Attiki in Athens, Greece. It was found that among most teachers, there was more satisfaction with the nature of teaching, their colleagues, and the administration aspects. The satisfaction levels were low when it came to potential rewards, benefits, and salary. The study also concluded that gender is a predictor in the colleagues and in promotion aspects, while age was a predictor of the nature of work, colleagues, potential rewards, and administration. Similar results have been reported from other regions of Greece, which also observed that teachers exhibited an increased level of satisfaction from the intrinsic parameters of their profession [,].

Teachers in other European countries may exhibit differences in the sources of job satisfaction/dissatisfaction, according to the European survey TALIS in 2013. Spain was one of the participating countries with over 3000 teachers and 192 schools as participants []. The TALIS data were collected through questionnaires. According to the study, individual characteristics were found to be essential in job satisfaction compared to school characteristics. When it comes to individual components, the one factor with the most effect on job satisfaction is classroom discipline. As for school characteristics, the teacher–student relationship is the most important. Unfortunately, Greece was not included in the TALIS data analysis to facilitate a comparison.

Primary school teachers face a carrier paved with challenges and rewards. In Greece, primary school teachers experience rapid changes in the curriculum as well as changes in the skills required for their job. For example, teachers in Greece faced the introduction of changes in the teaching methods; they also need to develop IT literacy skills and be trained to work with a multicultural student population as a result of the prolonged influx of economic migration and refugees in this country. In spite of the challenges, teachers have positive stimuli associated with their personal fulfillment as teachers and the recognition of their teaching profession by students, parents, and the society.

Occupational burnout is a significant parameter that can minimize employees’ effectiveness and productivity. Occupational burnout can occur when employees are exposed to unfavorable working conditions, and this condition can be assessed by investigating levels of emotional exhaustion (characterized by physical and psychological fatigue), depersonalization (characterized by cynical behavior and detachment from the job), and personal achievement (characterized by feeling inefficient/incompetent at work) of the employees [,]. Burnout is preceded by a lengthy exposure to occupational stress, which can eventually lead to burnout, and burnout is associated with depersonalization, reduced personal achievement, and emotional exhaustion [,]. Burnout problems can be seen in schools, with teachers who experience workload and psychological demanding work. The magnitude of the problem may increase by the length of the exposure to stressful job parameters and leads to occupational stress [,,].

Occupational burnout may require a lengthy exposure to unfavorable conditions of the employees, and the first signs of this issue may be related to physical and psychological issues related to work and can gradually progress to emotional exhaustion, depersonalization, and a low sense of professional accomplishment. As a result, employees may enter the “professional burnout zone” and exhibit reduced productivity and low levels of job satisfaction [,,,]. Teachers are frequently exposed to demanding and stressful working conditions, and burnout is frequently reported globally [,]. Burnout can reduce employees’ performance, and the problem is manifested and established after prolonged exposure to unfavorable working conditions, which can result in occupational stress [,,]. Although job satisfaction and occupational stress are not directly related, in practice, satisfied employees may be less stressed and thus work more efficiently. This has a positive long-term effect for the employees and their employer or their organization [].

As discussed above, job satisfaction depends on a range of variables that may change during the teaching career of an individual. Teachers may have different aspirations and needs according to their career stage, professional growth, or personal needs. External variables may also change with time according to wider changes in the society. For example, in times of financial crisis, employees may face salary cuts and feel unsecure for the future. As a result of the prolonged economic problems of the Greek government, teachers together with other professions in the country had to perform their tasks with limited resources, reduced wages, and shortages in staff. These working conditions can lead to emotional resource depletion and be a source of job stress and emotional exhaustion [].

Burnout and job satisfaction can interact with each other and can also be affected by several job characteristics, working conditions, organizational factors, personality traits, age, gender, and work experience [,]. As a result of a prolonged economic crisis and austerity measures in Greece, teachers have experienced rapidly changing working conditions that included school closures, relocation of teachers, aging workforce, and wage reductions. These changes may have an impact on teachers’ job satisfaction and burnout levels [,,,,], but the effect may be modulated by age and work experience [,,,]. For example, with age, teachers may develop social skills and experience that may help them to be more efficient, be satisfied with their job, and cope with job related stress [,].

Objectives of the Current Study:

The aim of the present work is to investigate the level of job satisfaction and burnout of primary school teachers in Greece during a period of a prolonged economic crisis, and how age or work experience may be a predictor of emotional exhaustion (EE), depersonalization (DP), and personal accomplishment (PA).

2. Materials and Methods

The present research was carried out during March and April 2017, in primary school units in the region of Epirus in Northwestern Greece. The head teachers of randomly selected (n = 19) school units (primary education) were informed about the aim of the present work and were asked to collaborate. In total, 150 questionnaires were distributed, and 125 completed questionnaires were collected (return rate 83.33%). The number of completed questionnaires corresponds to about 12% of the total number of primary school teachers in the region.

The distributed questionnaire included questions about demographic data as well as Maslach’s Burnout Inventory as adopted for usage in the Greek language by Kantas and Vassilaki [] and Kokkinos [].

Job satisfaction was measured with the use of the Job Satisfaction Scale [], which has been previously validated and used in Greece and has a good (α = 0.71–0.91) internal consistency [,]. Teachers were asked to indicate on a Likert response scale (from extremely dissatisfied to extremely satisfied) the extent to which they are satisfied or dissatisfied with each of the 15 given statements perceived as job characteristics that are either extrinsic (e.g., physical work conditions, working hours, salary relationship with coworkers, quality of supervision) or intrinsic (e.g., freedom to choose work method, job recognition, opportunities for promotion). Teachers were also asked, “What is the most stressful factor of your job?” The answers to this question were grouped in two groups, namely intrinsic and extrinsic job characteristics [], and the percentage of teachers for each group was calculated. The teachers were grouped in five work experience groups (0–5 years, 6–10 years, 11–15 years, 16–20 years, and over 21 years) and four age groups (20–30 years old, 31–40 years old, 41–50 years old, and over 50 years old).

The data were analyzed using SPSS (version 14.01), and Pearson’s correlation was used to examine the relationships between the variables. Cronbach’s alpha coefficients were used to assess the internal consistency of the instruments. The Cronbach alpha coefficient for job satisfaction was 0.81, and it was 0.79 and 0.83 for extrinsic and intrinsic job characteristics, respectively, thus providing assurance for the internal consistency [] of the data. A t-test was used to compare the scores of female and male teachers. A one-way MANOVA followed by univariate ANOVAs was used to assess the impact of age and work experience on the EE, DP, and PA of the participants. The null hypothesis of the test is that occupational burnout does not vary with age and work experience.

3. Results

The sample teachers who participated in the present work included 125 responders who completed the questionnaires, of which 62.4% were female and 37.6% were male. The participants were distributed in four age groups: 7.2% of the samples were 20–30 years old, 21.6% were 31–40 years old, 44.0% were 41–50 years old, and 27.2% were over 50 years old.

The professional experience was distributed in five age groups: 10.4% between 0–5 years, 8.6% between 6–10 years, 16.0% between 11–15 years, 36% between 16–20 years and 29.0% over 21 years.

3.1. Job Satisfaction and Dimensions of Burnout

The overall job satisfaction was 4.80 (±0.68), with similar values exhibited in intrinsic (4.74 ± 0.46) and extrinsic (4.62 ± 0.71) job characteristics (). There was no significant difference between female and male teachers in terms of the overall job satisfaction, but female teachers exhibited a higher level of job satisfaction from intrinsic job characteristics. Compared to male teachers, female teachers exhibited a lower score on EE and on a lower score on the lack of personal accomplishment ().

Table 1. Job satisfaction and occupational burnout of primary school teachers (n = 125) in Epirus in Northwestern Greece.

The majority of the teachers who participated in the present work (59.2%) perceived the extrinsic job characteristics as the most important stressful parameters of their job, such as working conditions and erratic working hours ().

Figure 1. Primary school teachers’ perceptions on the sources of stress from extrinsic and intrinsic job characteristics. Out of the 15 job characteristics included in the job satisfaction survey, teachers were asked to select one as a source of stress.

The answers on the questions for the dimensions of burnout () indicate that teachers exhibited a high score for emotional exhaustion, a medium score for depersonalization, and a high score for the lack of personal accomplishment. There was no gender effect on the overall job satisfaction but compared to male teachers, female teachers exhibited higher levels of satisfaction from intrinsic job characteristics and a lower level of EE, whereas male teachers exhibited a higher score for lack of personal accomplishment.

3.2. Correlation Analysis

The Pearson correlation analysis () reveal that age correlated negatively with all other variables except working experience. However, only the relationship with working experience (r = 0.328, p < 0.001), job satisfaction (r = 0.001, p = 0.001), and emotional exhaustion (r = −0.204, p = 0.023) are statistically significant.

Table 2. Correlation analysis.

Working experience correlated positively with age (r = 0.328, p < 0.001). Job satisfaction related negatively with EE (r = −0.593) and positively with age (r = 0.297, p = 0.001). A significant correlation between age and emotional exhaustion (r = −0.204, p = 0.023) was observed.

A MANOVA analysis () was conducted to examine whether there were cross-group mean differences in occupational burnout based on categorical demographic variables. The p values of the Wilk’s Lambda for dependent variables EE and DP were 0.763 and 0.257, respectively (). Since the p values are greater than 0.05, the null hypothesis in regard to EE and DP failed to be rejected. Further, the p value of Wilk’s Lambda value of the variable PA was 0.03, which is less than 0.05. Since the p value is less than 0.05, the null hypothesis that there is no statistically significant difference in personal accomplishment based on respondents’ demographics was rejected. However, the univariate ANOVAs indicate a nonsignificant effect of both age (p = 0.147) and working experience (p = 0.131), and hence posthoc tests were not necessary.

Table 3. One-way MANOVA results (conducted using EE, DP, and PA subscales as the dependent variables).

A regression analysis between each burnout component (EE, DP, and PA) as the dependent variable and job satisfaction (JS) was carried out.

(i) Emotional exhaustion (EE)

The R2 for EE was 0.351, which suggests that the predictor job satisfaction accounts for 35.1% of the total variation in the dependent variation EE. Additionally, the predicted model is statistically significant (F(1,124) = 66.094, p < 0.001). The coefficient of job satisfaction is −3.527, and its p value is less than 0.05 (p < 0.001), indicating that job satisfaction has a significant negative effect on emotional exhaustion, such that an additional unit in job satisfaction will lower emotional exhaustion by 3.527. Therefore, the equation of the regression model will be EE = 47.173 − 3.527(JS).

(ii) Depersonalization (DP)

The R2 for depersonalization regressed against job satisfaction is 0.001, which suggests that job satisfaction accounted for only 0.1% of the variation in the outcome variable DP. However, the predicted model is statistically insignificant (F(1124) = 0.143, p = 0.706). This could be explained by the fact that the negative coefficient of job satisfaction of −0.027 is statistically insignificant since its p value is greater than 0.05 (p = 0.706).

(iii) Personal accomplishment (PA)

The value of the multiple of R when PA was regressed against job satisfaction is 0.004, which suggests that the predictor of job satisfaction accounts for 0.4% of the total variation in the dependent variation EE. Moreover, the predicted model is statistically insignificant (F(1124) = 0.446, p = 0.506). The coefficient of job satisfaction is −0.058 with a p value of 0.506, which is greater than 0.05. This indicates that the negative effect of job satisfaction on personal accomplishment is statistically insignificant. A significant negative effect of job satisfaction on emotional exhaustion is exhibited. There is no significant effect of job satisfaction on DP and PA. More research and a larger sample may be required to confirm this.

Based on the regression analysis, the results of the present work indicate that job satisfaction has a negative impact on emotional exhaustion. There was no gender effect on the overall job satisfaction, but compared to male teachers, female teachers exhibited higher levels of satisfaction from intrinsic job characteristics and a lower level of EE, whereas male teachers exhibited a greater score for lack of personal accomplishment. Moreover, there are no statistically significant differences in EE, DP, and PA based on respondents’ age and work experience. Specifically, there is no statistically significant difference in emotional exhaustion (F(240, 4) = 0.717, p = 0.763, Wilk’s sΔ = 0.0.001), depersonalization (F(46,198) = 1.149, p = 0.257, Wilk’s sΔ = 0.6230), and personal accomplishment (F(30, 112) = 1.637, p = 0.025, Wilk’s sΔ = 0.659) based on the respondents’ age. It is important to note that despite the p value of personal accomplishment being less than 0.05, the effect of age is statistically insignificant, indicating that personal accomplishment does not differ based on the age.

4. Discussion

The significance of the extrinsic and intrinsic characteristics for job satisfaction has been demonstrated in several professions [,], including teachers [,,]. The significance of extrinsic job characteristics (e.g., working conditions, wages) on the level of job satisfaction of teachers has been observed in other countries [,]; this was also observed in the present work, and extrinsic job characteristics were also a significant source of stress for the teachers who participated in the present work. Similar results have been reported from teachers working in public schools in Greece [,]. Teachers may enjoy the nature of their job, but extrinsic factors can have an impact on their job satisfaction. For example, teachers in public schools consistently exhibit lower levels of job satisfaction compared to their colleagues who work in private schools in Greece. This difference between the level of job satisfaction of teachers working in public and private schools stems from differences in working conditions, with private schools’ teachers exhibiting higher levels of job satisfaction from the support, infrastructure, and school management compared to those in public schools []. In addition to job satisfaction, burnout components may be affected according to working conditions. For example, as a result of austerity measures initiated during the prolonged economic crisis in Greece, teachers’ gross income has been drastically reduced. In the same manner, the entire public sector in Greece was downsized and operated with limited resources. School salaries were cut by 40%, and shortages in staff and lack of resources became a norm in the Greek public sector (12.These conditions can result in emotional resource depletion leading to emotional exhaustion [], but the effect may vary according to personality traits and demographics. Nevertheless, a recently published study presented some evidence suggesting that teachers in Greece are exhibiting an alarmingly rising level of EE during the long period of economic crisis currently in this country and the unfavorable changes in some of the extrinsic job characteristics of their job [].

In the present work, emotional exhaustion correlated with age, and female teachers exhibited lower levels of EE compared to male teachers. In addition, job satisfaction correlated positively with age and negatively with EE. In Greece, teachers are hired in public schools via a national hiring system and exams. The age may vary according to the periodicity in which the Greek government may organize the hiring process. It may also vary between different levels of education, skills, and subjects, with demand for computer teachers being higher compared to math teachers, for example.

Work experience may be negatively or positively correlated with the three dimensions (EE, DP, PA) of burnout. In some professions, length of service is associated with prolonged exposure to demanding and stressful working conditions. For example, the experience of special education teachers is a predictor for emotional exhaustion and depersonalization [,]. In other professions, the length of service may be negatively correlated with the level of burnout. For example, experienced employees may develop coping strategies [,,] as well as social [] and professional skills [] or they may enjoy increased salaries and better working conditions, and all these factors may contribute to reducing the risk of occupational burnout of employees [,,,].

Irrespective of the gender, experienced and older primary school teachers may exhibit high scores of job satisfaction due to differences in their salary, working hours, responsibilities, and their perceptions for their efficacy, as compared to the less experienced teachers. Furthermore, in Greece, experienced primary education teachers may be more likely to be promoted, have reduced work load, be able to unofficially select their teaching classes, and be less exposed to stressful working conditions compared to less senior and less experienced teachers. Moreover, teaching experience and age may help some teachers to improve their teaching efficacy and emotional intelligence [,]. This potential beneficial effect of work experience is also reflected in the positive correlation between work experience and job satisfaction exhibited in the present work (). Furthermore, other factors may interact with job satisfaction and its characteristics. For example, a mediating effect of self-efficacy and school climate on the job satisfaction of primary school teachers has been reported [,,].

The results of the present work indicate that proactive human resources policies may be required to protect the newly hired and less experienced teachers from burnout. Personality traits, age, experience, and working conditions can mediate the effect of job characteristics on job satisfaction [,,,,,,,]. In turn, unsatisfied teachers may gradually develop negative emotions for their job and be emotionally exhausted [,]. In the present work, a high level of emotional exhaustion was associated with reduced job satisfaction. Emotional exhaustion is a precursor to depersonalization, which subsequently can lead to lack of personal accomplishment [,]. Burnout can lead to decreased job performance, lack of enthusiasm and commitment, and reduced job satisfaction [,,,,,,,]. Educational policy makers could initiate mentoring or aiding initiatives that may be employed to assist teachers in developing skills. Leadership style can also contribute in reducing the level of exposure to stressful conditions of teachers [,,,]. For this reason, school leaders should be encouraged to exploit all available tools to handle the increased risk for occupational burnout of the younger or less experienced teachers.

5. Conclusions

The results of the present work indicate that female teachers were more likely to exhibit increased satisfaction from intrinsic job characteristics whereas male teachers were more likely to exhibit increased emotional exhaustion and lack of personal accomplishment. Frequent sources of stress were extrinsic job characteristics such as working conditions and working hours. Job satisfaction and age had a significant negative impact on emotional exhaustion. The results of the present work could be used by managers and policymakers for assessing and preventing the development of occupational burnout in their workforce.

Author Contributions

Conceptualization, S.A. and E.B.; methodology, S.A. and E.B.; data curation, E.B.; writing—original draft preparation, S.A. and E.B.; writing—review, S.A. and E.B.; editing, A.M.; supervision, A.M. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

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MOOD linked to AGE:

Mood generally tends to improve with age, particularly after late adulthood, with older adults often reporting lower levels of negative emotions and higher levels of life satisfaction. However, this is a broad trend, and individual experiences can vary significantly. Some older adults may experience increased variability in their mood or even show a decline in emotional well-being due to factors like neurodegenerative diseases or social isolation.

Here's a more detailed look at how mood changes with age:

Childhood and Adolescence:

Mood swings are common in childhood and adolescence due to hormonal fluctuations and brain development.

Younger children may have difficulty regulating their emotions, while older children and teenagers develop more sophisticated coping mechanisms.

Moodiness during puberty is often linked to hormonal changes, and these tend to stabilize as individuals move into their early twenties.

Adulthood:

While some studies show a positive trajectory in mood with age, particularly in late adulthood, others highlight individual differences in emotional well-being.

Older adults may experience a decline in negative affect and an increase in positive affect, possibly due to better emotional regulation skills and social support.

Older adults also report being better at regulating their emotions, including minimizing negative emotional responses and experiencing positive emotions more intensely.

However, some older adults may face challenges like neurodegenerative diseases or social isolation, which can negatively impact mood.

Key Factors Influencing Mood Across the Lifespan:

Hormonal Changes:

Fluctuations in hormones, such as during puberty, pregnancy, perimenopause, and menopause, can significantly impact mood.

Cognitive Changes:

Age-related changes in cognitive function, such as processing speed and executive function, can influence emotional regulation and mood.

Social Factors:

Social support, relationships, and life events can all affect emotional well-being across the lifespan.

Health Factors:

Physical health, including chronic conditions and neurodegenerative diseases, can play a role in mood changes.

Personality Traits:

Individual differences in personality traits, such as neuroticism and openness to experience, can also influence emotional patterns across the lifespan.

In conclusion, while older adults tend to experience more positive emotional states and improved mood regulation, it's crucial to acknowledge the individual differences and potential challenges associated with aging, including neurodegenerative diseases and social isolation.

Teenage moodiness is a common experience during adolescence, largely due to hormonal fluctuations and ongoing brain development, particularly in areas related to emotional regulation. While some mood swings are normal, significant and persistent changes in mood, especially when they disrupt daily life, could indicate a more serious issue like depression or other mood disorders.

Normal Teenage Mood Swings:

Hormonal Changes:

Puberty involves significant hormonal shifts, particularly in estrogen, progesterone, and testosterone, which can affect mood, emotions, and impulses.

Brain Development:

The prefrontal cortex, responsible for emotional regulation and decision-making, is still developing during the teenage years, which can make it harder for teens to manage their emotions effectively.

Social and Academic Pressures:

Teens face increasing social expectations, academic demands, and the pressures of navigating social media, which can contribute to moodiness and anxiety.

Sleep Habits:

Changes in sleep patterns, often due to biological factors or lifestyle choices, can also impact mood and emotional stability.

When to be concerned:

Persistent Sadness or Irritability:

If feelings of sadness or irritability last for more than a couple of weeks and interfere with daily activities, it's important to seek professional help.

Changes in Sleep or Appetite:

Significant changes in sleep patterns or appetite, especially if accompanied by other symptoms, could indicate a mood disorder.

Loss of Interest:

A loss of interest in activities previously enjoyed, or withdrawal from social interactions, may be a sign of depression.

Feelings of Worthlessness or Suicidal Thoughts:

These are serious symptoms that require immediate professional attention.

How to support a moody teenager:

Open Communication:

Create a safe space for teens to express their feelings without judgment.

Encourage Healthy Coping Mechanisms:

Help them develop healthy ways to manage stress and emotions, such as exercise, mindfulness, or spending time in nature.

Promote a Healthy Lifestyle:

Ensure they get enough sleep, eat nutritious meals, and engage in regular physical activity.

Seek Professional Help:

If you are concerned about your teenager's mood, don't hesitate to seek professional guidance from a therapist, counselor, or doctor.

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Dev Psychol

. Author manuscript; available in PMC: 2012 Mar 1.

Published in final edited form as: Dev Psychol. 2011 Mar;47(2):318–330. doi:

Age-Related Differences in Profiles of Mood-Change Trajectories

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PMCID: PMC3076052  NIHMSID: NIHMS255084  PMID:

The publisher's version of this article is available at

Abstract

As a group, older adults report positive affective lives. The extent to which there are subgroups of older adults whose moods are less positive, however, is unclear. The aim of the present study was to identify and characterize different subgroups of adults who exhibit distinct trajectories of mood-change across a relatively short time period. Seventy-nine young and 103 older adults continuously reported their moods while viewing emotional and neutral faces. Cluster analysis revealed four subgroups of mood-change trajectories. Both the most positive and the most negative subgroups included more older than younger adults (ps < .05), suggesting that not all older adults exhibit higher positive affect than young adults. Analyses of variance revealed that the most negative group exhibited slower processing speed, more state anxiety and neuroticism, and looked less at happy faces, than the other groups (ps < .05). The results are discussed from an adult developmental perspective, focusing on the increased variability of mood trajectories in the older adults and whether this is a reflection of adaptive functioning, or a potential harbinger of dysfunction.

Keywords: aging, mood-change, gaze, individual differences

We all strive to maximize positive affect in our lives, whether seeking out immediate pleasure or postponing such pleasure in service of achieving a long-term goal (; ). Some people may be better at maximizing positive affect than others. Maintaining a certain level of positive affect is important for both mental (e.g., ) and physical () health. Interestingly, life satisfaction remains stable with age () and increasing age is related to high positive affect and low negative affect when functional health limitations are controlled (). These findings are further qualified by new evidence that older adults report experiencing higher low arousal positive affect and lower negative affect (both low and high arousal) than young adults (). This phenomenon of maintained or increased affective well-being with age is surprising because older adulthood is perceived as a time of relatively greater losses than gains (; ). Together, these findings have raised interest in how older adults are able to maintain such positive affective lives given all of the losses associated with older adulthood.

Many studies have investigated whether this age-related improvement in positive affect is a result of age-related motivational shifts (e.g., socioemotional selectivity theory; ) or increased experience in maintaining a positive mood (). A question less often asked in the literature is whether all older adults are exhibiting these positive affective profiles, and if not, what distinguishes older adults with positive affective profiles from those who do not exhibit such profiles? That is, another way to investigate how older adults are able to maintain positive affective lives is to compare older adults who do show high levels of positive affect to those who do not. Characteristics (such as level of cognitive and attentional functioning, personality, and emotion regulation strategy use) which differ between older adults showing more or less positive affective profiles may suggest necessary and/or sufficient characteristics for maintaining a positive affective life into old age. By identifying a distinctive profile of characteristics associated with sustained positive mood maintenance, we may be able to better understand how older adults, as a group, are able to maintain positive affective lives despite the age-related losses they are experiencing.

Before turning to our investigation of these specific factors in the present study, we first briefly review the relevant literature regarding losses in later adulthood, and current explanations for maintained subjective well-being despite these losses. We consider limitations of past approaches to studying age differences in affective experience. Finally, we describe why a person-centered combined with a variable-centered approach -- rather than only the standard variable-centered approach -- might be particularly useful in elucidating the individual characteristics that undergird age and individual differences in affective well-being.

Older Adulthood: More Losses than Gains

Older adulthood is characterized by relatively more losses than gains (; ; ). For example, cognitive aging researchers have documented that memory performance, especially for episodic and working memory, declines with age (). Overall, cognitive declines associated with aging have been ascribed to older adults’ slower processing speed (), reductions in the ability to inhibit irrelevant information (), and fewer attentional resources (, ). In addition to these cognitive changes, visual and auditory sensory functioning exhibit age-related declines (), as well as physical health and functioning (e.g., ). These cognitive, sensory, and physical declines are coupled with increasing social losses such as the deaths of important social partners ().

Maintenance of Subjective Well-Being in Later Adulthood

Despite all of the losses associated with increasing age, subjective well-being is largely maintained in older adulthood (particularly before the 8th decade; ), a phenomenon sometimes referred to as the “paradox of well-being” (; ; ). How are older adults able to maintain subjective well-being levels comparable to that of young adults in the face of these losses, as evidenced in both longitudinal and cross-sectional studies (; ; ; )?

One focus of research in this area has examined whether there are age differences in the three components of subjective well-being, which may help to describe the nature of well-being and how it changes across the lifespan. Life satisfaction appears to remain fairly stable across the lifespan (), although longitudinal evidence suggests a peak in life satisfaction at age 65 and a gradual decline thereafter (). Positive affect has been found to remain fairly stable across the lifespan (until very old age where there is a slight decline; () in longitudinal () and cross-sectional studies (), and sometimes even shows increases with age in cross-sectional studies (). Longitudinal and cross-sectional research suggests that negative affect decreases across the adult lifespan (; ; ). The presence, intensity, and frequency of positive and negative affect experienced by older adults are important given the emerging evidence that 1) older adults may have a heightened reactivity to stressors, compared to young adults (), and 2) positive affect may serve as an antidote that helps buffer the individual against the negative physiological effects of daily stressors ().

Thus, older adults may need to adapt to the greater toll that stressors take on their physiology (; ), perhaps by maximizing their positive emotions. But how are older adults able to achieve this adaptation? It is likely that many factors contribute to the surprisingly positive affective lives of older adults, including changes in goals, greater experience, and honed emotion regulatory skills. Each of these theoretical accounts is briefly discussed below.

One explanation offered in the literature for age-related maintenance and/or improvement of positive affect is that later adulthood is associated with a shift in goals. As adults perceive their time as more limited (e.g., with increasing age), they are motivated to prioritize emotionally gratifying experiences (; ). This suggests that young adults might be willing to endure unpleasant emotions in service of achieving a long-term goal, while older adults might be less likely than young to foresee achieving long-term goals in their relatively limited future, and thus less willing to endure negative emotions in the service of future achievements (; ; ). A number of studies have found that older adults, compared to young adults, do preferentially attend to () and remember (; ) positive stimuli over negative stimuli, thereby exhibiting positivity effects () in their information processing. Thus, older adults may be motivated to devote what resources they do have to the regulation of emotional experience. It is important to note that some studies have found that a certain level of cognitive functioning, in particular executive control, must be met in order for positivity effects to emerge (; ), although these differences are not seen under all manipulations of cognitive load (). Thus, an age-related shift in goals can explain why older adults might be more motivated than young adults to maintain a positive mood, but does not fully address how they are able to do it. Older adults may be able to maximize positive affect because this shift toward maximizing positive affect becomes a chronic goal such that its activation and implementation is less and less resource-demanding over time (). That is, because maximizing positive affect is a chronic goal in older adulthood, older adults become so practiced at it that it no longer requires as many resources; it becomes somewhat automatized. This may also vary by individual differences in personality; for example, perhaps individuals high in neuroticism are less motivated to maximize positive affect than individuals low in neuroticism ().

One specific way in which individuals can maximize the positivity in their lives is through managing their emotions, or emotion regulation. Emotion regulation is considered any process that influences which emotion is experienced (e.g., anger vs. sadness), when it is experienced, and how we experience and express that emotion (). Several studies suggest that we become more adept at regulating our emotions with age: older adults report having greater control over their emotions (; ) and experience fewer negative emotions (; ; ; ) than their younger counterparts, even when differential exposure to negative experiences is taken into account ().

Altogether, there are several plausible accounts for both why (shift in motivational goals) and how (greater experience) older adults overcome the losses associated with later adulthood to optimize their emotional experience. These accounts are not mutually-exclusive and some combination of such accounts is likely at play. In the present study, we used a unique approach to try to better understand the nature and ubiquity of these positive age-related effects.

Utility of a Subgroup Approach

Although many studies suggest that older adults report more positive affective profiles than their younger counterparts, most of these studies have examined this phenomenon using a limited set of paradigms, such that the heterogeneity of older adults’ affective profiles has not been investigated. Previous studies on mood and mood regulation in older adults (; ; ; ; ; ) have focused either on one report of mood in a moment or a one-time retrospective assessment of mood averaged across a year or day (even experience sampling studies do this, just over lots of moments), but a full understanding of affect requires an examination of the dynamics of affect (). For example, research on the buffering properties of positive affect highlight the need to examine the temporal dynamics of mood; individuals high in trait resilience recovered more quickly from a stressor than those low in trait resilience (; ). Timing has also been an important factor in identifying an attentional bias in trait anxious individuals for threatening material. By investigating different delays between cue and target presentation, researchers were able to determine that the bias for threatening material appears earlier, rather than later (). Thus, emotional processes are necessarily dynamic in nature, suggesting that not only are the magnitudes of positive and negative affect important to consider, but also how these moods unfold over time. Any examination of the potential variability of affective experience across adulthood would therefore need to consider the unfolding of such experience across time.

To our knowledge, no study in the adult development literature has used a person-centered approach (; ; ) to identify subgroups of mood dynamics in real time. Such an approach permits the investigation of relationships between stable and situation-specific affect, strategy use (such as gaze), cognitive functioning, attentional ability, and demographic variables as a function of mood-change subgroup. The advantage of combining a person-centered approach with the standard variable-oriented approach is that the person-centered analyses are more likely to uncover higher-order and nonlinear patterns in the data (), -- in our case, “profiles” of mood ratings across time. Increased interindividual variability within older age groups in a number of domains, such as health (; ), suggest there may also be heterogeneity in mood change profiles amongst older adults that may or may not align with those of young adults.

One way to investigate mood and how it unfolds over time is to simultaneously and continuously record mood while participants are completing a task in which they might be able to regulate their mood, so that a temporal link between mood change and behavior can be observed. In the present study, we aimed to do just that: participants’ eyes were tracked while viewing emotional images, providing a behavioral measure of gaze, or attention deployment, as one strategy to change one’s mood. At the same time, participants continuously rated their mood during the slideshow of emotional images, providing a measure of mood change. By identifying distinct subgroups (profiles) of mood change across a short time period and then examining the characteristics associated with each group (both strategy use as well as person-level variables), we were able to investigate whether certain patterns of mood change over time are associated with a specific profile of characteristics: such profiles might suggest specific barriers to, and/or pre-requisites (e.g., certain cognitive resources) for, maintaining positive affective lives. Identifying the characteristics of adults who do and who do not exhibit positive affective profiles will broaden our understanding of individuals who are the most likely to suffer in the face of stressors such as bereavement (; ; ). On the other hand, we might also find a subgroup of older adults who are able to maintain positive moods over time, which would be consistent with the maintenance of positive affect in older adulthood.

Research Questions

The present study examined three research questions. First, we investigated whether people could be grouped according to different distinct trajectories of mood-change across a relatively short time period (~25 minutes). Past work suggests that 81% of individuals do change their moods in 20 minutes or less under conditions of mood elicitors (). Secondly, we investigated whether young and older adults would be more likely to belong to certain types of mood-change trajectory groups. Our third and final question was whether cognitive, attentional, dispositional, state, or behavioral factors could further distinguish group membership.

Hypotheses

In regard to our first research question, we expected several different trajectories of mood-change to emerge. We expected groups to differ in their initial moods due to individual differences in baseline moods, and we also expected groups to differ in their trajectory of change over time, with some groups showing a more positive trajectory and others a negative trajectory. For the second research question, we expected older adults to be more likely than young adults to belong to the group(s) that maintain the most positive mood across time, consistent with work suggesting maintenance or increases in experienced positive affect with age (; ), as described above. Other studies have found that older adults on average improve their moods more than young adults during lab-based emotion regulation paradigms (e.g., ; ; ). However, given that for many constructs the variability between individuals increases with age (; ), we did not expect all older adults to exhibit this most positive pattern. Indeed, we expected older adults would not belong to a homogenous positive group, but instead older adults would belong to several distinct trajectories of mood change. Consistent with past work, however, we expected the majority of older adults to exhibit positive mood trajectories. Our third research question was more exploratory in nature. In general, we expected cognitive, attentional, personality, and behavioral characteristics to differentiate more positive and more negative mood trajectories. Specifically, we expected individuals with better cognitive and attentional abilities to be more likely to exhibit positive or neutral mood trajectories than negative mood trajectories because active emotion regulation requires cognitive and attentional resources (; ). We expected personality characteristics such as neuroticism to be related to mood (). Previous work suggests that neuroticism is linked to affect across the lifespan such that individuals high in neuroticism show less of a decrease in negative affect in later adulthood (; ). Consistent with recent findings that suggest gaze can be used as a tool to regulate mood (; ), we also expected individuals within groups that exhibited a trajectory of mood improvement, as opposed to those who do not report an improvement in mood, to be more likely to attend to the more positive faces within an emotional-neutral synthetic face pair.

Method

Participants

Eighty-six young adults (aged 18–30 years) and 106 community-dwelling older adults (aged 58–89 years) living in the northeastern region of the United States participated in this study. Young adults were recruited from an introductory psychology course and with flyers posted on campus. Older adults were recruited from a lifelong learning class and with advertisements. Participants received either course credit or a monetary stipend. Ten participants were excluded from analyses because part or all of their mood slider data were missing due to technical failures, leaving 79 young adults (44 women and 35 men; aged 18–30 years; M = 19.84, SD = 2.13) and 103 older adults (74 women and 29 men; aged 58–88 years; M = 72.05, SD = 6.97) for analyses. All participants spoke English fluently. Participants were highly educated; on average participants had either attended some college or were college graduates. Eighty-nine percent of the sample was White, 4% Asian, 3% Other, 1% Black, 1% Hispanic, and 2% mixed or no response. No participant scored below our cutoff criterion of 24 on the Mini-Mental State Exam ().

Materials and Measures

Gaze and mood measurement

Equipment

Face-pair stimuli were presented in random order on a 17-in. display with GazeTracker software (Eye Response Technologies, Inc., Charlottesville, VA). While viewing the 25 minute face-pair slideshow, participants continuously rated their current mood from 0 (worst) to 100 (best) in real time using a potentiometer slider (Empirisoft Corporation, New York, NY) that collected responses at a rate of once every second. We captured a mood measurement from the potentiometer slider approximately every two minutes, creating 14 mood measurement variables for each participant. Eye movements were recorded at a rate of 60 Hz with an Applied Science Laboratories (Bedford, MA) Model 504 Eye Tracker with magnetic head transmitter.

Emotional face stimuli

Slides of synthetic face pairs consisting of an emotional face (angry, afraid, sad, or happy) and its neutral counterpart were presented to participants while their eyes were tracked. The emotional synthetic faces were created based on  guidelines for each emotion (for more information on how the synthetic faces were created and validated see ; ). The face pairs were presented on a gray background. Several variables were counterbalanced to avoid order effects: the side of the screen the emotional face appeared on (left or right), the sex of the face, and the emotion of the emotional face.

Gaze measures

For the eye tracking data, a fixation was defined as an interval when gaze was focused for 100 ms or more within 1° visual angle (). Gaze measures were calculated as ratio scores that reflect the relative fixation to the emotional face in the emotional-neutral face pairs compared to fixation to the neutral face. Thus, for each face a ratio score was calculated using this formula: (emotional − neutral)/ (emotional + neutral). These ratio scores were averaged across faces within the four emotion types to create four ratio scores: Anger, Fear, Happy, and Sad (see  for means and standard deviations of gaze ratio scores). A positive ratio score reflects greater fixations toward the emotional face, a negative ratio score reflects greater fixations toward the neutral face, and a score of zero indicates that the emotional and neutral faces received an equal number of fixations.

Table 1.

Means and Standard Deviations (in parentheses) for measures of Gaze, Cognition, Attention, Perception, and Affect for Young and Older Adults

Note. Sample sizes differ due to missing data: Gaze Fixation Ratios (N = 130), Cognitive Functioning (N = 179), Attentional Functioning (N = 172), Perceptual Functioning (N = 181), and Affect Measures (Ns = 173–182). Higher scores indicate better performance unless otherwise indicated.

a

Gaze Measures computed as ratio scores: (emotional − neutral)/ (emotional + neutral).

b

For the Digit Symbol, lower scores indicate better performance.

c

Mini-Mental State Exam, maximum score of 30 (range: 24–30).

d

For Snellen and Rosenbaum tests, lower scores indicate better performance.

e

Life Orientation Test (), Optimism Test total score.

f

Center for Epidemiological Studies Depression Scale ().

Measures of related constructs

See  for means and standard deviations of measures of related constructs.

Cognitive functioning

We included a battery of cognitive measures in order to investigate whether differences in cognitive functioning would impact participants’ mood ratings, especially given our interest in age effects. Short term memory was assessed with the Wechsler Adult Intelligence Scale-Revised Forward and Backward Digit Span (WAIS; ) in which participants repeat a series of numbers forward and backwards in increasingly larger sets. Processing speed was measured with the WAIS Digit Symbol Substitution (). Crystallized intelligence was measured with the Shipley Vocabulary Test (). In addition, the Mini-Mental State Exam (MMSE; ) was administered to screen for cognitive impairment.

Attentional abilities

Attentional abilities were assessed with the Attention Network Test (ANT; ) which measures three different attention networks: alerting, orienting, and executive attention. In the ANT, participants indicate the direction a central arrow is pointing (left or right). Sometimes the arrow is presented above fixation, and sometimes below fixation. In addition, sometimes the arrow is presented with flankers, and sometimes without. The alerting score reflects the individual’s efficiency at alerting when a cue is present vs. absent, the orienting score reflects efficiency at orienting to a spatial cue, and the executive control score reflects the individual’s efficiency at resolving conflicts that arise due to flankers. The authors report test-retest correlations for the three networks ranging from .52 to .77 (). Recent work has found that good attentional functioning may be related to the use of gaze for mood regulation ().

Perceptual functioning

Because we wanted to ensure that all individuals were able to perceive the stimuli presented on the computer, participants’ perceptual functioning was assessed with three measures: the Snellen chart for visual acuity (), the Rosenbaum Pocket Vision Screener for near vision (), and the Pelli-Robson Contrast Sensitivity Chart ().

Affect measures

We included measures of affect so that we could examine whether state and trait affect variables are related to mood rating changes across a short time period. Thus, participants completed five affective measures: the State-Trait Anxiety Inventory (STAI; ), the Life Orientation Test (LOT; ) designed to assess dispositional optimism and pessimism, the Neuroticism Questionnaire (N-Questionnaire; ), the Positive and Negative Affect Schedule (PANAS; ), and the Center for Epidemiological Studies Depression Scale (CES-D; ).

Demographic variables

Participants reported their age, gender, and education level and rated their health on a 5-point Likert-type scale (1 = poor, 2 = fair, 3 = good, 4 = very good, 5 = excellent).

Procedure

After obtaining informed consent, participants were asked to complete the demographics form and the self-report affect measures. Next, participants were administered the cognitive and attention tests, followed by the three vision tests. Then participants were asked to self-induce into one of three randomly assigned moods: positive, neutral, or negative, using a variant of the Eich Continuous Music Technique (CMT; ). Specifically, participants were asked to imagine hypothetical situations or think of autobiographical events that evoked the assigned mood while listening to music that matched that assigned mood. In the positive condition, participants were instructed to think about a particularly pleasant event, something very upbeat or exciting while you listen to the music. In the neutral condition, participants were instructed to think about a particularly neutral event, something that really didn’t have a significant effect on you, where you felt neither pleasant nor unpleasant, while you listen to the music. And in the negative condition, participants were instructed to imagine, in a lot of detail, something that would make you feel very unpleasant and tense or agitated, while you listen to the music. Participants continuously rated their mood on an affect grid containing valence and arousal dimensions. The mood induction was considered successful once their ratings remained within the appropriate area of the grid for at least 30 seconds.

After the mood induction, participants were seated in front of the potentiometer slider and the eye tracker. A 17-point calibration was performed to ensure accurate measurement of participants’ gaze. Participants rated their current mood from 0 (worst) to 100 (best) on the potentiometer. Participants were instructed to watch the slideshow that followed naturally, as if they were watching TV at home and to report their mood on the potentiometer throughout the presentation. The slideshow consisted of 272 face pair slides displayed for four seconds each, followed by a 500 ms crosshair slide to re-align gaze to the center of the screen. To minimize skew of results due to blinks and moments of lost tracking (from head movement, pupil obfuscation, etc.), two criteria were used to identify individual trials in which the fixation pattern indicated unreliable recording: trials with all fixations to “off” regions (no fixations on faces), or trials with < 900 ms total fixation anywhere on the slide. These trials were not included in the ratio scores. As a reminder, participants were prompted randomly throughout the slideshow to rate their current mood using the potentiometer. Immediately following the conclusion of the slideshow, participants made a final rating of their mood on the potentiometer.

Results

Mood-change Trajectory Types

In order to answer our first question regarding whether participants could be categorized into distinct groups of mood-change trajectories, we performed a cluster analysis on the mood ratings. This method allowed us to categorize participants into subgroups according to their responses on all 14 mood variables rather than on a single mood-change score. We captured a mood rating from the potentiometer device approximately every two minutes for each participant, yielding 14 mood ratings (ranging from 0 = worst to 100 = best) for each participant. These mood ratings represent the first slider rating immediately following the mood induction procedure, 12 ratings during the 23.5 minute face pair slide show, and a last slider rating immediately following the slide show. These 14 mood ratings were standardized into Z-scores and submitted to a two-step clustering procedure (). Not surprisingly, the 14 mood ratings were all significantly correlated (see  for intercorrelations among the 14 mood ratings). Cluster analysis is sensitive to high intercorrelations among variables (). Two variables which are highly correlated might exhibit undue influence on the determination of cluster group membership. However, because no two mood ratings seemed differentially highly correlated, other than what would be expected based on time proximity, we went ahead with the analysis despite significant intercorrelations among the variables to be clustered.

Table 2.

Intercorrelations Among the 14 Mood Ratings (N = 182)

Note. All correlations significant, p < .05.

First, we applied a hierarchical clustering method using Ward’s () minimum-variance method with squared euclidean distances to help determine the theoretically and statistically appropriate number of clusters. We used multiple criteria to decide on the optimal number of clusters (): specifically, we examined the clustering coefficient from the agglomeration schedule produced from the hierarchical clustering procedure in SPSS 16.0 (SPSS Inc., 2007) to identify cluster combinations that were just prior to a substantial decrease in within-cluster similarity (exhibited by a relatively large increase in the coefficient value). We also implemented the Ward’s procedure () using PROC CLUSTER in SAS 9.1 (SAS Institute, 2002–2003) to obtain the pseudo-F statistic, the pseudo-T2 statistic, and Sarle’s cubic clustering criterion (CCC; ) for each cluster step. The pseudo-F statistic represents separation among all clusters at the current step and the pseudo-T2 statistic represents the dissimilarity of the two clusters most recently joined. We used a peak in the CCC () as another indication of the ideal number of clusters (; ). These four decision criteria converged on either a three or a four cluster solution as the ideal number of clusters. The four cluster solution seemed most appropriate for investigating our research questions regarding variability in mood change. Given how little data there is on the heterogeneity of mood change among older adults, we chose the four cluster solution because we believed the solution that modeled greater heterogeneity would be more conceptually useful. For the second step of the two-step clustering procedure, we then submitted the mood ratings to a nonhierarchical (k-means) clustering procedure using SPSS 16.0 (SPSS Inc., 2007) to optimize cluster membership assignment.

As expected, several distinct mood-change trajectories emerged from the cluster analysis (see ). The four clusters are named from the most positive subgroup (“Increasingly Positive”) to the most negative subgroup (“Increasingly Negative”). Two groups (Positive to Neutral and Negative to Neutral) exhibited a pattern of becoming more neutral over time. Participants who belong in the Negative to Neutral group reported negative initial mood ratings but gradually rated their moods more and more neutral across the mood rating period. The mood-change trajectory of the Positive to Neutral group shows the opposite pattern, with participants initially rating their moods as positive, but becoming more neutral over time. The other two groups (Increasingly Positive and Increasingly Negative) exhibited more extreme mood ratings over time. Participants in the Increasingly Positive group rated their mood as initially positive and became more positive over the mood rating period. Participants in the Increasingly Negative group showed the opposite pattern with negative initial mood ratings that became more negative over time.

Figure 1.

Mood-change trajectories across ~25 minute slide show as a function of cluster membership group.

Relationship of cluster group membership to mood induction condition

We included a mood induction in the design of the study in order to create variability in mood states before the primary tasks of interest (capturing a 25-minute interval in which none of the participants’ moods were changing would not allow a good test of mood change profiles). Moods started to vary immediately following the end of the induction: only 52% of the sample reported the same mood at the end of the induction and a few minutes later, when potentiometer mood ratings (which we focused on in the current study) started. In other words, the mood induction was not overwhelmingly successful in inducing a lasting mood, as only half of the participants were in the intended mood at the first measure of the potentiometer ratings. Nonetheless, it was important to show that mood induction condition and cluster membership were not redundant categories. Mood trajectory group membership did not entirely overlap with our mood induction conditions. That is, some participants from each of the three mood induction conditions belong to each of the four mood trajectory groups. Increasingly Positive: positive n = 13 (8 older adults), negative n = 13 (12 older adults), neutral n = 11 (5 older adults); Positive to Neutral: positive n = 25 (10 older adults), negative n = 11 (6 older adults), neutral n = 16 (7 older adults); Negative to Neutral: positive n = 12 (9 older adults), negative n = 26 (11 older adults), neutral n = 24 (13 older adults); Increasingly Negative: positive n = 8 (6 older adults), negative n = 12 (7 older adults), neutral n = 11 (9 older adults).

Spearman’s rank correlation coefficient between cluster group membership and mood induction condition was not significant, ρ(181) = .13, n.s., suggesting that cluster group membership is not related to mood induction condition. Cluster group membership and mood induction condition are also not significantly related when examined separately for each age group (young adults: ρ(78) = .13 and older adults: ρ(103) = .14, ps > .15 ). These findings suggest that the cluster creation and group membership assignment was not simply a reflection of our experimental mood induction conditions, meaning that our cluster analysis was not confounded by the induction; rather, the induction simply set the stage for a context with a great deal of variability in mood change trajectories, which was important for addressing our research questions.

Age Make-Up of Groups

In order to determine whether young or older adults were more or less likely to belong to certain mood-change trajectory groups, we conducted a chi-square analysis comparing the distribution of young and older adults amongst the four groups (similar to ). As expected, we found that the two age groups were differentially distributed across the four mood trajectory clusters, χ2(3) = 7.94, p < .05 (see  for number of older adults in each of the mood trajectory clusters). Specifically, older adults were overrepresented in the Increasingly Positive and Increasingly Negative groups in comparison to the Positive to Neutral group, ps < .05. We expected the most positive group (Increasingly Positive) to consist of more older adults than young adults based on previous research. We did not, however, expect older adults to be overrepresented in the most negative group (Increasingly Negative) as well.

Table 3.

Mood Trajectory Group Differences by Age Group and Correlates

Notes:

a

For the correlates, post-hoc comparisons of means were conducted using Tukey’s Honestly Significant Difference (HSD).

b

Results based on Multivariate Analyses of Variance (MANOVAs) and univariate analyses of Variance (ANOVAs). Sample sizes for the five correlate type categories differ due to missing data: Gaze Fixation Ratios (N = 130), Cognitive Functioning (N = 179), Attentional Functioning (N = 172), Perceptual Functioning (N = 181), and Affect Measures (NStateAnxiety = 179 and NNeuroticism = 173). Only those correlates which were significantly different (p < .05) by mood trajectory group are presented in the table. Reported means of correlate scores and standard errors (in parentheses) are from the estimated marginal means for the MANOVA models.

c

ANT Mean RT was computed for correct trials only.

\*

p < .05;

\*\*

p < .01.;

\*\*\*

p <.001.

Because we had a fairly large range of ages in our older adult sample (31 years), we tested whether the average age of older adults in the Increasingly Negative group (M = 71.23, SE = 1.44) was older than the average age of older adults in the Increasingly Positive group (M = 74.24, SE = 1.35). A univariate analysis of variance (ANOVA) on just the older adult sample revealed that the Increasingly Negative and Increasingly Positive groups did not differ according to the average age of older adults in the group, p > .05.

Characteristics of Groups

To address our third research question, which sought to define a profile of characteristics that distinguishes mood trajectory group membership, we first conducted chi-square analyses comparing the distribution of gender, education, and self-reported health amongst the four mood trajectory groups. Because the results of these analyses failed to reach significance, these demographic variables were not included in further analyses.

Next, we conducted multivariate analyses of variance (MANOVAs) and univariate ANOVAs to identify characteristics that distinguish cluster group membership. We chose to conduct MANOVAs for groups of variables that were highly intercorrelated and represented the same construct, such as the four gaze variables, the three measures from the WAIS (Digit Span Forward, Digit Span Backward, and Digit Symbol Substitution), the three networks of the ANT, and the three perceptual measures, because MANOVA allows for the covariance structure among common variables and controls for experiment-wide error rate (). Mood trajectory cluster membership was entered as the independent variable for each of these analyses. Univariate ANOVAs were examined to determine subgroup differences for each of the specific dependent measures following a significant effect in the MANOVA (; ). Post-hoc analyses were conducted with Tukey’s Honestly Significant Difference (HSD) to determine which groups differed on a specific measure. Several differences between the groups emerged (see  for means, standard errors, tests of significance, and post-hoc comparisons for significant effects).

Gaze

We observed a multivariate significance for the main effect of cluster group membership on gaze variables, Wilk’s λ = .83, F(12, 383.93) = 2.30, p < .05, ηp2 = .06. Univariate ANOVAs and follow-up post-hoc tests indicated that of the four fixation ratios entered as dependent variables in the MANOVA (Anger, Fear, Happy, Sad), only the Happy Fixation Ratios differed according to cluster group membership, with the Increasingly Negative group looking less at happy faces than the Positive to Neutral group.

Cognitive functioning

The multivariate significance for the main effect of cluster group membership on the three WAIS cognition variables was significant, Wilk’s λ = .87, F(9, 421.19) = 2.70, p < .01, ηp2 = .05. Univariate ANOVAs and follow-up post-hoc comparisons indicated a significant cluster group difference for Digit Span Forward scores (a measure of short term memory), p < .01, with the Positive to Neutral and Increasingly Negative groups scoring higher than the Negative to Neutral group. In addition, there was a significant univariate effect of cluster group for the Digit Symbol Substitution Test (a measure of processing speed), p < .05. Post-hoc analyses indicated that the Increasingly Negative group had higher (slower) processing speed scores than Groups 1 and 2. The groups did not differ on vocabulary scores, p > .05.

Attentional functioning

The multivariate effect for cluster group differences in the three attention networks (alert, orient, conflict) did not reach significance, p > .05. However, a univariate ANOVA yielded a significant cluster group difference for overall reaction time (across all trial types) for correct responses in the ANT, p < .05, with the Increasingly Positive group exhibiting slower reaction times than the Positive to Neutral group.

Perceptual functioning

For the three perceptual tests (Snellen visual acuity, Pelli-Robson contrast sensitivity, and Rosenbaum near vision), the multivariate test for cluster group differences did not reach significance, p > .05.

Affect measures

Univariate ANOVAs revealed significant cluster group differences for state anxiety, F(3, 175) = 3.80, p < .05, ηp2 = .06, neuroticism, F(3, 169) = 3.05, p < .05, ηp2 = .05, and approached significance for depression, F(3, 177) = 2.63, p = .05, ηp2 = .04. Post-hoc analyses indicate that the Increasingly Negative group reported greater state anxiety than the Positive to Neutral group and greater neuroticism than the Increasingly Positive group. The Increasingly Positive group (M = 8.80, SE = 1.46) reported lower levels of depression than the Increasingly Negative group (M = 14.70, SE = 1.60), p < .05.

In sum, individuals in the most positive group (Increasingly Positive) had slower response times on average for correct responses in the ANT than individuals in the Positive to Neutral group, which is consistent with more older adults belonging to the Increasingly Positive group than the Positive to Neutral group. In addition, the most negative group (Increasingly Negative) had greater state anxiety (than the Positive to Neutral group), had better short term memory scores (than the Negative to Neutral group), slower processing speed (than the Increasingly Positive and Positive to Neutral groups), and looked less at happy faces compared to neutral faces (than the Positive to Neutral group). Finally, the Positive to Neutral group also exhibited better short term memory scores than the Negative to Neutral group.

Discussion

In this study we investigated age and individual differences in mood-change profiles using a person-centered approach to complement the standard variable-oriented approach, which allowed for a richer and more complex variety of mood-change profiles than previously seen in the literature. Overall, older adults exhibited all three types of trajectories (positive, negative, and neutral), while young adults were less varied in their trajectory of mood change; most showed a pattern of shifting toward a neutral mood. Interestingly, older adults were more likely than young adults to belong to mood-change groups that exhibited the most extreme trajectories: either positive to more positive or negative to more negative. Thus, contrary to expectations based on overall age group differences in subjective well-being and positive affect (; ), some older adults were more likely than young adults to exhibit a trajectory of maintained and even increased negative mood over the course of the 25 minute slideshow.

The main factors that differentiated the two extreme groups were that the negative group (Increasingly Negative) had slower processing speed than the two more positive groups (Increasingly Positive and Positive to Neutral) and higher neuroticism than the Increasingly Positive group. Additionally, the Increasingly Negative group had more state anxiety and looked less at happy faces than the Positive to Neutral group but did not differ on those characteristics from the Increasingly Positive group. So, although members of the Increasingly Negative group were more anxious than those in the Positive to Neutral group, which could certainly usurp resources that could otherwise be devoted to mood maintenance, it does not explain the differences between the Increasingly Positive and Increasingly Negative groups. Interestingly, our measure of neuroticism did differentiate these two extreme groups, which is consistent with research suggesting that individuals high in neuroticism are less likely to repair a negative mood than those lower in neuroticism and thus tend to stay in negative moods for longer (). In addition, individuals in the Increasingly Negative group reported higher levels of depression than those in the Increasingly Positive group, which is consistent with research that has found that less depressed individuals show greater belief in the possibility of proactively changing moods ().

Unlike previous findings of a relationship between higher levels of executive control and better emotion regulation amongst older adults (; ), the only cognitive variable that differentiated members of the Increasingly Positive group from the Increasingly Negative group was processing speed. One possible explanation for this relationship is that individuals with slower processing speed may be less able to engage in methods that would improve their mood. Alternatively, slow processing speed may be an overall marker of cognitive changes that constrain the ability to improve mood. The relationship could even be more direct, as faster thinking has been linked to happier thoughts (). It may also be that processing speed undergirds higher level functioning related to the executive functioning required to maintain a positive mood. It is curious then that we did not see differences between the Increasingly Positive and Increasingly Negative groups on the measures of attentional functioning (), which include a measure of executive control (i.e., conflict). We also found better short-term memory scores for the Positive to Neutral and Increasingly Negative groups compared with the Negative to Neutral group. This is puzzling because it is in contrast with what would be expected if cognitive resources are required for improving one’s mood: it seems the two groups who showed declines in mood at least have better short-term memory abilities than a group who improved its mood. Perhaps short-term memory is not as essential to mood maintenance as processing speed, but future research needs to address this question more directly.

Theoretically, an age-related shift toward prioritizing emotionally gratifying experiences is useful for explaining differences between age groups. Because older adults are exhibiting a variety of different patterns of mood-change in this study, it is possible that the members of the positive and negative groups differ in the degree to which they have shifted toward maximizing positive affect, or whether this is a chronically activated goal for them at all. That is, we cannot assume that all older adults are equally motivated to maximize positive affect. Past work has suggested one factor that might differ between older adults who do and do not exhibit positivity effects is the availability of cognitive and attentional resources (; ). In the present study, members of the Positive to Neutral group looked more at happy faces and had faster processing speed than members of the Increasingly Negative group, consistent with the hypothesis that older adults with more available cognitive resources are better able to actively regulate their moods by selectively attending to positive images. Indeed, these looking preferences may have helped individuals improve their mood as individuals in the Positive to Neutral group exhibited more positive mood trajectories than did those in Increasingly Negative group.

Nevertheless, even considering the increased individual differences associated with age (), it is still surprising that so many older adults belong to the mood-change trajectory group that is the most negative. This is in stark contrast to studies reporting overall more positive average affect for older adults than young adults (; ). Older adults who exhibit the most negative mood trajectory do not fit with the paradox of well-being trend. Instead, these older adults (and young adults) are not maximizing positive affect in our lab-based paradigm, and whether this transfers to similar negative patterns in other situations in their daily lives remains to be seen. One possibility is that these atypical negative mood change patterns could be linked to cognitive or attentional difficulties. Although one of the advantages of this study was the real-time mood capture linked with gaze behavior over a short duration, it is unknown how long it takes individuals to regulate their moods. It may be that some of the older adults who belong to the Increasingly Negative group would change group membership to a more positive group if we extended the duration of the study. Twenty-five minutes may not be enough time for some older adults (i.e., those with slower processing speed, greater anxiety, or just transitioning into the goal state of maximizing positive affect) to transition out of negative mood states into more positive ones. Of course, it is also possible that even long-term follow-up would find these individuals still in negative states.

Limitations

There are a number of limitations to this study. Because the design of the study was cross-sectional, we cannot be sure that the age differences exhibited are due to developmental changes rather than, for example, differences between cohorts in the processing of emotions. Another limitation is the lack of differentiation in both the negative mood induction and the mood ratings. There is a growing literature which suggests that very different aging effects emerge when different discrete negative emotions are considered (e.g., anger vs. sadness; ; ). We do not know from the present work whether reports of a negative mood were people feeling angry versus sad. It may be that a sad negative mood is more likely to be tolerated than an angry negative mood. Thus, some participants may have been less motivated to regulate out of their negative mood if they were sad rather than angry. Nevertheless, this study was able to differentiate groups of people who were more or less likely to improve their negative moods (whether sad or angry) over the course of 25 minutes. It is also possible that not all participants are equally motivated to regulate out of a negative mood, or to change their mood at all. This study is limited in that it did not include a measure of whether participants wanted to improve their moods. Also related to the time course issue, it is possible that 25 minutes is not an ecologically valid time frame for differentiating the globally more positive affective lives of older adults from the less positive reports generally given by young adults. In addition, it should also be noted that this was a relatively small sample size for cluster analysis (), thus conclusions drawn from these results are tempered until it is replicated with a larger sample size. Furthermore, although we chose to use a mood induction to insure variability in starting moods of participants, this may have unduly influenced our mood trajectory groups. Future research should use a single mood induction or use mood as a repeated measures factor to eliminate this possibility.

Conclusions and Future Directions

In this study we used a person-centered approach to capture subgroups of distinct mood change trajectories and the person and group level variables that are related to different trajectories. By employing a person-centered approach, we were able to examine the heterogeneity among subgroups of older adults in the dynamics of mood change over time. Overall, the results suggest that some older adults do experience and maintain negative moods over a short time period, even more so than young adults. There is an emerging literature identifying the conditions under which older adults experience and report negative moods and emotions (; ; ). Future research should investigate the implications of this variability in mood change trajectories amongst older adults and whether this is a reflection of adaptive functioning or a potential indicator of dysfunction. It would also be interesting to gain a better understanding of the motivational mindset of individuals who exhibit a negative mood trajectory. It could be that an individual’s subjective age, rather than their objective age, might better differentiate mood-change trajectories (; ). Future work could also examine in more detail what characteristics distinguish the Increasingly Positive group from the Increasingly Negative group, such as functional limitations or more specific components of health. Perhaps investigating mood change among very old individuals could help to highlight such distinctions.

The characteristics that differentiate the most negative and the most positive groups suggest that they differ in their affective profiles, cognitive functioning, and their use of gaze as a regulatory tool in this paradigm. This suggests that the dynamics of mood change across a short time period may be multiply determined. Although the present study cannot address the causal direction of these relationships, it is a first glimpse into factors beyond age group and executive functioning that are related to different patterns of mood change. While these results paint a less positive portrait of affect and aging than other work, there is an upside to our findings as well. Given recent literature suggesting that positive affect may help buffer an older adults’ more vulnerable system (; ; ), the possibility that differences in multiple domains (e.g., faster processing speed, less anxiety and neuroticism, more attention to happy faces) are related to more positive mood trajectories is promising because it suggests that older adults who exhibit decline in one domain (e.g., processing speed) may still be able to maximize positive affect in their lives by capitalizing on strengths in another domain (e.g., personality traits).

Acknowledgments

This research was supported by National Institute of Health Grants: R01AG-026323 awarded to Derek M. Isaacowitz & T32AG-00204. We wish to acknowledge Deborah Goren and Hugh Wilson for creating the synthetic faces used in the study.

Footnotes

1

This study was part of a larger study, portions of which have been published elsewhere ((; ; ). Previous results reported from this sample restricted the age range for young adults to an upper limit of 25 years (). In the present study, we included the 30-year-old in our analyses. We also ran the analyses excluding the 30-year-old and our cluster creations did not differ from that with the 30-year-old nor did any participant’s cluster group membership change. Thus, we report here analyses including the 30-year-old.

2

Data from 52 participants were excluded from the eye tracking analyses because 1) they were not trackable: eye movements could not be calibrated (e.g., due to droopy eyelids), they were not successfully tracked for at least 25% of the trials (68 trials), or 2) one of their fixation ratio scores was more than 3 SD away from the group means. After excluding these 52 participants from any eye-tracking analyses, a total of 130 participants’ eye tracking data remained (74 young adults, 56 older adults). Comparison of trackable participants to nontrackable participants within each age group revealed that older nontrackable participants had worse visual acuity (Snellen) than trackable participants, and nontrackable young adults had slower response times in the attention network test (ANT) than trackable young adults, ps < .05. No other cognitive, affective, or demographic measures significantly differed between trackable and nontrackable participants within the two age groups.

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The Impact of Aging on Mood Disorders

Melanie Donohue, LCSW

Founder & Licensed Clinical Social Worker

3:59 am

Mood disorders can profoundly impact an individual’s well-being and quality of life. As people age, they may become more susceptible to experiencing mood disorders due to various factors. Understanding the relationship between aging and mood disorders is crucial for addressing the mental health needs of older adults and improving their overall well-being.

Mood Disorders and Aging

The prevalence of mood disorders among older adults is a significant concern.  has shown one in four elderly individuals suffers from a mood disorder. Age-related changes in brain chemistry, hormonal shifts, and physical health conditions can increase the likelihood of developing mood disorders in older adults. Additionally, the loss of loved ones, retirement, and other life changes can contribute to emotional distress in this population.  
   
Different types of mood disorders commonly found in older adults include major depressive disorder, generalized anxiety disorder, and bipolar disorder. Each of these disorders presents unique challenges and requires specific treatment approaches.

Risk Factors for Mood Disorders in Aging

Various risk factors contribute to the development of mood disorders in older adults, including biological, psychological, and social factors.

Biological Factors: Genetic predisposition, hormonal fluctuations, and the presence of chronic illnesses can influence the development of mood disorders in older adults. Understanding these biological factors helps identify individuals who may be at higher risk and facilitates targeted interventions.

Psychological Factors: Older adults often face significant life changes, such as retirement, losing loved ones, and health issues. These psychological stressors, coupled with grief and the challenges of adapting to new circumstances, can increase the risk of developing mood disorders.

Social Factors: , limited social connections, and a lack of emotional support contribute to the burden of mood disorders in aging. Maintaining a strong social network and fostering social engagement is crucial for mitigating the risk of these disorders.

The Impact of Mood Disorders

Mood disorders in aging have significant consequences that extend beyond emotional distress. These disorders can have far-reaching implications for an individual’s physical health, cognitive function, and social well-being. Older adults with mood disorders are at a higher risk of developing physical health conditions such as cardiovascular disease, diabetes, and obesity, as chronic stress and physiological changes take their toll.  
   
Furthermore, mood disorders can contribute to  and increase the likelihood of developing dementia in older adults. Socially, mood disorders can lead to social isolation, loss of independence, and a diminished overall quality of life. Recognizing and addressing these consequences is crucial for promoting the well-being and overall functioning of older adults with mood disorders.

Treatment Options for Mood Disorders

Treatment options for mood disorders in aging encompass a range of approaches to improve mental well-being and overall quality of life. Some of the key treatment options include:

Psychopharmacological treatments: Medications such as antidepressants and anxiolytics can be prescribed to manage symptoms and regulate brain chemistry.

Psychotherapeutic treatments: Psychotherapy, such as cognitive-behavioral therapy (CBT) and interpersonal therapy, can help older adults identify and modify negative thought patterns, develop coping strategies, and enhance social support networks.

Complementary therapies: Practices like  and  have shown promise in reducing symptoms of depression and anxiety in older adults.

Lifestyle modifications: Encouraging healthy lifestyle habits, including , balanced nutrition, and adequate sleep, can positively impact mood and overall well-being.

Social support and engagement: Encouraging older adults to maintain , participate in meaningful activities, and seek support from family, friends, or support groups can help alleviate symptoms of mood disorders.

Integrated care: Collaboration between mental health professionals, primary care physicians, and specialists can ensure comprehensive and coordinated care for older adults with mood disorders.

By implementing a combination of these treatment options tailored to the specific needs of each individual, it is possible to effectively manage mood disorders in aging individuals and enhance their overall mental health and quality of life.

Senior Counseling for Mood Disorders

offers specialized counseling services for seniors dealing with mood disorders. Our dedicated team of mental health professionals understands the unique challenges older adults face and is committed to providing compassionate and effective support. Through individualized , we address a variety of mood disorders.  
   
Our therapists utilize evidence-based approaches, such as cognitive-behavioral therapy (CBT) and interpersonal therapy, to help seniors identify and manage their symptoms. At Blue Moon Senior Counseling, we prioritize the well-being and mental health of our senior clients, providing them with the tools and support they need to navigate and overcome mood disorders.

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Blue Moon Senior Counseling is a group of Licensed Clinical Social Workers (LCSWs) that provide counseling and psychotherapy to persons in various senior living communities and private residences.

Our Mission

To promote the emotional health and well-being of seniors through supportive counseling, education and advocacy.

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ANXIETY linked to AGE  
Anxiety's expression and prevalence can change across the lifespan. While younger adults may experience higher rates of certain anxiety disorders, older adults may face unique challenges and symptom presentations, including anxiety related to health concerns and fear of falling. Some anxiety disorders, like social anxiety, may persist and potentially worsen with age, while others, like panic disorder, may become less prevalent.

Here's a more detailed look:

Younger Adults:

Higher overall prevalence: Younger individuals, particularly those aged 16-29, are more likely to experience some form of anxiety.

Specific disorders: Social anxiety disorder and panic disorder may be more prominent in younger adults.

Worry focus: Younger adults may worry more about work and interpersonal relationships.

Older Adults:

Unique anxieties:

Older adults may experience anxiety related to health concerns, fear of falling, cognitive decline (e.g., memory loss), and the well-being of loved ones.

Underreporting:

Older adults may underreport anxiety symptoms, and diagnoses can be missed or misdiagnosed due to overlapping physical and mental health conditions.

Potential for worsening:

Social anxiety may worsen with age.

Less severe symptoms:

Some anxiety disorders, like panic disorder and social phobia, may present with less severe symptoms in older adults compared to younger adults.

Physiological changes:

Aging can bring about physiological changes in the nervous system that may contribute to anxiety.

Medication and health conditions:

Older adults often take more medications and have more physical health problems, which can increase the risk of developing anxiety disorders.

Fear of falling:

Fear of falling is a specific phobia that increases in prevalence with age.

Impact on quality of life:

Anxiety can significantly impact the quality of life and independence of older adults.

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How Is Age Related to Anxiety?

Written by  | Reviewed by

Updated on June 9, 2023

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Key takeaways:

Anxiety disorders can happen at any time in life, from childhood to old age.

People with anxiety disorders can have a wide range of physical and emotional symptoms.

Children, teens, and older adults, are all more likely to have physical symptoms of anxiety.

Sometimes it’s hard to diagnose anxiety disorders in these age groups, as they look like other medical illnesses.

Table of contents

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Having some mild anxiety from time to time is normal. But, for some people, persistent anxiety, worry, and fear can be symptoms of an  — especially if these symptoms get in the way of day-to-day life.

Anxiety disorders are common in people of all ages. But they can have different symptoms and risk factors at different ages. And researchers are learning that anxiety disorders can look different depending on age and that treatment decisions need to consider age.

In this article, we’ll discuss what anxiety disorders look like in children, teens, young adults, and older adults. Read on for more information about what anxiety looks like at different stages of life as well as which symptoms and disorders are most common in each age group.

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Does anxiety get worse with age?

Anxiety disorders don’t necessarily get worse with age. But the number of people dealing with them may . This may be due to a range of things, including changes in the brain and nervous system that happen with age and the higher likelihood of experiencing stressful life events that can trigger anxiety.

The  that people face may also vary with age. For example,  and  often first appear in childhood or early adulthood. But older adults may be more likely to experience . Let’s walk through each of these age groups.

Anxiety in young children

Young children can experience anxiety, though it can sometimes look different from anxiety in teens or adults. Children with anxiety may worry about the future and fear being separated from loved ones. They may also fear people, places, or things.

How common is anxiety in children?

Anxiety is more common in older children than in younger children. Around  and  show signs of an anxiety disorder.

Signs of anxiety in children

Some anxiety is normal and healthy in young children. Separation anxiety among toddlers is common when they’re away from their parents or caregivers. And they may experience  when they meet people they don’t know. But a child may be dealing with an anxiety disorder if their anxiety interferes with school, play, or home life.

Here are the most  in children:

Separation anxiety: This is when a child is  from parents or caregivers. Sometimes they refuse to separate at all. Children worry that something bad will happen when they’re apart. Separation anxiety is normal between 18 months and 3 years of age. But it might be a sign of a disorder if it continues beyond that.

Generalized anxiety: This is a wide variety of worries and fears, to the point that a child becomes preoccupied with these thoughts. Anxiety often interferes with sleep, schoolwork, and activities.

Panic disorder: This involves episodes of intense fear (panic attacks) that may include symptoms like dizziness, rapid heart rate, and difficulty breathing. The child may also be scared of having more .

Phobias: A child may be afraid of specific objects or places, such as animals or the doctor’s office. And they may refuse to interact with them despite reassurance and support.

Social anxiety disorder: A child feels fearful of and refuses to be in public places, like school. The child worries that they will do something embarrassing or that others will judge them.

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It’s important to remember that children may have a hard time expressing their anxiety in words. Instead of talking about their fear, they may seem irritable or have physical pains and trouble sleeping. Depending on their symptoms, other people may label them as “shy,” “clingy,” or a “worrier.” They may also have a hard time at school or in social situations.

Risk factors

There are no known causes of anxiety disorders. But certain  or experiences may raise the chances that a child may develop anxiety, including:

Having certain

Growing up with a parent or sibling with an anxiety disorder

Having medical problems

Experiencing the death or loss of a loved one

Experiencing problems in school, such as difficulty learning or bullying

Treating anxiety in children

There are many  for childhood anxiety disorders. These include:

Psychotherapy:  (CBT) is the best type of therapy for childhood anxiety disorders. CBT may involve gradually exposing a child to their fears and teaching them how to cope in the process. CBT can also help a child reframe negative thoughts and learn new ways to cope with worry and fear.

School-based interventions: This is where parents work with teachers if a child’s anxiety affects their academic performance or ability to go to school.

Medications: Some children also benefit from taking medications, either on their own or combined with therapy. Commonly prescribed medications include  (selective serotonin reuptake inhibitors), like duloxetine (Cymbalta),  (Zoloft), and  (Paxil), as well as  (serotonin-norepinephrine reuptake inhibitors), like  (Effexor).

Anxiety in teens

Anxiety in teens is even more common than it is in younger children. Teens go through many physical and emotional changes that can contribute to developing anxiety.

How common is anxiety in teens?

About  experience anxiety at any given time.  have dealt with an anxiety disorder.

Signs of anxiety in teens

of generalized and social anxiety, phobias, and panic disorder in teens can be like those in younger children. But other times, teens can deal with their anxiety in very different ways. They may act out by using drugs, alcohol, or sex to cope with their feelings. They may also refuse to go to school or spend time with peers. And they may report physical symptoms, like stomach aches, headaches, muscle pains, and fatigue.

Risk factors

Children who experience anxiety are more likely to experience anxiety as teens. Other risk factors that can raise the chances that a teen develops anxiety include:

Having a family member with an anxiety disorder

Stressful life events, like divorce, health issues, or death of a loved one

Going through a difficult time at school or at home

Medical problems

Alcohol or drug use

A lack of

Treating anxiety in teens

As with young children, treatment for anxiety in teens usually involves CBT (which can include behavioral and exposure therapy) and/or medications, including SSRIs and SNRIs.

The type of anxiety disorder and how severe it is help determine whether medications will be helpful. Some studies show that treatment that includes  may be more effective at lowering anxiety in teens than either medication or  alone.

Anxiety in young to middle-age adults

Many adults experience anxiety. Adults who have had anxiety as children and teens may be more likely to develop anxiety again in their adult years.

How common is anxiety in adults?

Based on a 2001 to 2003 survey of adults in the U.S. ages 18 to 60,  of adults reported having had an anxiety disorder at some point in their lives. Adults ages 30 to 44 have the highest rate of  of this age group, with around  reporting an anxiety disorder within the past year.

Signs of anxiety in adults

Signs of anxiety in adults depend on the particular disorder. Here’s how different disorders may look:

Generalized anxiety disorder: Someone worries excessively for months about things like work, school, finances, and relationships. It may come with muscle tension, difficulty concentrating, sleep disturbances, and irritability.

Panic disorder: Someone may have repeat  that may include sudden fear or dread, heart palpitations, shortness of breath, and shaking. People with panic disorder often feel afraid of having more panic attacks in the future.

Specific phobia: This is an intense fear of an object, situation, or place. People with a phobia may either avoid them or endure them with a lot of anxiety.

Social anxiety disorder: This is significant fear of  because of fear of being judged or embarrassed. The individual may endure them reluctantly or avoid them all together.

Risk factors

for anxiety in adults are similar to those in other age groups. They include:

Shy or inhibited temperament as a child

A history of stressful or traumatic life events

A family history of mental health issues

Certain physical health issues, like

Treating anxiety in adults

Treating anxiety in adults can involve psychotherapy, medications, or both. As with other age groups, CBT (including behavioral and exposure therapy) can be an effective treatment for many types of anxiety disorders, including generalized anxiety disorder, , and phobias.

There’s a wider range of  for adults:

SSRIs and SNRIs are first-choice options.

, like  (Xanax) and  (Klonopin),  treat anxiety disorders, like generalized anxiety disorder and panic disorder. These types of medications are prescribed extra carefully, since they can lead to tolerance and dependence.

(Buspar) is another medication that can sometimes help with anxiety. It’s not a benzodiazepine and does not have a risk of dependence.

Anxiety in older adults

Adults 60 years of age and older are more likely to experience  of anxiety than younger people. This age group also has a higher risk for medical problems, and they may take more medications. Both of these things can  of developing an anxiety disorder.

How common is anxiety in older adults?

Researchers believe that anxiety affects at least . The percentage might be higher because older adults tend to experience physical symptoms of anxiety rather than worry or fear. So they may not report that they have anxiety.

Signs of anxiety in older adults

Along with constant and debilitating worry, older adults with anxiety often have , like:

Weakness

Fatigue

Restlessness

Poor concentration

Trouble sleeping

Older adults may be  to talk about their feelings or admit they’re dealing with an emotional issue. It’s important to know this because older adults with anxiety tend to experience other mental health issues, like depression, at the .

Risk factors

Risk factors that can raise the risk of anxiety in older adults include:

Medical problems

Chronic pain

Limited functioning, such as difficulty walking or getting around

Loss of family or friends

Financial changes due to retirement

Physical, verbal, , or sexual abuse, neglect, or abandonment (also known as elder abuse)

Treating anxiety in older adults

Again, treatment for anxiety in older adults may include psychotherapy and/or medication. Practicing relaxation strategies to lower stress can also be helpful.

When it comes to anxiety medications, older adults may absorb and metabolize them at different rates. So, to prevent dangerous side effects, they may need lower doses and close monitoring.

Common medication options include:

Buspirone (Buspar)

Antidepressants, like  (Lexapro),  (Paxil), and  (Cymbalta)

Certain benzodiazepines, like  (Valium) and  (Klonopin)

The bottom line

Anxiety disorders have many different symptoms, including physical symptoms and debilitating worry and fear. Anxiety disorders can affect people at any time in life. But they often affect people of different ages in different ways. Fortunately, there are effective treatments — including psychotherapy and medications. And healthcare providers tailor them for specific age groups and individuals.

Why trust our experts?

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Healthy Aging Guide

What to Know About Anxiety in Older Adults

Medically Reviewed by  on April 27, 2025

Written by

4 min read

Feelings of anxiousness or nervousness are common in both adults and children. But when those feelings start to be overwhelming and affect your daily life, you could have an anxiety disorder. Mood swings and debilitating worry are important signs to watch for.

in older adults are fairly common, affecting 10% to 20% of people. However, anxiety disorders often go undiagnosed. Anxiety is found more often than  and cognitive disorders in older adults.

Generalized Anxiety Disorder (GAD) is the most common type of anxiety disorder diagnosed in older adults. This is followed by phobias, panic disorder, and Obsessive-Compulsive Disorder (OCD). These and Post Traumatic Stress Disorder (PTSD) are the most common types of  disorders diagnosed.

Types of Anxiety Disorders

Having more anxiety as you age is a common issue in older adults. The most common types of anxiety disorders are:

Generalized Anxiety Disorder (GAD). This type of anxiety causes racing thoughts, constant worrying, and a feeling of hopelessness.  aren’t able to sleep or concentrate as well. They also feel tired, irritable, and nauseous. They may also have to go to the bathroom often. Hot flashes and feeling out of breath are additional signs of GAD.

‌Phobias. This type of anxiety fills people with intense fear of a place, thing, or event. Often, these fears are irrational and are about things that do not pose a real threat.

Common types of  for older adults are fear of death, disaster, and danger to the family. A fear of dental procedures is also common. When facing these fears you might feel dizzy, have chest pain, or heart palpitations. Shortness of breath is also common.

Panic disorder. When an older adult has a panic disorder, they can get sudden feelings of terror. This feeling is often accompanied by a racing heart, chest pain, weakness, nausea, and feeling faint or dizzy.

Panic attacks happen randomly and are not necessarily triggered by anything. They usually peak within 10 minutes and then fade away. Older adults with this condition may feel like they’re having a heart attack or stroke and not want to be left alone.

Obsessive-compulsive disorder (OCD).  causes persistent and disturbing thoughts. Older adults with this condition will feel like they can only get control by doing repeated actions. OCD can also include overwhelming thoughts of possible violence or harm happening to a loved one.

Post-traumatic stress disorder (PTSD). This type of anxiety is caused by a traumatic event. In some cases, symptoms of the trauma may not emerge until months or even years after the event. Older adults may be triggered by a previous traumatic event after feeling helpless because of a new disability.

Symptoms of Anxiety in Older Adults

People of all ages will typically show the same signs of anxiety. Some types of disorders may have different symptoms. Common symptoms of an anxiety disorder include:

Shakiness and panicky feeling

Difficulty breathing, sweating, and nausea

Dizziness or feeling lightheaded

Digestion problems and chest pain

Headaches and confusion

Eye and vision problems

Muscle tension, soreness, and fatigue

Irrational thoughts

Forgetfulness

Irritability

Avoidance of activities, places, people, and even thoughts that trigger anxiousness

Changes in weight, appetite, or eating habits

Inability to sleep

Not wanting to leave home, withdrawal, and isolating themselves

Obsessive thoughts and compulsive behavior

How to Manage Anxiety in Older Adults

Anxiety isn’t always caused by a specific trigger. It typically happens because of overwhelming environmental and situational factors. As  deal with frequent changes, they can become more anxious. Some common triggers for older adults include:

Financial insecurity

Health problems, immobility, or chronic pain

Dementia

Loss of independence and isolation

End-of-life planning

Grief and loss

Being aware of these triggers can help identify when you or a loved one might need help. Here are some other ways to help manage anxiety in older adults:

Learn about your anxiety disorder. Understanding what triggers feelings of anxiety and how to cope will help you recognize when you feel out of control.  can help you learn ways to cope with your anxiety. You’ll learn relaxation methods and how to handle other stressors.

Create a social support network. Family, friends, and people nearby that you trust can be a helpful resource for you to turn to when you feel yourself losing control. They may also be able to help you identify stressful situations and know when to get you out of them. ‌

Try to have a healthy, balanced life. Getting enough sleep, eating well, and staying active are important ways to manage your stress levels. Creating an active, balanced lifestyle with social interaction and hobbies you love can reduce stress and anxiety.

When to See Your Doctor

If you feel like your anxiety and nervousness are uncontrollable, you should contact your doctor. Your doctor can help diagnose you with an anxiety disorder and determine the right treatment plan for you.

Your doctor will refer you to a mental health professional. Your doctor may prescribe low dosages of  for older adults to find the right dosage for your body. Psychotherapy may also be recommended to effectively manage your anxiety disorder.

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ABSTRACT

Background

Little is known about the effects of age on the symptoms of anxiety disorder. Accordingly, this study sought to investigate age-related differences in the number and kind of symptoms that distinguish between individuals with and without a diagnosis of generalized anxiety disorder (GAD).

Methods

A sample of 3,486 self-reported worriers was derived from Wave 1 of the National Epidemiological Survey of Alcohol and Related Conditions (NESARC), an epidemiological survey of mental health conducted in the USA in 2001–2002. Participants were stratified into the following age groups (18–29 years, 30–44 years, 45–64 years, 65–98 years), and then divided into diagnostic groups (GAD and non-GAD worriers).

Results

Binary logistic regression analyses revealed that four distinct sets of symptoms were associated with GAD in each age group, and that numerically fewer symptoms were associated with GAD in older adults. Moreover, there were graduated changes in the type and number of symptoms associated with GAD in each successive age group.

Conclusions

There are graduated, age-related differences in the phenomenology of GAD that might contribute to challenges in the detection of late-life anxiety.

Key words:

anxiety

GAD

older adult

diagnosis

symptom presentation

assessment

Introduction

Anxiety disorders are among the most highly prevalent mental disorders in older people (Kessler et al., 2005; Bryant et al., 2008; Byers et al., 2010). However, diagnosis and treatment of late-life anxiety – particularly generalized anxiety disorder (GAD) – are challenging due in significant part to an insufficient understanding of age influences on symptom presentation and diagnostic status (Flint, 2005; Wetherell et al., 2005; Bryant et al., ; Wolitzky-Taylor et al., 2010; Lenze and Wetherell, 2011a; 2011b; Mohlman et al., 2011).

Previous studies have aimed to identify differences in the manifestation of worry symptoms – both quantitative and qualitative – between younger and older adults. These studies have demonstrated that older adults typically endorse numerically fewer worries relative to younger adults, and that the content of their worries is also distinctive (Basevitz et al., 2008; Gould and Edelstein, 2010; Gonçalves and Byrne, 2013). For instance, Basevitz et al. () found that older adults reported less intolerance of uncertainty and less belief in the functional value of worrying than younger adults; Gonçalves and Byrne () found that older adults tend to worry more about the health and welfare of loved ones, whereas younger adults tend to worry more about work and interpersonal relations; and Gould and Edelstein () found that younger adults report having less control over their anxiety. These findings suggest that anxiety symptoms in general, and worry in particular, can manifest differently as a function of age. However, such findings are not particularly informative about the impact of age differences on diagnostic status.

An alternative approach has been to identify differences in symptom presentation between individuals with and without current GAD diagnoses. Older adults with GAD can be differentiated from asymptomatic older adults and older adults with sub-threshold anxiety by higher frequency of worry, uncontrollability of worry, higher levels of distress and impairment, muscle tension, and sleep disturbance (Diefenbach et al., 2003; Wetherell et al., 2003). The observation that muscle tension and sleep disturbance differentiate between older adults with and without GAD is perhaps the most clinically informative data, given that the other anxiety symptoms (i.e. excessive and uncontrollable worry, distress and impairment) are integral to a GAD diagnosis. However, it is important to note that muscle tension and sleep disturbance can arise from a variety of causes, including medication use, as well as being part of the physical changes associated with normal aging (Wetherell et al., ). Moreover, given the relatively small sample sizes in these studies, it is unclear whether these findings generalize to the population at large. Finally, lack of young adult comparison groups makes it difficult to draw conclusions about age effects. Thus, a better understanding of how age influences symptom presentation and diagnostic status in anxiety is still needed, particularly in terms of differentiating between self-reported worriers with and without GAD across the lifespan.

The purpose of this study was to determine the type and number of symptoms that best predict GAD across the lifespan using a nationally representative dataset. We hypothesized that a distinct set of symptoms would characterize GAD in older adults, and that overall fewer symptoms would characterize GAD in older adults.

Method

Sample

The National Epidemiological Survey of Alcohol and Related Conditions (NESARC) was conducted in 2001–2002 by the U.S. Bureau of the Census and sponsored by the National Institute of Alcohol Abuse and Alcoholism (NIAAA). The NESARC consists of a nationally representative sample of civilian, non-institutionalized adults (age range 18–98 years; N = 43,093) sampled from all 50 US states and the District of Columbia. The overall response rate was 81%. Face-to-face interviews were conducted by trained lay interviewers using the Alcohol Use Disorder and Associated Disabilities Interview Schedule – DSM-IV version (AUDADIS-IV). African-Americans, Hispanics, and young adults were purposively oversampled, and data were adjusted for oversampling and non-response. Sampling weights were based on census data.

Participants who responded affirmatively to one of two screening questions (“Ever had a 6+ month period during which you felt: (a) tense/nervous/worried most of the time; or (b) very tense/nervous/worried most of the time about everyday problems”) were included in this study, because they were further assessed for overall GAD symptoms.

Measures

Twelve-month non-hierarchical GAD diagnoses were obtained with the AUDADIS-IV, based on DSM-IV criteria. Socio-demographic characteristics, including gender, education (some college or higher, completed high school, less than high school), personal income (0–9,999, 10,000–34,999, 35,000+ USD), marital status (married/cohabiting, widowed/divorced/separated, never married), urbanicity (urban, rural), geographic region (Northeast, Midwest, South, West), and self-perceived health (excellent, very good, good, fair, poor) were accounted for in all analyses.

Procedure

Participants were classified into one of the four age groups (18–29; 30–44; 45–64; 65–98 years), and one of the two diagnostic groups (12-month GAD; or No Current GAD diagnosis). Table 1, Table 2, Table 3, Table 4 indicate the distribution of participants across age and diagnostic groups. Self-reported symptoms were compared between diagnostic classes within each age group to assess the features that best differentiate between those with GAD and their age-matched counterparts, which resulted in four sets of binary logistic regression analyses, corresponding to one per age group.

Statistical analyses

All statistical analyses were conducted using Stata 12.0 (Statacorp, 2011). Appropriate survey commands were used to account for the complex survey design of the NESARC. Raw frequencies, weighted proportions, and chi-square tests were calculated within age groups and between diagnostic groups. A series of chi-square tests, comparing the proportion of each symptom between individuals with GAD and non-GAD worriers in each age group only warranted the exclusion of one variable from further analyses: “in worst period, ever found it difficult to stop being tense, nervous, or worried,” which perfectly discriminated between diagnostic groups due to this symptom being an integral part of a GAD diagnosis (for proportions of responses to each symptom, see Supplementary Tables S1–S4 available as supplementary material attached to the electronic version of this paper at ). Odds ratios (ORs) derived from weighted logistic regression analyses were used to indicate the utility of specific symptoms for predicting GAD group membership within each age group, after controlling for sociodemographic and health variables.

Results

Socio-demographic characteristics of the sample

The total sample of self-reported worriers consisted of 3,486 participants. The 18–29-year-old subgroup consisted of 499 participants (Mage = 24; 61% female), the 30–44-year-old subgroup consisted of 1,031 participants (Mage = 38; 64% female), the 45–64-year-old subgroup consisted of 1,319 participants (Mage = 53; 61% female), and the 65–98 subgroup consisted of 637 participants (Mage = 75; 71% female). Eighty-four percent of the total sample had completed a high school education, with 54% having completed at least some college. Seventy percent reported having a personal annual income of less than $35,000, and 78% of participants lived in an urban region. The overall marriage distribution was as follows: 56% married or cohabiting; 27% widowed, divorced or separated; and 16% never married. Sixty-nine percent of the sample reported that their health was good, very good, or excellent. A total of 988 participants, representing slightly more than one quarter of this screen positive sample, had a 12-month GAD diagnosis. See , , ,  for participants’ sociodemographic characteristics stratified by age and diagnostic groups.

Table 1. Socio-demographic characteristics of 18–29-year-olds, by current GAD diagnosis

\*p < 0.05; Pearson's χ2-test conducted for all comparisons.

Table 2. Socio-demographic characteristics of 30–44-year-olds, by current GAD diagnosis

\*\*\*p < 0.0001; Pearson's χ2-test conducted for all comparisons.

Table 3. Socio-demographic characteristics of 45–64-year-olds, by current GAD diagnosis

\*p < 0.05; \*\*p < 0.01; \*\*\*p < 0.0001; Pearson's χ2-test conducted for all comparisons.

Table 4. Socio-demographic characteristics of 65–98-year-olds, by current GAD diagnosis

\*p < 0.05; \*\*\*p < 0.0001; Pearson's χ2-test conducted for all comparisons, unless n ≤ 5 for a given cell (Fisher's exact).

Number of symptoms

A set of binary logistic regression analyses was conducted within each age group, with GAD group membership (coded GAD, 1, no GAD, 0) as the outcome variable and GAD symptoms as the predictor variables (See Table 5 for summary of analyses and Supplementary Table S5 (available online) for full analyses). These revealed that fewer symptoms differentiated between individuals with and without GAD in each successively older age group. In the 18–29-year-old group seven symptoms distinguished between diagnostic groups, in the 30–44-year-old group six symptoms distinguished between diagnostic groups, in the 45–64-year-old group five symptoms and one sociodemographic variable distinguished between diagnostic groups, whereas in the older adult (65–98-year-old) group only three symptoms and one sociodemographic variable differentiated between those with and without GAD.

Table 5. Summary of binary logistic regression analyses showing symptoms that significantly distinguished between self-reported worriers with and without GAD in each age group

\*p = 0.05; \*\*p = 0.01; \*\*\*p = 0.001.

Note: Results of full binary logistic regression analyses can be found in Supplementary Table S5 (available online).

Types of symptoms

Inspection of the binary logistic regression findings further revealed that a qualitatively different set of symptoms predicted GAD group membership in each age group. In the 18–29-year age group, “got tired easily” (OR = 2.08; 95% CI: 1.03 – 4.18), “had tense, sore, or aching muscles” (OR = 4.62; 95% CI: 2.48 – 8.61), “became so restless you fidgeted, paced, could not sit still” (OR = 0.33; 95% CI: 0.14 – 0.77), “felt keyed up or on edge” (OR = 2.98; 95% CI: 1.27 – 6.99), “felt irritable” (OR = 2.38; 95% CI: 1.01 – 5.59), “had trouble falling/staying asleep” (OR = 2.28; 95% CI = 1.18 – 4.41), and “had dry mouth” (OR = 3.09; 95% CI = 1.24 – 7.70) best distinguished between self-reported worriers with and without GAD.

In the 30–44-year age group, “got tired easily” (OR = 2.22; 95% CI: 1.27 – 3.90), “had tense, sore, or aching muscles” (OR = 1.67; 95% CI: 1.08 – 2.57), “had trouble concentrating/keeping mind on things” (OR = 2.14; 95% CI: 1.17 – 3.91), “felt irritable” (OR = 2.26; 95% CI: 1.22 – 4.22); “had difficulty swallowing/felt like lump in throat” (OR = 0.50; 95% CI: 0.28 – 0.87), and “had trouble catching breath, felt like smothering” (OR = 2.65; 95% CI: 1.44 – 4.88) best distinguished between self-reported worriers with and without GAD.

In the 45–64-year age group, “got tired easily” (OR = 1.92; 95% CI: 1.14–3.22), “often felt keyed up or on edge” (OR = 1.74; 95% CI: 1.02 – 2.97), “had trouble falling/staying asleep” (OR = 2.71; 95% CI: 1.64 – 4.47), “forgot what talking about/mind went blank” (OR = 2.06; 95% CI: 1.34 – 3.18) and “urinated frequently” (OR = 1.69; 95% CI: 1.10 – 2.59) best distinguished between self-reported worriers with and without GAD.

In the 65–98-year age group, low personal income (OR = 3.51; 95% CI = 1.07 – 11.43), “had trouble concentrating/keeping mind on things” (OR = 3.57; 95% CI = 1.62 – 7.89), “felt dizzy/lightheaded/like might faint” (OR = 3.02; 95% CI = 1.37 – 6.70), and “often had nausea, upset stomach, felt like vomiting or diarrhea” (OR = 0.39; 95% CI = 0.16 – 0.98) best distinguished between self-reported worriers with and without GAD.

Discussion

The most salient findings of this study are as follows. First, among screen positive worriers a distinct set of symptoms predicted GAD in each age group. Second, numerically fewer symptoms predicted GAD in older adults compared to all other age groups. Third, changes in the type and number of symptoms that predicted GAD occurred gradually across the lifespan. The results underscore important age differences in GAD symptom presentation, and further suggest that such differences in the degree and kind of symptoms that distinguish between self-reported worriers with and without GAD can be invoked to explain some of the challenges surrounding the detection of late-life GAD.

In the 65-year and older age group, (i) difficulty concentrating and keeping mind on things, and (ii) feeling dizzy, lightheaded, or like fainting were positive predictors of GAD, and (iii) had nausea, upset stomach, felt like vomiting or diarrhea was a negative predictor of GAD. Moreover, a sociodemographic variable, low personal income was a positive predictor of GAD in older adults. At first glance, these findings are apparently at odds with a previous study by Wetherell et al. (), which suggested that sleep disturbance and fatigue are useful for distinguishing between older adults with and without GAD. The results of the present study demonstrate that these symptoms have utility for distinguishing between individuals with and without GAD in the other age groups, but not in the older adult group. Upon closer examination of the Wetherell et al. study, however, we conclude that both sets of findings are compatible. Wetherell and colleagues found that sleep disturbance and fatigue distinguished between the sub-syndromal and asymptomatic groups, but did not distinguish between GAD and sub-syndromal groups. In the present study, the control group is more akin to the sub-syndromal group in the Wetherell et al. study than to the asymptomatic group. In our study, only participants who answered affirmatively to one of the screening questions (indicating that they worried frequently in the past six months) were included in the final sample, and all participants who did not subsequently receive a GAD diagnosis were included as controls. Participants who did not endorse one of the screening questions (i.e. asymptomatic participants) were not assessed on the anxiety portion of the diagnostic interview, and therefore could not be included in our study.

Although we acknowledge that inclusion of an asymptomatic control group could have provided for more thorough comparisons, we do not believe that the absence of an asymptomatic group is a major limitation of this study. Clinical decisions involving asymptomatic adults are typically straightforward. Difficult GAD diagnoses most often rely on the clinician's ability to distinguish between individuals with pathological and non-pathological anxiety, rather than between individuals with pathological anxiety and those with a relative absence of anxiety symptoms. For this reason, we believe that these findings are of particular clinical significance. A second issue concerns the fact that we did not control for co-morbid psychiatric conditions. We believe that future studies, designed specifically to address issues related to co-morbidity, would be better suited to account for such variables.

The present results demonstrate two novel ways in which age impacts the presentation of GAD symptoms and diagnostic outcomes. We believe that these results are particularly interesting in light of a heretofore unresolved question regarding late-life anxiety. It has been widely observed that prevalence estimates of anxiety disorders and the frequency of anxiety symptoms decrease into older adulthood (e.g. Kessler et al., ; Gonçalves and Byrne, ). However, sub-threshold anxiety symptoms (in the absence of a disorder) are highly prevalent, and individuals with sub-threshold anxiety symptoms are similar to threshold symptom groups in terms of shared health characteristics (Bryant et al., ; Grenier et al., 2011). It remains unclear whether decreases in the prevalence of disorders and the frequency of symptoms reflect age-related reductions in pathological anxiety, or whether these trends reflect the absence of age-appropriate criteria for older adults. We endorse the latter view, and believe that under-diagnosis of GAD in older adults could be partly attributed to the observations that older adults tend to endorse fewer symptoms compared to younger adults, that fewer symptoms are associated with GAD in older adults, and that these symptoms are qualitatively different to those observed in younger adults.

We will pursue these findings by investigating whether older adulthood is also associated with a lower threshold of symptoms required to meet the disability/distress criterion. If a lower magnitude of symptoms accounts for clinically significant disability and/or distress in older adults, it would suggest that late-life anxiety disorders are more highly prevalent than previous estimates suggest. Further, it would stress the need to develop age-appropriate criteria for older adults.

Conflict of interest

None.

Description of authors’ roles

B.M. performed statistical analyses. All authors were involved in the conception and planning of the study, and contributed to writing and editing the paper.

Supplementary Material

Miloyan Supplementary Material. Tables

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ENERGY LEVEL linked to AGE:  
Energy levels tend to decline with age due to a combination of physical and lifestyle factors. This includes a decrease in muscle mass and strength, reduced heart function, and changes in sleep patterns, all of which can contribute to feelings of fatigue. While some decline in energy is normal, it's possible to mitigate the effects and maintain a good level of energy through healthy habits and lifestyle choices.

Here's a more detailed look at how energy levels change with age:

Factors Contributing to Decreased Energy:

Muscle Mass and Strength:

As people age, they naturally lose muscle mass and strength, a process called sarcopenia. This can lead to reduced physical capacity and increased fatigue.

Heart Function:

The heart muscle can become less efficient at pumping blood, which can limit the delivery of oxygen and nutrients to the body, contributing to fatigue.

Sleep Patterns:

Sleep quality often declines with age, with older adults experiencing more sleep disturbances and less deep sleep. This can lead to feeling tired and less energetic during the day.

Metabolic Rate:

Resting metabolic rate (RMR), the number of calories the body burns at rest, tends to decrease with age. This can affect energy levels and make it harder to maintain a healthy weight.

Hormonal Changes:

Changes in hormone levels, such as decreased testosterone in men and estrogen in women, can also affect energy levels and contribute to fatigue.

Lifestyle Factors:

Reduced physical activity, poor diet, and increased stress can further exacerbate age-related energy decline.

Maintaining Energy Levels with Age:

Stay Active:

Regular physical activity, including both aerobic exercise and strength training, can help maintain muscle mass, improve heart health, and boost energy levels.

Prioritize Sleep:

Aim for 7-8 hours of quality sleep per night. Establish a regular sleep schedule and create a relaxing bedtime routine.

Eat a Healthy Diet:

Focus on nutrient-rich foods, including fruits, vegetables, lean protein, and whole grains. Proper nutrition supports energy production and overall health.

Manage Stress:

Find healthy ways to manage stress, such as exercise, yoga, or spending time in nature.

Consider Supplements:

Consult with a healthcare professional about potential benefits of supplements like B vitamins, which can play a role in energy production.

Stay Socially Engaged:

Maintaining social connections and participating in activities you enjoy can boost mood and energy levels.

By understanding the factors that influence energy levels with age and adopting healthy habits, it is possible to mitigate the effects of aging and maintain a good level of energy and vitality

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Feb 3, 2025

Energy & Aging: Understanding the Connection & What You Can Do

Experiencing low energy levels as you age? You're not alone. While dips in energy are normal, constant tiredness may signal deeper health issues, including imbalanced glucose levels, mitochondrial decline, or hormonal shifts. The good news: there are ways to boost energy levels naturally and protect long-term vitality.

Energy

Written by

Mito Team

Many factors can contribute to energy decline, including lifestyle choices, diet, stress, and underlying health conditions that affect metabolism and aging. The good news is we can influence our energy levels as we age, and it starts with understanding the connection between our body's energy production and aging.

How Aging Affects Energy, Mitochondria, and Glucose Levels

Scientists have long linked aging to metabolism—how our bodies convert food into energy. Early studies suggested that the speed of metabolism and its byproducts were significant factors in aging. At the heart of this process are mitochondria, which act like power plants within our cells. They convert food into Adenosine tri (ATP), the body's energy source.

Since mitochondria are central to metabolism, any decline in their function can have a ripple effect throughout the body. As we age, our mitochondria can become less efficient and accumulate damage, reducing ATP production. Factors contributing to this decline include mitochondrial DNA damage, reduced mitochondrial density, and increased .

This decline in mitochondrial function is a key reason for many people's lower energy levels as they age. It's not just about feeling tired; it can impact everything from how well we digest food to how efficiently our bodies repair themselves, affecting longevity.

On Aging and Energy​ Decline

Most people find their energy peaks in their younger adult years. So, do energy levels decrease with age? Studies have reported that elderly adults have lower energy levels than adults in their 20s and early 30s. (See chart below, data from )

How Energy Levels Change with Age

However, it's important to remember that everyone is different, and energy levels can vary significantly by age. Many people maintain high energy levels well into their later years, often thanks to healthy lifestyle choices. It's also crucial to recognize that underlying health issues, which become more common as we age, can significantly impact energy levels.

Impact of Aging on Energy Levels: What You Might Notice

As we age, those cellular powerhouse changes can start to show.  You might experience some of the following:

Increased Fatigue: Are you suddenly feeling tired after doing things that used to be easy? This is a common sign.

Decreased Stamina: Finding it more challenging to keep up during your workouts or daily activities? Your stamina might not be what it once was.

Slower Recovery: Does it take longer to recover from a workout or when you feel under the weather? This is another common effect of aging on energy.

Cognitive Changes: Do you feel a bit foggy mentally? Do you have trouble concentrating or remembering things? These mental changes can also be linked to lower energy levels.

Reduced Motivation: Just not feeling as enthusiastic or driven as you used to? A general lack of motivation can also be a sign of declining energy.

While some energy decline is normal during aging, feeling constantly exhausted isn't. Significant fatigue and low energy levels could indicate an underlying health issue, so it's always a good idea to check in with your doctor if you're concerned.

Understanding Your Energy: Key Biomarkers

Specific biological markers in the body can help us better understand what happens to our energy levels as we age. These biomarkers provide valuable insights into our overall health, metabolism, and how efficiently our bodies produce energy.

Glucose is the primary sugar your body uses for energy. Measuring fasting glucose helps assess how well your body regulates blood sugar. Consistently high glucose levels can signal insulin resistance or diabetes, making you tired.

HOMA-IR (Homeostatic Model Assessment for Insulin Resistance): This calculation is based on glucose and insulin levels. It shows how effectively your body responds to insulin. Insulin resistance can lead to energy crashes, fatigue, and risk of developing type 2 diabetes.

Hemoglobin A1c (HbA1c): HbA1c shows your average blood sugar levels over the past few months.  It's a helpful marker for long-term glucose control and is often used to diagnose and monitor diabetes.

Insulin: It is a hormone that allows the body to use glucose for energy or store it for later. Measuring insulin levels with glucose can provide insights into .

Uric Acid:  While often associated with gout, elevated uric acid levels are often linked to metabolic issues and inflammation, affecting energy levels.

eAG (estimated Average Glucose): Based on your HbA1c measurement, eAG estimates your average daily glucose level. It translates the HbA1c result into a number similar to what you might see on a glucose meter, making it easier to understand.

Taking control of your health starts with understanding what's happening inside. Mito Health makes it easy to access this valuable information with our comprehensive biomarker testing panels. Our offer a convenient way to assess over 100 biomarkers, including key markers related to energy and metabolism, and identify potential imbalances before they impact your energy levels.

Health Tips to Boost Energy Levels and Improve Glucose Control

Want more energy as you age? Here are some health tips for maintaining energy levels​ and reversing energy decline, especially when combined with insights from biomarker testing:

Balanced Diet: Eating for healthy blood sugar levels with whole foods, fiber, and protein.

Regular Exercise: Boosts mitochondrial health and helps maintain normal glucose levels.

Prioritize Sleep: Poor sleep affects hormone levels and energy restoration.

Manage Stress: Chronic stress disrupts glucose control and drains your energy.Practice stress-reducing techniques such as Andrew Huberman’s breathing protocols, meditation, or yoga.‍

Stay Hydrated: Dehydration can lead to fatigue. Drink plenty of water throughout the day.

Address Health Conditions: Talk to a health provider if you have low energy or constant fatigue.

Energy and Health: The Takeaway

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Your body’s ability to maintain normal blood glucose levels is essential for energy production. When blood sugar levels spike or crash, fatigue often follows. Tracking your blood sugar levels, insulin, and HbA1c helps identify whether you're maintaining healthy glucose levels throughout the day.

Unmanaged blood sugar fluctuations can lead to chronic tiredness, low energy, and increase the risk of type 2 diabetes.

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Energy Metabolism and Aging

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Article notes

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PMCID: PMC7994661  PMID:

Abstract

Aging is strongly related to energy metabolism, but the underlying processes and mechanisms are complex and incompletely understood. Restricting energy intake and reducing metabolic rate can slow the rate of aging and extend longevity, implying a reciprocal relationship between energy metabolism and life expectancy. However, increased energy expenditure has also been associated with improved health and longer life. In both experimental animals and humans, reduced body temperature has been related to extended longevity. However, recent findings on the function of thermogenic (brown or beige) adipose tissue produced intense interest in increasing the amount of energy expended for thermogenesis to prevent and/or treat obesity, improve metabolic health, and extend life. Evidence available to-date indicates that increasing adipose tissue thermogenesis by pharmacologic, environmental, or genetic interventions can indeed produce significant metabolic benefits, which are associated with improved chances for healthy aging and long life.

Keywords: Adipose tissue, beige; Adipose tissue, brown; Aging; Metabolic rate; Thermogenesis

INTRODUCTION

All biological functions of living organisms require energy consumption or expenditure. It is, therefore, not surprising that the biological process of aging, and the regulation of longevity, are related in various ways to energy metabolism. Much of the recent and current research on the biology of aging is directed at unraveling these fascinating relationships. This includes studies of the ways in which human energy metabolism could be modified to offset some of the consequences of a socalled “Western” lifestyle in the 21st century, including an imbalance of energy intake and expenditure. In this review article, we will briefly discuss the relationships between metabolic rate and longevity, the impact of various anti-aging interventions on energy metabolism, and the current interest in stimulating thermogenesis to promote healthy aging.

HOW ARE AGING AND LONGEVITY RELATED TO METABOLIC RATE?

In most species of animals, body temperature is identical, or very similar, to environmental temperature (eT). These exothermic (also known as poikilothermic or “cold blooded”) species include worms, snails, mussels, various marine invertebrates, insects, fish, amphibians and reptiles. In these animals, metabolic rate is determined primarily by eT, and thus is low in the cold and high in the warmth. Importantly, in these species, longevity and temperature are inversely related, where exothermic animals live longer in the cold and shorter in the warmth. Naturally, this relationship does not extend to extreme temperatures, which can be detrimental, or even lethal. The inverse relationship between eT and lifespan of exothermic species is striking, consistent, and well documented. This led early investigators to conclude that longevity is determined primarily by metabolic rate. This was long-believed to also apply to endothermic (stenothermic or “warm blooded”) animals, that is, mammals and birds that generally maintain their body temperature within very narrow limits, regardless of eT. This belief was strongly supported by the fact that body mass is a strong determinant of both metabolic rate and longevity with larger species having lower metabolic rate, and longer lifespan, than smaller species []. However, there are many striking departures from this relationship []. Birds have higher metabolic rates than mammals, but live longer (often much longer) than mammals of the same size. Some mammals (most notably bats and humans) live much longer than their body size would predict. Presumably, the ability to fly (birds and bats), and the intelligence combined with social organization in primates, greatly reduced the risk of death from predation, and thus allowed evolutionary development of life course characteristics and reproductive strategies promoting longer lifespan []. Interestingly, both metabolic rate and longevity of humans exceed the corresponding values measured in closely related large apes []. This might be related to the greater size and energy requirements of the human brain []. Other departures from the simple inverse relationships of metabolic rate and longevity in endotherms include species that deal with extremely low eTs by allowing their body temperature to drop for periods ranging from hours (torpor; common in small rodents) to months (hibernation; i.e., ground squirrels and marmots), and possess multiple physiological adaptations to these states of low metabolic rate [,].

While the concept of mammalian and avian longevity being directly controlled by metabolic rate has been rejected as overly simplistic, some of its elements have been incorporated into the concept of pace-of-life being an important determinant of aging and longevity []. Fast pace-of-life includes high metabolic rate, fast postnatal growth, early maturation, high fecundity, and relatively short lifespan, as observed in many species of small rodents. Slow pace-of-life, seen in larger mammals, includes lower metabolic rate, slower growth, later maturation, fewer offspring, and longer life. This concept fits well with the trade-offs between anabolism, growth, and reproduction, on the one hand, and stress resistance, repair processes, and longevity on the other [,]. It also fits well with the role of evolutionarily conserved cellular signaling pathways (insulin, insulin-like growth factors, and mechanistic target of rapamycin) in the control of aging [] and with the concept of partitioning available energy resources between the processes related to growth and reproduction and those related to maintenance and repair.

WHAT IS THE INFLUENCE OF AGING ON THE METABOLIC RATE?

Progressive decline in physical strength, speed of movements, energy level, and ability to recover from injury, diseases, or environmental insults (resilience) as well as reduced thermogenesis (feeling cold) are among the well-known correlates, and almost certainly effects, of aging. Reduced walking speed and increased difficulty walking for a long distance are among the most consistent functional changes during human aging and are used in geriatric medicine to assess the progression of aging, development of frailty, and risk of neurodegenerative disorders [,,]. These observations and age-related decrease in the levels of several anabolic hormones indicate that aging has a major impact on energy metabolism. In fact, an age-related decline in basal metabolic rate was described in both humans [] and experimental animals [,,]. However, there is also evidence that metabolic rate does not always decline with age, and may, in fact, increase due to age-related increases in chronic, low-grade, “sterile” inflammation []. This is a result of an accumulation of intra-abdominal adipose tissue that possess an increased abundance of senescent cells, as well as a hypoxic microenvironment, which together, lead to an increased secretion of proinflammatory factors []. Thus, age-related changes in metabolic rate in human cohorts representative of the general population can be very different from what is seen in exceptionally healthy individuals [] in whom inflammation may not override the effects of age on metabolic rate.

ENERGY METABOLISM IS ASSOCIATED WITH EXTREME LONGEVITY

Body temperature is related to metabolic rate, and there is evidence that reduced body temperature favors longevity. Thus, calorie restriction, the most effective way of slowing aging and increasing lifespan of laboratory animals, also results in reduced body temperature in mice [] as well as in humans []. Importantly, this association is very likely to be causal. Bioengineering mice to produce animals with reduced core body temperature increased median lifespan in both females and males []. In humans, lower body temperature has been associated with calorie restriction [] as well as with longevity []. A recent publication reported intriguing evidence that mean body temperature in United State adults has been decreasing during the last 157 years by 0.03℃ per birth decade []. The authors suggested that this may have contributed to improvements in health and longevity during this period.

We felt that some novel insights into the relationships of aging to energy metabolism can be gained by comparing animals with mutations which predispose them to slow aging and extreme longevity to their genetically normal (wild type) siblings. In mice, various naturally occurring mutations and targeted disruption of genes related to growth hormone (GH) signaling produce syndromes of GH deficiency and GH resistance, which are associated with remarkable extension of longevity in both sexes [reviewed in ,,,,]. We expected to find evidence for reduced metabolism in these long-lived animals, particularly in those mutants which, in addition to being GH-deficient, are also hypothyroid and have a marked reduction in body temperature []. However, metabolic rate in these remarkably long-lived mice (assessed by oxygen consumption per unit of body mass) was significantly increased, rather than reduced []. We believe that this unexpected finding reflects increased heat loss in these diminutive mutants housed in a standard room temperature of 23℃, and the consequent need for increased thermogenesis. In support of this interpretation, differences of metabolic rate between mutant mice and wild type animals could be diminished or even completely eliminated by housing them in a temperature of 30℃ [], considered a thermoneutral temperature for mice []. In addition to revealing differences in metabolic rate, indirect calorimetry studies of GH-deficient and GH-resistant mice showed a reduction in respiratory quotient (RQ; a ratio of the production of carbon dioxide to consumption of oxygen) [,]. A reduced RQ indicates an increased reliance on fatty acids as opposed to glucose as an energy substrate. Differences in RQ between normal and mutant mice also could be eliminated by housing at increased temperature []. An increased usage of lipids as metabolic fuel is associated with improved mitochondrial function, and a reduced production of harmful molecules that cause oxidative stress, both of which are likely mechanisms of aging.

We are currently investigating the effect of long-term exposure to different eTs on aging-sensitive traits and longevity of wild-type and GH-mutant mice. We have recently reported that life-long exposure to increased (thermoneutral) temperature does not eliminate the longevity advantage of GH-resistant Ghr-/- mice [].

There is increasing evidence that studying mice living at temperatures corresponding to their thermoneutral zone is important for obtaining data that can be “translatable” to humans [,,]. Standard animal room temperature is believed to produce conditions of mild cold stress for the mice [], while most humans live and work in spaces that are heated and/or air-conditioned which, together with wearing weather-appropriate clothing, produces conditions approaching thermoneutrality.

As we mentioned earlier, we hypothesize that in “standard” 23℃ housing temperature (that is cool for mice), the diminutive long-lived GH-related mutants devote a large part of their energy budget to thermogenesis. In support of this hypothesis, Ghr-/-, and Ames dwarf mice have an increased amount of brown adipose tissue (BAT) [,]. Measuring expression of thermogenesis-related genes in this tissue indicates that BAT is more metabolically active in these mutants than in normal animals from the same strain [,]. The role of BAT in thermogenesis, and the potential health benefits of stimulating BAT function, will be discussed in subsequent sections of this article.

BROWN, WHITE, AND BEIGE ADIPOSE TISSUE

Adipose tissue has multiple functions that are critical for health and survival. In contemporary, well-nourished humans, it is the largest organ in the body. In mammals, there are three types of adipose tissue: white adipose tissue (WAT), BAT, and beige adipose tissue [,]. The principal function of WAT is energy storage, which involves accumulation of lipids, which form large lipid droplets in individual white adipocytes. In addition to storing lipids, WAT secretes a multitude of bioactive factors, including leptin, which is important in the regulation of appetite, various proinflammatory molecules, and adiponectin, which enhances sensitivity to insulin and exhibits anti-inflammatory and antiatherogenic activity []. WAT is widely distributed, but most of it is present beneath the skin (subcutaneous WAT) and in the abdominal cavity (visceral WAT).

Technological and economic development during the twentieth and twenty-first century led to conditions which promote accumulation of WAT, leading to obesity, which now afflicts more than a quarter of adults in developed nations. Although genetic predisposition plays a role, these conditions essentially reflect a shift in energy metabolism, involving an unequal balance of energy expenditure and consumption. Inflammation of WAT is a result of this imbalance, and it leads to increased risk of type 2 diabetes, cancer, and cardiovascular disease [,,]. There is increasing evidence that obesity also increases the risk of Alzheimer's disease and other age-related neuropathology [,,,,], and likely accelerates the rate of aging []. These effects of obesity certainly increase mortality rate, and represent one of the key public health issues of the modern world. In this context, the potential of preventing and/or treating obesity by increasing thermogenic functions of adipose tissue is a focus of intense ongoing research.

BAT has a higher concentration of mitochondria than WAT and is responsible for non-shivering thermogenesis. BAT uses thermogenin, also known as uncoupling protein-1 (UCP1), to uncouple the electron transport chain from ATP production, resulting in the production of chemical energy in the form of heat []. To maintain this futile process, BAT must consume and expend energy from circulating glucose and lipids. Indeed, while BAT in mice may constitute only a few hundred milligrams, it can consume more than half of ingested lipids and glucose when maximally stimulated []. In humans, BAT was once thought to be present only in newborns, and would disappear during adolescence. Studies have now shown that BAT is still present in adult humans [,,,,]. BAT can be found surrounding the circulatory system to dissipate heat, and can be found near the heart, lungs, and kidney. In humans, the largest depot of BAT can be found in the supraclavicular region [,,]. Fifty grams of BAT mass accounts for 3% to 5% of a human subject's basal metabolic rate []. In mice, BAT differs anatomically from human BAT because it is concentrated in specific depots (e.g., the interscapular depot), whereas in humans, brown adipocytes tend to be dispersed within white adipose depots.

The spatial (anatomical) and functional separation of BAT and WAT is not absolute. Under some circumstances (for example, prolonged cold exposure), white adipocytes can express UCP1, acquire other characteristics of brown adipocytes, and assume a role in thermogenesis and maintenance of body temperature. This process is referred to as “beiging,” and the resulting type of adipose tissue is classified as beige [,]. Beige adipose tissue is sometimes referred to as brite. It is also possible for BAT cells to lose their thermogenic properties and to start resembling white adipocytes. This is called whitening of BAT. Physiologically, BAT and beige fat have widely overlapping (if not identical) functions, and thus, beiging of white fat and stimulation of BAT and beige adipocytes function are expected to produce nearly identical metabolic benefits []. It has been suggested that human BAT corresponds more closely to beige rather than brown fat in the mouse, but this is still a matter of some debate []. Interestingly, BAT development and metabolic health can be shaped during fetal development by maternal exercise [].

BENEFITS OF VARIOUS MEANS OF STIMULATING BROWN ADIPOSE TISSUE FUNCTION AND PROMOTING BEIGING OF WHITE ADIPOSE TISSUE

Age- and obesity-related declines in BAT mass and its thermogenic activity are associated with an increase in WAT, and this association is almost certainly causal. In humans, BAT mass has been shown to be inversely correlated with body mass index (BMI) [], and thus increase in adiposity and reduction of BAT may form a vicious circle [,]. Moreover, BAT levels decline with age [], although this can be prevented through interventions that stimulate the beiging of fat []. Indeed, the decrease in BAT as a result of increased BMI and age raises the possibility that promoting BAT may combat both obesity and age-related metabolic disorders. Methods of improving BAT thermogenesis and promoting formation of beige fat, along with some of the mechanisms which control the function of these tissues, are discussed below. Understanding these mechanisms should identify targets for development of pharmacological interventions.

1. Cold exposure

Cold exposure has been shown to directly increase energy expenditure. The results of a recent study of the effects of outdoor temperatures showed that the energy expenditure and the skin temperature of the supraclavicular region increased with cold exposure []. This indicates that BAT concentrated in that region effectively induced non-shivering thermogenesis to produce heat, thereby increasing energy expenditure. It was recently reported that presence of active BAT determines cold-induced increase in energy expenditure in humans []. Cold exposure has also been proven to induce white fat beiging []. This can reverse the deterioration of BAT with age due to oxidative stress [], which holds potential in treating metabolic disorders. In mice fed a high fat diet, chronic exposure to low temperature reduced obesity by enhancing BAT thermogenesis []. Importantly, intermittent exposure to cold was shown to improve control of blood glucose (“sugar”) levels in patients with type 2 diabetes []. In this study, acclimating patients to 15℃, over a 10-day period, while wearing only light clothing resulted in a 43% increase in insulin sensitivity. These, and similar findings, led to suggestions that lower setting of temperature controls in the house, sleeping under lighter covers, having windows open during the night, and using other means of reducing ambient temperature and stimulating thermogenesis are likely to have beneficial effects on body composition and metabolic health [,,,].

Additional evidence for beneficial effects of cold exposure was obtained from studies of individuals practicing winter (cold water) swimming, an extreme sport which is increasingly popular in various countries []. Practitioners of this sport swim regularly in natural bodies of water through most, or all, of winter in locations where water temperature drops to 1℃ to 5℃. Winter swimming produces a host of physiological responses including regional changes in blood flow, acute responses to the stress of cold water immersion (including transient increases in sympathetic tone and cortisol levels), adaptation to this stress, and stimulation of both shivering and non-shivering thermogenesis. Beneficial metabolic effects include improved insulin sensitivity and reduced insulin levels [,], as well as a reduction of and enhanced activity of anti-oxidant enzymes []. Although effects of increased thermogenesis in cold water swimmers are difficult (if not impossible) to separate from the effects of exercise and the hormetic responses to repeated stress, the observed physiological changes would be expected to reduce risk of chronic disease and to promote healthy aging. A pronounced reduction in the insulin levels and enhanced insulin sensitivity [,] are of particular note in this context. For the readers who might be interested in starting cold water swimming, we should add that this can be risky, particularly for those with some pre-existing heart conditions and generally untrained individuals without prior adaptation to cold [,]. Please consult with your physician first!

It appears that the potential benefits of immersion in cool water, rather than extremely cold water, have not been extensively explored. Although intensive exercise produces heat, therefore negating the effects of cold exposure, relaxed swimming in cooler water could potentially stimulate non-shivering thermogenesis due to water's evaporative cooling effect.

2. Dietary polyphenols

Polyphenols are micronutrients with multiple phenol groups. Some polyphenols have antioxidant properties, and can benefit metabolic health by targeting the sympathetic nervous system (SNS), which is responsible for adrenergic signaling. The SNS is importantly involved in thermoregulatory processes because it signals to interscapular BAT to induce heat production through activation UCP1 []. Various kinds of natural polyphenols can induce SNS signaling, and therefore BAT stimulation. Naringenin is a citrus flavonoid that was tested in human white adipocyte tissue cultures (hADSC) to determine if it induces browning. Studies of Rebello et al [] showed that naringenin increased the expression of UCP1 and adipose triglyceride lipase, which are both involved in thermogenesis. Oxygen consumption rates increased in naringenin-treated hADSC, signifying that it caused an increase in energy expenditure. Naringenin also increased glucose transporter type 4, adiponectin, and carbohydrate-responsive element-binding protein levels, which are all associated with improving insulin sensitivity []. These findings suggest that naringenin could potentially be used for treating obesity and diabetes.

Resveratrol is a polyphenol found in red cabbage, spinach, berries, red grapes and wine, and peanuts. In addition to its impact on sirtuins and on metabolism of carbohydrates and lipids [,], resveratrol can have beneficial effects on the gut microbiome []. It can improve gut function and activate metabolites in the intestinal tract through gut microflora mediated-biotransformation []. These actions can increase the beiging of WAT tissue.

Green tea extract which contains epigallocatechin gallate can promote weight loss by stimulating thermogenesis. This effect is most likely due to inhibition of the degradation of norepinephrine and the resulting increase in the sympathetic stimulation of BAT [].

Many other natural plant-derived polyphenols, including thyme and chysin, have been shown to enhance lipolysis []. Magnolol and Honokiol are components of bark extracts from Asian trees that have been used for medicinal purposes and have been found to induce thermogenesis, leading to increased lipolysis and reduced lipogenesis []. These natural sources of dietary polyphenols may offer possible safe treatment option for inducing lipolysis in obese patients by stimulating the SNS and initiating the beiging of WAT.

Dietary polyphenols combined with cold exposure is another potential treatment method for increasing energy expenditure in obese patients. Capsinoids are known to cause thermogenic activation, increasing energy expenditure through recruiting active BAT during cold exposure []. This method has been shown to be effective in patients with low BAT levels as well, meaning this treatment could combat BAT degeneration due to aging. Capsinoid food sources include chili peppers such as jalapeno and cayenne. Coupling a natural dietary polyphenol supplement with cold exposure could offer a safe and natural way to stimulate WAT beiging and raising energy expenditure levels in obese individuals.

3. Oxidative stress

The amount of BAT and its thermogenic functions tend to decline during aging []. Oxidative stress is believed to be one of the key mechanisms of aging []. The role of oxidative stress in age-related changes in BAT was tested through exposing BAT cells to hydrogen peroxide, an oxidative agent. This caused a decline in BAT cells. Importantly, it was also shown that antioxidant treatment reduced the effects of oxidative stress and reversed BAT activity decline []. Mitochondrial dysfunction can develop during aging, causing a decrease in fuel oxidation overall and a buildup of reactive oxidative species []. These reactive species are likely responsible for an increase in metabolic dysfunction rates with age, but antioxidant supplements could reduce these effects and reverse BAT deterioration.

4. Endogenous compounds: lipokines and bile acids

Although drugs such as mirabegron are appealing since they can activate BAT, they tend to have undesirable off-target effects, such as tachycardia. Therefore, there has been an emphasis on finding physiological compounds that can target, and activate, BAT. Lipokines, or lipids that are secreted from adipose tissue and have signaling properties, are a novel class of lipid, some of which have been able to increase BAT function. For example, 12,13-dihydroxy-9Z-octadecenoic acid (12,13-diHOME) is secreted from activated BAT, and acts in an autocrine manner to stimulate lipid uptake into brown adipocytes []. Another example is 12-hydroxyeicosapentaenoic acid (12-HEPE), which is secreted from BAT and acts in an endocrine manner to increase glucose uptake []. While it does act as an endocrine lipokine, it is also able to stimulate BAT-specific uptake of glucose as well. Therefore, treatment with 12,13-diHOME and 12-HEPE has the potential to decrease the abundance of circulating lipids and glucose through disposal by BAT. Unfortunately, there is currently no available data on the effects of these lipids on lifespan.

Another type of endogenous compound that can stimulate BAT are bile acids. Bile acids normally function in the gastrointestinal tract to emulsify consumed fat, however, they have garnered considerable attention as endocrine molecules in recent years, particularly in terms of glucose metabolism [reviewed in ]. Interestingly, several studies have suggested that bile acids are able to stimulate BAT activation, and even protect mice from diet-induced obesity [,]. Interestingly, bile acids have been shown to play a beneficial role in aged animals, particularly in the context of glucose metabolism []. Although an attempt to extend longevity through the use of a particular bile acid, ursodeoxycholic acid was unsuccessful [], there does appear to be a role of bile acids and aging. For example, the long-lived “little” mice have drastically higher levels of many bile acids [], which appears to be at least partially controlled by growth hormone signaling in the liver []. Moreover, treating progeroid mice with cholic acid was able to significantly extend longevity []. To what extent bile acids can impact BAT and longevity is still unknown.

STUDIES OF THE REGULATION OF DEVELOPMENT AND FUNCTION OF BROWN AND BEIGE FAT SUGGEST NOVEL TARGETS FOR INTERVENTION

Thermogenesis involves shuttling fatty acids to BAT or beige fat cells to produce heat rather than storing them in WAT []. This process in BAT is activated during cold exposure [,]. Targeting this mechanism of fatty acid redistribution could be beneficial for treating obesity and accompanying metabolic diseases, such as cardiovascular disease and diabetes and have been related to excess triglyceride storage in WAT.

Central nervous system control of BAT thermogenesis involves guanylate cyclase 2C receptors in the hypothalamus and it was recently shown that activation of these receptors by treatment with linaclotide reduced body weight of obese mice without changing their food intake []. This beneficial metabolic effect was related to inducing increased energy expenditure for BAT thermogenesis. Linaclotide is a drug approved for treatment of irritable bowel syndrome with constipation.

Research in this field is very active and several novel approaches to stimulating energy expenditure in order to improve metabolic health have been reported while this article was being finalized. Treating mice with an orally bioavailable mitochondrial uncoupler, BAM15, was shown to increase nutrient oxidation, and decrease adiposity without altering food intake, and improve insulin sensitivity []. These actions reversed diet-induced obesity and would be expected to promote healthy aging. A derivative of amphetamine modified to prevent its entry into the brain and acting as sympathofacilitator was reported to increase lipolysis, thermogenesis, and heat dissipation in mice, thus protecting the animals from obesity without having undesirable cardiovascular and central nervous system effects of amphetamine []. Disulfiram, which is approved treatment of alcohol addiction, was recently shown to reverse diet-induced obesity and metabolic dysfunction in mice by increasing energy expenditure []. An implantable wireless optogenetic device was shown to activate thermogenesis selectively in adipocytes by a mechanism independent of beta-adrenergic pathway []. In mice, this innovative treatment could increase thermogenesis and whole-body energy expenditure and prevent diet-induced weight gain []. Results of these and other recent studies identify new avenues that could be explored to stimulate activity of BAT and beige fat in people to produce metabolic changes that reduce a risk of age-related disease likely leading to extended longevity.

CONCLUSIONS

Age-related changes in body composition and in the risk of diabetes and other chronic diseases are related to energy metabolism. Activation of BAT and conversion of WAT to thermogenic beige fat can increase utilization of fat for thermogenesis (heat production) leading to reduced adiposity, improved glucose homeostasis, and healthier metabolism. Increasing energy expenditure for thermogenesis by cold exposure or by dietary or pharmacological interventions holds promise for reducing and/or preventing obesity and improving chances for healthy aging and long life.

ACKNOWLEDGEMENTS

We apologize to those whose work pertinent to the issues discussed was not cited due to limitations of the format or to inadvertent omissions. We are grateful for editorial assistance provided by Lisa Hensley and Dr. Tracy Evans

Writing of this article and our recent and current studies of this topic were supported by American Diabetes Association [ADA 1-19-IBS-126] and the William E. McElroy Charitable Foundation (Bartke A), National Institutes of Health [NIA R01AG057767 and NIA R01AG061937], the Center for Alzheimer's Disease and Related Disorders, and the Kenneth Stark Endowment (Hascup E, Hascup K), and the American Heart Association AHA 20POST35210497 (Darcy J).

Footnotes

Conflict of Interest: The authors have no potential conflicts of interest to disclose.

Author Contribution:

Article conception & design: AB.

Data acquisition: AB.

Data analysis and interpretation: AB.

Writing of the manuscript: AB, KH, EH, SB, JD.

Receiving grant: AB, EH, JD.

Approval of final manuscript: AB.

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Articles from The World Journal of Men's Health are provided here courtesy of Korean Society for Sexual Medicine and Andrology

AGE linked to SLEEP:

As individuals age, their sleep patterns typically undergo changes, with older adults often experiencing more difficulty falling asleep, frequent awakenings during the night, and earlier wake-up times. While the total sleep time may stay the same or slightly decrease (around 6.5 to 7 hours), the quality and structure of sleep are affected. These changes are a combination of normal aging processes, sleep disorders that become more prevalent with age, and other factors like medications, medical conditions, and lifestyle changes.

Here's a more detailed look at the relationship between age and sleep:

1. Changes in Sleep Structure:

Reduced Sleep Duration and Efficiency:

Older adults tend to spend less time in deep sleep (slow-wave sleep) and rapid eye movement (REM) sleep, which are crucial for physical and cognitive restoration. They also experience more awakenings during the night and a decrease in overall sleep efficiency.

Increased Sleep Latency:

It takes older adults longer to fall asleep compared to younger adults, indicating a higher sleep latency.

Circadian Rhythm Shift:

Older adults often experience a shift in their circadian rhythm, leading to earlier bedtimes and wake-up times, often referred to as a "morning chronotype".

More Time in Naps:

Older adults tend to nap more frequently during the day, which can disrupt nighttime sleep.

2. Factors Contributing to Age-Related Sleep Changes:

Physiological Changes:

Age-related changes in brain structure and function, as well as decreased melatonin production, can affect sleep patterns.

Comorbidities and Medications:

Older adults are more likely to have underlying health conditions and take medications, many of which can interfere with sleep.

Sleep Disorders:

Sleep disorders like insomnia, sleep apnea, and restless legs syndrome become more common with age, further impacting sleep quality.

Lifestyle Factors:

Retirement, decreased physical activity, social isolation, and changes in metabolism can also contribute to sleep difficulties in older adults.

3. Implications of Sleep Changes:

Daytime Sleepiness and Fatigue:

Reduced sleep quality and duration can lead to daytime fatigue, impaired cognitive function, and decreased physical performance.

Increased Risk of Falls and Accidents:

Daytime sleepiness and impaired cognitive function can increase the risk of falls and accidents, particularly in older adults.

Impact on Overall Health:

Poor sleep has been linked to a higher risk of various health problems, including cardiovascular disease, diabetes, obesity, depression, and cognitive decline.

4. Tips for Improving Sleep in Older Adults:

Practice Good Sleep Hygiene:

Maintain a regular sleep schedule, create a relaxing bedtime routine, and ensure a comfortable sleep environment.

Address Underlying Medical Conditions:

Consult with a healthcare professional to manage any underlying medical conditions or medications that may be affecting sleep.

Consider Sleep Disorders:

If sleep problems persist, seek evaluation for potential sleep disorders like insomnia or sleep apnea.

Engage in Regular Physical Activity:

Regular exercise, especially during the day, can promote better sleep at night.

Limit Caffeine and Alcohol Before Bed:

Avoid caffeine and alcohol, especially in the hours leading up to bedtime.

AGE linked to STEPS WALKED

Generally, daily step counts tend to decrease with age, although there's a wide range of activity levels at any given age. Younger adults tend to walk more than older adults, and males often walk more than females.

Here's a more detailed breakdown:

Younger adults (18-40):

that younger adults may average between 7,000 and 13,000 steps per day. Younger adults are more likely to meet recommended physical activity guidelines .

Older adults (60+):

Older adults may average between 6,000 and 8,000 steps per day, with some studies suggesting that even 4,500-7,500 steps can be beneficial.

Impact of age on gait:

Age-related changes in gait patterns can lead to slower walking speeds and changes in step length and width, potentially increasing the risk of falls.

Benefits of walking:

Regardless of age, regular walking is beneficial for overall health and can reduce the risk of various diseases. For example, one study found that women who walked 4,400 steps per day were less likely to die than those who walked 2,700 steps per day.

Individual variation:

It's important to remember that these are just averages, and individual activity levels can vary significantly based on factors like occupation, lifestyle, and personal health.

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How Many Steps Do People Take Per Day on Average?

As wearable fitness trackers become increasingly popular, more people are taking a closer look at their daily steps. And it seems to be paying off.

According to the , people who track their steps take an average of 2,500 more steps per day than those who don’t.

If you’re one of the millions who participate in a quest to hit the commonly  goal, your efforts won’t go unrewarded.

Regular activity, including walking, offers a number of health benefits, including a reduced risk of:

heart disease and stroke

high blood pressure

diabetes

obesity

depression

certain cancers, including breast and colon cancer

But how many steps per day does the average person really take? And is it enough?

Steps decrease with age

A  concluded that adults over the age of 18 take anywhere from 4,000 to 18,000 steps per day. Another  looked at children and adolescents.

It found that those under 18 take anywhere from 10,000 to 16,000 steps per day. The authors noted that the number of daily steps drops significantly as teenagers approach age 18.

Age definitely seems to play a role in how much walking people are doing. Younger adults are also  to meet the Centers for Disease Control and Prevention (CDC) guidelines for aerobic activity than older adults.

Males tend to walk more

There appears to be a significant difference in the average number of steps taken by females and males. From childhood through adulthood, males tend to walk more. As children and teens, they walk an average of  steps per day. Young females, on the other hand, get 10,000 to 12,000.

This trend continues into adulthood, at least in the United States. A  looked at pedometer data for just over 1,000 adults. Overall, males took an average of 5,340 steps per day, compared to 4,912 for females.

Your job likely plays a role, too

What you do for a living may impact your average steps per day, too. Jenny Craig conducted a  in 2012 involving 10 participants from Australia, each with a different job. They were given pedometers to track their steps.

Here’s a breakdown of the average steps per day associated with 10 professions, from highest to lowest:

Keep in mind that this data wasn’t collected as part of a formal, controlled study. It only includes data for one person in each occupation and doesn’t account for important factors, such as sex or age.

Still, it’s an interesting snapshot of how much the average steps per day can vary from person to person.

Numbers vary from country to country

People in certain countries tend to take more steps per day than those in other countries. A  tracked activity levels of 717,527 people in 111 countries over an average of 95 days using smartphones.

Here’s what the study found:

It’s not clear why the average number of steps per day varies from country to country. A range of factors likely play a role, including:

obesity rates

climate

walkability of roads and sidewalks

income

See how you measure up

The  recommends that adults, including older adults, get a minimum of 150 minutes of aerobic activity, such as brisk walking, per week. A brisk pace translates to roughly 100 steps per minute. This means you’ll need to take 15,000 steps per week (a little over 2,000 steps per day) to meet the CDC’s minimum guidelines.

For more health benefits, the CDC recommends upping that goal to 300 minutes. This equals about 30,000 steps per week (just under 5,000 steps per day).

Remember, this refers to walking at a fast pace, one that leaves you at least slightly out of breath.

Chances are this doesn’t apply to every step you take throughout your day, so 10,000 steps per day is still a good goal to work toward to ensure you’re getting enough. Just make sure a portion of those involve walking at a faster pace.

If you’re not sure how you can add more steps to your daily routine, try these tips:

Take the stairs instead of the elevator.

Park farther away from the door when running errands.

Walk with a friend.

Clean your house.

Take a walk during breaks at work.

Walk in the mall when the weather’s poor.

How we reviewed this article:

Sources

History

Our experts continually monitor the health and wellness space, and we update our articles when new information becomes available.

Current Version

Oct 6, 2023

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Medically reviewed by Micky Lal, MA, CSCS,RYT — Written by Adrienne Santos-Longhurst — Updated on October 6, 2023

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Generally, student steps walked per day tends to decrease with age. Younger students, particularly in elementary school, often average between 10,000 and 15,000 steps daily, while adolescents and older students tend to average fewer steps, with 18-year-olds typically averaging around 8,000-9,000 steps per day.

Here's a more detailed breakdown:

Younger Children (Preschool/Elementary):

Younger children, especially preschool-aged, tend to be very active and can average 10,000-14,000 steps per day.

Elementary/Middle School:

As children move into elementary and middle school, their daily step counts tend to be higher, with averages often between 12,000-16,000 steps for boys and 10,000-13,000 for girls, .

Adolescents:

As students enter their teenage years, their step counts tend to decrease, with 18-year-olds typically averaging around 8,000-9,000 steps per day, .

Factors Influencing Steps:

Several factors influence the number of steps students take, including:

Age: As discussed, age is a significant factor, with younger students generally taking more steps.

Gender: On average, boys tend to take more steps than girls, .

Activity Levels: Students involved in sports or other physical activities will likely have higher step counts.

School Environment: The school's location, access to walking paths, and overall design can also influence step counts, according to ScienceDirect.

Transportation: Walking or biking to school will increase step counts compared to being driven or taking a bus.

Obesity: Overweight and obese children may have slightly lower step counts, according to ScienceDirect.

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Daily steps in midlife and older adults: relationship with demographic, self-rated health, and self-reported physical activity

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PMID: 18664036

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Abstract

The relationship between average daily step counts and age, body mass index (BMI), self-reported physical activity (PA) level, and perceived health was determined in 85 middle-aged and older adults who wore a pedometer for 7 consecutive days. Average daily steps were significantly (p < .05) correlated with BMI (r = -.26), age (r = -.44) and perceived health (r = .53) but not with self-reported PA level (r = .19). The adjusted percentage of participants classified as meeting the PA recommendation in < or = 5,000, 5,001-9,999, and > or = 10,000 steps/day categories ranged from 53 to 61%. These findings support previous evidence in younger populations suggesting that the recommended minimal level of health-related PA may be achieved despite not accumulating 10,000 steps/day.

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January 24, 2023

Link between hydration and aging

At a Glance

Higher blood sodium in middle age was associated with increased mortality, chronic disease risk, and biological aging.

The findings suggest that poor hydration may accelerate biological aging and increase the risk of chronic disease and death.

Image

The study suggests that drinking enough fluids may help reduce the risk for serious chronic diseases.

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As people live longer, the world’s population is aging. This has led to an epidemic of age-related chronic diseases. Finding ways to slow down aging and prevent such diseases has become a pressing task for medical research.

Studies in mice have shown that restricting water intake shortens the mouse lifespan and leads to organ degeneration. This suggests that staying properly hydrated might help slow down the aging process. A research team at NIH’s National Heart, Lung, and Blood Institute (NHLBI), led by Dr. Natalia Dmitrieva, explored whether hydration might also be associated with aging in people. Their findings appeared in eBioMedicine on January 2, 2023.

The team looked for associations between aging and hydration in data from a study that followed more than 15,000 people from four U.S. communities for more than 25 years. Participants were 45-66 years old at the beginning of the study. As part of the study, sodium levels in the participants’ blood sera were measured at enrollment and at their first follow-up visit three years later. Serum sodium goes up as people drink less fluids, so serum sodium levels can serve as a proxy for hydration.

The team looked at study participants with normal levels of serum sodium—between 135 and 146 mmol/L. They found that, even within this range, differences in serum sodium were associated with differences in mortality. People with serum sodium near the middle of the normal range—137 mmol/L to 142 mmol/L—had the lowest mortality rate. Those with serum sodium above 144 mmol/L had 21% greater risk of dying at an earlier age. Higher serum sodium was also associated with increased risk of chronic diseases including heart failure, dementia, chronic lung disease, and stroke.

The researchers calculated the participants’ biological age based on various biomarkers. The risks of premature mortality and chronic disease both increased with biological age. And people with serum sodium levels above 144 mmol/L were 50% more likely to have a biological age greater than their chronological age.

The results suggest that serum sodium above a certain threshold may be a risk factor for faster aging. This, in turn, increases the risk for chronic disease and premature death.

Reduced fluid intake is the most common reason for elevated serum sodium. Thus, Dmitrieva says, “proper hydration may slow down aging and prolong a disease-free life.”

The researchers note that their results don’t prove that elevated sodium causes accelerated aging. Establishing a causal link will require randomized controlled clinical trials. But the findings do suggest that a clinical evaluation could help people with elevated serum sodium. They may benefit from drinking more fluids, or may have underlying conditions that lead to fluid loss.

Related Links

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Funding

NIH’s National Heart, Lung, and Blood Institute (NHLBI); Department of Health and Human Services.

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ISSN 2375-9593

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Water intake recommendations generally increase with age in students. Younger children (4-8 years) should aim for about 40 ounces (5 cups) per day, while older teens (14-18 years) may need 64 to 88 ounces (8 to 11 cups). Physically active students, or those in hotter climates, may need even more.

Elaboration:

Age-Related Increases:

As children grow, their bodies increase in size and activity levels, leading to a higher daily water requirement.

Recommendations:

4-8 years: 40 ounces (5 cups).

9-13 years: 56-64 ounces (7-8 cups).

14-18 years: 64-88 ounces (8-11 cups).

Factors Influencing Needs:

Activity Level: Students who are very active or participate in sports will likely need to drink more water than those who are less active.

Climate: Hotter climates increase the need for fluids to compensate for sweat loss.

Plain Water Intake:

Plain water is a healthy alternative to sugary drinks, and its intake is inversely associated with sugar consumption in youth.

Monitoring Hydration:

Signs of dehydration include infrequent urination, dark yellow urine, and feeling thirsty. It's important for students to be aware of their hydration status and drink water throughout the day to prevent dehydration.

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May 30, 2023//

Drink Up: The Connection Between Age and Dehydration

Body changes put older adults at increased risk of dehydration

It’s no secret that your body changes as you age. But what may surprise you is that one of those changes involves your sense of thirst.

As you age, your body doesn’t demand water like it used to in your younger years. The issue with that, of course, is that you still need fluids to function — and not drinking enough puts you in danger of .

Many people aged 65 and older don’t drink enough liquids, says geriatric clinical nurse specialist . Let’s take a closer look at the issue and how to best address it.

Why are older adults more susceptible to dehydration?

Older adults are at a  because of how body composition changes with age. Those in the 65-and-older crowd simply have less water in their bodies than younger adults or children. Decreased kidney function also can affect fluid levels.

The reduction in thirst that comes with age can keep that already low supply from being replenished. “By the time an older adult feels thirsty, that’s already an indication of early dehydration,” says Vanderbilt.

Water is necessary for nearly every bodily function, from lubricating joints to regulating body temperature and pumping blood to your muscles. Not getting enough of it can have serious health consequences.

That’s why dehydration is a common cause of hospitalization among those 65 and over.

“Adding to the problem is that symptoms of dehydration in older adults often go unrecognized,” she adds. “Symptoms can be easily attributed to other medical conditions, medications or natural effects of aging.”

What are signs of dehydration?

Dehydration can affect you physically, mentally and emotionally, as blood vessels in your brain and throughout your body constrict due to dwindling fluid levels. Physical signs of dehydration include:

and weakness.

or loss of coordination.

Dry mouth and/or a dry cough.

.

Muscle cramps due to the loss of  through sweating.

Chills or heat intolerance.

Flushed skin.

Someone who’s dehydrated also may seem confused, cranky or anxious. (These symptoms may appear worse in someone who has , a group of diseases that can affect memory and behavior. It’s estimated that about 50% of people age 85 and older have dementia.)

Persistent dehydration that causes more severe symptoms can land older adults in an emergency room or hospital.

Tips to prevent dehydration

The best way to prevent dehydration is as obvious as it seems: Consume more fluids. The “eight glasses of water per day” rule is a general recommendation that became popular because it’s easy to remember, explains Vanderbilt.

“But some people definitely can tolerate less, and sometimes, you need more, like in the heat if you’re sweating,” she says. (Learn more about .)

Older adults can work to avoid dehydration by using these tips:

Mix it up

Water is ideal for hydration, but we all know that drinking H2O all day every day can get boring. Make that glass of clear liquid a bit more interesting by dropping in sliced fruit, like lemon or strawberries.

But there are plenty of other options, too.  offer hydration and nutrition. Ditto for fruit juices. (A lot of , though, which can be an issue, especially if you have diabetes. Consider a mix of juice and water if sugar is a concern.)

Avoid caffeine

Caffeinated beverages like  and  can have a diuretic effect, meaning you’ll pee more — an obvious way to lose fluid. So, while it’s OK to enjoy those drinks in moderation, don’t make them a significant part of your daily fluid intake.

Eat hydrating foods

Fluid doesn’t have to come out of a glass. It can come from your plate, too.

Many foods  content and can help you stay hydrated. The list includes cucumbers, celery and the aptly named , which is 91% water. ( count, too!)

Make hydration an all-day effort

Build hydration into your routine and consistently sip throughout the day, particularly when the temperatures start to climb on hot days. Purchase a nice mug, cup or tumbler to always keep on hand for easy access.

“What I often see in advanced older adults — people in their 80s and 90s — is that they can’t sit down and drink a full 8-ounce glass of water,” notes Vanderbilt. “It fills them up, causes bloating and then, makes them have to run to the bathroom. So, little sips throughout the day are better.”

Know your needs

People with certain medical conditions — heart failure, for example — may have more specific fluid needs. Make sure to consult with your healthcare provider before making significant fluid intake changes.

Final thought: Drink up!

Avoiding dehydration really is as simple as drinking more fluids, says Vanderbilt. It’s important to stay hydrated at any age, of course, but risks associated with dehydration grow with the number of birthday candles on your cake.

“Drinking water is something you need to focus on more as you age,” she encourages. “Make it a habit — especially since your body might not be sending you the message that you’re thirsty.”

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CAFFEINE linked with AGE:

As individuals age, their sensitivity to caffeine and its effects can change. Older adults may experience heightened sensitivity to caffeine's effects, including increased blood pressure and slower caffeine clearance from the body. However, caffeine can still provide potential benefits for older adults, particularly in terms of physical function.

Here's a more detailed look at the relationship:

Increased Sensitivity with Age:

Slower Metabolism:

Older adults tend to metabolize caffeine more slowly than younger individuals. This means the effects of caffeine can linger longer in their system, potentially leading to sleep disturbances or other unwanted side effects.

Heightened Cardiovascular Response:

Studies have shown that older adults may experience a greater increase in blood pressure in response to caffeine consumption compared to younger individuals.

Potential Benefits of Caffeine:

Improved Physical Function:

Some studies suggest that caffeine can still offer benefits for older adults, potentially improving physical performance and functional capacity in daily tasks.

Reduced Risk of Chronic Diseases:

Research indicates that coffee consumption may be associated with a reduced risk of certain chronic diseases and mental health issues in older women.

Important Considerations:

Individual Variability:

Responses to caffeine can vary significantly between individuals, regardless of age.

Moderation:

It's generally recommended that older adults consume caffeine in moderation and be mindful of how it affects their sleep and overall well-being.

Consultation with Healthcare Professional:

If there are concerns about caffeine's effects on an individual's health, it's always best to consult with a doctor or other healthcare professional.

Caffeine's impact on students varies with age. Younger students are more susceptible to caffeine's effects due to smaller body size and developing systems, potentially leading to sleep disruption and behavioral issues. Older students, including those in college, often consume caffeine to stay alert, but may develop sensitivities or experience withdrawal symptoms if they reduce or stop intake.

Younger Students (Children and Adolescents):

Increased Sensitivity:

Children and adolescents are more sensitive to caffeine's effects due to their smaller body size and developing systems.

Potential Negative Effects:

Caffeine can disrupt sleep, increase anxiety, heart rate, and blood pressure, and may contribute to behavioral problems.

No Established Safe Amount:

There are no federal guidelines for caffeine intake for children under 12, and the American Academy of Pediatrics discourages caffeine consumption for this age group.

Limited Recommendations:

For adolescents (12-17), some organizations suggest limiting intake to less than 100 mg per day.

Older Students (College Students and Beyond):

Caffeine Use for Alertness:

Many older students, especially in college, consume caffeine to stay awake and focused, particularly during late-night study sessions.

Development of Sensitivity:

As people age, their bodies clear caffeine more slowly, and the enzymes involved in caffeine metabolism become less efficient, potentially leading to increased caffeine sensitivity .

Potential for Withdrawal:

Reducing or eliminating caffeine intake can lead to withdrawal symptoms like headaches, irritability, and insomnia.

Individual Variability:

Responses to caffeine vary based on genetics, habituation, and other factors.

Overall:

Moderation is Key:

Regardless of age, moderation is important when it comes to caffeine consumption.

Consider Alternatives:

For students looking for energy, exploring alternatives like exercise, a balanced diet, and good sleep hygiene can be beneficial.

Seek Professional Advice:

If students are concerned about their caffeine intake or experiencing negative effects, they should consult with a healthcare professional or a registered dietitian for personalized advice.

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doi: 10.2165/00002512-199813010-00005.

Caffeine and the elderly

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PMID: 9679208

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Abstract

The most common source of dietary caffeine among the elderly is coffee, with consumption averaging about 200 mg/day. Because of the greater proportion of adipose tissue to lean body mass in older humans, and because caffeine is distributed essentially only through lean body mass, a dose of caffeine expressed as mg/kg total bodyweight may result in a higher plasma and tissue concentration in elderly compared with younger individuals. The metabolism of, and physiological responses to, caffeine is similar in elderly and younger individuals. However, there is a limited amount of evidence that responses to caffeine in some physiological systems may be greater in the elderly at doses in the 200 to 300 mg range. Although caffeine consumption increases urinary calcium levels similarly in both younger and older individuals, the preponderance of data suggest that caffeine has a greater impact on calcium metabolism and bone in older people. Evidence also suggests that increasing age is associated with increasing sensitivity to the pressor effects of caffeine. Caffeine appears to affect metabolic and neurological responses similarly in both young and elderly individuals, when differences in baseline performance are taken into account.

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We join you, along with billions (yes, billions-with-a-b) of people throughout the world in your devotion to caffeine. Whether it’s coffee, tea or other caffeinated beverages, we humans love the lift it gives. Recent data estimate that 85% of adults in the United States consume caffeine in some form each day.

Caffeine stimulates the central nervous system. Due to its physiological effects, as well as its potential for abuse, it is considered a drug. In fact, caffeine withdrawal, which can cause headache, anxiety, insomnia and depression, is a recognized disorder. At the same time, research continues to link coffee and tea, the two most widely consumed caffeinated drinks, to a range of physical and cognitive benefits.

As you have come to suspect, it is indeed possible to develop caffeine sensitivity. Due to certain changes that take place in our bodies as we grow older, this becomes more common as we age. Research shows that older adults clear caffeine from the body more slowly than younger people. In one study, coffee drinkers between the ages of 65 and 70 took 33% longer to metabolize caffeine than did younger participants. A slower clearance rate means the same amount of coffee that someone has been habitually drinking would have an amplified effect. This can cause unpleasant symptoms such as anxiety, irritability, jumpiness, difficulty with sleep, sleeplessness and the “racy” feeling that you describe in your letter.

Caffeine is rapidly and completely absorbed by the body. In fact, within 45 minutes of drinking a cup of coffee, 99% of the caffeine it contains has been absorbed. It makes its way from the digestive tract to the bloodstream, where it can reach peak levels within 15 minutes of consumption.

After a few hours, certain enzymes in the liver begin to metabolize, or break down, the caffeine. This occurs gradually, and in a series of steps. In a healthy young adult, it takes about six hours for the liver to cut the amount of circulating caffeine in half. But as people age, the enzymes involved in caffeine metabolism grow less efficient. This leads to the slower clearance rate that we discussed earlier. Other factors, such as pregnancy, certain medications and being a smoker can also slow the rate at which caffeine is metabolized.

When someone becomes sensitive to caffeine, it can become necessary to rethink consumption in order to avoid the adverse effects. An 8-ounce cup of coffee delivers between 80 and 100 milligrams of caffeine. Research shows that for older adults, amounts in the range of 50 to 100 mg are well-tolerated. To manage caffeine sensitivity, try limiting yourself to one cup a day. And if multiple cups are your routine, consider switching to a half-caf blend.

(Send your questions to askthedoctors@mednet.ucla.edu, or write: Ask the Doctors, c/o UCLA Health Sciences Media Relations, 10960 Wilshire Blvd., Suite 1955, Los Angeles, CA, 90024. Owing to the volume of mail, personal replies cannot be provided.)

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Published: 30 April 2025

Caffeine induces age-dependent increases in brain complexity and criticality during sleep

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Abstract

Caffeine is the most widely consumed psychoactive stimulant worldwide. Yet important gaps persist in understanding its effects on the brain, especially during sleep. We analyzed sleep electroencephalography (EEG) in 40 subjects, contrasting 200 mg of caffeine against a placebo condition, utilizing inferential statistics and machine learning. We found that caffeine ingestion led to an increase in brain complexity, a widespread flattening of the power spectrum’s 1/f-like slope, and a reduction in long-range temporal correlations. Being most prominent during non-rapid eye movement (NREM) sleep, these results suggest that caffeine shifts the brain towards a critical regime and more diverse neural dynamics. Interestingly, this was more pronounced in younger adults (20–27 years) compared to middle-aged participants (41–58 years) during rapid eye movement (REM) sleep, while no significant age effects were observed during NREM. Interpreting these data in the light of modeling and empirical work on EEG-derived measures of excitation-inhibition balance suggests that caffeine promotes a shift in brain dynamics towards increased neural excitation and closer proximity to a critical regime, particularly during NREM sleep.

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Introduction

For many, enjoying the delicate flavors of an espresso coffee ranks high up on the list of life’s little pleasures. Unfortunately, although caffeine-containing products have a range of positive effects, such as increased alertness, mental focus, and cognitive performance, it also has a disruptive effect on the quality of sleep, which is critical for general health and well-being,. On the other hand, caffeine has been shown to exhibit neuroprotective qualities, particularly against Parkinson’s disease,,,, adding to the complexity of its impact on health. Caffeine is a psychoactive stimulant that is consumed by people across all age groups on a daily basis through a wide variety of products such as coffee, tea, soft drinks, energy drinks, chocolate, and several pharmaceutical drugs. It is therefore critical to understand how caffeine affects the brain during sleep, and across age.

Caffeine affects the quality of sleep in several ways. It increases sleep latency (i.e., the time it takes you to fall asleep) and it decreases sleep efficiency (the ratio of total sleep time to the time you spend in bed). The reduction of sleep duration caused by caffeine intake is particularly visible in the amount of time spent in the S2 sleep stage,,,. Further, both acute and regular daytime caffeine intake was found to delay rapid eye movement (REM) sleep promotion and lead to a reduction in the quality of awakening. However, a recent study proposed that the caffeine-induced reduction in sleep duration observed in humans could be attributed to a lack of flexibility in wake-up times instead of being a direct effect of caffeine. Nevertheless, lack of sleep and sleep disorders can lead to the deterioration of the proper functioning of sleep-related brain processes, weight gain, hypertension, cardiovascular diseases, diabetes, and increase the risk of depression.

As a psychostimulant and an adenosine antagonist, caffeine reduces natural homeostatic sleep pressure by binding to adenosine receptors, thereby inducing a feeling of higher alertness and invigoration. Adenosine, which is crucial for brain homeostasis, has been shown to mediate permeability of the blood-brain barrier (BBB) by binding to A1 and A2 adenosine receptors,. Activation of these receptors leads to increased permeability of the BBB, allowing transport of macromolecules like dextrans and β-amyloid antibodies into murine brains. Hence, because it is an adenosine antagonist, caffeine is likely to interfere with BBB permeability rhythms during sleep. Despite encouraging progress, the mechanisms by which caffeine alters brain dynamics during sleep remain poorly understood. Beyond its direct effects on adenosine signaling, caffeine triggers a cascade of downstream effects on other neurotransmitter systems, including enhanced dopamine and norepinephrine release, increased acetylcholine availability, and modulation of GABAergic and glutamatergic transmission. These complex interactions between different neurotransmitter systems likely contribute to caffeine’s diverse effects on brain function and sleep architecture.

Electrophysiological effects of caffeine: from spectral power to brain complexity and criticality

Previous research has reported caffeine-induced effects on spectral power of electroencephalography (EEG) signals recorded during sleep. Generally, caffeine was found to decrease power in low frequency oscillations in the delta band and increase power in sigma and beta frequencies,,,,,,. Another study conducted in Cynomolgus monkeys, which have been suggested to have sleep patterns similar to those of humans,, found that caffeine ingestion led to a decrease in delta and theta power (1–8 Hz) and increased beta and low-gamma power (20–50 Hz) during sleep.

While spectral power analysis provides important insights into the oscillatory properties of brain signals, it does not capture the diversity and full complexity of EEG signals. Complementary insights can be harnessed by assessing brain signal complexity. The complexity of a system can generally be divided into two main subtypes: Type 1 complexity increases linearly with randomness (e.g., entropy or Lempel-Ziv complexity), while Type 2 complexity follows an inversely parabolic pattern, peaking at moderate randomness and declining at extremes (e.g., criticality or Kolmogorov Complexity),.

One common approach to measure Type 1 complexity is by measuring entropy, which generally assess the degree of unpredictability or randomness within a signal. These measures can provide valuable information about the underlying dynamical processes of the brain with high entropy signals occurring in states of wakefulness, while low entropy signals can be observed during deep sleep or anesthesia. In fact, entropy was shown to vary consistently across sleep stages with wakefulness exhibiting the highest levels of entropy, followed by REM and NREM sleep. Crucially, brain entropy has also been found to correlate positively with an array of cognitive functions including attention, memory, and verbal fluency.

However, Type 1 complexity as measured via entropy does not capture the full spectrum of complexity, as a purely random process–despite being highly entropic–lacks structure and meaningful organization. High entropy alone does not necessarily indicate maximal complexity in brain function. In contrast, Type 2 complexity addresses this limitation by highlighting that maximal complexity arises in systems that achieve an optimal balance between order and randomness. According to criticality theory, this critical point characterizes the state of maximal computational efficiency and optimal information processing. Such states, often associated with criticality, enable the brain to balance stability and flexibility, a hallmark of higher-order cognitive processes,,. As a matter of fact, the so called edge of chaos criticality, characterized by a balance between order and disorder, can be assessed through various metrics, including Lempel-Ziv complexity, the slope of the aperiodic power spectrum, and long-range temporal correlations,. These measures have been shown to track cognitive states and arousal levels, suggesting they capture functionally relevant aspects of neural dynamics.

Aim and hypotheses

The aim of the present study was to provide an in-depth assessment of the influence of caffeine on the brain’s electrophysiological signals during sleep with a focus on brain complexity and criticality. Additionally, we expanded on previous power spectral investigations by disentangling periodic and aperiodic components in the EEG spectra, revealing a refined perspective on caffeine’s impact on the EEG power spectrum during sleep.

In wakefulness, caffeine ingestion facilitates alertness and cognitive performance by blocking the action of adenosine, a neurotransmitter that promotes sleep drive. Given that cognitive performance is closely linked to brain complexity and criticality, one would expect that caffeine intake leads to an increase in EEG complexity or entropy and a shift closer to a critical regime. In fact, a previous fMRI study has provided evidence for caffeine-induced increases in brain entropy during wakefulness. However, it is yet unknown whether similar effects extend to sleep EEG signals.

Furthermore, caffeine is known to alter sleep architecture by reducing slow-wave sleep (SWS) and increasing lighter sleep stages such as N1 and N2,. Complexity measures, including entropy, have been shown to reliably reflect these changes, with entropy being highest in wakefulness, followed by REM sleep, and progressively decreasing across N1, N2, and SWS,. We expect that caffeine-induced alterations in sleep architecture, specifically the reduction of SWS and the increase in lighter sleep stages (N1 and N2), will result in a measurable increase in EEG complexity during NREM sleep.

Aging is characterized by a decrease in adenosine receptor density, reduced time spent in deep sleep, and shifts in brain dynamics, including increased neural entropy and a flattened power spectrum slope,,,. Given these baseline changes and caffeine’s known effects on arousal and sleep architecture, we anticipate that caffeine’s impact on brain complexity and criticality during sleep will be weaker in middle-aged compared to younger individuals.

Based on the above, the main hypothesis of this study is that caffeine ingestion leads to increased EEG complexity and a shift closer to a critical regime during NREM sleep. Our secondary hypothesis is that caffeine-induced changes in brain complexity and criticality are weaker in middle-aged compared to younger individuals, reflecting known age-related differences in adenosine receptor density, sleep architecture, and neural dynamics.

By contrasting the effects of caffeine and placebo using inferential statistics and machine learning (ML) separately for non-REM (NREM) and REM sleep, as well as for young and middle-aged groups of adults, we provide the first evidence that caffeine induces a broad increase in EEG brain entropy and a shift towards critical dynamics during sleep. These effects were more widespread in NREM compared to REM sleep, while age-related differences were observed exclusively in REM. To ensure the robustness of our results, we provide a comparison of several different metrics of entropy and criticality. Collectively, these findings advance our understanding of how caffeine modulates brain dynamics across different sleep stages and age groups, while offering methodological insights into the assessment of brain signal complexity and criticality under the effect of psychostimulants.

Results

Sleep EEG data were collected from 40 healthy participants during two non-consecutive nights under caffeine and placebo conditions. After preprocessing and artifact removal, we extracted a range of features from the EEG, including power spectral density (PSD), entropy measures, and complexity metrics, to capture caffeine-induced changes in brain activity (see Section Feature extraction). These features were analyzed both statistically (see Section Direct statistical analysis) and using supervised ML classifiers (see Section Supervised machine learning analysis) to identify differences between conditions. A summary of Cohen’s d values for statistical results can be found in Supplementary Table . The detailed experimental design, feature extraction, and analysis pipelines are described in the Methods section. In the following, we will go over the results of the spectral power analysis, followed by complexity and criticality-related observations, before covering age-related effects.

Caffeine-induced changes in sleep EEG oscillations

Figure  shows the effect of caffeine, compared to placebo, on spectral power in five key frequency bands, compensating for changes in the aperiodic component (see Section Feature extraction). The topographies depict the results of standard statistical testing (permutation T-tests) alongside ML decoding accuracy topographies (SVM and LDA classifiers), and are presented separately for NREM and REM sleep stages.

Fig. 1: Brain activity patterns during sleep (NREM and REM), comparing caffeine versus placebo effects on periodic neural oscillations (after removing aperiodic spectral components).

Left column shows statistical differences (blue: reduced during caffeine, red: increased during caffeine), while SVM/LDA columns show classification accuracy between conditions (green). Dots indicate statistical significance (gray: p < 0.05, white: p < 0.01).

During NREM sleep, caffeine led to statistically significant reductions in power in the delta, theta and alpha frequency bands (3 left columns in Fig. ). While this decrease spanned parietal and central channels for the delta and theta bands, the decrease in alpha power was localized between central and prefrontal channels. Interestingly, beta power showed a widespread increase across parietal and frontal channels. Compared to the results of the SVM and LDA classification, the t-test analyses yielded a larger number of channels with statistically significant results. This said, the spatial distributions of the significant results were consistent across all three methods, which speaks to the robustness of the findings across within-sample and out-of-sample analysis methods.

The most prominent caffeine effect observed during REM sleep was a significant reduction of theta power in temporal, parietal, and occipital channels. While the t-tests showed statistically significant differences between caffeine and placebo, the decoding accuracy obtained with SVM and LDA, although elevated, did not reach the p < 0.01 significance threshold level. This said, the LDA-based analysis during REM sleep revealed statistically significant (p < 0.05) classification using beta power in the frontal cortex. This effect was driven by a reduction in beta power, which contrasts with the strong beta power increase observed during NREM sleep.

Disentangling contributions from periodic and aperiodic components to caffeine-induced spectral changes

Crucially, and in contrast to previous work, the caffeine-induced power modulations discussed above were obtained using spectral feature computations that correct for the 1/f slope in the power spectrum (see Section Feature extraction). This correction takes into account the possibility that the aperiodic component of the spectrum (1/f slope) may be different across the two experimental conditions. In which case, not correcting for the 1/f slope may lead to confounding results that amalgamate oscillatory and non-oscillatory signals. To appreciate the impact of this correction on the EEG presented here, we repeated the spectral power comparisons (caffeine vs placebo) shown in Fig.  but without correcting for the 1/f slope. The results of both approaches are shown in Fig. a. While the direction of the effect is largely consistent across both approaches (with the exception of delta power during REM sleep), we found the effects to be more pronounced after removing the aperiodic component from the power spectrum (channels with statistically significant t-values are scarce without the correction): Several frequency bands do not show any significant effects when looking at the full original power spectrum and only become significant after removal of the aperiodic component.

Fig. 2: Assessing the impact of changes in the slope of the aperiodic component on spectral power in canonical frequency bands.

a Brain activity before (uncorrected) and after (corrected) removing the aperiodic (1/f) component from the power spectrum. The topographic maps show t-values (caffeine-placebo condition) with blue indicating reduced and red increased spectral power during caffeine (dots: gray p < 0.05, white p < 0.01). b Illustrative example of caffeine-induced shifts in aperiodic slope (solid lines), showing full power spectra (dashed lines) from a single subject at electrode Fz (red star) in a log–log plot. Subject and channel were chosen to be representative of the effect found across subjects. This panel does not contain results of statistical tests but rather serves as a clarification to the reader about the effect of the aperiodic slope on power spectral density across frequency bands.

Figure b depicts an illustrative example of power spectra from a single subject (dashed lines) and the fitted aperiodic components (solid lines), which are straight lines in a log–log plot. A flattening of the aperiodic component after the ingestion of caffeine is visible (see Section Caffeine-induced changes in sleep EEG complexity and criticality).

Taken together, the comparisons between the corrected and uncorrected spectra highlight the utility of removing the aperiodic component when assessing caffeine’s impact on neural oscillations during sleep. In addition, the differences we observed between the results obtained with and without this correction strongly suggest that the aperiodic component of the spectrum (i.e., its slope) is affected by caffeine—otherwise removing it would not have modified the results. These changes in the scaling behavior of the EEG spectra can be linked to altered EEG self-similarity, which in turn may be related to shifts in neural criticality. In general, the discrepancies we found between the corrected and uncorrected spectral power results point towards the relevance of considering the aperiodic component of the power spectrum as a candidate EEG feature that is altered by caffeine.

Caffeine-induced changes in sleep EEG complexity and criticality

To assess the differential impact of caffeine and placebo on EEG complexity and criticality during sleep, we contrasted the two conditions using statistical inference and supervised ML, similar to our assessment of spectral power changes. The results shown in Fig.  depict the t-values and ML decoding accuracy obtained with multiple metrics in NREM and REM sleep stages. Overall, all EEG complexity measures (SpecEn, SampEn, SpecSampEn, and LZc) showed consistent increases under caffeine (p < 0.01 corrected, Cohen’s d between 0.67 and 0.93). In addition, the two metrics we used to probe shifts in critical behavior (i.e., DFA scaling exponent and the slope of the aperiodic activity) both showed consistent reductions, indicative of a shift towards the critical regime. During NREM sleep, the caffeine-induced modulations in brain signal complexity and criticality were widespread and prominent. However, during REM sleep, the effects were limited to the occipital regions and remarkably weaker (Fig. ). More globally, the direction of the effects was consistent among the four measures of complexity, and among the two metrics used to assess critical behavior. Interestingly, the most accurate classification between caffeine and placebo sleep EEG was obtained by using Spectral Sample Entropy as a feature in NREM sleep, with a 75% decoding accuracy, surpassing the best results from using spectral power. It is also worth mentioning that the mean DFA scaling exponent during NREM and REM sleep took values of 1.31 and 1.21, respectively.

Fig. 3: Comparison of caffeine versus placebo effects on brain complexity and criticality measures during NREM and REM sleep.

Left columns show statistical differences (blue: reduced during caffeine, red: increased during caffeine). Middle and right columns show classification accuracy (green) from SVM and LDA models, validated using permutation tests. Dots indicate statistical significance (gray: p < 0.05, white p < 0.01). Most prominently, we see broad caffeine-induced increases in entropy and complexity, and a flattening of the aperiodic slope.

Single-epoch classification

The features used in the classification analyses discussed so far were based on computing mean values at each electrode in each subject. We decided to extend this by asking whether it is possible to train a classifier to discriminate between caffeine and placebo conditions using features computed from single epochs, without averaging. The findings were largely inline with the results observed with the subject-wise averaged features (Supplementary Fig. ). This said, the decoding performances were lower because the single-epoch features were obviously noisier than the averaged features. Given the large number of samples, decoding scores in the single-epoch classification were found to be statistically significant (p < 0.01 corrected) in a broad selection of channels even though passing the statistical decoding chance level only marginally. The overall agreement between the single-epoch and subject-wise ML results speaks to the robustness of the observations as well as to the single-trial sensitivity of the selected features to the effect of caffeine.

Multi-feature Machine learning

In order to further explore the insights that can be harnessed through a data-driven approach, we built a random forest (RF) classifier which we trained on all extracted features simultaneously (11 features × 20 channels = 220 total; see Section Supervised machine learning analysis). The spectral features were corrected for the aperiodic component. We chose the RF classifier as it provides straightforward access to individual feature importance scores, allowing us to rank and compare the contributions of the distinct features in discriminating between the caffeine and placebo data. The RF classifier achieved substantially higher decoding accuracy in NREM sleep (75.22% ± 0.15) than in REM sleep (58.63%  ± 0.13) after averaging the scores from 1000 random reinitializations of the classifier.

More importantly, the feature importance scores from the RF model shown in Fig.  revealed interesting insights into the nature of the most relevant features as well as their topographical distribution. Remarkably, the feature importance bar plots (colored according to the type of feature) reveal that, among all features, the complexity features are the most useful for the caffeine versus placebo classification during NREM sleep (all the blue features). These were followed by the criticality-related metrics (green), and then the corrected spectral power (warm colors). A closer look reveals that LZc and SpecSampEn exhibited high degrees of feature importance during NREM, contributing 37% of the classifier decision across all 11 features. Additionally, SampEn and the DFA scaling exponent saw prominent levels of feature importance. In other words, we found that the complexity and criticality-related measures outperformed the spectral features in terms of their contribution to the classification of caffeine versus placebo samples during NREM.

Fig. 4: Feature importance across brain regions during NREM and REM sleep, derived from random forest models trained on 220 features (11 features  × 20 channels).

Bar plots rank input dimensions by feature importance, with warm colors (red to yellow) showing spectral power bands and cold colors (blue and green) showing measures related to entropy, complexity, and criticality. Topographic maps display the spatial distribution of importance values, averaged across 1000 models per sleep stage. Darker colors indicate higher feature importance.

By contrast, the distribution of features ranked by importance during REM was more heterogeneous and less structured, including high levels of importance in temporal theta power, occipital DFA scaling exponent, and SpecEn. Sigma power and the aperiodic slope additionally showed increased contribution to the classification during REM.

Supplementary Table  provides a list of the ten most important feature-electrode pairs as determined by the RF classifier. These results highlight the prominence and leading contribution of complexity (as measured by LZc and SpecSampEn) over central, parietal, and frontal areas.

Age-related effects

To explore how caffeine impacts sleep EEG across different age groups, we analyzed the data separately for young adults (20–27 years old, mean age 22.8 years; n = 22, 10 females) and middle-aged adults (41–58 years old, mean age 50.6 years; n = 18, 9 females). Figure  presents the results of paired T-tests comparing caffeine and placebo conditions within each group, as well as the independent T-test results for age-related differences ((caffeineyoung − placeboyoung) vs. (caffeinemiddle-aged − placebomiddle-aged)).

Fig. 5: Topographical maps showing age-related differences in brain responses to caffeine versus placebo.

The “young” (20–27 years) and “middle-aged” (41-58 years) columns display t-values of paired T-tests between caffeine vs. placebo. To rule out statistical effects of sample size, the remaining columns show the results of independent T-tests (t- and p-values) between age groups ((caffeineyoung − placeboyoung) vs. (caffeinemiddle-aged − placebomiddle-aged)). Gray dots indicate p < 0.05, white dots p < 0.01.

During NREM sleep, caffeine had significant effects on several EEG features in both young and middle-aged adults, although the effects were more pronounced in the young group. Notably, the independent T-test results revealed no significant age-related differences in the impact of caffeine during NREM sleep, suggesting that the weaker significance in the middle-aged group is likely attributable to the smaller sample size.

In REM sleep, caffeine-induced changes were significant only in the young group, affecting features such as spectral entropy (SpecEn), sample entropy (SampEn), Lempel-Ziv complexity (LZc), and the DFA scaling exponent. By contrast, no significant effects of caffeine were observed in the middle-aged group during REM sleep. Interestingly, the independent T-tests demonstrated significant age-related differences in these same features, indicating that the effect of caffeine on REM sleep is more pronounced in younger adults compared to middle-aged individuals.

To further contextualize these findings, we examined the baseline EEG differences between the young and middle-aged groups using data from placebo nights only (Supplementary Fig. ). This analysis revealed that middle-aged individuals exhibited significantly higher complexity (SpecEn, SampEn, and LZc), a lower DFA scaling exponent, and a flatter aperiodic slope compared to the younger group, particularly during REM sleep. These age-related baseline differences align closely with the caffeine-induced effects observed in the young group, supporting the hypothesis that aging alters sleep EEG dynamics in a manner similar to caffeine, potentially diminishing its impact in the middle-aged group.

Control analysis: sleep duration

Given that caffeine alters total sleep duration and architecture (distribution of sleep stages), it is theoretically conceivable that some of our findings were caused by an unequal number of epochs between caffeine and placebo. Having more epochs in one condition would lead to more reliable averages due to reduced noise in the measurements. To rule out this possibility, we added a control analysis where we used random subsampling to equate the number of epochs used to compute the features across conditions. This was done on a per-subject basis and separately for NREM and REM. This control analysis showed the robustness of the reported results and ruled out that they can entirely be attributed to caffeine-induced changes in sleep duration; we replicated the same statistical effects from Figs.  and  with an equated number of epochs in Supplementary Fig. .

Discussion

The objective of this study was to investigate the effect of caffeine ingestion on the brain during sleep. In particular, we compared the effects of caffeine to that of placebo on neural oscillations, brain complexity and measures of critical behavior. Importantly, we set out to characterize these effects across REM and NREM sleep, and across age. In a nutshell, we found that caffeine induces a broad boost in brain complexity and a prominent shift towards criticality. These effects were substantially more widespread in NREM, compared to REM sleep. Furthermore, REM sleep in younger subjects (20–27 years) showed a significantly increased response to caffeine in terms of brain entropy when compared to middle-aged subjects (41–58 years).

Importantly, throughout this study, we paid particular attention to probing the robustness of our results through rigorous methodological procedures: First, the caffeine and placebo were contrasted using standard inferential statistics (t-tests) as well as two cross-validated ML classification algorithms (SVM and LDA) to check for consistency. Second, the statistical significance of these analyses (including the ML decoding results) was systematically assessed using non-parametric permutation tests and corrected for multiple comparisons. Third, we separated the aperiodic (1/f-like background) and periodic (oscillatory) components of the EEG power spectra before analysis, allowing us to specifically examine neural oscillations without the influence of broadband activity. Fourth, we used multiple metrics to characterize the underlying complex dynamics from different angles—examining entropy (signal predictability), complexity (information content and compressibility), and signatures of critical behavior—with largely consistent patterns emerging across these complementary measures. Fifth, we tested the robustness and interpretability of our ML framework by adding single-trial decoding as well as multi-feature classification using random forests, and feature importance assessment and visualization. Last but not least, we accounted for an array of possible confounds including age-dependent baseline EEG differences.

In the following, we discuss the key findings from this study in the light of previous work.

An update on the impact of caffeine on neural rhythms during sleep

Our findings on power spectral density, when analyzed across the full power spectrum, align well with previous observations of caffeine’s influence on EEG power in distinct frequency ranges. The existing literature highlights a decrease in delta and frontal alpha power and an increase in sigma and beta power, as well as in occipital alpha power,,,. Interestingly, when we used 1/f-corrected power spectra (i.e., excluding the aperiodic component), the results were more enhanced and reached statistical significance over numerous channels. As shown in Fig. a the caffeine-induced decrease in delta, theta, and frontal alpha power during NREM sleep only became statistically significant after removing the aperiodic component from the power spectrum.

In addition, discarding the aperiodic component uncovered a strong statistically significant increase in beta power over multiple parietal, central and frontal sites. While adenosinergic inhibition mostly targets excitatory neurons (specifically acetylcholine and glutamate), it also reduces GABAergic activity, a key modulator of beta oscillations in the brain,,. Taken together, the caffeine-induced increase in beta power might be directly attributable to elevated GABA levels, which result from reduced adenosinergic inhibition of GABAergic neurons.

Moreover, while we saw a non-significant decrease in delta power during REM, matching previous reports, this effect appeared to be reversed when we used the 1/f-corrected power spectrum. This discrepancy—as well as the other differences we found using corrected versus uncorrected power spectra—can be attributed to the 1/f activity acting as a confounding factor. Crucially, although commonly referred to as 1/f-noise, the aperiodic activity, has been shown to exhibit inter-subject variability that is linked to cognitive ability and age. In sum, the caffeine-induced changes in oscillatory power reported here confirm but also extend previous reports by disentangling rhythmic components from broadband aperiodic activity.

Caffeine ingestion increases EEG entropy during sleep

Prior quantitative work investigating the effect of caffeine on sleep EEG has predominantly focused on characterizing its effect on brain rhythms. Our findings extend this body of work by uncovering important effects of caffeine on the predictability of neural signals as measured via metrics of entropy. In fact, by analyzing the feature importance scores from random forest classifiers, we found robust evidence that EEG signal entropy played a more important role in distinguishing caffeine from placebo samples, compared to (corrected) spectral power features.

Although our results provide the first evidence that caffeine enhances EEG entropy during sleep, they are consistent with a previous fMRI study showing that caffeine enhances entropy during resting wakefulness. Although widespread, the most significant entropy increases were found in the lateral prefrontal cortex, default mode network, visual cortex, and the motor network. Although these fMRI results obtained in the waking state are not directly comparable to our polysomnographic sleep data, they are consistent with the caffeine-related increases we found across all entropy measures (SpecEn, SampEn, SpecSampEn) during NREM and REM sleep. Our findings extend the literature not only by revealing that caffeine elevates the complexity of the brain’s electrophysiological activity, but also by detecting such changes during sleep. Finally, our data also suggest that this caffeine-mediated boost in brain entropy is age-dependent in the REM stage.

In a prior investigation assessing the complexity of biological systems, low approximate entropy (ApEn) was associated with the isolation and segregation of dynamical processes. Furthermore, experimental work suggests increased segregation of the brain during NREM sleep,, which was later shown to be reflected in decreased ApEn. These observations provide an interesting framework in which to interpret the caffeine-induced increase in sample entropy (SampEn), which we found during NREM sleep. Given that SampEn is closely related to ApEn, our results may therefore indicate that caffeine ingestion reduces the separation between brain networks, promoting greater integration. These results also suggest an increase in information processing during NREM, which brain entropy is commonly seen as a proxy for ref. . This relationship between entropy and information processing aligns with theories of criticality in neural systems, where states near the critical point are characterized by maximal integration across scales and optimal information processing capacity. The higher SampEn values we observed after caffeine administration may indicate a shift away from the subcritical regime, where local processing dominates and in which the brain operates during NREM sleep. This shift towards the critical point may reflect a transition into a more integrated state that allows for enhanced information flow across multiple temporal scales, which also aligns with our findings on LRTC, as evaluated by the DFA scaling exponent.

Higher entropy in neural signals during sleep has been associated with enhanced information integration and dynamic adaptability, processes that are critical for cognitive functions reliant on sleep, such as optimal neural communication and adaptive information processing. The caffeine-induced increase in EEG entropy during sleep may therefore reflect changes to these processes, potentially impacting the brain’s ability to efficiently process and integrate information across different neural states. As the caffeine-induced increase of brain entropy was most pronounced in NREM, the stage known to exhibit low brain entropy, it is tempting to associate the effect of caffeine with a deterioration of sleep quality. Although increased brain entropy during sleep has been linked to hypertension and early-stage Alzheimer’s disease, further investigation is needed to elucidate the impact of pharmacologically induced alterations in sleep brain entropy and their implications for sleep-dependent cognitive functions.

Caffeine increases Lempel-Ziv complexity and shifts critical dynamics in the sleeping brain

Given that Lempel-Ziv complexity (LZc) quantifies the compressibility of neural signals—another measure of the richness of information content – it is not surprising to see that caffeine’s influence on LZc and entropy metrics was similar, displaying widespread increases during NREM sleep and a localized increase in occipital channels during REM sleep compared to placebo. Interestingly, LZc has previously been shown to inversely track the distance to criticality in the brain, i.e., an increase in LZc is tied to activity closer to the critical point, which further supports the hypothesis that caffeine causes a shift from subcritical dynamics closer to the critical point, particularly during NREM sleep. LZc has also been found to be inversely related to the aperiodic slope, another marker for critical dynamics,. Additionally, the observed increase in entropy and decrease in DFA scaling exponent suggest elevated degrees of activity during NREM sleep,.

Considering our results in light of the brain criticality literature suggests that—especially during NREM sleep—the dynamics of the caffeinated brain are shifted closer to the critical point and towards a more active state. Our data also suggest that this effect is more pronounced in younger subjects (20–27 years old) than in middle-aged subjects (41–58 years old), with age effects observed only during REM sleep, potentially due to aging-related changes in adenosine A1 receptor density. It is tempting to associate these findings with the deterioration in sleep quality and its restorative properties, as documented in the literature on caffeine and sleep.

Caffeine-induced neural excitation is associated with a shift towards a critical point

Caffeine works by reducing the activity of adenosine, an inhibitory neurotransmitter that causes drowsiness. As a result, consuming caffeine enhances alertness, improves information processing, and boosts cognitive performance. However, due to adenosine’s key role in regulating sleep, the effect of blocking adenosine receptors via pharmacological intervention might not be equivalent during wakefulness and sleep, as the underlying adenosinergic signaling and receptor dynamics likely differ between these distinct brain states. Furthermore, caffeine not only affects adenosine signaling directly but also triggers a cascade of changes in other neurotransmitter systems, including increased dopamine and norepinephrine release, enhanced acetylcholine availability, and modulation of the balance between GABAergic and glutamatergic transmission,. While these complex interactions across multiple neurotransmitter systems make it challenging to predict caffeine’s global effects on brain dynamics, examining changes in the excitation–inhibition balance may provide a more tractable framework for understanding its impact.

Both modeling and experimental studies have shown that the slope of the 1/f component of the power spectrum (and related measures like scaling and Hurst exponents) can serve as indicators of the excitation-to-inhibition (E:I) ratio,,,,,. Our data reveal that caffeine induces a flattening of the 1/f slope and a drop in the scaling exponent, providing evidence for a shift towards increased excitation. Interestingly, this finding takes on additional significance within the framework of brain criticality, where E:I balance serves as a control parameter that can drive neural dynamics closer to or further from the critical point. The critical point represents a state poised between order and chaos that allows for maximal computational efficiency and flexibility. Our results suggest that caffeine reduces the characteristic inhibition-dominated dynamics typically observed during sleep, particularly during NREM sleep, shifting the system towards a state of increased excitation.

Interestingly, the link we make here between caffeine’s antagonistic effect on adenosine receptors and the observed shift in criticality is conceptually consistent with previous research showing that by blocking GABA receptors and thus reducing inhibitory synaptic transmission, an artificial upward shift in excitation can occur, leading to a supercritical state with larger-than-expected neuronal avalanches,. This suggests that, while adenosine blockers have an upregulating effect on GABAergic neurons, the global impact of caffeine on the excitation-inhibition (E:I) balance appears to be positive, as indicated in the literature.

Age-related differences in the impact of caffeine on the sleeping brain

Previous research has shown that middle-aged adults are more sensitive to caffeine’s effects on sleep latency, duration, and efficiency, but age-related differences in electrophysiological sleep features remain less understood. In our study, we observed that caffeine had a significantly greater impact on REM sleep EEG features (specifically SpecEn, SampEn and DFA scaling exponent) in younger participants compared to middle-aged adults, while no significant age effects were found during NREM sleep.

This pattern may reflect an interaction between age-related neurophysiological changes and the distinct ways in which adenosine modulates NREM and REM sleep. Adenosine is a key regulator of sleep-wake dynamics, and its effects are mediated primarily through A1 and A2a adenosine receptors. Aging is associated with a natural decline in A1 receptor density, which likely reduces the capacity of adenosine to modulate sleep-related processes, particularly during REM sleep, where adenosine activity is already lower compared to NREM sleep.

In younger adults, higher A1 receptor density may amplify the effects of caffeine, which functions by antagonizing adenosine binding; this amplification may be attributable to the increased receptor availability, thereby promoting a higher rate of receptor inhibition. During REM sleep, this interaction could result in a compound effect of reduced adenosine activity (characteristic of REM) and higher receptor availability, enabling caffeine to exert a more pronounced influence on brain dynamics. By contrast, the diminished A1 receptor density in middle-aged adults likely limits caffeine’s impact, as fewer receptors are available for adenosine binding and subsequent blockade by caffeine.

The absence of significant age effects during NREM sleep may also be explained by the interplay of these factors. Adenosine activity is upregulated during NREM sleep, and this robust baseline activity may mask age-related differences in receptor availability. Consequently, while caffeine induces comparable changes in NREM-related EEG features across age groups, the distinct dynamics of adenosine and receptor density during REM sleep appear to drive the observed age-dependent effects.

Beyond receptor mechanisms, several factors may explain age-related differences in caffeine sensitivity during REM sleep. Age-related changes in caffeine metabolism likely play a role, as decreased hepatic clearance in older adults can alter caffeine’s concentration during different sleep phases, potentially explaining the attenuated effects we observed in middle-aged participants. Baseline sleep architecture differences may also contribute–middle-aged adults typically experience reduced REM sleep quantity and quality—potentially creating a ceiling effect where already compromised REM sleep shows less disruption from caffeine. Additionally, age-specific lifestyle factors such as work stress, family responsibilities, and exercise habits may modulate baseline sleep characteristics and caffeine responses through indirect pathways involving stress hormones and inflammatory markers.

Taken together, these findings suggest that caffeine’s greater impact on younger adults’ REM sleep EEG features arises from an age-dependent interplay between adenosine signaling, receptor density, caffeine metabolism, and caffeine’s pharmacological action. Age-related differences in hepatic clearance and baseline sleep architecture likely contribute to the attenuated response in middle-aged adults. Future studies should further explore these interactions, particularly with respect to regional and receptor subtype-specific variations in adenosine activity, caffeine pharmacokinetics, and lifestyle factors, to better understand the nuanced effects of caffeine on sleep across the lifespan.

Limitations

A few limitations of the present study are worth considering. First, although the statistical comparisons and ML classification revealed significant effects in a substantially larger number of channels (and higher decoding performances) in NREM compared to REM sleep, we need to keep in mind that the different number of epochs available for each stage in each subject can lead to comparatively noisier estimates of the extracted features in REM. This said, during preprocessing, we averaged features across epochs of each sleep stage in each subject, effectively reducing per-sample noise.

Second, despite the strong consistency between the effects we found across three entropy metrics—especially between SpecEn and SpecSampEn—we should be mindful that SpecSampEn is a slight variation of spectral entropy computation that is not commonly used. Therefore, its increased feature importance compared to SpecEn in the multi-feature random forest analysis (in NREM sleep) is a possibly interesting observation, but it will require further validation and needs to be interpreted with caution.

Third, while some of our interpretations rely on modeling and empirical evidence that the E:I ratio is correlated with the slope of the power spectrum and the DFA scaling exponent, more work is needed to fully establish the mechanistic links between these EEG measures and E:I balance at multiple meso- and macroscopic scales.

Fourth, caffeine is known to alter the ratio of NREM stages (N1, N2, SWS) to each other, making it difficult to disentangle the effect of caffeine on individual NREM stages from the caffeine-induced shift in sleep architecture (less SWS, more N1/N2). Many of the caffeine-related significant changes we found in NREM are characteristic of such a shift. Specifically, hallmark features of SWS, such as low entropy/complexity, will contribute less to the aggregated measures investigated in this study.

Finally, our study focused on healthy individuals, which may limit the generalizability of our findings. Altered baseline brain dynamics and sleep architecture associated with sleep disorders and neurodegenerative diseases may interact with caffeine’s effects on the brain in complex ways. While regular daytime caffeine consumption has been associated with neuroprotective qualities, particularly in the context of Parkinson’s disease,,,, acute caffeine intake close to bedtime is known to disrupt sleep, potentially affecting critical brain processes that occur during sleep. For example, caffeine could hypothetically exacerbate sleep fragmentation already present in Alzheimer’s and Parkinson’s disease, though our study does not provide empirical evidence for this specific interaction. Given the complex interplay between caffeine’s beneficial neuroprotective effects, its disruptive influence on sleep, and the sleep physiology changes observed with aging, future research should examine how caffeine-induced alterations in sleep brain dynamics manifest across different clinical populations. Such studies could help inform tailored caffeine consumption recommendations for individuals with neurological disorders.

Conclusion

In this work, we investigated the effects of caffeine, the most widely consumed psychoactive drug, on the activity of our brains as we sleep. In particular, we extend previous research on the neural impact of caffeine on sleep by focusing on two promising—yet underexplored—features of neural dynamics, which are complexity and criticality. This study provides the first evidence that caffeine ingestion leads to a broad increase in EEG complexity, especially during NREM sleep. Crucially, we also discovered that, compared to placebo, caffeine shifts the brain closer towards a state known as a critical regime, where the brain is thought to be most sensitive to inputs, most adaptable, and able to process information most efficiently. Importantly, we propose a mechanistic explanation of the observed shifts by connecting caffeine’s effect on adenosine transmission to changes in E:I balance, which are manifest across multiple EEG measures. Finally, our data suggest that the shifts in brain dynamics due to caffeine are more prominent in younger adults than in middle-aged individuals during REM sleep, a difference that could be explained by aging-related changes in adenosine A1 receptor concentration. While our primary focus was on the influence of sleep on brain electrophysiology, we anticipate that future studies will uncover similar outcomes during wakefulness. Considering the widespread consumption of caffeine, gaining a comprehensive understanding of its effects on the brain both during wakefulness and sleep could have far-reaching implications for society and public health.

Methods and materials

Data acquisition

Sleep EEG (256 Hz) data were recorded from 40 subjects (19 females, 21 males) at the Center for Advanced Research in Sleep Medicine (CARSM), with a channel layout according to the 10–20 international system. Subjects were in good health, aged from 20 to 58 (mean 35.3 ± 14.3 years). The participants reported moderate caffeine consumption, equivalent to one to three cups of coffee per day. All participants were non-smokers and free of drugs or medicine which could influence the sleep-wake cycle. Subjects also reported no sleep complaints, night work, or transmeridian travel in the 3 months before the recording. Participants with a history of psychiatric or neurological illnesses or a body mass index (BMI) above 29 were excluded from the study. Blood sample analysis (complete blood count, serum chemistry including hepatic and renal functions, levels of prolactine, levels of testosterone in men, and levels of estrogen, follicle-stimulating hormone (FSH), and luteinizing hormone in women) and urinalysis results were examined by a certified physician to exclude significant medical irregularities. To eliminate further irregularities in participants, a polysomnographic screening night at the laboratory was conducted where a nasal/oral thermistor, electromyographic leg electrodes, EEG, and electro-oculogram were recorded. The presence of sleep disturbances such as sleep apnoeas and hypopnoeas (index per hour  >10), periodic leg movements (index per hour  >10), prolonged sleep latency (>30 min), or low sleep efficiency (<85%) resulted in the exclusion of the participant. Peri-menopausal women and women using hormonal contraceptives or receiving hormonal replacement therapy were excluded, premenopausal women reported having regular menstrual cycles (25–32 days) during the year preceding the study, no vasomotor complaints (i.e., hot flashes, night sweats) and showed low FSH levels (<20 iU L-1) and all postmenopausal women reported an absence of menses during the past year and their FSH levels were  >20 iU L-1. All participants signed an informed consent form which provided detailed information about the nature, purpose, and potential risks of the study. The research project was approved by the hospital’s ethics committee, and subjects received financial compensation for their participation. All ethical regulations relevant to human research participants were followed.

Experimental protocol

After the adaptation and screening night, each participant spent two non-consecutive experimental nights at the sleep laboratory. The time between each night in the laboratory was 6–9 days. On days of recordings, the consumption of foods and beverages containing caffeine was ceased at noon. Instructions were given to maintain a regular sleep-wake pattern within 30 min of the habitual sleep-wake cycle, as well as a habitual caffeine consumption one week before the first night to prevent potential withdrawal effects. They were asked to complete the French version of the Pittsburgh Sleep Diary on a daily basis during this time and to abstain from alcohol on experiment days. The participants arrived at the laboratory 6–8 h before their habitual sleep time and left 1–1.5 h after habitual wake up time. Bedtime and wake time in the laboratory were determined by averaging each participant’s sleep-wake cycle from the sleep diary. The total dose of caffeine administered was 200 mg (100 mg per capsule) which is considered to be moderate (equivalent to 1–2 cups of coffee) and induces significant changes in the sleep of young subjects. Two-piece telescopic hard capsules were used, allowing the ingestion of caffeine without oral contamination, in a double-blind cross-over design using stratified randomization.

Sleep variables

An extensive analysis of sleep variables and their alteration with caffeine was conducted in previous work in our group with the same data,. Briefly, this data exhibits a significant caffeine-induced increase in sleep latency and a decrease in total sleep time, sleep efficiency, and time spent in stage 2 sleep,. We therefore controlled for the effect of changes in sleep duration in our analysis and found no significant change, suggesting our results are robust in this regard. In other words, the difference in the feature estimations was not due to the variable amount of data across conditions but rather to the underlying changes in neural dynamics.

EEG preprocessing

The data was divided into 20s windows and visually scored by an expert into five sleep stages: S1, S2, S3, S4, and REM according to the Rechtschaffen and Kales manual, modified to allow scoring based on 20s epochs. While scoring sleep into S1, S2, S3, and S4 is no longer standard practice and has since been replaced by the AASM guidelines, which consolidate S3 and S4 into a single N3 stage, this approach reflects the common scoring practice at the time of data collection. Importantly, this distinction does not impact the study’s conclusions, as we combined S1, S2, S3, and S4 into a single NREM stage for analysis. From a signal processing standpoint, we have no reason to believe that our results would differ were we to use 30s epochs. After scoring, artifact-containing epochs (4s) were eliminated from NREM data by visual inspection of channels C3 and C4. Due to the relatively low number of epochs in S1, S3, and S4 compared to S2, these stages were grouped into the broader NREM category. This is consistent with previous research conducted on the same data. After artifact removal, the NREM stage contained 57,594 epochs, while REM consisted of 19,341 epochs, yielding a roughly 3:1 ratio. Before feature extraction, we applied a band-pass filter from 0.5 to 32 Hz to the raw epochs, removing further artifacts from the signal. Features were extracted independently for each channel, resulting in a single value per feature, channel, and epoch. To reduce noise and increase comparability between sleep stages, the epoch-wise features were averaged within each subject. For each feature, given that we had 40 individuals, this led to a total of 80 samples: 40 for caffeine and 40 for the placebo condition. Furthermore, the averaged features were z-transformed using the mean and standard deviation from the non-averaged samples across all channels and samples of one feature. The z-transform was applied separately to each subject, ensuring strict independence between training and test data sets in the ML analysis.

Feature extraction

We extracted a selection of relevant hand-crafted EEG features from the neural signals to examine the effect of caffeine on the brain in a data-driven manner. The aim was to differentiate between data from the caffeine or placebo condition using supervised machine learning, trained on these features. For the sake of consistency, all features were extracted from 20s epochs of continuous EEG. The following sections list the specific spectral, complexity, and criticality features analyzed in this work. Note that while the critical point is formally defined only for infinite systems, finite systems can still operate in a critical regime, exhibiting approximate scale invariance and power-law relationships over a range of scales. Therefore, the criticality features discussed below, such as DFA scaling exponent and aperiodic slope, remain valid indicators of critical dynamics even in finite neural systems.

Power spectral density

Power spectral density (PSD) was computed using Welch’s method with a window length of 4s and an overlap of 2s. To isolate changes in periodic (pure oscillatory) activity, we remove the aperiodic 1/f-like component from the power spectrum. Disentangling periodic and aperiodic components in the EEG spectra enables the isolation of distinct neural processes, with periodic activity reflecting oscillatory synchronization and aperiodic activity providing insights into scale-invariant properties of the EEG and the 1/f-behavior of its power spectrum, which has been linked to the neural excitation and inhibition balance,. This distinction is particularly relevant for understanding how caffeine modulates brain dynamics, as changes in the aperiodic component may highlight shifts in cortical excitability, while periodic changes can reveal alterations in specific oscillatory rhythms critical for sleep and cognitive function. The FOOOF algorithm was used to fit a power-law distribution to the power spectrum and extract periodic oscillations in the frequency range from 3 to 32 Hz, limiting the number of periodic peaks to 5. The lower and upper cutoffs were determined visually from the full power spectrum. The 1/f-corrected spectrum was then divided into five distinct frequency bands by averaging the power across frequency bins within the given intervals. The final frequency bands were delta (0.5–4.0 Hz), theta (4.0–8.0 Hz), alpha (8.0–12.0 Hz), sigma (12.0–16.0 Hz), and beta (16.0–32.0 Hz). We extrapolated the power-law distribution to also cover the delta band.

Sample entropy

To estimate complexity in the time domain, sample entropy (SampEn) was computed using the preprocessed EEG signal. The definition of SampEn is similar to that of approximate entropy (ApEn), a popular metric for complexity estimation of biomedical times series. ApEn, however, is known to have limitations regarding relative consistency across parameter choices, bias due to counting self-matches, and dependence on sample length. SampEn was developed to combat these limitations,. It is defined as the negative logarithm of the conditional probability that two matching windows/embeddings of length m still match when increasing their length to m + 1. A match between two windows is defined as having a distance smaller than r times the standard deviation of the signal. Distance was calculated using the maximum norm and self-matches were excluded. Mathematically, it can be described as \({{{{\rm{SampEn}}}}}(m,r)=-\log (\frac{A}{B})\) with A being the number of matches with window size m + 1 and B the number of matches of length m. Therefore SampEn measures how unlikely it is to find a window that matches another part of the signal where the continuation of the window is still a match. We set SampEn’s parameters to m = 2 and r = 0.2 as suggested in the literature.

Spectral entropy

Complexity of the power spectrum or spectral entropy (SpecEn) can be computed by applying entropy measures to the power spectrum of a signal. Traditionally, spectral entropy uses Shannon entropy, which disregards local patterns and only takes the signal’s distribution of values into account. When applied to the power spectrum, Shannon entropy captures the amount of variance in the frequencies, which make up the EEG signal,. Additionally, we computed a variant of SpecEn, which we refer to as spectral sample entropy (SpecSampEn): Following the idea of SpecEn, we applied SampEn (m = 2, r = 0.2) to the full power spectrum. By looking at windows of multiple neighboring frequency bins, SampEn is able to incorporate local patterns in the power spectrum into its complexity estimate. This goes beyond the permutation invariant Shannon entropy and treats the power spectrum more as a coherent signal with meaningful relations between neighboring frequency bins, potentially capturing further aspects of complexity. The power spectrum we used to compute SpecEn and SpecSampEn was estimated as described in Section Feature extraction (Power spectral density), however, it was neither corrected for the 1/f-like component nor split into frequency bands.

Note that by applying entropy not only to the raw EEG signal (SampEn), but also to the power spectrum (SpecEn), we gain insights into the degree of randomness in both the temporal and spectral domains of brain activity, providing complementary perspectives on neural dynamics.

Lempel-Ziv complexity

Lempel-Ziv complexity (LZc) is a complexity measure designed for binary sequences and text. It counts the number of unique substrings in a sequence, thereby measuring how repetitive a signal is. That is, a less complex signal, according to LZc, consists of repetitions of a few different sub-strings while more complex signals are made up of non-repeating segments. As the initially proposed version of LZc is strongly influenced by signal length, we used a normalized variant, which scales LZc by \(\frac{{\log }\_{b}(n)}{n}\) where n is signal length and b the number of unique characters in the signal. In line with standard practice, we applied a median split to the preprocessed EEG epochs to transform the signal into a binary sequence, allowing it to be processed by the Lempel-Ziv algorithm. In the context of neuroscience, LZc has been useful to track disorders of consciousness and was shown to reach a peak at the edge of chaos critical point.

Detrended fluctuation analysis

To measure the signal’s long-term statistical dependence, we performed Detrended Fluctuation Analysis (DFA), on the raw EEG signal using the AntroPy toolbox. DFA, an estimate of self-affinity, divides the signal into windows and computes standard deviations as a function of window sizes. A power-law with exponent/slope α is then fitted to the resulting graph. The estimated α parameter is a generalization of the Hurst exponent, capable of dealing with non-stationary time series. Similar to the Hurst exponent, a slope less than 0.5 corresponds to an anti-correlated process, a slope of 0.5 indicates a white-noise process and a slope larger 0.5 suggests a correlated signal. In contrast to the Hurst exponent however, DFA can return slopes larger than one in the case of unbounded, non-stationary signals. Furthermore, the presence of long-range temporal correlations (LRTC) measured by DFA has been linked to systems operating near criticality,,.

We also analyzed the DFA scaling exponents of canonical frequency bands after computing the Hilbert transform. The frequency bands used were the same as in the PSD analysis, and we additionally calculated a broadband DFA in the range of 3 to 32 Hz. While our main focus is on DFA computed from the raw signal, these additional results are provided in Supplementary Fig. .

Aperiodic slope

We used the FOOOF algorithm to estimate the slope of the aperiodic component of the EEG signal, which corresponds to the exponent in the 1/f-like distribution of the signals’s power spectrum. FOOOF was fit on the power spectrum between 3 and 32 Hz, limiting the number of periodic peaks to 5 and setting peak width limits to 0.5 and 12. The power spectrum was computed in the same way as described in Section Feature extraction (Power spectral density). FOOOF extracts the aperiodic slope from the power spectrum by fitting a parameterized model of the 1/f-like aperiodic component and separating it from the periodic oscillatory peaks. The aperiodic slope has previously been shown to reflect changes in E/I balance,,, which could link the effect of caffeine, an antagonist of the inhibitory neurotransmitter adenosine, to changes in E/I balance in the brain. Additionally, a flattening of the aperiodic slope is commonly seen as an indicator of a shift towards more critical dynamics,,. For ease of interpretation we report the negative slope (i.e., positive values) in this work. A reduction in slope therefore, corresponds to a flatter distribution while an increased slope refers to a steeper decline in power.

Direct statistical analysis

To evaluate the difference between the caffeine and placebo conditions, two-sided paired permutation-based pseudo T-tests were performed using exhaustive permutations (n = 104) and corrected for multiple comparisons using the maximum statistics method. The T-tests were carried out on all extracted features (PSD bands, SpecEn, SampEn, SpecSampEn, PermEn). Statistical significance between the caffeine and placebo condition was evaluated at p < 0.05 and p < 0.01, and we report summarized effect sizes according to Cohen’s d.

We additionally analyzed age-related differences by comparing young (20–27 years) and middle-aged (41–58 years) subgroups using the same paired t-test approach between caffeine versus placebo effects within each age group. To examine age-related differences in caffeine response, we conducted independent t-tests comparing the caffeine-placebo difference between age groups ((caffeineyoung − placeboyoung) vs. (caffeinemiddle-aged − placebomiddle-aged)). Statistical significance was corrected for multiple comparisons via the FDR Benjamini/Hochberg method and evaluated at p < 0.05 and p < 0.01.

Supervised machine learning analysis

To improve robustness and interpretability of the statistical results, we additionally trained supervised machine learning classifiers to distinguish between samples from the caffeine or placebo condition.

Single-feature classification

To assess the impact of caffeine on specific features in single channels, different machine learning classifiers were trained on single-feature, binary classification between the placebo and caffeine conditions. Two different classification algorithms were used, namely support vector machine (SVM),,, with an RBF kernel and linear discriminant analysis (LDA),. Models were trained and evaluated separately for the different sleep stages.

Permutation tests, (n = 1000) were applied to the trained model to determine the statistical significance of the classifiers’ accuracy scores. The results were corrected for multiple comparisons using the maximum statistics method. During each permutation, the model’s average score across folds in a grouped tenfold cross-validation was used. Due to the low sample size, we decided to additionally fit an LDA classifier on single-epoch data (sample sizes NREM: 26,776 caffeine and 30,818 placebo, REM: 9448 caffeine and 9893 placebo), instead of subject-wise averages. Here, we chose to evaluate classifier performance using the balanced accuracy metric (BAcc) due to class imbalance. While accuracy is biased towards the majority class, BAcc was shown not to overestimate classifier performance even in cases of extreme class imbalance.

Multi-feature classification

In addition to the exploration on a single-channel and single-feature level, we chose to implement a broader multi-feature classifier that takes all features from all channels to build a single model. Spectral power was computed from the power spectrum after removal of the 1/f-like component, since our previous analysis showed a better separation between the two conditions when using corrected spectral power. We were able to access the contributions of individual features and channels by examining feature importance. To achieve this, we used a random forest, which estimates feature importance by averaging the relative rank of each feature across the decision trees that make up the forest. To measure variance in feature importance, the training process was repeated 1000 times for each sleep stage, applying grid search with grouped sevenfold cross-validation inside a nested cross-validation, leaving out samples from five different subjects in each iteration. See Supplementary Table  for the selection of hyperparameters optimized during grid search. The overall model score was determined using samples from the left-out testing subjects.

Statistics and reproducibility

EEG data were acquired from 40 healthy adult participants who each completed both placebo and caffeine conditions. For statistical analysis, features were averaged within subjects across artifact-free 20s EEG epochs, yielding 80 paired samples per feature. Two-sided, paired permutation-based pseudo t-tests (n = 104) were used to assess condition differences, with correction for multiple comparisons via the maximum statistics method. Age-related subgroup comparisons were evaluated using independent t-tests and FDR correction. Classifier significance was assessed using grouped cross-validation and permutation testing (n = 1000). Several independent analyses, including statistical tests and supervised machine learning models, yielded converging results, supporting the robustness of our findings.

Reporting summary

Further information on research design is available in   linked to this article.

Data availability

EEG data cannot be shared as participant consent for public data sharing was not obtained at the time of collection.

Code availability

All analyses were done with Python 3.8, utilizing the software modules scikit-learn for machine learning, MNE-Python for visualization, and, together with statsmodels, statistical analysis. The SciPy stack was used for efficient data structures, mathematical operations, and plotting functionalities. A large share of the code was developed inside the Jupyter Notebook and IPython framework. The machine learning analysis was enabled in part by support provided by the Digital Research Alliance of Canada (). All code used for analysis and visualization can be found at .

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P.T., M.A., and T.L. contributed to the development of software. P.T. and K.J. conducted the main data analysis. S.F. and J.C. were responsible for data acquisition. P.T. and K.J. drafted the manuscript and contributed to its revision and adaptation. All authors were involved in the conceptualization and design of the study and approved the final version of the manuscript.

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Ethics declarations

Competing interests

The authors declare no competing interests.

Peer review

Peer review information

Communications Biology thanks Klaus Linkenkaer Hansen and the other, anonymous, reviewer(s) for their contribution to the peer review of this work. Primary Handling Editors: Enzo Tagliazucchi and Jasmine Pan. A peer review file is available.

Additional information

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About this article

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Received01 July 2024

Accepted14 April 2025

Published30 April 2025

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ISSN 2399-3642 (online)

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AGE linked with WORK HOURS:

Generally, as people age, there can be a shift in the desired and actual number of work hours, often influenced by factors like health, career stage, and personal preferences. Older workers may prefer to reduce their hours due to declining capacity or to prepare for retirement, while others may seek to increase hours for financial reasons or to stay active. However, this relationship isn't always straightforward, and factors like occupation, gender, and individual circumstances play a significant role.

Here's a more detailed look:

Age and Desire for Reduced Hours:

Declining capacity:

Some older workers may find that their physical or cognitive abilities decline with age, making it harder to maintain the same work pace or hours as when they were younger.

Retirement planning:

As retirement approaches, some individuals may choose to reduce their work hours to ease the transition or to begin enjoying more leisure time.

Health considerations:

Certain health conditions may make it more challenging to work long hours, leading individuals to seek reduced schedules.

Overemployment:

Studies have shown that a significant number of older workers feel "overemployed," meaning they would prefer to work fewer hours, .

Age and Desire for Increased Hours:

Financial needs:

Some older workers may need to work longer hours to meet financial obligations or to save for retirement.

Underemployment:

Conversely, some older workers may be "underemployed," meaning they desire to work more hours than they currently do, .

Staying active:

Some individuals may simply enjoy their work and prefer to stay engaged in the workforce for longer, even if they don't need the income.

Other Factors:

Occupation:

The type of work significantly impacts the relationship between age and working hours. Some jobs may require physically demanding tasks, making it harder to maintain long hours with age.

Gender:

Studies have shown that female GPs, for example, tend to work fewer hours than their male counterparts, regardless of age.

Individual preferences:

Ultimately, the decision of how many hours to work is a personal one, influenced by a variety of individual factors.

In conclusion: While there's a general tendency for older workers to consider reducing their hours, the relationship between age and work hours is complex and influenced by many factors. Some older individuals may need to work longer hours for financial or other reasons, while others may desire to work less as they age.

Search

Age-related differences in working hours among male and female GPs: an SMS-based time use study

Research

Published: 19 December 2017

Age-related differences in working hours among male and female GPs: an SMS-based time use study

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volume 15, Article number: 84 (2017)

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Abstract

Background

In several countries, the number of hours worked by general practitioners (GPs) has decreased, raising concern about current and impending workforce shortages. This shorter working week has been ascribed both to the feminisation of the workforce and to a younger generation of GPs who prefer more flexible working arrangements. There is, however, limited insight into how the impact of these determinants interact. We investigated the relative importance of differences in GPs’ working hours in relation to gender, age, and employment position.

Methods

An analysis was performed on real-time monitoring data collected by sending SMS text messages to 1051 Dutch GPs, who participated during a 1-week time use study. We used descriptive statistics, independent sample t-tests, and one-way ANOVA analysis to compare the working time of different GP groups. A path analysis was conducted to examine the difference in working time by gender, age, employment position, and their combinations.

Results

Female GPs worked significantly fewer hours than their male peers. GPs in their 50s worked the highest number of hours, followed by GPs age 60 and older. GPs younger than 40 worked the lowest number of hours. This relationship between working hours and age was not significantly different for women and men. As shown by path analysis, female GPs consistently worked fewer hours than their male counterparts, regardless of their age and employment position. The relationship between age and working hours was largely influenced by gender and employment position.

Conclusions

The variation in working hours among GPs can be explained by the combination of gender, age, and employment position. Gender appears to be the most important predictor as the largest part of the variation in working hours is explained by a direct effect of this variable. It has previously been reported that the difference in working hours between male and female GPs had decreased over time. However, our findings suggest that gender remains a critical factor for variation in time use and for policy instruments such as health workforce planning.

Background

Many countries fear, or are already confronted with, shortages of general practitioners (GPs) [,,]. This is not only caused by an increasing demand for primary care, but also by the decreasing number of hours worked by GPs [, ]. This development is often ascribed to changes in the composition of the GP labour supply and to their personal preferences. An important change is the steady feminisation of the profession seen in the Netherlands and in other European countries []. In the period 2005–2015, the share of Dutch female GPs has increased from 33 to 48% []. This percentage will continue to increase in the coming years as most of the trainees are women [,,].

One of the consequences of this feminisation for the GP workforce is that female GPs are more likely to work part-time or take career breaks than their male counterparts [, ]. Female GPs prefer more flexible working positions and serve fewer patients [, ], which has led to concerns about the availability and accessibility of GP care []. The number of working hours not only differs between the sexes but also depends upon the life course of GPs. Several studies have showed that women, especially at younger ages, work fewer hours than their male counterparts [, ]. For example, a time use survey conducted in the UK revealed that female GPs worked 11 h fewer than male GPs, because women chose to invest their time in the care of their children []. The number of hours women work can be understood as the result of how they choose to balance their time between family and work []. This assumes ‘freedom of choice’, but as sociologists and gender scholars pointed out, a number of constraints determine this choice of behaviour. A key constraint on the preferred working time of women is the idea and discourse of gender roles in which domestic duties are considered a woman’s work, not only by men, but also by women []. Indeed, numerous studies have shown that women spend considerably more time on child care, and on domestic tasks in general, and less on paid jobs [].

There are, however, new developments in the division of domestic tasks between men and women in different professions, and among GPs in particular. In recent years, male employees also spent more time on family duties and have a greater need for flexible working hours. As a result of this, the differences in working hours between male and female GPs have become smaller over the course of time. There is a new generation of GPs who tend to work fewer hours [].

A shortcoming of the existing studies on gender and the working hours of GPs, however, is that these provide limited insight into how gender differences in working time are influenced by other factors such as age and employment positions. In addition, the effect of how these factors interact on GPs’ working time is also important. While age is a proxy for the family duties GPs are expected to embrace, one’s employment position is important as women especially, and younger GPs too, prefer to work on a salaried basis. This enables them to choose a shorter and more flexible working week and is more compatible with childcare commitments [,,]. Another limitation of previous studies is the measurement of working time. Different types of survey and diary data raise question marks about their validity. In this paper, we use and analyse new and more valid data on GPs’ working time.

The aim of the present paper is to investigate the relative impact of gender and age on the working hours of Dutch GPs by applying a path analysis model. We will also provide insight into the effects of how these variables interact, in particular with regard to the employment position of GPs. The analyses are based on real-time data of GPs’ working hours collected by a large Dutch time use study.

Methods

Data collection

The analyses in this paper are based on time use data collected in order to estimate the working hours of GPs per week as precisely as possible. The time use survey was not set up in a traditional manner, for weekly monitoring was conducted by means of an SMS application. Messages were sent randomly during one full diary week to each GP participating in the study. GPs were texted every day to measure their activities during time slots of 3 h. Exceptions were made when they indicated that they would be out of their office during a part of the day. The text messages asked GPs to select one of four exclusive answers in reply to an SMS message. These were as follows: “At this moment I am; (a) not working as a GP; (b) working directly with patients; (c) working indirectly with patients, or; (d) working as a GP but not directly or indirectly with patients”. Fifty-six messages were scheduled per GP, per week. The data collection was conducted in 57 consecutive weeks from December 2012 to January 2014.

During the period of field work, more than 5000 letters of invitation were sent in two monthly batches in order to ensure a sufficient number of GPs were recruited. Seven stratified samples by employment position and gender were drawn from the NIVEL national registration of GPs []. In addition to the letters of invitation, media announcements were made in several newsletters and websites in order to encourage GPs to sign up for the study. In total, 1051 GPs in both full, and part-time employment, participated in the period studied. This was, on average, 19 GPs per week, with 44 GPs participating twice. The study resulted in 61,320 time data point measurements.

Box 1 Calculating the working hours based on SMS

All groups of GPs, based on gender and employment position, were represented sufficiently in most of the SMS weeks, providing power to execute split sampling and subgroup analyses. More detailed information of the SMS instrument is described elsewhere [].

Data analysis

With regard to the employment position of GPs, our research sample contained self-employed GPs, salaried GPs who work in service of another GP, and GP locums. We focus here for practical reasons on the first two groups. In doing so, both employment position and gender were able to be coded as dummy variables. The results below are therefore based on a selection of the time use data collected—that is, the monitoring data from 856 GPs.

We first compared means and standard deviations of the working hours of different groups of GPs based on their gender, age and employment position. Then bivariate analyses were performed depending on the type of variables as defined by independent samples t-tests or one-way ANOVA (f-tests). For the next analyses, we excluded the GPs above the age of 60 to exclude the effect of early retirement on working hours. A multiple linear regression analysis was performed with the independent variables representing a GP’s gender and age and working hours as the dependent variable. Both unstandardised (b) and standardised (beta) regression coefficients were calculated to measure the effect size and the relative effect of the independent variables on working hours. Then, we added the interaction term of gender and age to analyse to what extent these two variables have an interacting effect on working hours. Finally, a path analysis was conducted to examine the relationships between gender, age, and employment position as predictors of working hours. To explore the relationships between these variables, we computed both Pearson correlations and standardised regression coefficients, thus disentangling the direct and indirect relationships between them. The tolerance/variance inflation factor (VIF) was calculated to check for multicollinearity between the independent variables age, gender, and employment position on working hours. This proved that there was no need to remove one of the variables from the analyses. The statistical analyses were performed in Stata 14.0.

Results

Mean hours worked

Taking the self-employed and salaried GPs together, the GPs in our study reported working 44.9 h per week on average (Table ). There are significant differences between male and female GPs and between GPs of different age groups. Male GPs work, on average, 8 h more than female GPs. Concerning age, it is shown that GPs in their 50s worked the highest number of hours, followed by GPs age 60 or older. GPs younger than 40 worked the lowest number of hours. Table  also shows that there is a relatively large and significant difference in working hours between self-employed GPs (48.4) and salaried GPs (34.5).

Table 1 Number of GPs and mean number of working hours per week, divided by gender, age, and employment position

Multiple regression analysis: the interacting effect of gender and age on working hours

The first linear regression equation estimates the independent effect of age and gender on the working hours of GPs (Table , model 1). In accordance with Table , the differences in the working hours of GPs, by gender and age, remain significant. An effect is found for gender (female GPs work fewer hours compared to their male counterparts (β = − 0.216, b = − 6.726)) and a positive effect of age (β = 0.243, b = 0.433).

Table 2 Effect of gender and age on the number of working hours for GPs under the age of 60 (multiple regression)

When the interaction term between gender and age is added to the model (model 2), it appears that the main effect of gender is considerably higher (β = − 0.409, b = − 12.731) while the main effect of age (β = 0.203, b = 0.360) is lower compared to model 1. There is, however, no significant interaction effect between age and gender. This confirms that the relationship between the number of working hours and age does not significantly differ between women and men. This is also illustrated in Fig. .

Fig. 1

Effects of age on working hours for male and female GPs under the age of 60

Path analysis: causal relationships between gender, age, employment position, and working hours

Correlations

The Pearson correlation in Table  reveals the relationships presented above between gender, age, employment position, and working hours. Firstly, there is a negative linear correlation between gender and working hours (r = − 0.266) confirming that women generally work fewer hours than men. Secondly, there is a positive correlation between age and working hours (r = 0.288) showing that the average number of working hours is higher for the older age categories of GPs.

Table 3 Pearson correlations of gender, age, employment position, and number of working hours for GPs under the age of 60

Path analysis model

To disentangle the direct and indirect relationships behind the bivariate correlations in Table , two additional multiple regression analyses were performed. These were firstly, taking the employment position and, secondly, taking working hours, as a dependent variable (Tables 5 and 6 in ). The standardised regression coefficients are plotted in Fig.  which shows the actual path model. It can be seen that there are significant direct and indirect effects of gender and age on the number of working hours with employment position as the intermediate variable.

Fig. 2

Effects of gender and age on working hours of GPs under age 60. The relationship between gender and age is the correlation coefficient of Table , because this relationship goes both ways. Effect of gender on employment position is significant at 90% confidence level. All other results are significant at 99% confidence level. (c) Beta-coefficient of Table 5 in . (d) Beta-coefficient of Table 6 in . (e) Correlation-coefficient of Table

By focussing on gender, we can notice a direct standardised effect of − 0.199 on working hours. In addition to this, there are three indirect effects of gender on working hours when we include employment position and age as predictors:

I.

The first indirect effect of gender can be seen through the employment position. This can be separated out into:

A positive relationship of 0.053 between gender and employment position, as female GPs are more often salaried GPs than men

A negative relationship between employment position and working hours of − 0.327, because salaried GPs work fewer hours than self-employed GPs (see also Table ).

Hence, the indirect effect of gender by employment position on working hours is (0.053\*− 0.327=) − 0.017.

II.

The second indirect effect of gender on working hours can be seen through age. There is:

An association between gender and age of − 0.204, because, on average, female GPs are younger than their male counterparts

A positive effect of age on working hours of 0.097 as working hours increase when GPs are older.

Hence, the effect of gender on working hours by age is (− 0.204\*0.097=) − 0.020.

III.

Finally, there is a third indirect effect of gender on working hours by age and employment position. This results from:

A negative effect of − 0.204 of gender on age, a negative relationship between age and employment position of − 0.448

A negative relationship between employment position and working hours of − 0.327.

Thus, the third indirect effect of gender on working hours by age and employment position is (− 0.204\*− 0.448\*− 0.327=) − 0.030.

Taken together, the indirect effect of gender on working hours is − 0.067. This implies that 25.2% of the correlation (− 0.266) between both variables is explained by the abovementioned indirect effects. The largest part (74.8%) of the correlation is explained by the direct effect of gender on working hours.

Based on the path analysis and Fig. , a similar analysis can be performed focussing on age:

I.

The first indirect effect of age on working hours seen through the employment job position is (− 0.448\*− 0.327=) 0.146.

II.

The second, through gender, is (− 0.204\*− 0.199=) 0.041.

III.

The third, through gender and employment position, is (− 0.204\*0.053\*− 0.327=) 0.004.

The sum of all indirect effects for age on working hours results in a standardised regression coefficient of 0.190, while this is 0.097 for the direct effect. Hence, the largest part of the correlation (0.288) between age and working hours can be explained by indirect effects (66.2%) and a smaller part by a direct effect (33.8%).

Table  summarises the indirect and direct effects of gender and age on working hours.

Table 4 Summary of direct and total indirect effects of gender and age on the number of working hours for GPs under the age of 60 (results are significant at 90% and 99% confidence level)

Discussion

Summary of the results

The main question posed by this paper is how differences in the working hours of GPs can be explained by their gender, age, and employment position. If we know the relative and interacting impact of these variables upon the actual working hours of GPs, then this may help future workforce planning.

Based on bivariate analyses, we first found that female GPs work 8 h less than their male peers. GPs in their 50s worked the highest number of hours, followed by GPs age 60 and older. GPs younger than 40 worked the lowest number of hours. Multiple regression analysis showed that the relationship between working hours according to the age of GPs, for those GPs younger than 60, was not significantly different for women compared to men. In addition, by using a path analysis model, we found that a small part of the relationship between gender and working hours is explained by age and employment position, while the largest part (75%) is explained by a direct effect between both variables. This implies that female GPs consistently work fewer hours than their male counterparts, regardless of their age and employment position. Secondly, we found that the direct effect of age on working hours is relatively small (34%). Young GPs mainly work fewer hours compared to their older counterparts because these younger GPs are more often women and work as a salaried GP—that is in the service of another GP.

Comparisons with other research

Our results are in line with many other studies from different countries showing that female physicians work fewer hours than their male counterparts [, ]. The results are also consistent with the finding that young physicians work fewer hours than their older peers []. This is shown for both male and female GPs below the age of 60. The lower number of working hours for young female GPs is often explained by their having children [, , , ]. Research into the domestic and family duties of physicians has shown that men are spending more hours on these activities when they have children, but this effect is at least twice as strong for women [].

What has not been previously reported is that no significant differences exist between male and female GPs with regard to the relationship between age and working hours. This suggests that during their career and life course female and male GPs adapt their career to children similarly. However, our time use data does not contain information about the domestic arrangements of the GPs and whether they had children or not.

It is often cited that female GPs work fewer hours because they are generally younger and work more often on a salaried basis than male GPs []. Our study shows that the lower number of working hours for women compared to men is a consistent difference that barely changes when taking age and employment position into account. These results contradict the suggestion of van den Berg [] that in the future gender would probably be irrelevant for differences in working hours. Van den Berg reported that the gender gap became smaller between 1987 and 2001; however, we found that in 2013 gender still appears to be the strongest determinant of GPs’ working time in the Netherlands. Therefore, we conclude that it is important to keep investigating the differences in working hours between the sexes, in particular from a policy perspective and in relation to health workforce planning.

As in many countries, the share of women in the GP workforce in the Netherlands has increased, and will increase further in the future, as most of the new entrants are women [, ]. This feminisation of the profession can put pressure on the availability of primary care [, ]. Policy makers responsible for health workforce planning are confronted with the challenge of sustaining a proper balance between the supply and the demand for care. It implies that more GPs need to be trained or recruited from other countries to meet this demand []. There are, however, other options for sustaining the level of services which have been suggested by some authors. A possible strategy is to develop family-friendly measures and flexible working conditions in order to keep women in the workforce [, ]. Another option is to organise the work more efficiently, for example by employing more support staff to perform standard tasks carried out by GPs []. Previous studies, however, have shown that the practice nurse (praktijkondersteuner huisartsenzorg or POH in Dutch) improved the quality of care, but did not yet reduce the workload for GPs [, ]. Further research is required to gain more insight into the value of different types of support staff and the most adequate skill mix in practices [].

Strengths and limitations

An important strength of this study is that it is based on a large dataset containing more than 61,000 time measurements during the working weeks of more than 1000 GPs. These measurements were obtained by a work sampling methodology using an SMS tool to monitor the activities of GPs each week in real time in a valid and user-friendly manner. Compared to the traditional time use survey methods, these unique data provide data of high quality to measure the working time of GPs.

Some limitations should be taken into account as well. Firstly, we studied the relevance of the life course by analysing the total and controlled differences between age categories. We speculate that the working hours of younger GPs may be lower related to childcare responsibilities and, conversely, higher at older ages when familial duties are less demanding. Our data, however, does not contain information on the age of respondents’ children. Therefore, we analysed only the working time difference according to the age of GPs and its interaction effect with gender. However, previous studies investigating the composition of households indicate that the presence of children is strongly related to the age of women or men []. A cohort analysis of women born in the 1940s, 1950s, and 1960s showed that approximately three quarters of the higher educated women, such as GPs, had children []. Secondly, this study analysed differences in working hours between individual GPs. Personal variables such as gender, age, and employment position explained a relatively considerable part (21%) of the variation in working hours, but 79% of this variance is still explained by other variables. These could, for example, concern the type of practice and the supporting staff. Considering the developments in the reallocation of tasks [, ], and the increasing number of co-owned practices in several countries [, ], future research is useful in order to gain more insight into the effects of these variables.

Finally, the analyses in this paper were based on cross-sectional data. The differences we found in working hours according to age, gender, and employment position provide no insight into how these can change over the course of time. Longitudinal data collected over several years can provide more insight into how the careers of female and male GPs develop during the course of their life with regard to their working hours.

Conclusions

The proportion of female GPs is increasing, and they elect part-time employment more often, compared with their male peers. Furthermore, there is a new generation of female and male GPs who seem to choose to spend more time on leisure activities, and with their families, and therefore tend to work on salaried bases with which they can limit their working hours. These trends appear to suggest clear consequences for health workforce planning. The capacity of GP care may decline in the future. There is, however, still limited insight into the relative impact and interaction effects of gender, age, and employment position on working hours. Our analyses can be seen as a first step, presenting the important conclusion that the variation in working hours can be explained for a large part by the combination of age, gender, and employment position. Gender appears to be most important as a large part of the variation in working hours is explained by a direct effect of this variable and a smaller part by indirect effects.

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Acknowledgements

Not applicable.

Funding

The original study was funded by the Advisory Committee on Medical Manpower Planning (Capaciteitsorgaan).

Availability of data and materials

Data are available from the authors upon reasonable request and with permission of the Advisory Committee on Medical Manpower Planning (Capaciteitsorgaan).

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Contributions

DvH has taken a major role in analysing the data and writing the paper. LvdV has taken a major role in checking the analyses and writing the paper. DdB has taken a major role in writing the paper. RB has taken a major role in supervising the study process and writing the paper. All authors read and approved the final manuscript.

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Ethics declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Publisher’s Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Additional information

Dinny de Bakker has a deceased

Appendix

Appendix

Table 5 Effect of age and gender on employment position for GPs under the age of 60 (multiple regression)

Table 6 Effect of gender, age, and employment position on the number of working hours for GPs under the age of 60 (multiple regression)

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About this article

Cite this article

AGE linked with STUDY HOURS:

The relationship between age and study hours is complex and multifaceted, with no simple linear correlation. While younger individuals might require more study time due to less developed cognitive skills, older adults may require less time due to better-developed strategies and a larger knowledge base. However, older adults may also face age-related cognitive declines that impact their ability to learn effectively.

Factors to consider:

Cognitive Development:

Younger individuals are still developing their cognitive abilities, including executive functions like planning, organization, and time management, which can influence how efficiently they study.

Knowledge Base:

Older adults often have a larger knowledge base and more developed cognitive strategies, allowing them to learn more efficiently and potentially require less study time for similar tasks.

Learning Styles:

Different age groups may have different learning preferences and styles. Younger students may prefer more interactive and hands-on learning, while older students may be more comfortable with independent study and asynchronous learning tools.

Cognitive Decline:

Age-related cognitive decline can affect memory, processing speed, and the ability to effectively regulate study time.

Motivation and Goals:

Motivation and goals can significantly impact study habits at any age. Older adults may be more motivated by specific career or personal goals, while younger adults may be more focused on academic performance.

Individual Variability:

It's crucial to remember that age is just one factor influencing learning and study habits. Individual differences in learning styles, prior knowledge, and motivation can lead to significant variations within age groups.

In essence: While younger individuals may need to study longer due to less developed cognitive skills, older adults may require less time due to experience and knowledge. However, older adults may also face age-related cognitive challenges that can impact their learning process and study efficiency. Ultimately, the optimal study time and approach are highly individual and influenced by various cognitive and personal factors

ArticlePDF Available

Dissecting the Relationship Between Study Time, Gender, and Age: A Holistic Approach to Understanding Academic Performance in Contemporary Education

December 2024

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References (24)

Figures (1)

Abstract and Figures

Academic performance is a complex and multifaceted outcome shaped by cognitive, behavioral, and biological factors influencing students' academic performance. This study aimed to investigate the relationships between the student’s study time, gender, age, and academic performance in a sample of students. The study used correlation and comparative statistical methods to explore how these variables might influence student grades. The correlation between study time and grades was found to be weakly positive (p = 0.037, R = 0.105), indicating that while more study time is associated with slightly better grades, the strength of this relationship is modest. The comparative analysis between male and female students revealed a significant difference in average grades, with male students achieving higher grades (p = 0.041). The average grade for male students was 10.91, while female students averaged 9.97. Additionally, the correlation between age and academic performance was negative (p = 0.001, R = -0.173), suggesting that as students age, their academic performance tends to decline, albeit weakly. These findings underscore the complexity of factors influencing academic success, suggesting that study time, gender, and age play a role, but their impacts may vary in strength. The results highlight the need for further research to explore the cognitive, social, and biological factors that interact with these variables and contribute to students' academic performance. The modest correlations suggest that other variables, such as study strategies, motivation, and neurobiological factors, maybe more substantial in determining academic success.

Relationship between Study Time and Age Towards Grade

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International Journal of Health Literacy and Science 2 (2) (2024)

International Journal of Health Literacy and Science

Dissecting the Relationship Between Study Time, Gender, and Age: A Holistic

Approach to Understanding Academic Performance in Contemporary

Education

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Article Info

Abstract

Article History

Submitted: November 18, 2024

Revised: November 28, 2024

Accepted: November 30, 2024

Academic performance is a complex and multifaceted outcome shaped

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average grades, with male students achieving higher grades (p = 0.041).

The average grade for male students was 10.91, while female students

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further research to explore the cognitive, social, and biological factors

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performance. The modest correlations suggest that other variables, such

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substantial in determining academic success.

Keywords:

Study Time; Gender; Age; Academic

Performance; Contemporary

Education

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pISSN 2964-2035

eISSN 3025-9258

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Introduction

Academic performance is a complex and multifaceted outcome shaped by cognitive, behavioral, and

biological factors influencing students' academic performance. Study time is often identified as one of the

critical determinants of academic success, with numerous studies indicating that increased time dedicated

to studying is positively correlated with improved knowledge retention, comprehension, and overall

academic performance. (Liu, 2022). Research suggests that students who devote more time to their studies

are better equipped to consolidate information, reinforce learning, and retain knowledge over the long

term. In particular, longer study sessions allow for the repeated retrieval of learned material, facilitating

deeper cognitive processing and reinforcing neural pathways associated with memory. (Roediger & Butler,

2011). This extended engagement with study materials contributes to better outcomes, as students can

internalize information more thoroughly and make stronger connections between concepts. However, the

relationship between study time and academic success is not uniform across all students. A range of

individual differences, including gender and age, may significantly influence how effectively study time

translates into academic achievement. (Amabile et al., 1994).

From a biological perspective, the impact of study time on academic performance is shaped by factors

such as brain structure, hormonal profiles, and developmental stages. These biological variations influence

cognitive processes like memory consolidation, learning ability, and neuroplasticity, affecting how

individuals respond to study routines. The brain's ability to adapt and change in response to learning is

critical to academic success, and this neuroplasticity is influenced by age and hormonal factors. (Kolb &

Gibb, 2011). For instance, gender-based hormonal differences, particularly estrogen’s role in memory

enhancement and neuroplasticity may contribute to variations in study efficacy between male and female

students. (Hara et al., 2015). Estrogen has been found to enhance synaptic plasticity, especially in areas of

the brain involved in memory and learning, such as the hippocampus. As a result, female students may

experience improved cognitive processing and memory retention during study sessions, making their study

time more effective than their male counterparts in some contexts. Additionally, males tend to have higher

testosterone levels associated with different cognitive patterns, potentially affecting how they engage with

study materials and their academic performance. (Beauchet, 2006).

Age-related changes in brain development further complicate the study-time-performance

relationship. As individuals age, their brains undergo significant structural and functional changes that

influence learning and cognitive function. (Poldrack, 2000). These changes, particularly in regions related

to executive function and learning, suggest that older students may process information more efficiently,

which could lead to them requiring less study time to achieve similar academic outcomes as younger

students. (Salthouse, 2012). Older students often have more advanced cognitive strategies and better-

developed executive functioning skills, which enable them to organize information, manage their time, and

solve problems more effectively. This might allow them to optimize their study time, using it more

productively than younger students still developing these cognitive skills. As a result, while younger

students may need to spend more time studying to achieve the same academic outcomes, older students

may require less time due to their more refined cognitive abilities.

Understanding the complex relationships between study time, gender, and age provides valuable

insights into how to optimize educational strategies tailored to individual student needs. Educators and

researchers can use this knowledge to better design study interventions and provide personalized learning

experiences considering these biological and cognitive factors. Such a comprehensive approach improves

academic outcomes and helps create a more inclusive and effective educational environment. By

recognizing the differences in how study time is utilized based on gender and age, creating more targeted

and efficient teaching strategies that foster success for diverse students becomes possible. (Wiederholt et

al., 1993).

Methods

The Design of The Study and The Participants

This cross-sectional study sampled secondary data from the UCI Machine Learning Repository.

Participants were selected based on the availability of the duration of weekly study time, age, gender, and

final grade.

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The Collection of The Data

This study utilized data gathered during the 2005-2006 school year from two public schools in the

Alentejo region of Portugal. The data was collected through school reports and questionnaires containing

37 questions, completed in class by 788 students.

The Analysis of The Data

The statistical analysis was conducted using the Statistical Package for the Social Sciences software

on an observational, cross-sectional study to assess the correlation between the duration of weekly study

time, age, gender, and final grade.

Results

Correlation Between Study Time and Grade

The correlation between study time and grade was assessed using the Spearman rank correlation

test, which yielded a p-value of 0.037 and a correlation coefficient (R) of 0.105. The p-value indicates a

statistically significant relationship between the time spent studying and students' grades, as it is below the

conventional significance level of 0.05. However, the relatively small correlation coefficient suggests that

while study time impacts grades, this relationship's strength is weak.

This finding supports the notion that more studying time can lead to better academic performance,

but other factors may contribute more significantly to academic success. It is essential to recognize that this

small correlation may be influenced by individual differences in study habits, study effectiveness, and the

quality of the study sessions rather than simply the quantity of study time. Future studies could explore

these additional variables, such as the focus and strategies employed during study sessions, which may

provide a clearer picture of the relationship between the study's time and academic achievement. (Van Den

Hurk et al., 1998).

Correlation Between Age and Grade

The correlation between student age and grade was assessed using the Spearman rank correlation

test, yielding a p-value of 0.001 and a correlation coefficient of -0.173. The negative correlation indicates

that as student age increases, their grades tend to decrease, and this relationship is statistically significant

given the p-value is well below the 0.05 threshold. The negative direction of this correlation suggests that

older students, on average, maybe performing worse than younger students.

Several factors could explain this finding. Older students may face more external pressures, such

as work or family responsibilities, which could reduce the time and energy available for academic tasks.

(Zimmer-Gembeck et al., 2023). Additionally, the learning needs of older students might differ from those

of younger students, potentially making it more challenging for them to keep up with academic demands.

Another possibility is that older students may have developed less effective study habits or strategies over

time, leading to lower academic performance. However, it is essential to note that the strength of the

correlation is modest, and other factors, such as student motivation and cognitive development, may also

play significant roles in explaining the observed relationship between age and academic performance. (Shi

& Qu, 2022).

Table 1. Relationship between Study Time and Age Towards

Grade

Variables

Grade

R

p-value

Study Time

0.105

0.037

Age

-0.173

0.001

Gender Differences in Academic Performance

The Mann-Whitney U test comparing male and female students’ grades revealed a p-value of 0.041,

indicating a significant difference in the statistical test between the two groups. Male students' average final

test grade was 10.91, while female students had an average grade of 9.97. This suggests that male students,

on average, performed slightly better than female students in terms of grades.

One possible explanation for this difference could be related to study habits, motivation, or the

specific academic domains being assessed. Male students may have a different approach to studying those

results in higher grades or be more likely to engage in subjects that align with their strengths (Saxena et al.,

2024). Additionally, the study does not account for other variables, such as socioeconomic status,

extracurricular involvement, or teaching methods, which could influence the academic outcomes of both

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Educ Gerontol

. Author manuscript; available in PMC: 2013 Jun 13.

Published in final edited form as: Educ Gerontol. 2012 Jun 13;38(9):604–615. doi:

Age-Related Effects of Study Time Allocation on Memory Performance in a Verbal and a Spatial Task

1

Author information

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PMCID: PMC3398696  NIHMSID: NIHMS385024  PMID:

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Abstract

Past studies have suggested that study time allocation partially mediates age relations on memory performance in a verbal task. To identify whether this applied to a different material modality, participants ages 20-87 completed a spatial task in addition to a traditional verbal task. In both the verbal and the spatial task, increased age was associated with poorer utilization of study time, suggesting that age differences in study time allocation are qualitatively similar across material modality. Furthermore, age differences in how individuals allocated their study time partially mediated the age relations on memory performance in both tasks, indicating the importance of effective regulation of study time when learning information. Finally, age differences in study time allocation did not appear to be due to differences in awareness of performance. When a subset of participants was asked about their prior performance, awareness of previous performance was not associated with study time allocation on either task. Interestingly, asking participants about their prior performance tended to decrease recall performance. Overall, these results illustrate that how one allocates study time is related to subsequent memory performance in both a verbal and spatial modality, but knowledge about prior performance is not associated with study time utilization, and inquiring about past performance during study may disrupt rather than facilitate learning.

wrote that “one of the truly unique characteristics of human memory [is] its knowledge of its own knowledge” (p. 477). This knowledge about one’s memory is defined as metamemory. One key question over the last few decades is whether age-related memory declines are related to metamemory deficits. For example, if older adults are less aware of the effectiveness of a particular strategy, implementing a less effective one could contribute to poorer memory performance (). In light of the hypothesis that some of the age relations on memory may be related to declines in metamemory, the study of metamemory in older adults has become a flourishing area of research.

There are a variety of ways in which one can assess metamemory, and it can be examined before learning, during learning (encoding), and at retrieval (See , for a review). It is especially important to consider whether there are age relations on metamemory at encoding since it may be the case that age differences in metamemory at learning contribute to some extent to age differences in memory performance. Intuitively if individuals incorrectly believe that they have adequately encoded information, then they may not allocate additional resources to try to remember the information (e.g., they may stop rehearsing the information), and as consequence, they might not retrieve this information at a later time.

Some evidence suggests that one type of metamemory measure, study time allocation, is related to memory performance. For instance, recall readiness studies, in which participants study an entire list before declaring when they are ready to take a test, demonstrate that older adults’ poorer recall performance may be at least partially due to prematurely terminating study during learning (; ). When older adults were instructed to study a list a certain amount of time before terminating the study phase (e.g., the minimum amount of time spent studying a list was 30 seconds), they recalled more items than older adults who were allowed to terminate study at any time (). An inspection of the study times revealed that participants allowed to terminate study at any time spent less time studying each list compared to the other group. Therefore, the results from the recall readiness studies suggest that older adults may terminate study before fully learning the items and this contributes to differences in memory performance.

Furthermore, previous research that has examined how long each item is studied using verbal materials (e.g., word pairs) has provided supporting evidence that there are age differences in study time allocation. When given the opportunity to restudy information before a subsequent memory test, both younger and older adults allocated more study time to previously incorrect word pairs; however, older adults less consistently allocated additional study time to items that they previously failed to recall compared to younger adults (; ). Importantly, regression analyses revealed that when a measure of study time allocation was partialled from a measure of recall performance, the magnitude of the age differences in recall performance was attenuated (; ). These studies suggest that differences in how individuals of different ages utilize study time in a verbal task partially mediate the age relations on memory performance. One goal of the current project was to determine if this finding could be replicated in a verbal task using a continuous age sample, and whether a similar pattern would be evident in a task involving spatial to-be-remembered information.

Utilization of study time was assessed by investigating how long individual items were studied based on previous performance. It was expected that younger adults would demonstrate better recall performance compared to older adults partly due to differentially allocating study time to previously incorrect items relative to previously correct items. Based on previous research (; ) it was hypothesized that increased age would be associated with poorer regulation of study time, as manifested by less consistent allocation of more study time to previously incorrect items relative to previously correct items when given an opportunity to restudy these items in a subsequent study trial. In addition to attempting to replicate previous findings of age-related effects on study time allocation in a task with verbal materials, the current research investigated whether a similar finding is also evident in a nonverbal, spatial task. Although verbal and spatial memory may rely on distinct processes (e.g., ; ), it was hypothesized that the age relations on study time allocation would be qualitatively similar for both a verbal and a spatial task, and that the process by which participants determine whether an item is learned well enough to terminate study would be similar across the two tasks.

There are at least two reasons why increased age may be associated with poorer allocation of study time. First, older adults may be poorer at effectively regulating their study time. For instance, individuals might prematurely terminate studying items, or they may excessively allocate study time to items that are already well-learned. Second, there may be age differences in the knowledge of the item’s status on the previous trial (i.e., Does the participant remember whether an item was recalled or not?), and this may influence how long a particular item is studied. For example, if an individual incorrectly believes that an item was correctly recalled on the previous test, less study time may be devoted to that item. In fact, there is some evidence that knowledge about past performance may be impaired with increased age (e.g., ), which may help to explain age differences in study time allocation. That is if older adults incorrectly believe that they recalled an item, then the study time for this item may be equivalent to the study times for items that they actually recalled. The result is that older adults would appear to be less effective at regulating their study time, as evidenced by less consistently allocating more time to previously incorrect items; however, this would be due to differences in awareness of the prior status rather than differences in differentially allocating study time to previously incorrect items.

Typically these two influences, differences in utilization of study time and knowledge about prior performance, are not distinguished (e.g., ), likely because it is assumed that participants are aware of their prior performance. However, an experiment by Dunlosky and Connor (, Experiment 2) partially addressed the issue of whether differences in remembering the status of the items contributed to age-related differences in study time allocation. Even when participants were presented with feedback about the item status (i.e., previously recalled versus previously unrecalled) during the self-paced study trials, older adults were worse at allocating their study time, as indicated by less consistently allocating more time to previously incorrect items. This suggests that age differences in effectively regulating study time is the primary determinant of age differences in study time allocation and that knowledge about prior performance is unlikely to be an important factor. Nevertheless, this is the only experiment that has provided feedback. The current study more directly examined the effects of knowing about the item’s status by including a judgment during the study phase about prior test performance. Based on the finding by  that older adults are poorer at monitoring what they recalled, it is hypothesized that increased age is associated with poorer judgment accuracy, such that older adults may incorrectly believe that they recalled an item on a previous test when they did not, or incorrectly believe that they did not recall an item on the prior test when they actually recalled it. Furthermore, it was also hypothesized that this would contribute to the age relations on study time allocation.

To summarize, the current project determined whether study time allocation is a mediator of the age relations on memory performance. It was hypothesized that increased age would be associated with poorer study time allocation performance in both a verbal task and a spatial task, and that this would partially contribute to lower recall performance with increased age. Further, the second major goal was to assess whether age relations on study time allocation are due to differences in awareness of prior performance. It was predicted that increased age may be associated with deficits in assessing whether an item was correctly recalled on the previous test, and this may result in poorer allocation of study time on a subsequent self-paced study trial.

Method

Participants

Four-hundred-eighty-one participants completed the two tasks in two different sessions separated by 1-14 days as part of a larger scale study. Participants were assigned to one of three conditions, with 118 participants (Probe 1) being asked in List 1 about their prior performance (i.e., when re-presented with an item for study, they were asked if they correctly recalled the item on the previous test), 154 participants (Probe 2) being asked in List 2 about their prior performance, and 143 participants (No Probe) not being asked in either list about their prior performance.

In these sessions participants completed a series of cognitive ability tasks before they were administered the two meta-memory tasks. The sessions lasted two hours, and the meta-memory tasks were always administered at the end of the session. The majority of the participants completed both tasks, but some of the participants did not complete one of the lists or one of the tasks due to time constraints.

Participants were recruited from the community; none were college students. All had a high school degree, and participants who scored below a 25 on the Mini-Mental Status Exam (MMSE; ), a standard test used to screen for dementia, were excluded from the analyses.  provides the descriptive characteristics of the sample. The age-adjusted scaled scores for four tests from the Wechsler Adult Intelligence Scale-III () and the Wechsler Memory Scale-III () are reported to indicate the representativeness of the sample. As shown in the table, increased age was associated with higher functioning on the majority of the tasks, indicating that any age differences observed in the subsequent analyses are not a by-product of the older adult sample being worse on the reference measures.

Table 1. Descriptive characteristics of participants, arbitrarily divided into three groups.

Note: Parentheses contain the standard deviation.

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p< .05

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p< .01. Age r refers to the correlation between the demographic variables and age.

Materials

For the verbal task 40 Swahili-English translations (e.g., hadithi-story) were selected from the most difficult items in the Swahili-English database (), with the exception of the first two and last two items, which were less difficult. Two lists consisting of 20 translations were constructed to have the same mean level of difficulty. For the spatial task 32 non-objects were selected from the  line drawing database so that these objects were not easily labeled, making the spatial task a nonverbal task. These non-objects were presented in a 4 × 4 matrix.

Procedure

The verbal and the spatial task were administered in counterbalanced order across participants on two testing days. Each task was composed of two lists, and participants completed the lists in the same order.

In both the verbal and spatial tasks participants viewed a series of instructions informing them about the purpose of the task along with practice trials to familiarize them with the task. They were told that during the first study phase the computer would control how long the items appeared on the screen, and that they should try to remember these items because they would be given a subsequent memory test. The participants were informed that after they completed the memory test that they would then be re-presented with the same items to study again. They were told that during this second presentation of the items that they would be given some control in determining how long they wanted to study each item. It was explained to them that by pressing the SPACEBAR the next item (Spatial task) or pair of items (Verbal task) would appear on the screen. During the self-paced study trial there was always a prompt at the bottom of the screen informing the participants to press the spacebar to move on to the next item/pair so that participants would not forget which type of study trial they were completing (i.e., computer- vs. self-paced). They were informed that if they did not press the SPACEBAR within 8 seconds that they would automatically be advanced to the next item/pair. Participants were also told not to waste time studying because the time they spent studying also reflected the efficiency of their learning. Following the self-paced study trial, participants completed a recall test. After the second recall test, participants were re-presented with the same items for study in a final self-paced study trial, and following the study trial they completed a final memory test. See  for an illustration of the procedure.

Figure 1.

Schematic diagram of multiple study-test trials procedure for Lists 1 and 2.

For the verbal task, the Swahili word always served as the cue word in the recall tests, and participants provided the English translation. The experimenter typed their responses. Participants were given up to 10 seconds to respond, and they were allowed to pass if they could not remember the translation. For the spatial task, during the recall tests participants were given an empty matrix, and they were shown a non-object at the bottom of the screen. They were asked to click on the cell where they thought the item had appeared, or if they were uncomfortable using the mouse the participants pointed to the cell and the experimenter clicked on the cell for them. If participants did not respond within 10 seconds, they were automatically advanced to the next question.

Participants in the probe conditions were asked during the second and third study trials about their performance on the previous recall test in either List 1 (Probe 1 condition) or List 2 (Probe 2 condition). Specifically, they were re-presented with the items one by one and were asked to make an immediate yes-no judgment as to whether they correctly recalled the item on the previous test. Then they were allowed to re-study the item in a self-paced study trial.  depicts an illustration of the procedure for the probe conditions. Note that the diagram contains an example from the verbal task, but the same format was used in the spatial task.

Figure 2.

Diagram of the probe procedure to examine awareness of prior performance (monitoring accuracy).

In sum, participants completed six recall test trials – three in the first list and three in the second list – and six study trials, with the first trial always being computer timed followed by two additional self-paced study trials. Some participants were asked about their previous test performance during Study Trials 2 and 3, either in List 1 or List 2, depending on their condition. The presentation of the study material was presented in a fixed order, but the test order was random. The procedure for the verbal and spatial tasks was identical, with only the material modality varying.

Results

Results from a pilot test suggested that the first items were more likely to be studied for a longer duration relative to items in the other portion of the list, while the last two items were studied for a shorter duration. There is also considerable evidence that individuals are more likely to remember items from the first and last portion of a list compared to the middle portions (e.g., Glanzer & Cunitz, 1966). Therefore, the first two and last two items were excluded from the data analyses.

Since some participants completed the verbal task first and the spatial task second, and vice versa, preliminary analyses were conducted to test for order effects. These analyses did not yield a significant main effect of order or significant Age × Order interaction in the verbal or spatial tasks, F’s< 3.70, p’s>.05; therefore, subsequent analyses are collapsed across task order.

Recall Performance

A 3 (Age Group: Young, Middle, Older) × 3 (Condition: No Probe, Probe 1, Probe 2) × 2 (List: List 1 vs. List 2) × 3 (Recall Trial: Trial 1, Trial 2, Trial 3) ANOVA on the proportion of items recalled in the verbal task was performed. The ANOVA yielded a significant main effect of Age Group, F(2, 406) = 34.54, ηp2 = .15, p< .001, with LSD post hoc tests indicating that younger adults (M = .42) recalled more translations compared to both middle-aged (M = .33) and older adults (M = .20), and middle-aged adults recalled more than the older adults. Additionally, there was a main effect of List, F(1, 406) = 6.43, ηp2= .02, and Trial, F(2, 812) = 963.97, ηp2= .70, p’s<.05. There were three significant interactions involving List – List × Condition, F(2, 406) = 5.84, ηp2 = .03, List × Trial, F(2, 812) = 14.14, ηp2= .03, and List × Trial × Condition, F(4, 812) = 11.25, ηp2 = .05, p’s<.05. As seen in the upper portion of , the interactions were a result of lower performance in the probe conditions when participants were asked about their previous performance on a particular trial in a list. Specifically, there was lower performance on lists that included the probe question, and lower performance on Trials 2 and 3 when the question was present. Finally, there was a significant Age Group × Trial interaction, F(4, 812) = 20.56, ηp2= .09, p<.01, with increased age being associated with less improvement across trials.

Figure 3.

Proportion of items recalled in a verbal and a spatial task by condition across trials and lists.

A similar ANOVA was performed on the proportion of items correctly recalled on the spatial task. Similar to the verbal results, there were significant main effects of Age Group, F(2, 401) = 23.48, ηp2= .11, List, F(1, 401) = 103.73, ηp2= .21, and Trial, F(2, 802) = 974.78, ηp2 = .71, p’s<.001. Furthermore, unlike the verbal results, in the spatial task there was a main effect of Condition, F(2, 401) = 5.71, ηp2= .03, p<.01, with Probe 1 condition (M = .42) showing poorer performance compared to the No Probe condition (M = .50) as indicated by LSD post hoc tests. Likewise, similar to the verbal task, there were significant interactions for List × Condition, F(2, 401) = 30.35, ηp2= .13, List × Trial × Condition, F(4, 802) = 18.85, ηp2= .09, and Age Group × Trial, F(4, 802) = 7.48, ηp2= .04, p’s<.05. There was also a significant Age Group × Trial × Condition interaction, F(8, 802) = 2.21, ηp2= .02, and an Age Group × List × Trial interaction, F(4, 802) = 2.75, ηp2= .01, p’s<.05. Overall, as was the case with the verbal task, when participants were asked about their prior performance, this resulted in poorer recall performance, suggesting that the probe interfered with their learning. Furthermore, the Age Group × Trial × Condition interaction suggests that the probe in the spatial task was more deleterious with increased age.

Age, Study Time Utilization, and Recall Performance

Study time utilization was analyzed by computing gamma correlations between study time allocation on a subsequent study trial and prior recall performance (i.e., previously incorrect vs. previously correct). Gamma correlations range from −1 to +1, with −1 indicating that an individual consistently allocated study time to previously incorrect items. Importantly, gamma correlations measure the degree of overlap of the two item types – previously incorrect versus previously correct, regardless of the absolute duration of study time. Thus, the absolute values of the study times do not matter, but rather it is the extent to which participants’ study time consistently discriminates between the two item types.

To investigate the possibility that lack of awareness of prior performance may influence the study time allocation scores, participants were asked to make judgments on the second and third study trials in either List 1 (Probe 1 Condition) or List 2 (Probe 2 Condition) about whether they believed that they correctly recalled an item on the previous recall trial (e.g., on the second study trial participants answered whether they believed that they correctly recalled an item on Test 1). Participants could be accurate by correctly responding that they recalled an item on the previous test or correctly responding that they did not recall an item on the previous test. They could be inaccurate by incorrectly responding that they recalled an item on the previous test or incorrectly responding that they did not recall an item on the previous test. A monitoring accuracy score was computed such that the sum of the number of correct responses was divided by the sum of the participants’ total number of correct and incorrect responses.

To icrease the reliability of measures, performance variables were aggregated across trials and lists. For example, Study Time Utilization was calculated by averaging gamma correlations between subsequent study time allocation and previous test performance (i.e., gamma correlations for Recall Trial 1-Study Trial 2 and Recall Trial 2-Study Trial 3 for Lists 1 and 2 were averaged). Furthermore, Recall Performance was computed by averaging the number of items recalled on Trials 2 and Trials 3 across Lists 1 and 2. Therefore, study time utilization and recall performance measures were averaged across four scores. Monitoring Accuracy scores were collapsed across trials in List 1 (Probe 1 Condition) and List 2 (Probe 2 Condition). There was not a monitoring accuracy score for those in the No probe condition.

Correlations between age, recall performance, study time utilization, and monitoring accuracy by condition are displayed in  for the verbal (upper portion) and spatial (lower portion) tasks. As shown in the table, increased age was associated with fewer items recalled on both the verbal and spatial tasks across conditions. In addition, increased age was related to less consistently allocating more study time to previously incorrect items, and this finding was consistent across tasks and conditions. Furthermore, better allocation of study time (i.e., study time utilization) was associated with better recall performance on both tasks. While increased age was not associated with poorer monitoring accuracy in the verbal task, nor was monitoring accuracy related to recall performance or study time utilization, there was a tendency for increased age to be associated with poorer monitoring accuracy in the spatial task (Probe 1 condition only), and poorer monitoring accuracy in the spatial task was associated with poorer spatial memory. Importantly, monitoring accuracy and study time utilization were not related in either task, suggesting that monitoring accuracy is not associated with subsequent study time allocation.

Table 2. Correlations among age, recall performance, study time utilization, and monitoring accuracy by condition collapsed across lists and trials.

Note:

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p<.05

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p<.01. The upper portion represents the verbal bivariate correlations, and the lower portion represents the spatial correlations.

Regression analyses were conducted to assess the extent to which study time utilization mediated the age relations on recall. Two values were computed in the regression analyses: 1) The total amount of variance in recall associated with age (R2 with Age alone), and, 2) the amount of variance associated with age after partialling for study time utilization (R2 Change). The percentage of reduction in age-related variance in recall when controlling for study time allocation was calculated using the following formula: [(R2 with Age alone - R2 Change)/R2 with Age alone]. Regression analyses were performed for each condition and task using the aggregated performance variables. Partialling for study time allocation reduced the age-related variance in verbal recall performance by 61.3% in No Probe [(.173-.067)/.173], by 66.3% in Probe 1 [(.178-.060)/.178], and by 77.6% in Probe 2 [(.210-.047)/.210] conditions. Similarly, the age-related variance in spatial recall performance was reduced by 26.0% in No Probe [(.150-.111)/.150], by 69.7% in Probe 1 [(.152-.046)/.152], and by 54.7% in Probe 2 [(.095-.043)/.095] conditions. These results suggest that age differences in how one allocates study time may contribute to some extent to age-related memory declines.

In addition to examining study time allocation as a mediator of the age relations on memory, regression analyses were also conducted for the probe conditions to assess whether monitoring accuracy was a mediator of the age relation on study time utilization. With the exception of Probe 2 condition in the spatial task (25.5% reduction), monitoring accuracy did not appear to be a mediator of the age relations on study time allocation (Less than 1% reduction for Spatial Probe 1 and Verbal Probe 1 and Verbal Probe 2 conditions). Therefore, age differences in monitoring accuracy do not appear to be largely related to age differences in study time.

Discussion

The current project investigated whether there were age differences in study time allocation, and if so, whether those differences might be contributing to age differences in memory. A primary goal of the current project was to assess whether age differences in how one allocated study time to previously incorrect and previously correct items when given an opportunity to restudy these items (i.e., study time utilization) would contribute to the age relations on recall performance. This was investigated using both a verbal and a spatial task to evaluate whether age relations on study time allocation were modality specific. Furthermore, a secondary aim was to assess whether age differences in monitoring one’s prior test performance contributed to the age relations on study time allocation.

Regarding the primary goal, consistent with previous research (; ), the correlational analyses revealed that increased age was characterized by poorer utilization of study time in a verbal task, with increased age associated with less consistent allocation of more study time to previously incorrect items. Furthermore, although prior research has only examined study time allocation in verbal tasks, this pattern was also found in a spatial task. Although there is some evidence that verbal and nonverbal memory may rely on different processes (; ), these results suggest that study time allocation may be independent of task type, possibly because effectively utilizing study time relies on similar processes and brain regions regardless of the material modality. Specifically, monitoring and controlling the contents of one’s memory has been shown to rely on the prefrontal cortex (See , for a review), an area that experiences shrinkage with increased age (; ). It is therefore tempting to speculate that older adults are less effective at allocating study time because the regions responsible for carrying out meta-memorial processes decline with age.

With respect to the secondary aim, the results suggest that increased age was not associated with poorer monitoring accuracy of prior performance on the verbal task, although there were age differences in monitoring accuracy in the spatial task. However, it should be noted that in neither tasks was monitoring accuracy correlated with study time utilization. Overall, these results are consistent with  finding that increased age is associated with poorer utilization of study time, but that this is not because they are unaware of their prior test performance. Interestingly, the monitoring probe appeared to interrupt learning, as indicated by poorer performance on recall trials following study trials with probes. Therefore, explicitly having individuals make a decision about their prior performance may disrupt learning when they are restudying information.

While age differences in knowledge about prior performance do not appear to be related to age-related declines in study time allocation, it is possible that age differences in study time allocation may be due to differences in beliefs about memory. There is much evidence to suggest that older adults believe they have less control over their memory (e.g., ), and studies from an educational setting suggest that individuals who believe that they will do poorly on a task may be less likely to plan strategies that will enhance performance (). More recently  found that older adults chose to restudy easier items, suggesting that they might have believed that they could not master the more difficult items. Therefore, differences in beliefs and strategies may contribute to the age relations on study time.

Although the reason(s) for why increased age is associated with poorer study time allocation is not evident in the current project, the results clearly show that how one allocates study time based on prior performance is related to subsequent performance in both a verbal and a spatial task, with study time allocation partially mediating the age relations on recall performance. However, these age relations on study time allocation do not appear to be due to differences in awareness of prior performance. Given the relationship between study time allocation and memory performance it is important to understand just what it is about a person and the learning situation that contributes to being able to successfully allocate study time. This information will be useful not only for research targeting potential aging interventions, but also for the educational field in general.

Acknowledgments

This research was supported by a grant from the National Institute of Aging (NIA R37AG024270) awarded to Timothy A. Salthouse. The study was a part of a dissertation conducted at the University of Virginia. I would like to thank my dissertation committee members Chad Dodson, Daniel Willingham, Jane Crawford, and Timothy Salthouse for their thoughtful suggestions regarding this project. I would especially like to thank Timothy Salthouse for his outstanding mentoring and guidance. Finally, I would also like to acknowledge the research assistants at the Salthouse Cognitive Aging Laboratory for their assistance with the data collection.

Footnotes

1

Participants who used the 8 second maximum on 75% of the study trials were removed from the analyses since these participants were not regulating their study time (i.e., they relied on the computer pacing). This resulted in the removal of six participants from the verbal task and zero participants from the spatial task.

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Article

Stress and academic achievement among distance university students in Spain during the COVID-19 pandemic: age, perceived study time, and the mediating role of academic self-efficacy

Published: 21 June 2024

Volume 39, pages 4275–4295, (2024)

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Stress and academic achievement among distance university students in Spain during the COVID-19 pandemic: age, perceived study time, and the mediating role of academic self-efficacy

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Abstract

The COVID-19 pandemic, and the associated confinement, imposed a novel personal and social context for university students; nevertheless, few studies have addressed the effects of this on distance university students. Indeed, defining the needs of these students under such unique circumstances will allow them to receive the support necessary to effectively reduce their perceived stress and improve their academic achievement. A predictive model was designed to examine the direct effects of the variables’ age and perceived study time on stress and academic achievement in students in an online learning context, as well as to assess the indirect effects through the mediating role of academic self-efficacy. Using path analysis, the model was tested on a sample of 1030 undergraduate students between 18 and 60 years old enrolled on a psychology degree course at the UNED (National Distance Learning University of Spain). The model provides a good fit to the data, confirming the mediating role of academic self-efficacy. Perceived study time is a factor negatively associated with stress and positively with academic achievement. However, it appeared that age was not related to academic achievement, indicating that academic self-efficacy had no mediating effect on these two variables. Academic self-efficacy is a mediator and protective factor in challenging times like the COVID-19 pandemic. These results may contribute to the design of educational and clinical interventions for students at an online learning university over an extended age range.

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Introduction

The COVID-19 pandemic and the associated quarantine measures significantly affected the lives of all individuals in distinct circumstances (Brooks et al., ), as well as the mental health of people of different ages (Justo-Alonso et al., ). Governments implemented different measures to contain the virus and reduce the number of positive cases, such as lockdowns and isolation. In Spain, the period of confinement started on March 15, 2020, and the state of alarm ended on June 21, 2020 (Gobierno de España, , ). Like many other countries, the quarantine measures imposed on the population implied radical changes in lifestyle, with fundamental restrictions on mobility, which had an important impact on the daily activities and psychosocial situation of individuals (Brooks et al., ; Chu et al., ; Rodríguez-Rey et al., ). Indeed, the pandemic and the related restrictions had a significant impact on mental health, inducing uncertainty (Bakioğlu et al., ; Ruiz-Robledillo et al., ), and increasing the levels of stress, anxiety, and depression in individuals of different ages and conditions (González-Sanguino et al., ; Odriozola-González et al., ; Sandín et al., ). Due to the COVID-19 quarantine, universities worldwide announced closures and restrictions on applications, and there was an abrupt transition from in-class lectures to online learning (Ali, ; Centers for Disease Control & Prevention, ). University students and educators have had to adapt quickly to these changes in teaching methodology (Pokhrel & Chhetri, ; Tasso et al., ), using hybrid models or fully online teaching (Faura-Martínez et al., ). These urgent changes led to emergency online learning (Hodges et al., ), which cannot be equated in terms of planning, development, and experience with programs specifically designed to be taught online (Talsma et al., ). Online learning methodology relies on meticulous instructional design and planning, following a systematic model, and it may be considered a different experience from courses offered online in response to a sudden crisis (Hodges et al., ). Indeed, distance university courses taught with online methodology before the COVID-19 outbreak did not change substantially, involving virtual courses, online study materials, and communication forums. However, during the COVID-19 pandemic, face-to-face activities like exams were also cancelled to comply with social distancing measures and they were carried out online (Aristeidou & Cross, ).

Perceived available study time in university students during the COVID-19 restrictions

In university students, the lockdown measures had an impact on the perception of their available study time and their capacity to organize their studies. During the pandemic, many students had to take on new responsibilities within the family, such as caring for family members or working to help financially, which decreased the time they could dedicate to their university work (Keyserlingk et al. ). Previous studies showed that academic demands can generate stress in students, particularly when it becomes difficult to balance study, work, and home commitments (Birbeck et al., ). High levels of uncertainty are associated with academic stress (Clabaugh et al., ), such that a perception of having less time to study can be an additional stressor in students, even in students at online distance universities (Aristeidou & Cross, ). Indeed, a longitudinal study showed that university students who lacked adequate time and energy for study experienced higher levels of psychological distress (Keyserlingk et al. ), suggesting that students may have faced additional challenges during the pandemic and that they may not have had sufficient personal resources to effectively cope with these.

The COVID-19 restrictions may not only negatively influence the psychological health of students but also their academic performance. Changes and uncertainty originating from the COVID-19 restrictions may affect academic achievement, although the true nature of this impact needs to be clarified. Thus, university students’ performance during the spread of COVID-19 might vary depending on the design and objective of the study (Aguilera-Hermida, ). Most studies have focused on face-to-face university students. Indeed, in approximately 50% of university students in a recent survey, the COVID-19 pandemic led to fewer study hours and a decline in their academic performance (Aucejo et al., ). Furthermore, around 10% of the students delayed their graduation, they withdrew from classes, and there was a higher intention to change their studies. Some individuals studied less than usual during this time, although others spent more time studying, depending on their personal circumstances. The amount of time available to study during the COVID-19 restrictions may have depended on several factors. Low income and health problems might affect a student’s available study time (Aucejo et al., ), with the pandemic probably exacerbating the socioeconomic disparities in higher education. Indeed, how life-related difficulties influence the time it takes to complete academic activities in an online learning context has recently been assessed (Aristeidou & Cross, ). Elsewhere, lockdown restrictions were not seen to deteriorate academic grades relative to those before the pandemic, despite having adverse effects on the individual’s life. Enhanced academic performance of students has been reported during the pandemic, for example, among a sample of Spanish students who performed better during the spread of COVID-19 than those in an earlier cohort (González et al., ). In fact, a comparison of academic grades among Spanish university students who completed a face-to-face course before the pandemic and those who completed the same course entirely through distance learning during spring 2020, concurrent with the COVID-19 restrictions, indicated the results achieved were better during emergency online learning (Iglesias-Pradas et al., ). However, these improvements may reflect several issues, such as the use of technology when students shift from face-to-face methods (García-Peñalvo et al., ) or the increase in the time available to study (Liao et al., ).

Time management plays a significant role in successful learning (Aeon et al., ), especially in the distance education context (Neroni et al., ). The time available for study may be a relevant issue if the importance of time management skills in the online learning environment is taken into account (Hodges et al., ). The greater flexibility and autonomy of students in online learning places greater importance on their time management skills (Zhu et al., ). There is evidence that the number of hours dedicated to study is related to academic performance (Bernt & Bugbee, ), and as the COVID-19 restrictions may have provoked changes in the time available for study, the student’s perception of having more or less time to study may have affected their academic achievement. Nevertheless, the impact of the pandemic on the study time available to distance learners has not been addressed to date.

The relationship of age with stress and academic achievement among university students during the COVID-19 restrictions

In general, younger generations appear to be more vulnerable to perceived stress, as reflected in the development of disorders involving anxiety and depression (Mazza et al., ; Nwachukwu et al., ; Wang et al., ). Indeed, these populations have been seen to be more strongly affected by the psychological consequences of the pandemic (Aucejo et al., ; Husky et al., ; Rogowska et al., ), which may in part reflect that they are part of the active workforce, and they might suffer greater economic challenges as a result of business closures (Salari et al., ). The uncertainty and forced isolation associated with the COVID-19 outbreak may have had a negative psychological impact on university students during quarantine (Pedrosa et al., ), who, as emerging adults, are a vulnerable group three times more likely to develop mental health complaints than the general population (Arnett, ; Auerbach et al., ). University students are particularly vulnerable to prolonged situations of stress (Xiong et al., ), and in this regard, the impact of the pandemic on stress in university students has been assessed considering the age of students. When students between 19 and 27 years old were studied at eight universities in Germany, it was not possible to detect differences in the influence of age on mental health or distress (Gewalt et al., ). However, higher mean stress, anxiety, and depression were found during the pandemic among 18–25 years old in Spain (mostly university students), as well as in those who were 26–60 years old, although the average in the three dimensions was lower for those over 60 (Ozamiz-Etxebarria et al., ). This may reflect that younger students cope less effectively with stress due to using fewer active coping strategies than older students, probably because they generally have less life experience and fewer environmental resources (Babicka-Wirkus et al. ; Lopes & Nihei, ). Despite these studies analyzing stress in face-to-face university students during the pandemic, no study has yet emerged on this in the context of distance online education.

In terms of academic achievement, to our knowledge, the influence of age on achievement has not been studied in the context of the pandemic, although there is moderate evidence that older university students obtain higher grades (Richardson et al., ). However, studies have generally focused on students within a limited age range, in particular younger adults studying at face-to-face universities. In the context of online education, fewer studies have analyzed the relationship between student age and academic performance. In a study conducted at a Spanish distance learning university where students are mature individuals (62.6% between 25 and 40 years of age, and 34.5% aged from 41 to 55), the older students are more confident in their learning abilities, which in turn leads to better academic performance (Castillo-Merino & Serradell-Lopéz, ). However, in another study also conducted at a Spanish online university with 21- to 70-year-old subjects, younger students obtained better academic achievement (Bravo-Agapito et al., ). Indeed, a recent systematic review highlighted that the relationship between the age of students at distance online universities and academic performance is unclear, suggesting that other factors like academic self-efficacy may have greater importance (Chung et al., ).

The mediational role of academic self-efficacy

Self-efficacy theory refers to beliefs about one’s capabilities to perform or learn a specific task at designated levels (Bandura, ). Self-efficacy can be considered an essential factor related to motivation and the regulation of students learning, with effects on academic performance (Bandura, ). Academic self-efficacy is associated with self-regulated learning, and it helps students to accomplish long-term tasks through the use of self-regulation strategies like self-monitoring, self-evaluation, goal setting, and planning (Zimmerman et al., ). For decades, evidence supports the idea that self-efficacy can influence the outcomes of achievement-related actions (Zimmerman, ). Students with strong self-efficacy have good learning self-regulation skills and the necessary strategies to regulate behaviour at the time of learning (Schunk & Pajares, ). These students feel more efficacious about their learning, adopting more adaptive behaviours, they work harder, they persevere in difficult times, and their academic achievements are better (Schunk & Pajares, ). Academic self-efficacy stands out as a dynamic factor that evolves with learning, given that students bring different levels of self-efficacy to learning scenarios, and as they engage in a task, performance cues are received and used to assess their progress, and they reinforce their self-efficacy for ongoing learning. This perceived advancement fuels motivation and fosters sustained learning (Schunk, ), underlining the crucial role of academic self-efficacy in the learning process.

Self-efficacy is not an inherent trait but, rather, it is a cognitive construct shaped by various information sources (Schunk & DiBenedetto, ). These sources encompass vicarious experiences, social persuasion, and physiological and emotional indicators, as well as enactive mastery experiences (Usher & Pajares, ). Information about self-efficacy derived from the four aforementioned sources does not directly affect self-efficacy, as it undergoes cognitive appraisal (Bandura, ). During this appraisal, individuals assess and integrate various personal and situational factors, such as task difficulty or the effort expended (Schunk ). The basis for these interpretations resides in the information individuals choose, and the rules they apply to weigh and combine this information. Indeed, the individuals’ interpretations based on their actions and achievements supply the data that shapes their self-efficacy. In higher education, researchers began to examine the potency of these sources by investigating the possible situational and instructional factors in educational contexts that affect a students’ self-efficacy, demonstrating that several factors appeared to influence this phenomenon (van Dinther et al., ).

In analyzing its relationship with age, academic self-efficacy can change in different stages of life. Although the precision of academic self-efficacy in children increases with age, it declines as they progress in the educational system, during adolescence and early adulthood (Shunk & DiBenedetto, ). The relationship between self-efficacy and academic achievement is reciprocal in adults while unidirectional in children. This can be attributed to the fact that adults, with their advanced cognitive development and extensive educational background, can form distinct and notably accurate evaluations of past performance results or anticipated task complexities, leading to variations in self-efficacy levels (Talsma et al., ). Earlier studies showed that academic self-efficacy can buffer perceived stress in university students (Pierceall & Keim, ; Zajacova et al., ). Indeed, the self‐efficacy underlying self‐regulation had a protective effect against the increase in students’ stress after the outbreak of COVID‐19, where stress was linked to procrastination (Keyserlingk et al., ).

Considering the dynamic nature of academic self-efficacy, it was hypothesized that the uncertainty in the context of the COVID-19 pandemic, and especially the moment of confinement, could have affected the self-efficacy beliefs associated with university students’ learning (Alemany-Arrebola et al., ). The psychological pressure of confinement combined with academic demands was proposed as a possible explanation for this phenomenon, and possible changes in academic self-efficacy due to confinement were measured in a longitudinal study of 414 students on a face-to-face university course (Wolniak & Burman, ). However, this study showed how academic self-efficacy was enhanced during confinement, such that the student’s sense of agency was thought to be stimulated amid the overall disruption brought on by the pandemic. Self-efficacy and academic grades were compared in university students in the age range from 18 to 51 (average of 23.5 years old) before and after COVID-19 (Talsma et al., ). Moreover, how a students’ perception of COVID-19 predicted academic performance outcomes, both directly and indirectly, was also studied, particularly through the influence on self-efficacy beliefs. As postulated by Bandura’s social cognitive theory (), students’ academic performance may be affected by modifications to their academic self-efficacy, which can occur through the influence of environmental factors. Individuals utilize their personal feelings of excitement, uncertainty, worry, stress, and exhaustion as indicators of their own effectiveness (Usher and Pajares, ). Feelings of calm can boost self-belief, while negative emotions related to academic tasks can weaken beliefs about one’s ability, lowering performance expectations (Bandura, ). Talsma et al. () consider how the emotional states generated during the pandemic could be identified as an influence on self-efficacy beliefs. To test this hypothesis, participants were asked to specify what effect they thought COVID-19-related changes to their university context would have on their ability to perform in their studies. The results of this study showed that students’ beliefs about the impact of COVID-19 on their ability did not predict either their grades or self-efficacy, where self-efficacy was found to be the only significant predictor of students’ grades. However, another measure could have been used to assess the perceptions related to COVID-19, such as the student’s dedication to study during the pandemic (Talsma et al., ). It was proposed that this measure, which refers to the time available for study, may influence academic performance. Hence, the reduction in social activities or the unemployment/underemployment associated with the COVID-19 pandemic could have led to more time being available for study, as pointed out previously (Aucejo et al., ).

While has been established that self-efficacy plays a crucial role in the academic performance of university students (Schunk & Pajares, ), more research is needed to analyze this relationship in online learning environments, and to fully understand the factors that influence such connections. Self-efficacy is especially relevant in the context of online distance education, as students must assume a greater degree of responsibility in planning and organizing their own learning (González-Benito et al., ). In this context, self-efficacy has been linked to better academic outcomes and greater adaptation to the distance learning modality (Zimmerman & Kulikowich, ). A meta-analysis demonstrated that academic self-efficacy tended to correlate with academic performance in the online learning environment in similar manner to that found in a general learning environment (Yokoyama, ). However, differences were also identified, such that specific characteristics of online learning environments may affect this correlation, like the familiarity with online learning devices and the value of tasks in online learning software. In addition, it is important to note that in online education contexts, academic self-efficacy is related to factors like time management (Zimmerman & Kulikowich, ). In learning situations characterized by an online teaching methodology, it is of utmost importance that students manage their time adequately, as they must know how to organize and study autonomously (Broadbent, ). For example, these students must organize their assignments, taking into account the management of virtual platforms that may require additional time and cause unforeseen events in terms of respecting deadlines. Moreover, if these analyses in the context of distance learning are carried out in difficult times like the COVID-19 pandemic, they could contribute to further defining the benefits of academic self-efficacy in an online teaching/learning scenario that is increasingly common in today’s world.

The current study

In this study, we assume that online learning methodology remained substantially unchanged during the COVID-19 restrictions. However, the pandemic did constitute a new personal and social context for students from online universities, probably changing factors like the time available for study that could in turn have repercussions on stress and academic achievement. In this regard, a student who perceives they have little time for study in a context such as that generated by confinement could feel further pressure regarding their academic work, apart from having the usual tasks and difficulties related to studying in a university context (such as having to submit tasks on time). Hence, here we examined the variable perceived study time for students at an online university and its relationship with both stress and academic achievement.

Factors like age and the relationship between stress and academic achievement have been little explored in online students. In the context of the UNED (National University of Distance Education of Spain), we can analyze a wide age range (18–60 years) of students, and more comprehensively explore to what extent age can predict stress and academic grades during a pandemic. This provided us with a privileged context to analyze how psychological maturity affects the affective-academic variables indicated. Finally, we consider it important to analyze the variable academic self-efficacy in students at an online university during the pandemic. We explored the mediating role of academic self-efficacy as a mechanism that students of various ages would use to confront the new situation, and as a factor that explains the perceived stress and academic achievement. Furthermore, perceiving a change in the availability of time may require an adaptation and adjustment in the planning of a task, where academic self-efficacy plays an important role since it expresses motivational beliefs that can influence the student’s work. Limited research has focused on how the exceptional circumstances of COVID-19 might influence the self-efficacy beliefs of university students, and our study has the added value of analyzing this aspect in the context of distance online education.

In the current study, employing an ex post facto and cross-sectional design, we aim to undertake a global analysis of all these factors and based on the existing literature, we propose a predictive model (Fig. ) to examine the direct effects of the variables’ age and perceived study time on both stress and academic achievement, as well as their indirect effects through the mediating academic self-efficacy.

Fig. 1

Predictive model proposed for the global analysis of the variables studied

As a result, we formulated the following hypothesis:

Hypothesis 1: The perceived study time is positively related to both academic self-efficacy and academic achievement (H1a), and negatively associated with stress (H1b).

Hypothesis 2: Age is positively related to both academic self-efficacy (H2a) and academic achievement (H2b), and negatively associated with stress (H2c).

Hypothesis 3: Academic self-efficacy is negatively associated with stress (H3a) and it is positively related to academic achievement (H3b).

Hypothesis 4: Age and perceived study time have an indirect effect on both stress and academic achievement, with academic self-efficacy acting as a mediating variable.

Methods

Participants

The total sample consisted of 1030 undergraduate psychology students at the UNED, of whom 267 (25.9%) were male and 763 (74.1%) were females. The age ranged from 18 to 60 years (M = 35.11, SD = 10.89). In relation to marital status, 541 (52.5%) of the sample was married or with a stable partner, 421 (40.9%) were single, 61 (5.9%) were separated or divorced, and 7 (0.7%) were widowed. In terms of employment, 638 (61.9%) subjects in the sample were employed and 392 (38.1%) unemployed.

Measures

Sociodemographic data was obtained through a brief questionnaire specifically designed for this study: age, gender, marital status, and employment situation.

Perceived study time was measured with an item established ad hoc and evaluated using a 5-point Likert scale. It assessed how the changes brought about by the pandemic were perceived to affect the time available for study. In particular, the participants were asked whether the time spent studying had decreased or increased since the confinement because of the pandemic: 1 = significantly decreased, 2 = somewhat decreased, 3 = neither decreased nor increased, 4 = somewhat increased, and 5 = significantly increased.

Academic self-efficacy was assessed using the School Self-Efficacy Scale (Pastorelli & Picconi, ), which was translated and adapted to Spanish, and then back-translated to ensure the accuracy of the translation. Two bilingual experts were involved in obtaining the Spanish version and translating it back into Italian, as well as in correcting any discrepancies between the two versions. After adaptation to a distance learning university context, perceived self-efficacy in performing specific academic tasks and achieving educational goals was measured with ten items, each evaluated on a 5-point Likert scale ranging from 1 = not at all good to 5 = very good (e.g. ‘carry out research or assigned tasks by independently consulting material that you can find at home, in the library and on the Internet’ or ‘prepare for several exams at the same time’). The total score for this scale ranges from 10 to 50 points. The original scale was shown to have high internal consistency, with a Cronbach’s alpha coefficient ranging from 0.83 to 0.86 depending on the subject. In the present study, this coefficient was 0.85.

The Perceived Stress Scale (PSS: Cohen et al., ; Spanish adaptation by Remor, ) was used to assess the variable stress. This scale is a self-report instrument that evaluates the level of perceived stress over the last month, assessing 14 items with a 5-point Likert scale: 0 = never, 1 = almost never, 2 = sometimes, 3 = often, 4 = very often (e.g. ‘In the last month, how often have you been upset because of something that happened unexpectedly’). The total score ranged from 0 to 56 points, which was obtained by summing the scores for all the items of the scale, and a higher score indicates more perceived stress. However, the PSS is not a diagnostic instrument and thus, there are no cutoffs to classify ‘high’, ‘medium’, or ‘low’ stress (Cohen et al. ). The internal consistency of the original scale (measured by Cronbach’s alpha) was 0.81 and here this was 0.90.

Academic achievement was assessed through the grade point average (GPA) obtained by the participants in the examined subjects they took in the second semester of the course. This information was collected from the administration of the Faculty of Psychology, with the scores for each subject ranging from 0 to 10 points. The subjects examined were all worth 6 ECTS (European Credit Transfer and Accumulation System), where one ECTS is equivalent to 25 h of study in Spain.

Procedure

Psychology students at UNED were recruited following a structured protocol, which involved inviting them to participate in the study through direct messages and the forums associated with the Psychology courses themselves. Interested individuals who wished to take part in the study contacted the research team and after the nature and aims of the research was explained to them, each participant was asked to provide their consent to participate as a prior requisite for their enrolment onto the study.

The data was collected in May 2020 using the Qualtrics tool (), through which the participants accessed the questionnaires and scales used. The participants took approximately 20–25 min to complete the questionnaires and all the students were surveyed in their second semester. The data was collected before the second-semester exams, which took place in June 2020. Data regarding academic achievement was obtained from the grades achieved in the same month of June. It is important to note that the lockdown in Spain began on March 12th and that the first-semester exams at the UNED ended in mid-February, so students experienced the effects of lockdown for almost the entire second-semester. This allowed them to focus their perceptions regarding their dedication to their studies only on this particularly complex period. A total of 1081 students enrolled onto the study but after excluding the participants who did not complete all the questionnaires, a final sample of 1030 participants was obtained. Participation was voluntary and but there was an incentive as the participants received one ECTS credit for completing the survey. The protocol was approved by the Ethics Committee at the UNED.

Data analysis

A preliminary analysis was carried out to test the assumptions of multivariate normality and to identify any outliers in the sample before examining the structural model. Multivariate normality was confirmed using Mardia’s () multivariate kurtosis coefficient, which was − 2.15. A critical kurtosis ratio < 5.0 demonstrates multivariate normality (Bentler, ). No multivariate outliers were found after calculating the Mahalanobis’ distance.

Descriptive statistics were calculated, including means and standard deviations, and Pearson’s correlations were examined to explore the relationships between the variables studied. This analysis was performed using SPSS 25.0 and a path analysis using maximum likelihood was then performed using AMOS 25.0 software (Arbuckle, ).

Several indices and goodness-of-fit criteria were used to evaluate the overall fit of the model, as recommended (Hu & Bentler, ; Kline, ): a normed chi-square (χ2/df < 3 acceptable and < 2 excellent); a comparative fit index (CFI > 0.90 acceptable and > 0.95 excellent); a normed fit index (NFI > 0.90 acceptable and > 0.95 excellent); standard root mean square residual (SRMR < 0.08 acceptable and < 0.05 good); and root mean square error of approximation (RMSEA < 0.08 acceptable and < 0.06 good). Finally, we evaluated the mediating effects using a bootstrapping method as recommended (Cheung & Lau, ), with 5000 bootstrap samples and 95% bias-corrected confidence intervals (CI). The mediation effect is considered statistically significant at the level of α = 0.05 if the CI does not include 0, showing an indirect effect (Shrout & Bolger, ).

Results

Descriptive analysis and correlations

The descriptive statistics, including the means, standard deviations, and the Pearson’s correlation coefficients, was calculated for all the study variables (Table ).

Table 1 Means (M), standard deviations (SD), and Pearson correlation coefficients between the variables studied (n = 1030)

The mean score for academic self-efficacy was statistically significantly higher than the midpoint of the scale (M = 37.68, midpoint = 30, t(1029) = 41.1, p < 0.001), and the same was true for academic achievement (M = 6.7, midpoint = 5, t(1029) = 29.22, p < 0.001). These results suggest that the participants generally had relatively high levels of both academic self-efficacy and academic achievement during the lockdown period. In contrast, the mean scores for perceived study time were statistically significantly below the midpoint of the scale (M = 2.15, midpoint = 2.5, t(1029) =  − 9.49, p < 0.001), and the same was true for stress (M = 25.80, midpoint = 28, t(1029) =  − 7.71, p < 0.001). These results suggest that, on average, the participants believed they spent less time studying and experienced lower levels of stress during the lockdown.

All the variables were significantly correlated in the directions predicted. Age and perceived study time were negatively correlated with stress, yet positively associated with academic self-efficacy and academic achievement. In turn, academic self-efficacy was negatively related to stress, while there were no significant associations between academic achievement and either age or stress.

Model testing and mediation analysis

The path analysis revealed that the model proposed showed a good fit to the data: χ2 /df = 0.28, CFI = 1.000, NFI = 0.999, SRMR = 0.0043, and RMSEA = 0.000. The path coefficients represented in Fig.  were all statistically significant.

Fig. 2

Standardized path coefficients among variables

Specifically, age predicted both academic self-efficacy (β = 0.11, p = 0.000) and stress (β =  − 0.27, p = 0.000), yet age was not a predictor of academic achievement. In turn, perceived study time was a predictor of the three variables academic self-efficacy (β = 0.20, p = 0.000), stress (β =  − 0.19, p = 0.000), and academic achievement (β = 0.10, p < 0.01). Finally, academic self-efficacy predicts stress (β =  − 0.33, p = 0.000) and academic achievement (β = 0.16, p = 0.000).

We examined the mediating role of academic self-efficacy to the extent that it could account for the relationship between the predictors (age and perceived study time) and the criteria stress or academic achievement. The findings indicated that age was not related to academic achievement as it did not satisfy one of the four conditions necessary to find a mediation effect (Baron & Kenny, ). Hence, only three path mediations were examined (see Table ).

Table 2 Results of mediation analysis

According to the results, age had a direct effect on stress, as well as an indirect effect through academic self-efficacy. In turn, perceived study time had a direct effect on both outcome variables (stress and academic achievement) and an indirect effect through academic self-efficacy. We evaluated if the direct β value without a mediator diminishes when the mediator is included (Table ), a condition that is satisfied in the three paths examined (partial mediation). Finally, the bootstrapping method shows that the mediation effect is considered statistically significant at the level of α = 0.05 because the CI does not include zero.

Discussion

The main purpose of this study was to test the model proposed in the context of a distance university during the COVID-19 pandemic. The research adopted a multidimensional approach, examining by analysis path of the direct relationships between age and perceived study time with both stress and academic achievement, as well as the indirect effects through academic self-efficacy and their mediating role in the model. The fit of the empirical model allowed us to confirm our proposed predictive hypotheses. We found only one exception: age was not a predictor of academic achievement, and therefore there was no mediating effect of academic self-efficacy between these two variables.

Very few studies have examined the variables studied here in the context of an online university and we found none did so from a multidimensional perspective at the time of the pandemic. Students at a national distance university like the UNED are characterized by their wide age range and distinct personal situations (Johnson, ), and they were using online methodology even prior to the Covid-19 pandemic. Online education implies an organizational infrastructure aligned with the goals of remote teaching and learning, and it is not a methodology applied temporarily (Fuchs, ).

The pandemic outbreak may have negatively affected university students’ mental health, exposing them to stress (Liyanage et al., ; Tasso et al., ). Here, a negative relationship between age and stress (H2c) was defined, although during the pandemic outbreak older students report lower levels of stress than younger students. This is consistent with findings in the general population (Justo-Alonso et al., ; Rodriguez-Rey et el., ) and in a traditional university setting that was forced to adopt a remote learning model during the pandemic, both environments in which students between the ages of 18 and 24 typically suffer more distress than older students (Browning et al., ; Prowse et al., ).

The findings of this study shed light on the stress levels among university students attending an online distance university. In our study, participants experienced low stress levels. However, it’s important to note that 75% of the participants are over 25 years old. These results align with the Spanish research by Ozamiz-Etxebarria et al. (), where participants aged 18 to 25, predominantly university students, demonstrated higher stress levels than individuals aged 26 to 60. The isolation provoked by the COVID-19 lockdown had a negative impact on stress in younger students even though their study methodology did not undergo significant changes, unlike those at other universities. There may be multiple reasons underlying these results. In a study into the psychological impacts of COVID-19 among 2534 university students in the USA, younger students appeared to be more concerned about their future education and college expenses than older students (Browning et al., ). Moreover, as the pandemic dominated the news, younger people may be exposed to more messages of the increased risk that had a negative impact on mental health, given that young people use social media more frequently than older people. This finding may also reflect the need of younger students for more life experience, resources, and strategies to cope effectively with stress (Babicka-Wirkus et al., ).

Alternatively, the personal and social situations experienced during the pandemic may also have affected the student’s perception of the time available for study. Our research examines this issue by asking students whether the time they had available for study increased, stayed the same, or decreased during the pandemic. The participants reported perceiving less time to dedicate to their studies, probably because during lockdown, students in an online context may have life-related difficulties that influence the time it takes to complete academic activities (Aristeidou & Cross, ). We found that the perceived study time had a significant relationship with stress (H1b), so students who perceived that their study time was reduced during the pandemic had higher stress levels. The situation may exceed the student’s resources to cope with this in terms of completing academic tasks, studying course content, and acquiring sufficient knowledge to pass exams. Conversely, those who perceived their study time had increased had lower levels of stress, probably because they perceived they had the time to manage and control the situation. Therefore, a reduction in the perceived study time available may be a significant stressor. Indeed, university students who consider time as a scarce resource are more likely to perceive stress. For example, a meta-analysis into time management and stress associated with academic failure in medical students showed that students who must cope with an intensive training curriculum with activities to be performed in limited time can have significant problems using their time efficiently. Strong time-related demands, such as higher workloads, time pressure, and regulation of self-study, may be a source of perceived stress, especially for less experienced students (Ahmady et al., ).

In addition to these direct effects, we proposed in the model that age and perceived study time indirectly affect stress through academic self-efficacy (H4). Self-efficacy is the students’ confidence in selecting and applying the self-regulated strategies required to achieve academic success (Zimmerman & Martinez-Pons, ). The theory of self-regulated learning has shown to be a good framework to explain the performance and success of students at online universities (Broadbent & Poon, ; Lynch & Dembo, ). Academic self-regulation was defined as the extent to which learners are meta-cognitively, motivationally, and behaviourally active in achieving their learning goals (Zimmerman, ). In the context of a distance university, students are more autonomous than in a traditional university (Broadbent, ) and they feel more responsible for their academic performance. In our study, participants have high academic self-efficacy, which could be explained by considering that they are all adults with a sense of agency stimulated by the situation generated by the pandemic (Talsma et al., ; Wolniak & Burman, ). One of the important findings of this study was the mediating role that academic self-efficacy plays in the model proposed (H4). Age is positively related to academic self-efficacy (H2a), such that older students have more academic self-efficacy. In online learning, autoregulatory skills like independent time management and self-monitoring are still developing in the age range of 18 to 25 years (Murray et al., ), and these young adults are still dependent on co-regulation by parents or teachers. Older students have more experience than younger ones, and better defined academic strengths and weaknesses, establishing a better basis for making accurate self-efficacy appraisals (Multon et al., ). Student age is also an important variable, with older students more likely to use discussion boards, and they tend to achieve better grades in online courses (Alstete & Beutell, ). This suggests that younger students may need more time to be ready for the self-directed and self-disciplined nature of online courses, and they may need more support from instructors regarding the online format. Our study also found that academic self-efficacy was negatively related to stress (H3a), an outcome consistent with the finding that students with low levels of self-efficacy suffer more stress (Navarro-Mateu et al., ). Self-efficacy and self-regulation can have a protective effect against the increase in stress of students during the lockdown in the spring of 2020 (Keyserlingk et al. ). One explanation is that students confident in their ability to learn perceived the situation created by the pandemic as less threatening and therefore they experienced less stress.

Regarding academic achievement, while a positive association with self-efficacy was found (H3b), there was no significant association with age (H2b), indicating that academic self-efficacy does not mediate between age and academic achievement (H4). Age is independent of performance in terms of the academic grades obtained by these students during the pandemic, which is consistent with other studies that failed to find an association between age and academic performance in students at distance universities. In a study performed on distance university students of different age ranges, older students study for longer than young students and they better use learning strategies, although age did not affect academic performance (Neroni et al., ). These results were also confirmed in studies that considered traditional students. An extensive review of academic achievement and correlates showed older students obtained higher grades (Richardson et al., ), yet these effects were small except for the large correlation observed between performance and self-efficacy.

The hypothesis about the mediating role of academic self-efficacy between perceived study time and academic achievement was confirmed (H4). Our results show that perceived study time is directly and positively related to academic achievement. In this sense, students who perceive they have less time to study also perform worse academically. These results highlight the importance of considering students’ perceptions of time and their self-beliefs in relation to their academic performance. In a distance theory framework, autonomy was proposed to be based on distance learners’ ability to control their learning (Moore, ). In this sense, previous studies suggested that effectively managing learning time is relevant to distance learner success. Time management and effort were the most important and positive predictors of academic performance in students from a distance university (Broadbent, ; Neroni et al., ). This also seems to be the case in times of the pandemic, indicating that the perception of having less or more time to study directly affects academic performance in a negative or positive manner, respectively. Moreover, our study confirms the existence of an indirect effect, revealing that students who perceive having less study time also exhibit lower levels of academic self-efficacy. This suggests that having less time to study negatively affects academic self-efficacy or belief about their ability to complete academic tasks. In turn, self-perception of ability and competence to perform a specific task is significantly related to academic achievement, as seen elsewhere (Ahmady et al. ).

Limitations

Our research has some limitations that must be borne in mind. The study adopted a cross-sectional design with limited causal relationships between the study variables. Hence, future longitudinal research should be conducted to establish robust casual relationships. Furthermore, given the complexity of the issue, other educational (e.g. learning strategies related to self-regulation or different learning technology) or sociodemographic variables (e.g. family income) could be explored in the future to determine their effect on the proposed model of stress and academic achievement in an online learning university. High levels of stress among students are worrying as it affects their mental well-being; hence, the mediating role of academic self-efficacy in difficult times like the pandemic is an important fact that needs to be explored in later studies. On the other hand, we need to know more about the factors that influence self-efficacy in online university learning, and whether these factors might influence the relationship between self-efficacy and academic performance.

Practical implications

Despite these limitations, the current study has practical implications for educational and clinical interventions used with online learning university students over different age ranges. In a difficult period, like the pandemic lockdown, perceiving less study time may be a negative factor for students, with a negative impact on both stress and academic achievement. We suggest that students who perceive they have less time need to develop more effective time management skills, such as setting practical goals, prioritizing tasks, and taking regular breaks to recharge. Therefore, educators may take these needs into account to help students succeed academically. We believe that teaching practical strategies in the context of online learning may be helpful and it is a possibility that should be carefully explored. Indeed, further research could explore programmes aimed at achieving this. Furthermore, it is worth noting that high academic self-efficacy is a valuable attribute for students, providing a protective factor against stress and yielding positive effects on academic achievement, even in challenging circumstances like the COVID-19 lockdown. In the light of this evidence, it would be beneficial to develop targeted interventions that specifically address the needs of online learning students with weak self-efficacy.

In conclusion, it is essential to recognize the importance of tailoring interventions to meet the specific needs and circumstances of individual students in online learning. By incorporating evidence-based practices that promote self-efficacy, educational institutions can better support students to build resilience, reduce stress, and achieve academic success in the face of challenging situations like the COVID-19 lockdown.

Data availability

The data from the current study is available upon request to the corresponding author, as deemed reasonable.

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Funding

Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature.

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All authors of the manuscript participated in the different phases and tasks of manuscript preparation. That is, they contributed to the conception and design, data acquisition, data analysis and interpretation, and revision of the article, and they approved the final version submitted for publication.

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Ethics declarations

Ethical approval

The study was reviewed and approved by the Ethics Committee of the National Distance Education University (UNED). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.S

Competing interests

The authors declare no competing interests.

Additional information

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Current themes of research:

Emilia Cabras. Academic achievement; teaching–learning processes in university students with online teaching; self-efficacy. Faculty of Education, Universidad Alfonso X El Sabio, Madrid, Spain.

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About this article

Cite this article

AGE linked with OUTFIT :

While there are no strict rules dictating what women of certain ages should wear, societal expectations often influence clothing choices as women age. These expectations, combined with personal preferences and physical changes, shape how women approach fashion at different stages of life.

Factors Influencing Outfit Choices:

Societal Norms and Expectations:

Age-related stereotypes can dictate what is considered "appropriate" or "inappropriate" for different age groups. For example, older women may be expected to dress more conservatively, with darker colors and more coverage, while younger women may be encouraged to experiment with trends and bolder styles.

Personal Style and Self-Expression:

Ultimately, women can choose to embrace or reject these expectations and dress in ways that reflect their personal style and identity.

Physical Changes:

As women age, their bodies change, and they may find that certain styles are no longer as comfortable or flattering as they once were.

Lifestyle and Activities:

A woman's lifestyle and daily activities also play a role in her clothing choices. A professional woman may opt for more formal attire during work hours, while a woman who enjoys outdoor activities may prefer comfortable, practical clothing.

Comfort and Confidence:

Many women find that as they age, they prioritize comfort and confidence over strict adherence to fashion trends.

General Trends:

Younger women:

May experiment more with current trends, bold colors, and shorter hemlines.

Middle-aged women:

May gravitate towards classic styles and pieces that are both fashionable and practical.

Older women:

May opt for comfortable, well-fitting clothing with a focus on quality and timeless style.

Breaking Stereotypes:

It's important to remember that these are just general trends, and women of all ages can choose to dress in any style that makes them feel confident and comfortable. There are no rules about what women "should" wear based on their age, and many women are actively challenging these stereotypes by embracing their personal style at any age.

In conclusion, while age can influence clothing choices, it's ultimately up to each individual woman to decide how she wants to express herself through fashion. There's no one-size-fits-all approach, and women can choose to embrace or reject societal expectations based on their personal preferences and comfort.

AGE linked with MUSIC :

Age significantly influences musical preferences for women, with younger women showing a greater tendency to listen to and identify with female artists, while older women may have a broader range of preferences influenced by their formative years. Musical tastes generally solidify around the late teens and early twenties, with individuals often preferring music released during that period of their lives. However, preferences can continue to evolve throughout adulthood, influenced by social contexts and personal experiences.

Here's a more detailed breakdown:

Younger women (18-34) are more likely to listen to and feel connected with female artists.

32% of women in this age group primarily listen to female artists, compared to 19% of women aged 35-54 and 7% of women aged 55 and older. This suggests a strong preference for representation and identification with artists who share their demographic.

Musical tastes tend to solidify in late adolescence and early adulthood.

Research indicates that individuals tend to prefer music released during their late teens and early twenties. This period, often referred to as "song-specific age," significantly shapes musical preferences.

Age-related changes in musical taste are influenced by social contexts.

Social interactions, cultural trends, and personal experiences all play a role in shaping musical preferences throughout life.

Older adults may experience a shift in their emotional response to music.

Research has shown that older adults may have a greater emotional response to happy music and a decreased response to sad or scary music.

Music can be a powerful tool for motivation and social connection.

Music can be a source of motivation and a way to connect with others, regardless of age.

While age influences preferences, it's not the sole determinant.

Individual tastes can vary widely, and people may enjoy music from different eras and genres throughout their lives.

Music listening habits can change over time.

People may listen to music in different contexts (e.g., at home, at work, while relaxing) at different stages of life.

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Front Psychol

. 2013 Oct 16;4:711. doi:

Age-related differences in affective responses to and memory for emotions conveyed by music: a cross-sectional study

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Article notes

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PMCID: PMC3797547  PMID:

Abstract

There is mounting evidence that aging is associated with the maintenance of positive affect and the decrease of negative affect to ensure emotion regulation goals. Previous empirical studies have primarily focused on a visual or autobiographical form of emotion communication. To date, little investigation has been done on musical emotions. The few studies that have addressed aging and emotions in music were mainly interested in emotion recognition, thus leaving unexplored the question of how aging may influence emotional responses to and memory for emotions conveyed by music. In the present study, eighteen older (60–84 years) and eighteen younger (19–24 years) listeners were asked to evaluate the strength of their experienced emotion on happy, peaceful, sad, and scary musical excerpts (Vieillard et al., ) while facial muscle activity was recorded. Participants then performed an incidental recognition task followed by a task in which they judged to what extent they experienced happiness, peacefulness, sadness, and fear when listening to music. Compared to younger adults, older adults (a) reported a stronger emotional reactivity for happiness than other emotion categories, (b) showed an increased zygomatic activity for scary stimuli, (c) were more likely to falsely recognize happy music, and (d) showed a decrease in their responsiveness to sad and scary music. These results are in line with previous findings and extend them to emotion experience and memory recognition, corroborating the view of age-related changes in emotional responses to music in a positive direction away from negativity.

Keywords: aging, musical emotions, emotional responses, facial muscle activity, incidental recognition, positivity effect

Introduction

Research on age differences in emotion processing has been mostly restricted to visual stimuli (e.g., facial expression, video, words, and pictures) but a growing body of research converges in indicating that music also serves as a powerful emotional trigger. For example, Blood et al. () have shown that classical musical stimuli which are selected to elicit intensely pleasant emotional responses engage neural networks that are implicated in reward. Neuropsychological studies have also demonstrated that the amygdala is recruited when processing scary music (e.g., Gosselin et al., , ). Physiological data have also put in evidence that music is a strong emotion inducer (e.g., Khalfa et al., ). Furthermore, music has the clear advantage of maintaining attention toward the emotions conveyed because it does not allow perceptual attention to be redirected (except if the listener takes off his/her headphones). For these reasons, music appears as a viable method to test age-related changes in emotion processing.

Among the past studies that have addressed the question of age-related changes in musical emotion processing, most of them have focused on the people's ability to recognize musical emotions (Allen and Brosgole, ; Laukka and Juslin, ; Drapeau et al., ; van Tricht et al., ; Lima and Castro, ; Vieillard et al., ). For instance, Drapeau et al. () compared healthy elderly adults and elderly adults with Alzheimer's disease in their ability to rate the extent to which the selected musical stimuli communicating happiness, peacefulness, sadness and fear (Vieillard et al., ) expressed each of these four emotions. Their findings showed that recognition performances of healthy older adults were relatively preserved with the highest recognition accuracy for happy stimuli. Laukka and Juslin () compared young and older adults' ability to recognize anger, fear, happiness, sadness, and neutrality in short melodies performed on an electric guitar with different degrees of expressivity. In their study, the participants judged the emotional expression of each stimulus in a forced choice task comprised of anger, fear, happiness, sadness, neutral, and “other emotion” alternatives. Compared to young adults, older adults were less accurate in recognizing negative emotions such as sadness and fear, but their ability to recognize other emotion categories was spared. More recently, Lima and Castro () went one step further by examining age-related changes in emotion recognition among three age groups of participants (i.e., young, middle-aged, and old). Selecting the same musical excerpts as those used in Drapeau et al. ()'s study, the authors asked the participants to judge the emotional intensity perceived for each stimulus on four rating scales (i.e., happiness, sadness, peacefulness, and fear) presented simultaneously. Consistent with previous findings, the authors found an emotion-specific age-related change characterized by a stable recognition of happiness and peacefulness categories but a gradual decline in responsiveness to sad and scary music from young adulthood to older age.

As an alternative to the hypotheses of age-related differences in cognitive functioning or hearing loss, the above findings have been interpreted as being the result of a combination of age-related changes in brain structure and functioning and in motivational goals. On the one hand, empirical evidence suggest that the observed decline found in older adults in negative emotion recognition may be the result of a linear reduction in the volume of the amygdala (e.g., Zimmerman et al., ) and/or of a decrease of the reactivity to negative information in the amygdala (e.g., Mather et al., ). On the other hand, Socioemotional Selectivity Theory (Carstensen et al., ; Carstensen, ) suggests that the decline in the recognition of negative emotions would reflect a motivational shift toward emotionally meaningful goals due to an increased awareness of the limited perspective of time. This so-called “positivity effect” which refers to all combinations of enhanced processing of positive information and reduced processing of negative information, has been thought of as an emotion regulation strategy to preserve high levels of well-being in later life. In a recent literature review, Reed and Carstensen () showed that this positivity effect (1) requires cognitive resources (e.g., Mather and Knight, ), (2) is sensitive to the experimental context (Kensinger et al., ; Grühn et al., ), and (3) is adaptive, i.e., it emerges when emotional well-being is prioritized. Consequently, the authors claimed that the positivity effect would represent a controlled shift in attentional resources rather than an automatic process associated with the neuronal degeneration in brain regions. Such view is compatible with the idea that the positivity effect may have a cognitive counterpart.

Recently, Vieillard et al. () conducted a study in order to test for age-related differences in the psychological structure of musical emotions, and to assess whether these changes may be associated with a decrease in emotional complexity. In this research, younger and older participants were presented with musical excerpts conveying different emotions such as happiness, peacefulness, sadness, and fear (Vieillard et al., ). Participants were asked to perform an emotional judgment task using different rating scales (i.e., valence, hedonic value, arousal, and liking) as well as a free categorization task in which they freely created emotional categories based on the perceived acoustical cues. Findings showed age-related differences characterized by a reduced processing of arousal for scary music, an increased focus on happy music, and an emotional dedifferentiation corresponding to a decrease in differentiation between the arousal and valence dimensions. Such results have been explained within the framework of the Dynamic Integration Theory (Labouvie-Vief, ; Labouvie-Vief et al., ) postulating that the degradation of emotional complexity would be the cognitive counterpart of the older adults' attempt to maximize positive affects and minimize negative affect in order to preserve well-being.

In short, the studies reviewed above show converging evidence for a positivity effect in how emotions in music are perceived, categorized, and recognized with advancing age. However, several questions remain open. First, little is known about age-related changes regarding the emotions experienced while listening to music. Previous findings have suggested that participants were more accurate in their judgment of intended emotions in musical excerpts when focusing on their own emotional experience (Vieillard et al., ). One of the goals of the present study was thus to investigate the influence of aging on emotion processing while being personally engaged in musical listening. This is an important question because it has been suggested that emphasizing on emotion rather than on knowledge may be more meaningful to older adults (e.g., Mikels et al., ). Second, as far as we know, the possibility of age-related changes in memory recognition for positive musical stimuli has yet to be examined. Past research showed that age-related changes in emotional goals influence memory. A positivity effect in memory recognition tasks has already been shown in older adults for affective pictures (e.g., Charles et al., ; Mather and Carstensen, ) and for words (e.g., Kensinger, ). The main explanation was that memory can work as an elaborative process to regulate emotions such that the older adults' goal to maintain well-being would influence mental constructions of the past and thus lead to a positivity effect in the way they remember events. In line with this hypothesis, it has been showed that memory for negative pictures decreased in older adults both in recall and recognition tasks (e.g., Charles et al., ). Kensinger () found a positivity effect in older adults for non-arousing words, explaining this as an age-related difference in the way positive information was primarily processed as a function of differences in motivational goals at each age level. To date, the question remains open whether age-related differences in the elaborative processing of memory may be observed in a non-verbal channel of emotion communication such as music. Third, to our knowledge, no previous study has investigated age differences in facial muscle activity when listening to music. Past studies examining age-related differences in facial expressiveness have found that young and older adults express similar patterns of facial responding to visual stimuli such as emotional scenes, objects or faces (Reminger et al., ; Smith et al., ; Bailey et al., ). However, older adults compared to younger adults may exhibit diminished reactivity in facial expressiveness (Smith et al., ; Burriss et al., ). The reduction of facial expressiveness in the elderly has been thought to be a possible consequence of general physiological losses in the nervous system. However, another explanation suggests that the reduction of facial expressiveness may reflect an attempt to regulate emotion since facial expression may be motivationally driven (Smith et al., ). Given such emotion regulation hypothesis and in line with the embodiment theory of emotion (Niedenthal et al., ), one can imagine that facial expressions may not only help to down-regulate emotion (by displaying less facial expressions), but also allow to modify the emotional reaction (by displaying a facial expression contrary to what one feels). In this perspective, facial electromyogram (EMG) appears as an interesting indicator of whether there is congruence between facial expressivity and musical emotion in both young and older adults, or do older adults express positive facial expression as a means to counteract negative emotions.

There is an agreement to consider that emotional responding is a multi-component process, giving rise to affective experiences, physiological adjustments and expressive behaviors (e.g., Scherer, ). These various aspects of emotion may be differentially influenced by age. Therefore, a unifying view of these changes is necessary to give more insight into the lifespan developmental course of emotion, particularly in the musical domain in which this topic has remained unexplored. To this end, we focused on different indexes of emotional response to music, namely subjective experience, emotion expression and memory recognition for musical excerpts that conveyed different emotions.

Finally, although the positivity effect has been observed across a number of experimental paradigms such as dot-probe tasks (Charles et al., ), eye-tracking paradigms (Isaacowitz et al., ,), working memory (Mikels et al., ), memory recognition and free recall tasks (Charles et al., ), and across a variety of stimuli (e.g., pictures, word lists, facial expressions), the robustness of this phenomenon has been mainly demonstrated through the visual channel of emotion communication. Consequently, research regarding the effect of age on emotion processing in music is needed to test for the generalizability of the positivity effect.

Current research

The present study was designed to further extend previous studies and expand experimental designs to the domain of music. Our aim was twofold: first, to investigate the effects of aging on the emotion felt when listening to music and second, to address age-related differences on memory recognition for musical excerpts as a function of their intended emotion. To this end, we used a set of musical stimuli expressing happiness, peacefulness, sadness, and fear which were all controlled for valence and arousal (Vieillard et al., ). We used a rating task focused on the emotion experienced by the participants rather than on the emotion recognized by the participants. In order to address more extensively the effect of aging on the experienced emotion, we designed the experiment so that the subjective report of the intensity of the emotion felt was coupled with a recording of participants' facial expressions. These particular indexes were chosen since past research has shown that facial expressions, measured by the corrugator (i.e., frowning) and zygomatic (i.e., smiling) muscle activity, were mostly related to the valence in music: positive emotions generally lead to increased zygomatic activity, while negative ones were associated more with increased corrugator activity (e.g., Witvliet and Vrana, ; Khalfa et al., ). Because it has been suggested that facial EMG may also be voluntarily modulated to serve emotion regulation goal (Smith et al., ), we used this index to examine to what extent and how older adults show positive or negative facial expression as a function of musical emotions.

Based on the hypothesis postulating a motivated attention toward positivity with advancing age, and given the view that situations relevant to a person's motivational goals may elicit more intense emotional experience (e.g., Charles and Piazza, ), we expected that older adults, compared to younger adults, would judge their feeling as more intense when listening to positive musical excerpts (especially happy music that is more arousing than peaceful one) than when listening to negative musical excerpts. Since no age-related changes in facial expressivity were found in previous research (e.g., Levenson et al., ; Tsai et al., ; Magai et al., ), we also expected older adults to be spared in their facial expressions (i.e., corrugators and zygomatic muscle activity). More specifically, if older adults have spontaneous facial activity, it is expected that they would display a greater zygomatic activity for positive music in comparison with their younger counterparts. At the same time, it is also expected that older adults would display voluntary facial expression as a tool to manage emotion. In this hypothesis, older adults would show reduced expressivity or incongruent expression, in particular in response to negativity. Moreover, in view of the scarce data available on the influence of aging on memory recognition for musical excerpts that convey different emotions, and because the memory elaborative processes for music are based on more abstract information than those involved in the memory for visual and autobiographical material, it is difficult to predict the nature of the effects likely to be observed. Consequently, we conducted an exploratory approach to test whether the positivity effect may be generalized to memory recognition for musical excerpts conveying different emotions. We expected that compared to younger adults, older adults should better recognize positive musical excerpts than negative ones.

Method

Participants

A total of 40 native French speaking volunteers (22% amateur musicians) participated in the present study. Exclusion criteria included the presence of uncorrected hearing, medical or psychiatric antecedents, psychotic symptoms, and history of substance abuse. As a result, the data of 18 young adults (19–24 years, M = 21 years; 61 % females) and 18 older adults (60–84 years, M = 66 years; 83% females) was analyzed. Younger and older adults were recruited respectively at the psychology department of the University of Franche-Comté and through senior social programs in Besançon. Participants did not receive financial compensation for their participation.

Apparatus

Participants were tested individually in a quiet room at stable ambient temperature at the University. Facial muscle activity was monitored continuously during the listening and rating phases using an MP150 Biopac system (Biopac Systems, Inc., Goleta, CA) at a sampling rate of 500 Hz and processed using AcqKnowledge software. Eprime software (Schneider et al., ) was used for excerpts presentation and ratings recording. Musical excerpts were presented binaurally through Professional 240 Sennheiser headphones.

Materials

Forty short musical excerpts, computer-generated in a piano timbre and taken from Vieillard et al. () set of unfamiliar musical stimuli were selected for their power to convey four distinct emotions (i.e., happiness, peacefulness, sadness, and fear). Musical excerpts were controlled for their valence (unpleasant vs. pleasant) and arousal (low vs. high). Each emotion category included ten musical excerpts that lasted an average of 10 s. The happy excerpts were written in a major mode at an average tempo of 137 Metronome Markings (MM range: 92–196), with the melodic line lying in the medium high pitch range (the pedal was not used). The peaceful excerpts were composed in a major mode, had an intermediate tempo (mean: 74 MM, range: 54–100), and were played with pedal and arpeggio accompaniment. The sad excerpts were written in a minor mode at an average slow tempo of 46 MM (range: 40–60), with the pedal. The scary excerpts were composed with minor chords on the third and sixth degree, hence implying the use of many out-of-key notes. Although most scary excerpts were regular and consonant, a few had irregular rhythms and were dissonant. Their tempo varied from 44 to 172 MM. Examples can be heard at . A previous study that was conducted to examine the effect of age on emotion perception in music demonstrated that older listeners successfully distinguished happiness, peacefulness, sadness, and fear conveyed by these musical excerpts (Vieillard et al., ). In a study phase described below, participants were presented with 20 musical excerpts (i.e., 5 happy, 5 peaceful, 5 sad, and 5 scary) and were instructed to indicate what they experienced in terms of Emotional Intensity. The 20 remaining musical excerpts were then used as lures in the incidental recognition task.

Procedure

The experiment was divided into two sessions separated by an interval of ~1 week. During the first session, participants completed a consent form and were asked about their age, musical listening, education level, self-reported health, visual and auditory acuity, and medical history. Auditory perception was controlled using free AudioTest software (). More specifically, it was assessed by presenting pure tones at intervals between 500 and 8000 Hz to both ears through Professional 240 Sennheiser headphones. For each participant, the lowest sound pressure level at which each frequency was detected was recorded. In addition, several tests assessing general cognitive function (MMSE, Petit et al., ), fluid intelligence (Raven's progressive matrices, set I, Raven et al., ), and working memory (letter-number sequencing from WAIS-III, Wechsler, ) were administered. The first session lasted about an hour.

During the second session, physiological sensors were attached while the participants sat comfortably in a quiet room in the presence of the experimenter. To prevent participants from focusing on their facial muscles, they were informed that the electrodes placed on their face were used to record their electrodermal activity during the experiment. At the beginning of the session, two musical excerpts different from those used in the experiment were used in order to adjust the volume of the headphones for each participant. In the study phase, two practice excerpts (1 happy and 1 peaceful) following by 20 excerpts (5 of each emotion) were then presented binaurally. After each trial, participants were asked to rate the intensity of the emotion felt using a 10-point scale ranging from 0 “weak” to 9 “strong.” Facial muscle activity was also recorded. The excerpts were presented in two pseudo-randomized orders that were created to ensure that no more than two excerpts of the same emotion category were presented consecutively. Each musical excerpt was preceded and followed by two baseline periods of at least 10 s of silence.

Before the incidental recognition task, participants completed two questionnaires to assess depression (BDI-II; Beck et al., ) and anxiety (STAI; Spielberger, ). In the recognition task participants were asked to indicate whether an excerpt had been heard before (“old”) or not (“new”) by pressing the appropriate key. In this phase, 40 musical excerpts (i.e., 20 old excerpts and 20 new excerpts) were randomly presented.

Finally, participants were instructed to listen to the same set of 40 musical excerpts presented binaurally in a randomized order. After each musical excerpt, participants were asked to judge to what extent they experienced “happiness,” “peacefulness,” “sadness,” or “fear” using a 10-point scale ranging from 0 “not at all” to 9 “a lot.” Accordingly, each excerpt was presented four times; each presentation was associated with one of the four emotion scales. The presentation order of each musical excerpt and each rating scale was fully randomized across participants. The second session lasted about 2 h. At the end of the session, participants were fully debriefed.

Data acquisition and transformation

Facial EMG activity (μVolts) was recorded over the left corrugator and zygomatic sites, using two pairs of 8 mm Ag/AgCl shielded electrodes filled with isotonic gel. The EMG data were band-pass filtered from 100 to 500 Hz and processed with a root mean square algorithm over 20 samples (with a 100-ms window). Recording artifacts were visually identified and discarded from the sample. These corresponded to less than 0.5% of all measurements.

Results

Sample characteristics

Younger adults reported more years of education than the older adults, t(34) = −2.33, p < 0.05. A chi-square goodness-of-fit test (χ2) indicated no significant differences between age groups in the proportion of formal musical training of at least 3 years χ2 (1, N = 36) = 4.5, p > 0.05. Age groups did not differ regarding their depression, state anxiety, or trait anxiety scores. Non-parametric Mann-Whitney U-test performed on the auditory thresholds (dB) did not show statistically significant differences between younger and older adults (U = 10.50, z = 0.77, p = 0.44 for 500 Hz; U = 0, z = 0, p = 1 for 1000 Hz; U = 10, z = 0.84, p = 0.40 for 2000 Hz; U = 8, z = 1.12, p = 0.26 for 4000 Hz; U = 33, z = 0.23, p = 0.81, for 8000 Hz). As was expected, younger adults scored better than older adults on fluid intelligence (Raven's progressive matrices, set I, Raven et al., ), t(34) = −2.84, p < 0.05. Younger adults tended to perform better than older adults on a working memory test (Digit Span from WAIS-III, Wechsler, ), t(34) = −1.94, p = 0.06. There were no significant age differences on self-reported health, t(34) = −0.81, p = 0.42. Finally, the Mini Mental State Examination (MMSE; Petit et al., ) scores for the older adults suggested no apparent signs of dementia (M = 29.7, 28–30). Sample characteristics are detailed in Table .

Table 1.

Sample characteristics.

Standard deviations are listed in parentheses. \*Significant difference at p < 0.05.

Emotion intensity felt

A mixed model analysis of variance was conducted on the mean score of the Emotional Intensity Felt with Age Group (younger adults, older adults) as the between-subjects factor and Intended Emotions (happiness, peacefulness, sadness, fear) as the within-subjects factor.

As illustrated in Figure , we found a significant Age Group by Intended Emotion interaction, F(3, 102) = 3.75, p < 0.05, η2G = 0.06. In order to test our hypothesis, we computed a planned comparison between the emotion intensity felt by young adults and that felt by older adults when listening to happy music. As expected, older adults compared to young adults reported experiencing higher emotional intensity when listening to happy music, F(1, 34) = 5.57, p < 0.05, η2G = 0.14. This older adults' reactivity for positivity was also confirmed by another set of planned comparisons indicating that older adults reported experiencing higher emotional activation when listening to happy music than when listening to sad music, F(1, 34) = 7.34, p < 0.05, η2G = 0.18, or scary music, F(1, 34) = 8.76, p < 0.05, η2G = 0.20, while younger adults did not. No other significant effect was found. A separate analysis with years of education, fluid intelligence scores, and working memory performances (i.e., factors that were found to be different between the two age groups) as covariates indicated that the Age Group by Intended Emotion interaction remained significant, F(3, 93) = 3.14, p < 0.05, η2G = 0.05.

Figure 1.

Mean score and standard error of emotion intensity felt, zygomatic and corrugator muscle activity as a function of intended emotions (happiness, peacefulness, sadness, fear) and age group (younger adults, older adults).

Facial muscle activity

Facial EMG responses were calculated as the difference between the signal (Area under the curve, μV\*sec) over the time course of the musical excerpt and a baseline EMG level measured from 1s prior to the onset of the excerpt (time -1 to 0 s) to the beginning of the excerpt. The area under the curve was extracted within these two time windows and was averaged for each condition and for each participant. Two participants were excluded (1 younger and 1 older adults) from the initial sample due to technical problems. Analyses were then conducted on seventeen younger and seventeen older adults. The Shapiro-Wilk normality test reached significance for the sample set of EMG data meaning that the assumption of normality has to be rejected. As a result, statistical analyses were performed using non-parametric tests. First, the differences between age groups were tested separately for zygomatic and corrugator using the Mann-Whitney U-test. Results showed a significant effect of Age Group both for zygomatic (U = 42, z = 3.51, p < 0.001) and for corrugator muscle (U = 83, z = 2.10, p < 0.05) indicating that facial activity was more important in older adults than in their younger counterparts. Friedman repeated measures analyses of variance (RM-ANOVA) were conducted separately on zygomatic and on corrugator activity to test the effect of Intended Emotion factor for each Age Group. For zygomatic muscle, data revealed a significant effect of Intended Emotion in older adults, χ2 = 12.46, df = 3, p < 0.05, but not in young adults, χ2 = 2.01, df = 3, p = 0.57. As shown in Figure , older adults showed an increased zygomatic activity, in particular for scary music. Regarding corrugator activity, no significant effect of Intended Emotion was found either in older adults, χ2 = 3.00, df = 3, p = 0.39, or in younger adults, χ2 = 5.68, df = 3, p = 0.13.

Incidental recognition task

Proportions of hits, false alarms, and corrected recognition scores (hits minus false alarms) are reported in Table . An analysis of variance was conducted on corrected recognition scores with Age Group (younger adults, older adults) as the between-subjects factor and Intended Emotion (happiness, peacefulness, sadness, fear) as the within-subjects factor. Analysis showed a significant main effect of Age Group indicating that younger adults recognized more musical stimuli than older adults, F(1, 34) = 30.87, p < 0.001, η2G = 0.50. There was also a significant main effect of Intended Emotion, F(3, 102) = 4.86, p < 0.05, η2G = 0.12, indicating that scary music stimuli were better recognized than peaceful and sad music stimuli. This was confirmed by post-hoc Bonferroni comparisons (ps < 0.05). No significant Age Group by Intended Emotion interaction was observed, F(3, 102) = 0.27, p = 0.84, η2G = 0.01. Younger adults' recognition performances were at chance level or above only for the highly arousing musical stimuli such as happy (52%) and scary (61%) ones, while older adults' recognition performances varied between 10 and 39% through the four intended emotions.

Table 2.

Hit rates, False Alarms Rates (FA) and Corrected Recognition (CR) by Emotions Catagory and Group Age.

Additional separate analyses conducted on hits and false alarms revealed that older adults generated more false alarms than younger adults, F(1, 34) = 18.47, p < 0.001, η2G = 0.35. There was also a significant main effect of Intended Emotion, F(3, 102) = 22.02, p < 0.001, η2G = 0.36, as well as a significant Intended Emotion by Age Group interaction for false alarm rates, F(3, 102) = 4.85, p < 0.05, η2G = 0.08. Post-hoc Bonferroni comparisons showed that the older listeners, compared with their younger counterparts, had more difficulty to correctly reject new happy musical stimuli (p < 0.05). Moreover, older adults were better to correctly reject new scary musical stimuli in comparison to all other intended emotions (ps < 0.001) while younger adults were better to correctly reject new scary musical stimuli in comparison to only low arousing stimuli like peaceful (p < 0.05) and sad (p < 0.05) ones. No significant effect or interaction was found for hits rates. Again, the analysis of covariance with years of education, fluid intelligence scores, and working memory performances as covariates showed that the Intended Emotion by Age Group interaction remained significant, F(3, 93) = 3.70, p < 0.05, η2G = 0.07.

D-prime was calculated using tables for d-prime and beta available in Hochhaus () and analyzed using another mixed ANOVA. This indicates the ability to discriminate between true targets and false targets (Green and Swets, ), with Age Group (younger adults, older adults) as the between-subjects factor and Intended Emotion (happiness, peacefulness, sadness, fear) as the within-subjects factors. We obtained a significant main effect of Age, F(1, 34) = 26.41, p < 0.001, η2G = 0.44 indicating that, overall, older adults showed lower d-prime score (M = 0.43, SE = 0.15) than younger adults (M = 1.50, SE = 0.15). This suggests a lower sensitivity in the discrimination of true musical excerpts from false musical excerpts in older adults. No other significant interaction was found with d-prime as the dependent variable. The beta value that indicates the minimum level of activation necessary for a participant to respond to a true target (Green and Swets, ) was also calculated (Hochhaus, ). No significant main effect or interaction was found with beta value as the dependent variable.

Differentiation in emotion felt

As in previous studies (Vieillard et al., ), we derived the best label attributed to each musical excerpt by each participant. This was done selecting the label (i.e., happy, peaceful, sad, scary) that had received the maximal rating. When the maximal rating corresponded to the label that matched the intended emotion, a score of 1 was given. When the maximal rating did not correspond to the emotion, a score of 0 was given. When the highest rating was given for more than one label, the response was considered ambivalent and received a score of 0. For example, when an excerpt was perceived eliciting both peacefulness and sadness to the same degree (e.g., with a rating of 7), it was considered as ambivalent. Best labels scores are presented in Table .

Table 3.

Mean percentage of the label that received the maximal rating of Emotion Felt by younger and older listeners as a function of the Intended Emotions.

Bold indicates the match between Emotion Felt and Intended Emotions. Ambivalent responses correspond to highest ratings given to more than one label.

A mixed model analysis of variance was conducted on the mean Best Label with Age Group (younger adults, older adults) as a between-subjects factor and Intended Emotions (happiness, peacefulness, sadness, fear) and Emotion Felt (happiness, peacefulness, sadness, fear) as within-subjects factors. Significant main effects of Age Group, F(1, 34) = 7.43, p < 0.05, η2G = 0.18, and Emotion Felt, F(3, 102) = 5.87, p < 0.001, η2G = 0.14 were found. As expected, results also indicated a significant Intended Emotion by Emotion Felt interaction, F(9, 306) = 71.45, p < 0.001, η2G = 0.58, as well as a significant Intended Emotion by Emotion Felt by Age Group, F(9, 306) = 5.10, p < 0.001; η2G = 0.09. No other significant main effect or interaction was observed. We first compared the experience emotion between younger and older adults for each intended emotion. The results indicated that older adults, compared to younger adults, reported experiencing lower levels of sadness when listening to sad music, F(1, 34) = 5.44, p < 0.05, η2G = 0.14, but reported higher levels of sadness when listening to scary music, F(1, 34) = 6.35, p < 0.05, η2G = 0.16. Moreover, when listening to scary music, older adults reported experiencing lower levels of fear, F(1, 34) = 18.78, p < 0.001, η2G = 0.36, than their younger counterparts. The second set of comparisons was conducted to compare the emotion experienced for each intended emotion within each age group. The results showed that older adults reported similar levels of sadness and peacefulness when listening to peaceful music, F(1, 34) = 1.92, p = 0.18, η2G = 0.05, and sad music, F(1, 34) = 0.85, p = 0.36, η2G = 0.03, as well as similar levels of sadness and fear when listening to scary music, F(1, 34) = 0.44, p = 0.51, η2G = 0.01. Younger adults reported similar levels of sadness and peacefulness only when listening to peaceful music, F(1, 34) = 0.73, p = 0.40, η2G = 0.02. Happy music was the only music that primarily elicited happiness (when compared with the level of peacefulness felt) in both young and older adults, F(1, 34) = 117.63, p < 0.001, η2G = 0.78, and F(1, 34) = 105.92, p < 0.001, η2G = 0.76, respectively. The Intended Emotion by Emotion Felt by Age Group interaction remained significant when years of education, fluid intelligence scores, and working memory performances were entered as covariates, F(9, 279) = 2.90, p < 0.05, η2G = 0.06.

The relationship between age and dependent measures

In order to check for any relationships between age and the different dependent measures (i.e., emotion intensity felt, physiological responses to music, recognition accuracy, and the type of emotion felt) for each of the four intended emotions, we computed a series of correlations. Because age was significantly correlated with years of education, r(34) = −0.41, p < 0.05, fluid intelligence, r(34) = −0.48, p < 0.05, working memory, r(34) = −0.35, p < 0.05, and each of the five measures of auditory thresholds, r(34) = 0.56, p < 0.001 for 500 Hz; r(34) = 0.54, p < 0.001 for 1000 Hz; r(34) = 0.61, p < 0.001 for 2000 Hz; r(34) = 0.42, p < 0.05 for 4000 Hz; r(34) = 0.75, p < 0.001 for 8000 Hz, these variables were controlled for in partial correlations. Results indicated that the mean scores of hits, corrected recognition, and d-prime for peaceful music were negatively and significantly correlated with age, r(34) = −0.34, p < 0.05 for hits, r(34) = −0.51, p < 0.05 for corrected recognition, and r(34) = −0.53, p < 0.05 for d-prime. Similarly, age was negatively and significantly correlated with the mean score of corrected recognition and d-prime for happy music, r(34) = −0.69, p < 0.001 for corrected recognition, and r(34) = -0.65, p < 0.001 for d-prime, while it was positively and significantly correlated with the mean score of false alarms, r(34) = 0.63, p < 0.001. Altogether, the data indicated that the older the people are, the lower their ability to discriminate studied positive musical excerpts conveying peacefulness and happiness from unstudied ones. The mean score of Beta index for sad music was also positively and significantly correlated with age, r(34) = 0.50, p < 0.05, suggesting that the older the people are, the more conservative they are to discriminate studied stimuli from unstudied musical excerpts conveying sadness. Moreover, data indicated that the older the people are, the stronger their experience of sadness while listening to peaceful music, r(34) = 0.46, p < 0.05, and the weaker their experience of fear while listening to scary music, r(34) = −0.49, p < 0.05. No other significant correlations were found.

The relationship between emotion intensity felt, facial muscle activity, and recognition performances

For each age group, we investigated to what extent the emotion intensity felt during the first presentation of musical stimuli was linked to the physiological responses as well as to the subsequent cognitive performances on the incidental recognition task. The relationship between physiological reactions and recognition performances was also examined. In younger adults, results indicated that the stronger the emotion intensity felt in response to sad music, the higher the hits, r(14) = 0.54, p < 0.05. In older adults, results showed that the stronger the emotion intensity felt for happy music, the higher the false alarms, r(14) = 0.54, p < 0.05. No other significant correlations were found.

Discussion

In this study, we investigated how the emotional experience as well as memory recognition for musical excerpts eliciting four different emotions (happiness, sadness, peacefulness, and fear) may change with age. To this end, younger and older listeners were asked to evaluate the intensity of the emotion felt while their facial expressions (i.e., zygomatic and corrugator muscle activity) were recorded. They were then instructed to perform an incidental recognition task followed by another task in which they had to assess for each musical excerpt to what extent they experienced each of the four emotions.

As predicted, the results showed that, when presented with happy music, older adults assessed the emotion felt as more intense than their younger counterparts. The fact that older adults rated their emotional experience as significantly more intense for happy music stimuli in comparison to sad and scary music stimuli is consistent with the literature showing that aging is associated with a relative preference for positivity over negativity. This also supports the view that emotions and motivations cannot be disentangled from each other. However, the assumption that the stronger emotional experience reported by older adults while listening to happy music would be reflected in a greater zygomatic activity was not supported. Compared to younger adults, older adults showed stronger facial expressions for both corrugator and zygomatic muscles as well as for all intended emotions. This suggests that facial expressions are not exclusively aligned with the emotional state, thus raising the question of whether the general increase of facial expressiveness in older adults would simply reflect a deeper engagement in the task. However and interestingly, the current results also showed that older adults' zygomatic activity, but not for young adults', varied as a function of the intended emotions in such a way that older adults showed an increased zygomatic activity for scary excerpts but not for happy or peaceful ones. This is in line with the idea that the reaction of smiling may serve as a defensive goal in inhibiting negative feelings for older adults. It can also be argued that zygomatic activity may reflect partial facial expression of fear, but then there we should have observed a greater concomitant activity for the corrugator muscle. However, this was not observed. Taken together, these findings are consistent with the idea that older adults' facial expressions possibly reflect an attempt to regulate emotion. Further research is needed to substantiate the role of voluntary facial expressions in the older adults' response to emotions.

Consistent with our expectations, our findings indicated that older adults correctly recognized less musical excerpts than their younger counterparts. Moreover, older adults' range of performances was quite similar to that found by Kensinger () with emotional words. This suggests that modality has little impact on the strength of the memory decline with aging. The results of the present study also indicated that younger adults as well as older adults better recognized negative and arousing musical excerpts (i.e., scary music) than all other excepts while producing low false alarms rates for these scary music stimuli. This corroborates the hypothesis of an increased distinctiveness of negative stimuli (e.g., Pesta et al., ) and extends previous studies that showed that older adults can visually detect arousing and negative stimuli as well as their younger counterparts (e.g., Magai et al., ; Knight et al., ). Our findings also gave evidence for increased false recognition for happy music stimuli in older adults but not for young adults. We found a negative relationship between age and the ability to discriminate between true and false happy musical excerpts as well as a positive relationship between the emotion intensity felt in older adults and their rate of false alarms for happy stimuli. Taken together, these findings suggest that positive emotion elicited by happy excerpts may produce an attentional bias in older adults that can lead to confusion between studied and non-studied excerpts and thus enhance the probability of false alarms. Such increase in discrimination threshold is consistent with previous studies showing that aging was associated to a higher false response rate to positive words (Fernandes et al., ; Piguet et al., ) and corroborates the idea that the reduction of distinctiveness for positive information in older adults would be the result of their liberal bias toward positivity. However, in the present study, the positivity bias is detrimental to memory accuracy.

Another main finding of the current research is that, when presented with sad and scary musical excerpts, older adults reported experiencing lower levels of sadness and fear than their younger counterparts. Correlation analyses indicated that the older the people are, the weaker their experience of fear felt while listening to scary music. This fits nicely with previous research demonstrating age-related changes in emotion recognition (Laukka and Juslin, ; Lima and Castro, ) and emotion perception (Vieillard et al., ) in music, and extends these studies by showing these changes also occur when participants are focused on their own emotional experience. Interestingly, compared to Lima and Lima and Castro' () recognition paradigm, the personal engagement involved in the current task seems to facilitate the older adults' ability to process negative emotions. This is consistent with previous findings demonstrating that older adults benefit more from instructions encouraging to focus on emotion than on information acquisition (Mikels et al., ) and corroborates the view of an age-related emphasis on emotion processing. Of course, further research is needed to compare the older adults' responsiveness to musical emotions in both contexts of recognition and of emotional experience.

Given the relatively short duration of the musical stimuli used in the present study, one may argue that this could challenge their ability to induce emotions, leading participants to rate their perceived emotions rather than their felt emotions. Although studies aiming to induce felt emotions in listeners tend to use longer excerpts than those investigating perceived emotions (Eerola and Vuoskoski, ), we believe that the short excerpts used in our experiment also successfully induced emotions. First of all, our results indicated that participants reported moderate intensity of the emotion felt along with significant differences in facial expressivity. Furthermore, previous findings demonstrated that musical excerpts as short as 13s may recruit neural mechanisms involved in pleasant/unpleasant emotional responses (Blood et al., ). In the study of Vieillard et al. () which used similar 10 s musical excerpts recorded in a piano timbre, listeners better recognized some intended emotions when focusing on their emotional experience rather than when focusing on the recognition of the emotion. This suggests that asking participants to focus on felt emotions increases the degree of personal engagement in musical emotion even for short musical excerpts. Taken together, these data corroborate the hypothesis that the musical emotions were not only recognized, but indeed felt.

One limitation of this study is that we used a cross-sectional design. Historical differences in the cultural system and in musical exposure may have affected young and older adults' performances differently. The observed age differences in emotional responses to music might thus reflect a cohort effect rather than an age effect. Future research would benefit from investigating this issue more thoroughly. Nevertheless, our study suggests that emotional response to music and memory recognition for musical excerpts conveying emotions show differences with advancing age. These age-related differences are characterized by a stronger emotional reactivity for happiness, an increased zygomatic activity in response to scary stimuli, an increase in false recognition for happy musical excerpts, and a decrease in responsiveness to sad and scary music. This study extends previous findings and expands them to music, a powerful channel of emotion communication. Importantly, the findings suggest that aging may cause a decrease in negative affects and an increase in positive affects even when these affects are elicited by a more abstract source of emotion that does not refer to specific events. Finally, the current data are in line with the hypothesis that older adults could use emotional coping skills acquired over the life span in order to avoid potentially negative events and maintain positive ones (Charles et al., ; Labouvie-Vief et al., ).

Conflict of interest statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Acknowledgments

This research was funded by the ANR “EMCO” program (Project Streem N ANR 11 EMCO 003 01). We are grateful to Alexandra Richen for her help in running the experiments as well as to Alejandra R. Velasquez and Joanna Blatter-Minn for their proofreading the manuscript.

Footnotes

1Emotion categories that were less accurately recognized by older adults were not those known to be the hardest to recognize.

2Age groups did not differ or only differed marginally on self-reported hearing loss.

3The musical training was measured as the proportion of participants who received at least 3 years of formal training and who were still practicing a musical instrument without reaching professional levels.

4BDI-II scores indicated that 75% (n = 27) of the participants scored below the cut-off (score of 11) for a minimum depression symptomatology and that 19.44% (n = 7) of the participants scored below the cut-off (score of 19) for at least mild depression. The remaining two participants (one young and one older adult) scored between 22 and 24, which indicates moderate depression symptomatology. STAI state anxiety scores indicated that 83.33% (n = 30) of the participants scored below the cut-off (score of 35) for very low state anxiety, 13.89% (n = 5) of them scored below the cut-off (score of 45) for low state anxiety, and that 2.78% (n = 1) of them scored below the cut-off (score of 55) for mild state anxiety. STAI trait anxiety scores indicated that 30.56% (n = 11) of the participants scored below the cut-off (score of 35) for very low state anxiety, 41.67% (n = 15) scored below the cut-off (score of 45) for low trait anxiety, and 19.44% (n = 7) scored below the cut-off (score of 55) for moderate trait anxiety. The remaining two participants (one young and one older adult) scored between 57 and 58, which correspond for a high anxiety state.

5Because the audio test software did not provide absolute thresholds, we used the lowest sound pressure level (dB) at which each frequency was detected as an ordinal data. For this reason, the non-parametric Mann-Whitney test (independent samples) was used. Although hearing thresholds varied as a function of age, the Mann-Whitney test did not reveal significant differences between age groups probably because of the variability observed within the groups, in particular in the older adults.

6We computed generalized eta squared statistics (η2G) with the aim to yield measures of effect size comparable across a wide variety of research designs (Bakeman, ), regardless of whether the factor is between or within subjects. These effect-size measures provide indices of effect that are consistent with (Cohen, ) guidelines indicating that η2G = 0.01 corresponds to a small effect, η2G = 0.09 to a medium effect, and η2G = 0.25 to a large effect.

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AGE linked with VOLUME LEVEL :

While research on the direct correlation between age and preferred music volume in women is limited, studies indicate that musical preferences and how they are experienced change throughout life. Age-related changes in hearing sensitivity, particularly a reduced tolerance for loud and high-frequency sounds, can influence preferences for certain music and volume levels as women age. Additionally, women's musical preferences are influenced by psychosocial development, personality, and social context, all of which evolve over time.

Here's a more detailed look:

Age-related changes in hearing:

Hearing sensitivity, especially to higher frequencies, tends to decline with age, particularly in women.

This decline can lead to a reduced tolerance for loud sounds and potentially influence preferences for music with a less intense volume.

Musical preferences and age:

Early life (childhood and adolescence):

Musical preferences are heavily influenced by social identity and exploration. Intense and contemporary music is often favored.

Adulthood:

Preferences shift towards mellow, sophisticated, and unpretentious music as individuals mature.

Older adulthood:

Some older adults may find that their preferred music genres and volume levels shift again, possibly due to the cumulative effects of hearing loss and changes in life priorities.

Other factors:

Personality:

Certain personality traits, such as openness to experience, can be linked to musical preferences and how much someone enjoys certain types of music.

Social context:

Music plays a role in social identity and bonding, and these factors can also evolve with age and life stage.

Psychological well-being:

Music can be a powerful tool for emotional regulation and well-being. Women may use music differently at different life stages to manage emotions and cope with stress.

In summary: While there isn't a direct correlation between age and music volume preference in women, research suggests that changes in hearing, personality, social context, and psychological needs all play a role in shaping musical preferences over a woman's lifespan. These factors may influence whether women prefer louder or quieter music as they age.

And ofc older people listen to really high volume or really low volume depending on their sensitivity.

AGE linked with TIME OF MUSIC:

Yes, there's a strong link between age and the type of music people tend to prefer. Research suggests that musical tastes are significantly shaped during adolescence and early adulthood, with preferences often solidifying by the early to mid-30s. This phenomenon, sometimes referred to as "music paralysis," indicates a tendency to gravitate towards music released during that formative period.

Here's a more detailed look:

Formative Years:

The years between 13 and 16 are often cited as crucial for developing musical preferences.

Shifting Tastes:

As people age, their musical tastes can change, often adapting to life's challenges and stages.

Nostalgia:

A strong preference for music released during late adolescence and early adulthood often develops, leading to a sense of nostalgia for that era.

Exploration vs. Exploitation:

Younger individuals tend to explore a wider range of music, while older individuals may prioritize "exploiting" music they already know and enjoy.

Social Factors:

Social influences, like listening to what friends or family enjoy, also play a role in shaping musical preferences.

Life Stages:

Different life stages, such as teenage years, early adulthood, and middle age, can be associated with different musical preferences.

Hearing Changes:

Age-related changes in hearing, such as decreased sensitivity to high frequencies, can also influence musical preferences.

Artist Age:

While an artist's age can influence the type of music they create, it doesn't necessarily dictate the quality or enjoyment of the music for listeners.

Music listening habits, including the time of day preferences, change with age. Younger individuals tend to listen to music more frequently throughout the day and in various settings, while older individuals may have more specific times and contexts for listening, often preferring private, less active moments like evenings.

Here's a more detailed breakdown:

Adolescents and Young Adults:

They are more likely to listen to music during commuting, social activities, and while engaging in other tasks like studying or working. Their music listening habits are often linked to identity formation, social trends, and exploration of new music.

Working Adults:

Music consumption often peaks during commuting and work hours, potentially as a way to manage stress or enhance focus.

Older Adults:

Music listening may become more selective and less frequent as people age, with a greater tendency to listen at night or during quiet, reflective periods. Older adults might also find their music preferences shifting towards genres they enjoyed earlier in life.

General Trends:

Studies suggest that music discovery peaks around age 24, and stagnation in musical exploration can set in around the early 30s. The role of music in one's life also evolves, transitioning from exploration and identity formation in youth to a more practical tool for managing daily life and eventually returning to its entertainment purpose.

Music Paralysis as We Age - The Scholarly Kitchen

3 May 2024

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Music Listening and Stress in Daily Life—a Matter of Timing

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Article notes

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PMCID: PMC5852177  PMID:

Abstract

Purpose

Despite increasing evidence suggesting that music listening in daily life has stress-reducing effects, studies mostly rely on subjective, retrospective data on music listening. Thus, the temporal dynamics underlying the stress-reducing effect of music listening remain unclear. Therefore, we aimed to examine the temporal dynamics of the associations between stress and music listening by assessing subjective and objective data on music in daily life.

Design

An exploratory Ambulatory Assessment study examining a total of 60 participants (37 women), aged 18 to 34 years (M = 22.4 years, SD = 3.5) was conducted.

Methods

For 1 week, participants answered questions on music listening and stress six times per day via an electronic diary device, which additionally objectively sampled the exact time point of music listening and its duration.

Results

Self-reports on mere music listening were associated with lower stress reports, whereas objectively assessed data was not. However, concerning duration of music listening, both subjective and objective data on music listening showed associations between a minimum of 20 min of music listening and lower stress reports. Concerning the latency, objective data on music listening revealed that the association between stress reports and music listening occurs in a time-delayed manner.

Conclusions

Although the study design does not allow for causal inferences, substantial associations among subjectively and objectively assessed data on music listening were found to differentially affect the experience of stress after music listening. In particular, when focusing on the temporal dynamics, objectively assessed data allowed for a more fine-grained analysis. In consequence, subjectively and objectively reported data on music listening should be assessed jointly when investigating effects of music listening on health. Experimental research with rigorous methodological control is required in order to corroborate our findings in a laboratory setting.

Keywords: Ambulatory assessment, Duration, Health, Music listening, Stress, Temporal dynamics

Music Listening and Stress in Daily Life—A Matter of Timing

Music listening in daily life may reduce stress []. Most of the evidence on this stress-reducing effect was gathered in quasi-experimental studies []. However, findings from these studies are quite heterogeneous, as they differ in terms of experimental design, music selection, and participants, making comparisons across studies difficult. Furthermore, in such quasi-experimental studies, participants are most often investigated only once, in one artificial setting (e.g., before surgery, before a standardized stress test). Thus, it remains unclear whether these findings can be generalized. Thus, research into the effects of music listening in various situations of daily life (in contrast to one artificial experimental situation) is warranted. To address this shortcoming, Ambulatory Assessment []—as a complementary tool to laboratory research—enables psychological phenomena to be studied in an ecologically valid way [].

Ambulatory research investigating the stress-reducing effects of music listening in daily life is still in its infancy. Some of the available studies focused on the effects of music listening on emotion regulation in daily life [–]. In this regard, Juslin et al. [] found that participants reported more positive emotions after having listened to music. The very few studies investigating associations between music listening and stress in daily life found that music listening does not reduce stress per se [, ]. Rather, situational factors may moderate this relationship: Music was only associated with stress reduction when other individuals were present while listening to music [] or when music was specifically listened to for relaxation purposes []. Taken together, these studies illustrate the importance of capturing situational factors using Ambulatory Assessment to gain a deeper understanding of when and why music listening reduces stress.

However, as promising as these results might be, there are at least two shortcomings that deserve critical discussion: (1) Previous studies have relied on subjective music listening data only, and (2) there is a lack of studies investigating the temporal dynamics of the beneficial effects of music listening. Regarding the first shortcoming, most research using Ambulatory Assessment has been built around self-reports of music listening behavior, with participants being asked to indicate whether they had listened to music since the last data entry [e.g., , ]. However, such data may be susceptible to retrospective memory biases []. Consequently, Juslin et al. [] called for studies which objectively sample the music individuals listen to. To the best of our knowledge, to date only one study has objectively assessed participants’ music-listening behavior []. In this study, participants were prompted to answer questions regarding emotion regulation strategies and music listening whenever they started listening to music on their smartphone. The authors found that music listening was effectively used to regulate emotions. However, given the limited evidence of one single study, more research is clearly needed to test whether objectively assessed music listening behavior can reproduce the stress-reducing effects of music listening found in studies using self-report measures only.

The second shortcoming in the literature on music-induced stress reduction is that it is unclear how long participants must listen to music in order for its beneficial effects to unfold (duration of music listening) and how long it takes for music to exert stress-reducing effects (latency). This information is necessary in order to shed light on the temporal dynamics underlying the effects of music listening on stress. In experimental studies, the time intervals of music listening vary from study to study, spanning periods, for instance, from 10 min [] to 45 min [] and even more than 3 h []. However, there is no recommendation on how long music should be listened to in order to exert health-beneficial effects.

Concerning the latency of these beneficial effects in daily life, most previous studies used retrospective self-reports on music listening, and only a small number of studies simultaneously assessed either music listening and mood [, ] or current and past music listening [, ]. However, interpretations might vary depending on whether current or past music listening is reported. When current music listening is assessed, it is possible to make predictions about acute effects of music listening on stress (as both music listening and stress are assessed at the same moment). However, the assessment of past music listening captures time-delayed effects of music listening on stress, as music listening and stress are not assessed simultaneously. It would be intriguing to study whether the beneficial effect of music listening varies depending on whether acute effects (e.g., current music listening) or time-delayed effects (e.g., past music listening) are assessed. Moreover, regarding time-delayed effects, knowledge on the latency of the stress-reducing effects of music listening is completely lacking. Thus, the optimal time lag between music listening and the assessment of stress remains unexplored. For example, Linnemann et al. [] reported that it was not possible in their study to determine how much time elapsed between music listening and the assessment of stress. However, to design specific music listening interventions for stress reduction purposes in daily life, research is needed to clarify the temporal dynamics underlying the associations between music listening and stress.

The Present Study

Taken together, several problems remain unresolved in the literature on the relationship between music listening and stress. A critical methodological limitation inherent in most studies set in daily life is that they rely on (often retrospective) self-reports on music listening, which might be subject to memory bias. Therefore, an objective assessment of music listening behavior is warranted, which captures when individuals listen to music and for how long. This should enable researchers to investigate (a) which duration of music listening is necessary for stress reduction and (b) whether music listening has acute and/or time-delayed effects on stress. We therefore conducted an Ambulatory Assessment study to pursue the following two aims: First, we investigated whether there was still an association between self-reported stress levels and music listening when music listening was objectively tracked. Second, we explored the temporal dynamics underlying the association between music listening and stress in terms of duration (that is, the duration of music listening that is necessary to be associated with beneficial effects) and latency (that is, how long it takes for music to be associated with beneficial effects).

Method

Participants

We conducted a dual-site exploratory Ambulatory Assessment study with a total of N = 63 undergraduate students (study site 1: n = 37; study site 2: n = 26). Data from three participants (n = 30 single observations) were excluded because they completed fewer than 33% of the total signals []. Thus, the final sample consisted of 60 participants (37 women), aged 18 to 34 years (M = 22.4 years, SD = 3.5). Inclusion criteria were sufficient mastery of the German language and the ability to operate a smartphone. Participants were excluded if they indicated that they were pregnant, currently breastfeeding, or suffering from a mental disorder. The study protocol was approved by the local ethics committees at both study sites.

Procedure

Informed consent was obtained from all individual participants included in the study. Basic demographic characteristics and self-reports on health using the Patient Health Questionnaire [] were given from all participants. Then, participants received instructions on how to use the electronic diary device (iPod touch at study site 1; department- or participant-owned smartphones at study site 2). Since participants were instructed to listen to music only using the study device via the application “Simple Last.fm Scrobbler” (The SLS Team, 2016), the music files to which they intended to listen during the ensuing week were uploaded onto the electronic diary device. Then, the use of the application was explained. The “Simple Last.fm Scrobbler” application automatically logged the exact time point of music listening for any song that was listened to for at least half the duration of the track. The collected data on music listening for each participant were saved on the Last.fm servers (Last.fm Limited, London, UK). Starting from the next day, for a total of six (study site 2) or seven (study site 1) consecutive days, participants received six signals over a time window of 12 h, beginning at 10.00. Upon each signal, participants were asked to complete items concerning stress, mood, and music listening behavior, among others. Following recommendations of Hektner, Schmidt, and Csikszentmihalyi [], this time window was divided into six blocks of 2 h, with the condition that consecutive signals were at least 30 min apart. If participants failed to respond to a signal or did not fully complete data entry, they were reminded twice with further signals. Participants were also able to postpone the signal if they were unable to complete the scheduled data entry at the current moment. Additionally, directly after waking up, participants completed a questionnaire on their electronic diary device, which included items on sleep quality, mood, and stress. However, data from this assessment are not included in the current analyses as no items on music listening were presented at this point. After completion of data collection, participants returned to the lab and were debriefed and reimbursed for their participation (either 20 euros or research credits).

A key advantage of Ambulatory Assessment methodology is its high external and ecological validity [], as processes are investigated in their daily life []. The internal validity of this approach is limited, though, given the lack of rigorous experimental control, which renders causal inferences difficult. Ambulatory Assessment, thus, serves as a methodological approach that complements experimental studies. It opens up opportunities to assess ecologically valid data and allows for the identification of meaningful associative patterns.

Participants at study site 1 received an iPod touch with the pre-installed application “iDialog Pad” (G. Mutz, University of Cologne, Germany), which was used for presenting the items. The data were stored locally on the iPod touch and exported upon completion of the Ambulatory Assessment period when participants returned to the lab. Participants at study site 2 either received an Android-based smartphone with Android OS 5.0.1 (Google, Mountain View, CA, USA) or used their own Android-based smartphones. The data were collected via the movisensXS experience sampling application, version 0.8.4203 (movisens GmbH, Karlsruhe, Germany), which was downloaded and installed either on the personal or the department-owned smartphone at the beginning of the study. The data were stored locally and uploaded to a secure server when the smartphone was connected to the internet. The administration of the items was comparable when either using the iPod or the smartphone.

Ambulatory Assessment Measures

Perceived Stress

To limit the burden on the participants, perceived stress (M = 1.17, SD = 1.02) was assessed using one item (“At this moment, I feel stressed,” 5-point scale ranging from 0 = not at all to 4 = very much; []).

Self-Reported Music Listening

For each signal, participants were asked whether they were currently listening to music (yes vs. no) and, if not, whether they had listened to music since the last signal (yes vs. no). Participants also indicated the duration of music listening on a 4-point scale: < 5 min, 5–20 min, 21–45 min, > 45 min.

Objectively Assessed Music Listening

The “Simple Last.fm Scrobbler” application collected information for each track (artist, title, date and time at the start of the track).

Analytic Approach

To test for associations between self-reported music listening and stress, we created the dichotomous variable self-reported music listening, which was coded “1” if participants either indicated currently listening to music at the time of the signal or having listened to music since the last signal. It was coded “0” if they had not listened to music. To test for the latency with which self-reported music listening and stress might be correlated, we created another variable, time lag, which compared whether participants were currently listening to music (1) or had listened to music since the last signal (0) according to self-reports. This enabled an assessment of whether self-reported music was associated acute and/or delayed with stress.

In line with the variables on self-reported music listening, we created a binary variable, with current music listening or music listening since the last signal coded as “1” and no music listening in this time frame coded as “0,” respectively. Since Last.fm also stores exact dates and times, we generated the duration of music listening in this time frame (M = 36.7 min, SD = 33.9) and the time lag between the current signal and the most recent track (M = 46.5, SD = 44.6) as two continuous variables. This enabled us to quantify and directly test associations among the amount of music listening, the latency of music listening relative to the assessment of stress, and stress reports.

Since multiple data entries (Level 1) are nested within participants (Level 2), we computed two-level models with random intercepts in Stata 14 (Stata Corporation, College Station, TX, USA) and investigated within-person processes. Continuous independent variables on Level 1 were person-mean centered, and those on Level 2 were grand-mean centered []. We did not enter the averaged continuous Level-1 independent variables as a measure of between-subject processes, since we were primarily interested in within-subject processes only and thus wished to keep the model as parsimonious as possible []. Categorical variables were dummy-coded (reference of subjectively assessed duration: “< 5 min”).

We computed separate multilevel models for self-reported and objective music listening predictors to increase statistical power, since self-reported and objectively assessed data on music listening did not always converge. We first fitted the unconditional model, which revealed that 68.3% of the total variance in stress was attributable to within-person variability (ICC (type 1) = 0.317). Then, in a first step, we entered music listening as Level-1 predictor to test its association with stress. In the second step, we included the variables assessing duration of music listening and the time lag between the last track that was listened to and the current signal. Besides time, all analyses controlled for study site and gender given the outlined methodological idiosyncrasies between the study sites and the unequal distribution of gender across the study sites (χ2(1) = 2.37, p = .124, Cramérs V = .20). We additionally included the lag-1 serial autocorrelation, that is the stress level reported at the last signal. Finally, we did not include random effects of the Level-1 predictors, because their inclusion did not improve model fit (χ2(3) = 4.35, p = .226 for the model with the subjective data and χ2(3) = 2.76, p = .430 for the model with the objective data).

As there are no widely accepted recommendations for computing statistical power in multilevel models, we opted for the general recommendation of having at least 50 participants to obtain acceptable estimates of standard errors of predictors []. P values of < 0.050 were considered significant. All tests were two-tailed.

Results

Compliance with the Ambulatory Assessment protocol was good [], with participants completing approximately 39 signals on average (83.3% compliance). To test whether the compliance deteriorated over the course of the study, we computed a multilevel logistic regression, in which the outcome was whether a participant responded to a presented signal (“1”) or not (“0”). Day of study and the signal number of a given day were included as predictors. According to this model, compliance did not deteriorate over the day (OR = 0.96, z = − 1.52, p = .129), but did deteriorate over the course of the study (OR = 0.89, z = −2.86, p = .004).

Descriptive Statistics

We compared the frequencies of self-reported and objectively assessed music listening episodes. Participants subjectively reported 692 episodes (38.5%) of music listening (either current or past music listening). However, the “Simple Last.fm Scrobbler” application registered only 486 episodes (26.9%) of music listening: Participants did not report 81 music listening episodes (4.6%) that were registered via Last.fm. At the same time, participants indicated 287 times (16.2%) that they were listening to music which was not registered via Last.fm. This indicates that participants possibly used other sources for music listening as well. Importantly, however, a chi-square test revealed a statistically significant relationship between self-reported and objectively assessed music listening, χ2(1) = 555.5, p < .001, Cramérs V = .56, which corresponds to a large effect size per convention (Cohen, 1988). The large effect size is also illustrated by an OR = 17.2, which indicates that it was 17.2 times more likely that an episode of music listening was registered via Last.fm. Thus, although there was a discrepancy between subjective and objective measures of music listening, the association between the two measures was significantly large and substantive.

Self-Reported Vs. Objectively Tracked Music Listening

As indicated in Table , the first step of the multilevel logistic regression using the self-report data on music listening revealed a significant negative association between music listening and stress. Participants indicated lower levels of stress when they reported current or past music listening (M = 1.09, SEM = 0.06) in comparison to no music listening (M = 1.19, SEM = 0.06). However, objectively assessed music listening via the “Simple Last.fm Scrobbler” application was not significantly associated with stress. Participants indicated similar stress levels when they reported current or past music listening (M = 1.13, SEM = 0.07) in comparison to no music listening (M = 1.10, SEM = 0.06). Thus, although the subjective data replicated previous evidence that music listening is associated with stress reduction, this association was not replicated using the objective measure of music listening.

Table 1.

Fixed Effects Estimates (Top) of Stress Levels as a Function of Music Listening, Temporal Distance and Duration

Stress was measured on a scale from 0 to 4. Duration represents how much participants listened to music between the current and the previous signal. Time Lag either compares music listening at the current signal with music listening prior to that (subjective measure) or the lag between the last played track and the current signal (objective measure). Chi-square tests reflect omnibus tests for the categorical subjective variable duration. All p-values are two-tailed

UC, unstandardized coefficient

Temporal Dynamics of Stress-Reducing Effects of Music Listening

Both self-reported and objective measures of music listening duration were significantly associated with stress (Table ). Participants reported significantly higher stress levels when they reported past music listening for less than 5 min (M = 1.15, SEM = 0.09) or 5–20 min (M = 1.17, SEM = 0.07) compared to music listening for 21–45 min (M = 0.98, SEM = 0.09) or more than 45 min (M = 0.85, SEM = 0.11). This was mirrored by the objective measure of duration, insofar as lower stress levels were associated with increasing duration of music listening. Compared to the subjective measures, the estimated marginal means showed that listening to music for less than 5 min was associated with the highest stress levels (M = 1.19, SEM = 0.08) compared to 5–20 min (M = 1.16, SEM = 0.08), 21–45 min (M = 1.11, SEM = 0.07), and 60 min (M = 1.03, SEM = 0.08). However, the effect size was larger for self-reported than for objectively assessed duration of music listening.

To test how long participants needed to listen to music in order to significantly detect an association with stress, we built another multilevel model with stress as the outcome and extended the categorical variable assessing duration by including data entries in which participants did not listen to music as the base category. This analysis is based on self-reported music listening. This model revealed that listening to music for less than 5 min, b = − 0.04, z = − 0.56, p = .577, and 5–20 min, b = − 0.04, z = − 0.07, p = .945, was not associated with reduced stress levels significantly, in contrast to listening for 21–45 min, b = − 0.18, z = − 2.44, p = .015, and more than 45 min, b = −0.34, z = −3.59, p < .001. Thus, these results suggest that music listening begins to be associated with reduced stress levels after around 20 min.

We also compared the descriptive statistics of the duration measures, which indicated that participants seemed to underestimate how long they listened to music. The mean objectively assessed duration of music listening was M = 24.5, SD = 19.5 when participants subjectively reported that they had listened to music for less than 5 min. Likewise, the objectively assessed mean duration was M = 33.2, SD = 28.3 when the self-reported duration was from 5 to 20 min, M = 46.9, SD = 36.84 for a self-reported duration of 21 to 45 min, and M = 81.1, SD = 50.2 for a self-reported duration of more than 45 min.

Next, we tested the latency of associations between stress and music listening. As a subjective measure of the latency of this association, we compared whether self-reported music listening at the current moment had a stronger association with reduced stress levels than having reported listening at a time point between the current and the previous signal. As indicated in Table , there was no significant difference for the self-report measure, insofar as stress levels did not differ depending on the time point of music listening. However, the objectively assessed time lag demonstrated a significant negative relationship with subjective stress levels, insofar as decreasing levels of self-reported stress were associated with an increasing time lag between the most recently played track and the current signal. These results demonstrate that beneficial associations between music listening and stress seem to occur in a time-delayed manner and not during the act of music listening per se.

Discussion

The first aim of the present research was to investigate whether associations between music listening and stress in daily life can be found when using either self-reported or objectively assessed data on music listening. This was not the case: Whereas self-reports on mere music listening were associated with lower stress reports, objectively assessed data on mere music listening were not associated with reduced levels of stress.

Although the self-reported and objective measures of music listening were largely concordant, there were notable discrepancies. On the one hand, participants subjectively reported more music listening episodes than were objectively sampled, and on the other hand, in some cases, they did not report music listening subjectively even though the objectively assessed data indicated music listening. This discrepancy might explain why only the subjective measure of music listening was negatively associated with stress. There are some possible explanations for this discrepancy between subjectively and objectively assessed data on music listening. First, it might be that participants sometimes forgot to report music listening. Second, it is possible that music listening was objectively recorded but participants did not actively listen to it (i.e., participants did not stop the music when interrupted by another activity). Third, it could be the case that participants did not always use the smartphone application for music listening, for example at a concert. Another potential explanation for the different associative patterns of the subjective and objective assessment of music listening and stress might lie in previous findings that music-induced emotions are a prerequisite for music to exert beneficial effects []: When reporting music listening subjectively, participants may think about the music they listened to and thus engage with music on a cognitive and emotional level. For objectively assessed music listening, it is not clear whether the music was consciously listened to. This might explain why stress-reducing associations of music listening seem to be limited to music that is subjectively reported. Another explanation might be related to potential placebo effects of music listening as health-beneficial effects of music listening are frequently presented in the public discourse. Thus, in this regard, the association between music listening and lower subjective stress ratings might reflect shared method variance with participants relating music listening to beneficial effects in terms of positive music-induced emotions and lower subjective stress levels. Furthermore, as music is ubiquitous in daily life, it might not be possible to objectively assess all music listening that occurs in the soundscape of participants. Thus, the results do not provide clear evidence that subjectively reported data on music listening are better than objectively assessed data, as a certain proportion of music listening was probably not captured by the application. Instead, we believe that the results demonstrate that self-report measures of music listening are a reliable and valid method of registering music listening in daily life, as they capture a broader range of situations in which individuals listen to music and reflect more conscious acts of music listening. However, future research should explore new approaches to objectively assess music listening in additional applications, for example by using the Electronically Activated Recorder [].

The second aim of the present study was to quantify how long individuals must listen to music in order to experience lower levels of stress and to explore the latency of these associations between music listening and stress. Concerning the duration of music listening, both subjectively and objectively assessed data revealed that with longer durations of music listening, individuals reported lower levels of stress, with a larger effect size for the subjective than for the objective assessment of duration. Our data further show that it seems necessary to listen to music for at least 20 min to show associations with stress. This association between duration and stress might explain why previous studies investigating the stress-reducing effects yielded inconsistent findings [] as studies vary hugely in terms of the duration for which music was employed. Thus, future research should investigate the moderating influence of duration of music listening, e.g., by conducting a meta-analysis or by experimentally manipulating the duration of music listening.

Besides duration, another important factor of music listening in our study was the time lag between music listening and the assessment of stress. Whereas, on a subjective level, we only distinguished momentary music listening from past music listening; a more fine-grained analysis of the exact time lags between music listening and the assessment of stress revealed that stress levels decreased with increasing time lags between the most recently played track and the current assessment of stress. This finding does not indicate that the positive association between music listening and stress disappears over time, but rather indicates that it increases. It might be that other processes, events, and acts in the less-controlled context of daily life mask the acute short-term effects of music listening on stress found in laboratory research [e.g., ]. Therefore, it might take some time before more persistent long-term associations between music listening and stress appear, similar to the results found for duration.

Future Directions and Outlook

Findings from this exploratory study can lead to hitherto neglected methodological hypotheses on the associations between music listening and stress. Thus, these findings should inspire future studies on music listening and stress—both experimental and Ambulatory Assessment studies—in order to gain more empirical evidence on methodological factors that may determine associations between music listening and stress. Furthermore, in order to prevent shared method variance from influencing the pattern of results, future studies should measure stress from a multimodal perspective by means of psychobiological stress measures in addition to mere self-reports. In addition to these methodological issues, the identification of confounders and moderators (e.g., personality factors) and a more detailed analysis of situational factors (e.g., the experience of stress before listening to music) are necessary in order to gain insights into both between-subject and within-subject processes concerning the complex associations between music listening and stress in daily life.

Strengths and Limitations

There are several limitations of the present study that warrant attention. First, as is common for intensive longitudinal data generated by Ambulatory Assessment, the correlational design cannot provide causal evidence for the effects of music listening on stress. Therefore, we cannot rule out alternative explanations, for instance that music listening co-varies with other factors possibly affecting stress. While our data cannot replace experimental studies on the stress-reducing effect of music listening, our study does provide evidence of the potential of such data for explaining the role of music listening on stress in naturalistic situations and confirms part of the experimental evidence outlined in the introduction with ecologically valid data. Second, to limit participant burden and to ensure compliance, we used short self-report scales, including a single-item measure of stress. Despite their frequent use in Ambulatory Assessment, single-item approaches limit reliability and predictive validity, especially of constructs that are multidimensional and broad in scope, such as stress []. Future research should assess stress more comprehensively. Furthermore, as stress is a multidimensional phenomenon, future studies should additionally assess physiological markers of stress to shed light on the mechanisms underlying the stress-reducing effect of music listening in daily life. Third, the variance of stress level was low, similar to findings from previous studies [, ]. Future studies should assess the associations between music listening and stress among different stressful situations, as was the case in a previous study in which students were investigated repeatedly during different stressful times of the university term []. Finally, the procedures at the two study sites differed in some aspects, such as smartphone or iPod touch application and study days, which may have affected the results. However, including study site as a control variable did not reveal significant differences between the study sites in the variables of interest, which, in our view, justifies the aggregation of the two samples.

Conclusions

Our findings suggest that only subjectively assessed data on mere music listening was associated with lower subjective stress levels, possibly because the subjective reports captured more instances of music listening besides the smartphone/iPod application and because the participants re-engaged with the music on a cognitive and emotional level. However, when temporal dynamics of this association are of interest, subjectively reported data on music listening should be complemented by objective data on the exact time of music listening. Nevertheless, as music is ubiquitous in daily life, it remains challenging to objectively assess all music listening that occurs.

Acknowledgements

Open Access Funding provided by University of Vienna. This research was supported by the early-stage researcher peer mentoring grant awarded to MW and AL by the Health Psychology section of the German Psychological Association.

Compliance with Ethical Standards

This study has been approved by the respective local ethics committees of the study sites and has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

All persons gave their informed consent prior to their inclusion in the study. There are no details in this text that might disclose the identity of the subjects under study.

Conflict of interest

All authors declare that they have no conflict of interest related to the study.

Footnotes

1

Since participants reported lower levels of stress on weekends, we additionally included weekend as a binary control variable. However, this inclusion did not change the presented results, that is none of the presented significant results became insignificant and vice versa.

Alexandra Linnemann and Mario Wenzel contributed equally to this work.

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The menstrual cycle is closely linked to a person's age, with notable changes occurring across the lifespan. Initially, during adolescence, cycles tend to be irregular and may be longer or shorter than the typical 28 days. As women mature, cycles usually become more regular and stabilize in early adulthood. However, as women approach perimenopause, typically in their late 30s and early 40s, cycles can become more variable, potentially lengthening, shortening, or becoming irregular. Finally, during menopause, which usually occurs around age 51, menstruation ceases altogether.

Here's a more detailed breakdown:

Adolescence:

Irregularity:

Menstrual cycles are often irregular in the first few years after menarche (the first period).

Cycle Length Variability:

Cycle lengths can fluctuate significantly, ranging from shorter to longer than the typical 28 days.

Possible Causes:

This variability is due to hormonal fluctuations and the reproductive system still maturing.

Early Adulthood:

Regularization: Menstrual cycles tend to become more predictable and regular in length.

Average Cycle Length: The average cycle length is generally around 28 days, though variations within a few days are also considered normal.

Perimenopause:

Hormonal Shifts:

As women approach menopause, their bodies begin to produce less estrogen and progesterone, leading to hormonal shifts.

Cycle Irregularity:

These hormonal changes can cause cycles to become longer or shorter, more frequent or less frequent, and potentially heavier or lighter.

Transition Period:

Perimenopause is a transitional period that can last for several years leading up to menopause.

Menopause:

Cessation of Periods: Menopause marks the end of menstruation, typically occurring around age 51.

No More Ovulation: The ovaries stop producing eggs, and periods cease.

Factors Influencing Menstrual Cycle Changes:

Age:

Age is a primary factor influencing menstrual cycle patterns, as described above.

Hormonal Fluctuations:

Hormones play a crucial role in regulating the menstrual cycle, and changes in hormone levels can affect cycle length, regularity, and flow.

Overall Health:

Factors like weight, stress, and underlying medical conditions can also influence menstrual cycle patterns.

Menstrual cycles and associated symptoms change throughout a person's life, influenced by age and fluctuating hormone levels. Menstrual cycles are typically longest and most irregular in the years following menarche (first period), gradually becoming shorter and more regular as a person ages, then becoming irregular again as menopause approaches. Symptoms like breast tenderness, mood swings, and sleep disturbances can also vary in intensity and frequency across different life stages.

Changes in Menstrual Cycle Length and Regularity:

Early Menarche:

In the first few years after menarche, cycles are often longer and more irregular, sometimes taking up to three years to become regular.

Adolescence and Young Adulthood:

As a person approaches adulthood, cycles tend to shorten and become more regular, with the average cycle length reaching around 28 days.

Midlife:

As women approach menopause, cycles can become longer, shorter, or more irregular, with skipped periods becoming more common.

Menopause:

Menopause marks the end of menstruation, and the transition can bring a range of symptoms like hot flashes, mood changes, and sleep disturbances.

Changes in Menstrual Cycle Symptoms:

Breast Tenderness:

Breast tenderness may be most common in the teenage years but can be more severe in the late 30s and early 40s.

Mood Changes:

Mood swings, irritability, and increased risk of depression are common, especially during perimenopause.

Sleep Disturbances:

Sleep disturbances, including difficulty falling asleep or staying asleep, tend to increase with age, particularly during the menopausal transition.

Other Symptoms:

Other symptoms that can change with age include bloating, fatigue, and changes in appetite.

Factors Influencing Menstrual Cycles and Symptoms:

Age at Menarche:

Early or late menarche can be associated with differences in cycle length and regularity.

Body Mass Index (BMI):

Higher BMI has been linked to longer and more variable menstrual cycles.

Other Medical Conditions:

Certain medical conditions and medications can also affect menstrual cycle characteristics.

Lifestyle Factors:

Vigorous physical activity may be associated with more regular cycles, while standing work and heavy lifting can be associated with increased cycle irregularity.

Understanding these age-related changes in menstrual cycles and associated symptoms can help individuals better manage their reproductive health and overall well-being throughout their lives.

Locations:

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Menopause

Menopause

Menopause is a point in time when a person has gone 12 consecutive months without a menstrual period. Menopause is a natural part of aging and marks the end of your reproductive years. On average, menopause happens at age 52.

Care at Cleveland Clinic

Contents

Overview

Lynn Pattimakiel, MD, explains the common symptoms associated with menopause and the importance of monitoring them.

What is menopause?

Menopause is a point in time when you’ve gone 12 consecutive months without a . It happens, on average, at age 52. It’s a natural process that occurs when your  stop producing reproductive . When menopause happens due to surgery or medical treatment, it’s called induced menopause.

Hormonal changes due to menopause can cause uncomfortable physical and emotional symptoms. There are treatments available to help with symptoms of menopause, like , medication or lifestyle adjustments.

What are the three stages of menopause?

Menopause is the permanent ending of menstruation. If it doesn’t happen because of any type of medical treatment or surgery, the process is gradual and happens in three stages:

or “menopause transition:” Perimenopause can begin eight to 10 years before menopause when your ovaries gradually produce less and less estrogen. It usually starts when you’re in your 40s. You can be in perimenopause for several months or several years. Many people begin feeling symptoms like irregular periods, hot flashes and mood swings in perimenopause.

Menopause: Menopause is the point when you no longer have menstrual periods. At this stage, your ovaries don’t release eggs, and your body doesn’t produce much estrogen. A healthcare provider diagnoses menopause when you’ve gone without a period for 12 consecutive months. Unlike the other stages, menopause itself is a defined moment, so you don’t stay in this stage.

: This is the time after menopause. You stay in postmenopause for the rest of your life. While most symptoms of menopause ease up in postmenopause, you can continue to have mild menopausal symptoms for several years in postmenopause. People in the postmenopausal phase are at an increased risk for osteoporosis and heart disease due to  levels.

What is premature menopause?

Menopause, when it occurs between the ages of 45 and 55, is considered “natural” and is a normal part of aging. Menopause that occurs before the age of 45 is called early menopause. Menopause that occurs at 40 or younger is considered . When there’s no medical or surgical cause for premature menopause, it’s called .

What is the average age for menopause?

The average age of menopause in the United States is 52 years old. But the transition to menopause usually begins in your mid-40s.

How long does menopause last?

Menopause is a point in time, so you don’t stay in menopause. You reach it when you haven’t gotten a menstrual period for one year. Immediately after you reach menopause, you move into postmenopause. This stage lasts for the rest of your life.

Symptoms and Causes

There are several symptoms that may mean you’re transitioning into menopause.

What are the signs of menopause?

You may be transitioning into menopause if you begin experiencing some or all of the following symptoms:

or periods that are heavier or lighter than usual

, also known as vasomotor symptoms (a sudden feeling of warmth that spreads over your body)

and/or cold flashes

that causes

Urinary urgency (a pressing need to pee more frequently)

Difficulty sleeping ()

Emotional changes (irritability, mood swings or )

Dry skin, dry eyes or dry mouth

Worsening  (PMS)

Breast tenderness

Some people might also experience:

Racing heart

Joint and muscle aches and pains

Changes in libido ()

Difficulty concentrating or memory lapses (often temporary)

Weight gain

Changes in your hormone levels cause these symptoms. Some people have intense symptoms of menopause, while others have mild symptoms. Not everyone will have the same symptoms as they transition to menopause.

Contact a healthcare provider if you’re unsure if your symptoms are related to menopause or another health condition.

How long do you have symptoms of menopause?

You can have symptoms of menopause for up to 10 years before it officially occurs. The average length of menopause symptoms is about seven years. Most women say their symptoms ease up or disappear completely once they reach postmenopause.

What makes menopause symptoms worse?

It depends on your symptoms. For example, if hot flashes and sweating are your main symptoms, you may want to avoid warm environments or stop eating spicy foods. If you have symptoms like anxiety or insomnia, you may find that relaxing activities like yoga or reading before bed help calm your mind and lead to a more peaceful sleep.

Some women find keeping a journal of symptoms helps them identify what causes their symptoms to worsen. Then, you can take steps to avoid certain activities that make your menopause symptoms worse.

How do I know if I’m in menopause?

You’ll know you’ve reached menopause when you’ve gone 12 consecutive months without a menstrual period. Contact your healthcare provider if you have any type of vaginal bleeding after menopause.  after menopause could be a sign of a more serious health issue.

Why does menopause happen?

When menopause happens on its own (natural menopause), it’s a normal part of aging. Menopause is defined as a complete year without menstrual bleeding, in the absence of any surgery or medical condition that may cause bleeding to stop, like hormonal , chemotherapy or . Surgical  will result in menopause if your surgeon removes both ovaries.

As you age, your reproductive cycle begins to slow down and prepares to stop. This cycle has been continuously functioning since puberty. As menopause nears, your ovaries make less . When this decrease occurs, your menstrual cycle (period) starts to change. It can become irregular and then stop.

Physical changes can also happen as your body adapts to different hormone levels. The symptoms you experience during each stage of menopause are all part of your body’s adjustment to these changes.

What hormonal changes happen during menopause?

The traditional changes we think of as “menopause” happen when your ovaries no longer produce high levels of hormones. Your ovaries produce the hormones estrogen and . Together, estrogen and progesterone control menstruation. Estrogen also influences how your body uses calcium and maintains cholesterol levels in your blood.

As menopause nears, your ovaries no longer release eggs, and you’ll have your last menstrual cycle.

Diagnosis and Tests

How is menopause diagnosed?

There are several ways your healthcare provider can diagnose menopause. The first is discussing your menstrual cycle over the last year. Menopause is unique in that your provider will diagnose it after it occurs. If you’ve gone a full year (12 straight months) without a period, you’ve entered menopause and are postmenopausal.

that check certain hormone levels can suggest that you’ve reached menopause. Usually, though, blood work isn’t necessary. In some situations, blood tests can be misleading because so many hormonal fluctuations occur during the perimenopause stage. Your provider may want to check hormone levels if they suspect an underlying health condition may be causing your symptoms.

Management and Treatment

What are treatments for menopause?

Menopause is a natural process that your body goes through. In some cases, you may not need any treatment for it. When discussing treatment for menopause with your healthcare provider, it’s about treating the symptoms of menopause that disrupt your life. There are many different types of treatments for managing menopause symptoms. The main types are:

(HT). A term used for hormones offered to those going through menopause at natural ages (after age 45).

Hormone replacement therapy (HRT). The word replacement is added when using hormones to treat menopause which occurs at a young age, especially before age 40.

.

It’s important to talk to your provider while you’re going through menopause to craft a treatment plan that works for you. Every person is different and has unique needs. People experiencing menopause before age 40 should be offered hormone replacement therapy, except in rare circumstances (such as a personal history of breast cancer at a young age).

What is hormone therapy for menopause like?

During menopause, your body goes through major hormonal changes — decreasing the amount of hormones it makes. When your ovaries no longer make enough estrogen and progesterone, hormone therapy can make up for lost hormones. Hormone therapy boosts your hormone levels and can help with symptoms like hot flashes and vaginal dryness. It can also help prevent osteoporosis.

There are two main types of hormone therapy:

Estrogen therapy (ET): In this treatment, you take estrogen alone. Your provider prescribes it in a low dose. Estrogen comes in many forms, such as a patch, pill, cream, vaginal ring, gel or spray. Estrogen therapy can’t be used alone (without a progestogen) if you still have a .

Estrogen progestogen therapy (EPT): This treatment is also called combination therapy because it uses doses of estrogen and a hormone similar to progesterone. Progesterone is available in its natural form or also as a progestin (a synthetic form of progesterone). Progestogen is a general name for treatments that can include both natural progesterone and synthetic progestins. This type of hormone therapy is for those who still have their uteruses.

There are risks to hormone therapy. Talk to your provider about the risks and benefits and whether hormone therapy is an option for you based on your health history, age and other factors.

What are nonhormonal treatments for menopause?

Though hormone therapy is an effective method for relieving menopause symptoms, it’s not the perfect treatment for everyone. Nonhormonal treatments include things like lifestyle changes and nonhormonal medications. These treatments are often good options for women who have medical reasons to avoid estrogen, including a personal history of blood clots or receiving  treatment. Some of the nonhormonal treatments that your provider may recommend include:

Changing what you eat

Avoiding triggers to hot flashes

Getting regular physical activity or exercise

Joining support groups

Prescription medications

Cognitive behavioral therapy (CBT)

Hypnotherapy

Changing what you eat and drink

Sometimes, changing what you eat can help relieve menopause symptoms. Limiting the amount of  you consume daily and cutting back on spicy foods can make your hot flashes less severe. You can also eat more foods that contain phytoestrogens (nutrients that have estrogen-like properties in the human body). Foods to try include:

Soybeans

Chickpeas

Lentils

Flaxseed

Grains

Beans

Fruits

Vegetables

Avoiding triggers for hot flashes

Certain things in your daily life may trigger hot flashes. To help relieve your symptoms, try to identify these triggers and work around them. This could include keeping your bedroom cool at night, wearing layers of clothing or . Maintaining a weight that’s healthy for you can also help with hot flashes.

Exercising

Exercise can be difficult if you’re dealing with hot flashes, but getting regular physical activity can help relieve several other symptoms of menopause. Any type of physical activity is good for you, even yard work or swimming laps in a pool. Calm, tranquil types of movement like yoga can also help with your mood and relieve anxiety.

Joining support groups

Talking to other women who are also transitioning to menopause can be a great relief for many people. Joining a support group can give you an outlet for the many emotions running through your head and may also help answer questions you may not even know you have. Be careful about joining groups that are not led by a menopause specialist.

Taking prescription medications

There are nonhormonal prescriptions you can get from your healthcare provider that improve menopause symptoms. Some of them are:

to help balance hormones

( and ) to manage symptoms like mood swings and hot flashes

(a seizure medication) or fezolinetant to treat hot flashes

Oxybutynin. A medication for overactive bladder that also treats hot flashes

Vaginal creams and lubricants to help with vaginal dryness

Speak with your provider to see if nonhormonal medications could help manage symptoms.

Outlook / Prognosis

What is the best thing to do for menopause?

Everyone experiences menopause differently. Because it’s so unique, there isn’t one best thing you can do for it. There are many different approaches to treating bothersome symptoms of menopause. What works for you may not work for your sister or best friend.

Talk to your healthcare provider about your symptoms and let them recommend what’s best based on your situation.

What are the health risks of menopause?

You’re at higher risk for conditions like osteoporosis and cardiovascular diseases after menopause. This is mainly due to low estrogen levels. Your healthcare provider may want to keep a close eye on your health to make sure your risk levels for these conditions isn’t too high. They may even prescribe treatment as necessary.

Osteoporosis

occurs when the insides of your bones become less dense, making them more fragile and likely to . Estrogen plays an important role in preserving bone mass. Estrogen signals cells in the bones to stop breaking down.

On average, you'll lose 25% of your bone mass from the time of menopause to age 60. This is largely because of the loss of estrogen. Your healthcare provider may want to test the strength of your bones over time. Bone mineral density testing, also called , is a quick way to see how much calcium you have in certain parts of your bones.

Cardiovascular diseases

After menopause, your risk for  tends to increase because of several things, including:

The loss of estrogen

Increased

Certain lifestyle habits like smoking cigarettes, drinking alcohol or eating unhealthy foods (if these habits apply to you)

A decrease in physical activity, which can lead to  and other conditions (depending on your activity levels after menopause)

Living With

When should I see my healthcare provider?

Contact your healthcare provider if symptoms of menopause are bothering you and affecting your quality of life. Most women begin the transition to menopause with mild symptoms like irregular periods or changes to their typical menstrual cycle. But symptoms can become severe and interrupt your daily life. Your provider can recommend treatments to help ease your symptoms.

Irregular vaginal bleeding can sometimes be a sign of other health conditions. Your healthcare provider may want to be sure menopause is causing your symptoms. You should contact your provider as a precaution if you have any of the following symptoms:

Your periods become much heavier than usual.

You pass several large blood clots (larger than a quarter).

You have your period for longer than seven days.

The length of time between your periods is less than 21 days.

You skip periods before the age of 45.

You bleed or spot between periods.

You bleed after sex.

What questions should I ask my healthcare provider?

Some questions you may want to ask your provider include:

How do I know when I’ve reached menopause?

What kind of treatments will help my symptoms?

Is hormone therapy an option for me?

How long should I expect my symptoms to last?

Do you recommend any lifestyle changes?

How do I know that this is menopause and not something else?

Additional Common Questions

Can I get pregnant during menopause?

Yes. Until you know for sure that you’ve completed menopause, there’s a chance of pregnancy. If you don’t want to become pregnant, continue to use some form of  until you’re sure you’ve gone through menopause.

Can menopause affect sleep?

Yes, you can experience trouble sleeping during menopause. This can be a normal side effect of menopause itself, or it could be due to another symptom of menopause. Hot flashes are a common culprit of sleepless nights during menopause.

Can menopause affect my sex life?

Yes, it can. Your declining hormone levels may affect how pleasurable sex is to you. Symptoms like vaginal dryness can make sex painful or uncomfortable. Not all women experience a decreased sexual desire. In some cases, it’s just the opposite. This could be because there’s no longer any fear of getting pregnant like there was before menopause. For many, this allows them to enjoy sex without worrying about family planning.

Don’t be afraid to talk to your healthcare provider about your sex drive or how sex feels. Your provider will discuss options to help you feel better.

Does menopause cause weight gain?

It may. . For example, you may start to lose muscle as you get older, which can affect how your body gains weight.

Are there any emotional changes that can happen during menopause?

Menopause can cause a variety of emotional changes, including:

A lack of motivation and difficulty concentrating

Anxiety, depression, mood changes and tension

Aggressiveness and irritability

These emotional changes can happen outside of menopause, too. You’ve probably experienced some of them throughout your life.

Your healthcare provider may be able to prescribe a medication to help you. It may also help to just know that there’s a name for the feelings you’re experiencing. Support groups and counseling are useful tools when dealing with emotional changes during menopause.

During your conversation, your provider will tell you about different treatment types and check to make sure there isn’t another medical condition causing your depression.

Do men go through menopause?

Andropause, or male menopause, is a term that describes decreasing testosterone levels in men. Testosterone production in men declines about 1% per year — much more gradually than estrogen production in women. Healthcare providers often debate calling this slow decline in testosterone “menopause” since it’s not as drastic of a hormone shift and doesn’t carry the same intensity of side effects. Some men won’t even notice the change because it happens over many years or decades. Other names for the male version of menopause are age-related , male hypogonadism or androgen deficiency.

A note from Cleveland Clinic

Menopause is a natural and normal part of the aging process. But knowing it’s going to happen doesn’t make it easier. The physical and emotional symptoms of menopause can be challenging and uncomfortable for many people. Fortunately, there are many treatments available to help you deal with the disruptive symptoms of menopause.

You don’t have to cope with menopause alone. Talk to your healthcare provider about the symptoms you’re experiencing and how they impact your quality of life. They can recommend treatments to manage your symptoms and make you feel better.

Care at Cleveland Clinic

Menopause is natural, but it also can disrupt your life. Cleveland Clinic is here to help you get relief.

Help

Article preview

Available online 23 January 2025

What’s this?

Original Research

Gynecology

Menstrual cycle characteristics across the reproductive lifespan and cognitive function in midlife women

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Background

Menstrual cycle characteristics are potential indicators of hormonal exposures and may also signal cardiovascular disease risk factors, both of which are relevant to cognitive health. However, there is scarce epidemiological evidence on the association between cycle characteristics and cognitive function.

Objective

We studied the associations of menstrual cycle characteristics at 3 stages of a woman's reproductive lifespan with cognitive function in midlife.

Study design

We studied participants from the Nurses' Health Study II, an ongoing longitudinal cohort of female nurses initially enrolled in 1989. Exposures were cycle regularity at 14 to 17 and 18 to 22 years, and cycle length (the interval between 2 consecutive cycles) at 18 to 22 years (all retrospectively reported at enrollment), and current cycle regularity and length at 29 to 46 years (reported in 1993). Outcomes were composite z scores measuring psychomotor speed/attention and learning/working memory obtained with 1 self-administered Cogstate Brief Battery assessment, measured among a subset of participants in 2014 to 2022. We included 19,904 participants with data on at least 1 menstrual cycle characteristic and a cognitive assessment. We estimated mean differences (β, 95% confidence intervals) using linear regression models adjusted for age at cognitive assessment, race and ethnicity, participants' education, wave of cognitive assessment, parental education and occupation, neighborhood socioeconomic status, age at menarche, adiposity, oral contraceptive use, and lifestyle factors (smoking, alcohol intake, physical activity, diet quality).

Results

In the analytical sample, the mean (standard deviation [SD]) age at cognitive assessment was 62.0 (4.9) years. Women with irregular cycles at 29 to 46 years scored lower in learning/working memory (β, −0.05 SD; 95% confidence interval, −0.08 to −0.01) than those with very regular cycles. We did not observe associations for cycle regularity at 14 to 17 or 18 to 22 years. Women with cycle length ≤25 days at 18 to 22 years scored lower in learning/working memory in later life (β, −0.05 SD; −0.09 to −0.02) than those with cycles 26 to 31 days. We did not observe associations of cycle length at 29 to 46 years with later cognitive function. In a secondary analysis, women whose cycles were regular at 14 to 17 or 18 to 22 years but became irregular by 29 to 46 years also had lower learning/working memory scores, compared to women whose cycles remained regular across time points.

Conclusion

In this large longitudinal study, cycles ≤25 days at 18 to 22 years and irregular cycles at 29 to 46 years were associated with lower performance in learning/working memory. Future studies in other populations should confirm our findings and investigate the biological processes underlying these associations.

Introduction

Dementia is a significant and growing health concern affecting around 57 million individuals globally.1,2 Women are affected by dementia 1.7 times more than men,1 leading to questions about the role of female-specific reproductive exposures in this disparity.3,4

AJOG at a Glance

Menstrual cycle characteristics might indicate hormonal exposures relevant to cognitive health, but limited evidence exists on the association between cycle characteristics and cognitive function.

Cycle characteristics during adulthood, specifically cycles ≤25 days at 18 to 22 years and irregular cycles at 29 to 46 years, were associated with lower learning/working memory performance.

Our study enhances the limited evidence on the relationship between cycle characteristics and cognitive function in later life by identifying associations between specific cycle characteristics during adulthood and lower learning/working memory in midlife. These findings underscore the potential impact of reproductive factors on cognitive health. Future research should aim to validate these findings and delve deeper into the underlying biological mechanisms.

Menstrual cycle characteristics during the reproductive years are potential indicators of hormonal exposures relevant to cognitive health and possibly dementia. Estrogens have neuroprotective effects and influence different aspects of cognition, such as verbal memory, fluency, and fine motor skills.5, 6, 7 Altered menstrual cycle regularity or length may reflect disruption in the hypothalamic-pituitary-ovarian axis and signal an imbalance in hormone levels, including reduced estrogen levels, that could contribute to a later risk of cognitive impairment and dementia.7, 8, 9 These hormonal imbalances and altered menstrual cycles might result from conditions such as polycystic ovary syndrome (PCOS), which is characterized by irregular cycles and high levels of androgens and has been associated with poor cognitive performance.10,11 Beyond their reflection of reproductive hormones, menstrual cycle characteristics can also be associated with cognitive outcomes through risk factors like type 2 diabetes (T2D) and cardiovascular disease.12, 13, 14, 15

Despite the plausible associations between menstrual cycle characteristics and cognitive function, epidemiologic evidence is limited.16 We examined the association between menstrual cycle characteristics at 3 stages of a woman's reproductive lifespan and cognitive function in midlife, using data from the Nurses' Health Study II (NHS II).

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Section snippets

Participants

The NHS II is an ongoing cohort of 116,429 female nurses aged 25 to 42 years at enrollment in 1989. Participants complete mailed or online questionnaires biennially.17 We assessed cognitive function in a substudy with 2 enrollment waves, 2014 to 2019 or 2018 to 2022. Appendix A in the supplement describes details regarding this substudy. Of 20,282 participants with 1 cognitive assessment, we excluded those with all menstrual cycle characteristics missing (n=7) and those diagnosed with cancer by

Results

In the analytical sample of 19,904 participants, the mean age (SD) at cognitive assessment was 62 (4.9) years (range, 50–74 years). At 29 to 46 years, 12.5% of the participants had irregular cycles, and compared to those with very regular cycles, they had a higher BMI, were older at exposure and outcome assessment, were more likely to report gynecologic conditions, and were less likely to use OC (Table 1). Cycles ≤25 days and ≥32 days were present in 16.7% and 14.2% of the participants,

Conclusions

In this cohort of US women, we found that cycles ≤25 days at 18 to 22 years and irregular cycles at 29 to 46 years were associated with lower performance in learning/working memory in midlife. These findings are important because memory impairment is characteristic of AD, the leading cause of dementia. It is crucial for future research to validate and further explore the biological mechanisms behind these associations.

CRediT authorship contribution statement

Diana C. Soria-Contreras: Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. Siwen Wang: Writing – review & editing, Data curation, Conceptualization. Makiko Mitsunami: Writing – review & editing, Conceptualization. Jiaxuan Liu: Writing – review & editing, Data curation, Conceptualization. Rebecca B. Lawn: Writing – review & editing, Data curation, Conceptualization. Jan L. Shifren: Writing – review & editing, Conceptualization. Alexandra C. Purdue-Smithe:

Acknowledgments

Data and/or research tools used in the preparation of this manuscript were obtained from the National Institute of Mental Health (NIMH) Data Archive (NDA). NDA is a collaborative informatics system created by the National Institutes of Health to provide a national resource to support and accelerate research in mental health. Dataset identifier(s): 10.15154/3akz-3b81. This manuscript