
A Survey of Well-being and Quality of Life in Middle Age and Older Adults: The Role of ADL and Gerontology

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Abstract

This survey paper explores the multifaceted nature of well-being and quality of life among middle-aged and older adults, emphasizing the importance of maintaining independence through Activities of Daily Living (ADL) and gerontology. It underscores the interdisciplinary approach required to address the physical, mental, and social dimensions of aging. Technological advancements, such as Information and Communication Technology (ICT) and social robots, are highlighted for their role in enhancing life quality by providing companionship and supporting daily activities. The paper also examines the impact of social connections and community engagement on life satisfaction, emphasizing the need for robust support networks. Furthermore, it discusses the integration of technology in ADL assessments and the challenges associated with implementing these technologies, such as high costs and the need for extensive datasets. The survey advocates for innovative interventions, including virtual and augmented reality, to improve ADL and cognitive health. Ethical and policy considerations are addressed, highlighting the importance of user privacy and equitable access to resources. Future research directions are proposed, focusing on expanding datasets, refining methodologies, and fostering interdisciplinary collaboration to enhance the understanding of aging and improve the well-being of older adults. By integrating diverse academic and practical perspectives, the paper aims to provide a comprehensive framework for supporting the independence and life satisfaction of aging populations.

1 Introduction

1.1 Importance of Enhancing Life Quality and Independence

Enhancing life quality and maintaining independence are critical for successful aging, significantly impacting overall well-being and social integration. Information and Communication Technology (ICT) plays a pivotal role in this context, offering tools that improve individual well-being and economic growth, thereby fostering independence among older adults [1]. While digital devices present opportunities for health enhancement [2], research must address limitations such as small sample sizes and inadequate measurement techniques. Subjective well-being (SWB) surveys provide valuable insights into personal satisfaction and happiness, complementing traditional indicators and offering a comprehensive understanding of life quality [3]. Personalized activities in nursing facilities have been shown to significantly enhance social interactions and overall life quality [4], highlighting the importance of tailored interventions.

The introduction of robots to assist with daily activities and provide companionship represents a significant advancement in enhancing life quality, particularly in mitigating social isolation exacerbated by the COVID-19 pandemic. However, material prosperity does not necessarily equate to societal well-being or individual happiness [5], necessitating holistic approaches that consider multiple well-being dimensions. Innovative methods, such as real-time sentiment measurement using

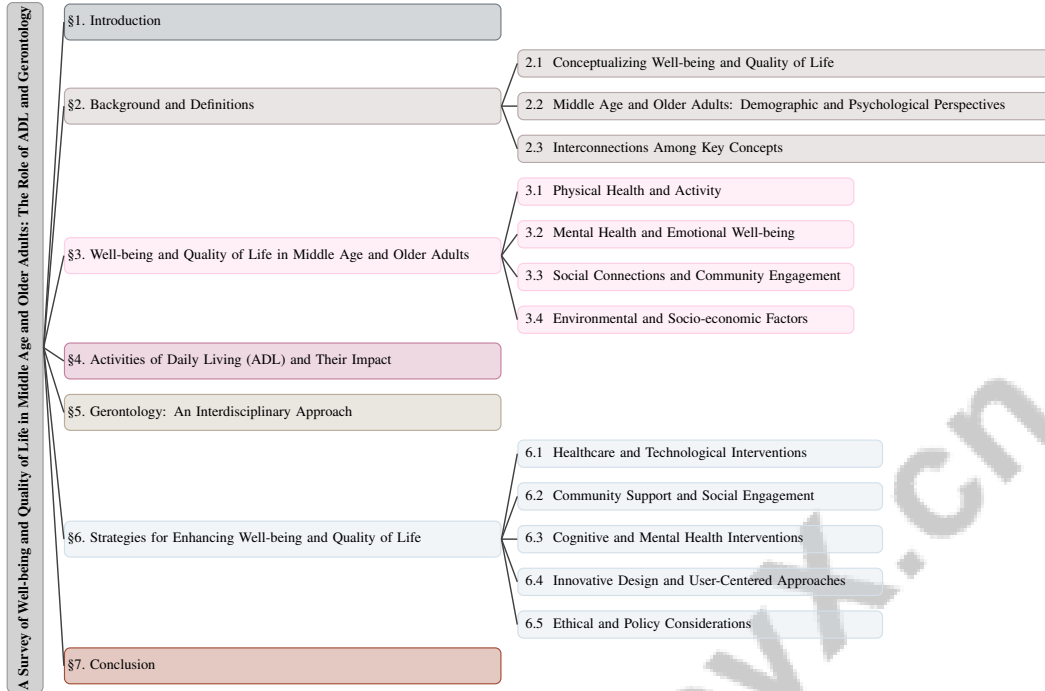


Figure 1: chapter structure

text data, are essential for capturing the nuances of welfare and improving the lives of older adults [6]. Adherence to WHO-recommended moderate physical activity levels is crucial for maintaining independence and improving quality of life [7]. The growing elderly population demands timely assistance and interventions to support home-based independence, facilitated by ambient technologies designed to meet their specific needs [8]. These diverse approaches, encompassing technological, psychological, and social dimensions, underscore the multifaceted nature of enhancing life quality and independence for older adults, necessitating personalized strategies tailored to individual needs to foster autonomy and well-being.

1.2 Interdisciplinary Nature of Well-being Studies

Investigating well-being and quality of life among middle-aged and older adults requires an interdisciplinary approach that synthesizes insights from physical, mental, and social domains. This methodology is essential for addressing the complexities of aging and the various factors influencing life satisfaction and independence. The integration of user interface design and psychology exemplifies this interdisciplinary approach, enhancing human well-being by improving user interactions with technology [9]. The relationship between social capital and mental health further illustrates the interconnectedness of these domains in promoting well-being [10].

The perception of social robots as complements to human interaction highlights the interdisciplinary nature of this field, merging the psychological impacts of loneliness with technological solutions [11]. This convergence of psychological insights and technological advancements is crucial for developing interventions that enhance older adults' quality of life. By categorizing social robots as tools to alleviate loneliness, this study bridges the gap between technological innovation and psychological well-being.

Incorporating diverse fields into well-being studies enables a comprehensive understanding of the factors contributing to life satisfaction and independence. This interdisciplinary framework is vital for formulating effective strategies and interventions to tackle the multifaceted challenges of aging. By integrating insights from technology, psychology, and social science, the framework addresses the diverse physical, mental, and social needs of middle-aged and older adults. For instance, technology can facilitate social participation, crucial for enhancing well-being and mitigating risks associated with loneliness and isolation, while psychological models of well-being inform the development of supportive environments that promote emotional and social health. Understanding older adults'

specific requirements in digital health contexts can lead to more tailored and effective interventions that enhance their quality of life [12, 13, 14].

1.3 Structure of the Survey

This survey provides a comprehensive exploration of well-being and quality of life in middle-aged and older adults, with a focus on Activities of Daily Living (ADL) and gerontology. It is organized into several key sections addressing critical aspects of aging. The introduction emphasizes the significance of maintaining independence and enhancing life quality while highlighting the interdisciplinary nature of well-being studies. The subsequent section offers a detailed overview of essential concepts such as well-being, quality of life, and gerontology, establishing a foundation for understanding their interconnections.

Following this, the survey examines factors influencing well-being and quality of life, including physical health, mental health, social connections, and environmental factors. An in-depth analysis of ADL explores its impact on independence and quality of life, discussing technological advancements and innovative interventions in ADL assessments. The survey then transitions to gerontology, emphasizing its interdisciplinary approach and the integration of technology to address aging challenges.

Finally, the survey reviews strategies for enhancing well-being and quality of life, covering healthcare interventions, community support, cognitive health strategies, and ethical considerations. The conclusion synthesizes key findings, underscoring the necessity of a holistic approach to aging that encompasses physical, mental, and social well-being. It emphasizes the critical role of comprehensive health monitoring systems, such as those developed for detecting undernutrition and analyzing wellness in elderly populations, and suggests future research directions to refine these methodologies for improved health outcomes and support the flourishing of older adults [15, 16, 14, 17, 18]. This structured approach ensures a thorough examination of the multifaceted aspects of aging, providing valuable insights for both academic and practical applications. The following sections are organized as shown in Figure 1.

2 Background and Definitions

2.1 Conceptualizing Well-being and Quality of Life

Well-being and quality of life are pivotal constructs in gerontology, encapsulating the multifaceted health and satisfaction dimensions among older adults. Well-being spans psychological, physical, and social aspects, crucial for assessing life satisfaction and health outcomes in aging populations. The psychological dimension is intricately linked to social experiences, with research highlighting how social isolation and loneliness detrimentally impact mental health. Studies on nurses' social experiences underscore the vital role of social factors in shaping quality of life perceptions [19].

Technological advancements play a crucial role in enhancing well-being, offering innovative solutions for monitoring and improving life satisfaction. The Feel Good Factor (FGF), derived from real-time sentiment analysis of social media, serves as a contemporary metric for assessing well-being and quality of life [6]. While smartphone data establishes normative patterns offering predictive insights into life satisfaction, excessive use may adversely affect mental health and social interactions [20]. Applying user interface design principles to encourage positive behavior change illustrates how digital tools can enhance well-being through improved user interactions [9].

Quality of life integrates subjective and objective measures, influenced by physical health, social relationships, and environmental conditions. The capacity to live independently is crucial, supported by systems providing timely non-medical assistance to the elderly, thereby preserving autonomy [8]. A novel analytical framework for nowcasting well-being through mobile phone data offers a unique approach to monitoring socio-economic development and its implications for quality of life [21].

Quantifying subjective well-being via social media sentiment analysis reveals complexities in capturing emotional states and perceptions of quality of life [22]. Despite rising material wealth, declining average well-being underscores the need for holistic approaches considering broader societal factors beyond economic indicators [5].

A comprehensive understanding of well-being and quality of life in aging populations necessitates an integrated approach encompassing social, economic, psychological, and technological factors.

Recognizing the emotional, social, physical, and mental well-being needs of older adults is essential for developing targeted interventions that effectively address their complex requirements. Such interventions can significantly enhance life satisfaction and health outcomes by leveraging insights from psychological well-being research, technological advancements in health monitoring, and a holistic approach to undernutrition detection and prevention, thereby promoting healthy aging and aligning with national public health objectives aimed at improving overall well-being in the aging population [15, 14, 23, 13, 18].

2.2 Middle Age and Older Adults: Demographic and Psychological Perspectives

Understanding the demographic and psychological characteristics of middle-aged and older adults is crucial for addressing their diverse needs and challenges. As individuals transition into older adulthood, their varying degrees of familiarity and comfort with technology significantly influence the design of interventions and support systems [13]. Technological innovations, such as tangible interfaces and IoT sensors integrated with machine learning, present promising opportunities for enhancing mental well-being technologies tailored to older adults, provided these innovations are customized to align with their unique preferences and competencies [24].

Psychologically, aging brings shifts in cognitive and emotional dynamics. A critical concern is the shortage of caregivers, which can lead to disengagement from cognitive activities if adequate support is lacking [25]. Societal taboos surrounding sensitive topics, such as sexuality in care settings, can further adversely affect older adults' psychological well-being [26]. Additionally, socio-economic disparities, particularly in regions like Mexico, complicate the relationship between income, happiness, and perceptions of security, thereby influencing subjective well-being [3].

The psychological effects of connected technologies, including potential addiction and mental health impacts, are pertinent as these technologies become increasingly embedded in daily life [27]. Factors such as age, sex, education, and job type significantly influence cognitive performance across various domains, necessitating personalized approaches to mental health interventions [28].

The COVID-19 pandemic has further underscored changes in public mental health and well-being, revealing the profound impact of external stressors on psychological states [29]. The correlation between online friendship networks and depressive symptoms highlights the importance of social relationships in maintaining mental health, especially as older adults increasingly utilize digital platforms [30].

Addressing the demographic and psychological needs of middle-aged and older adults requires a comprehensive approach that integrates technological innovations, social engagement strategies, and cognitive support systems. This approach should consider the barriers these individuals face in maintaining social participation, such as loneliness and isolation, while leveraging digital health solutions to enhance their emotional and physical well-being. Understanding older adults' requirements in the context of technology is vital for developing effective digital health software that meets their specific needs, ultimately promoting better health outcomes and quality of life. The role of pervasive technologies, such as AI and IoT, can significantly enhance care and support for individuals with dementia, addressing their wellness and active living through tailored solutions that overcome accessibility and usability challenges [31, 12, 13].

2.3 Interconnections Among Key Concepts

The interconnections among well-being, quality of life, Activities of Daily Living (ADL), and gerontology constitute a complex framework essential for understanding the aging process and developing effective interventions to enhance life satisfaction among older adults. Integrating social, economic, and technological factors is central to this understanding, as studies illustrate the role of social capital in mental health outcomes. Both bonding and bridging social capital are interconnected with mental health, emphasizing the importance of social relationships in well-being [10]. The psychological impacts of loneliness, particularly among older adults, are further explored through social companion robots designed to alleviate feelings of isolation and enhance overall quality of life [11].

Technological advancements such as predictive health monitoring and machine learning for chronic condition management play a significant role in maintaining independence and improving quality

of life for older adults. These technologies support ADL by facilitating timely interventions and fostering autonomy [32]. The integration of ambient technologies and community support systems is also crucial for sustaining independence and enhancing life quality, especially for the elderly and disabled [8].

Utilizing social media data to assess public sentiment and subjective well-being provides insights into the emotional and relational aspects of societal welfare, underscoring the importance of subjective well-being indicators in capturing the nuances of quality of life. However, challenges such as the rapidly evolving nature of social media platforms and reliance on self-reported data complicate these analyses, highlighting the need for robust methodological approaches [33].

Lifestyle choices that prioritize conspicuous consumption over factors contributing to true well-being illustrate the complex interplay of socio-economic conditions and quality of life [5]. This complexity is reflected in analytical frameworks that integrate mobility and social measures to estimate socio-economic indicators, elucidating the interconnections among well-being, quality of life, and socio-economic status [21].

Detecting lonesomeness through social media posts offers potential pathways for identifying individuals at risk of mental disturbances, providing opportunities for timely interventions [34]. Additionally, the psychological impacts of smartphone usage, including potential addiction and mental health effects, underscore the necessity for balanced digital and physical interactions to support well-being [20].

Understanding the intricate interconnections between emotional, social, physical, and mental well-being needs of older adults is crucial for developing comprehensive, user-centered approaches in digital health technologies. Such approaches address the diverse requirements of this population, enhancing their overall quality of life and promoting independence. By leveraging methodologies like Requirements Engineering and co-design practices, technological solutions can be tailored to the unique aspirations and preferences of older adults, ultimately bridging the digital divide and fostering greater social participation and well-being [14, 12, 35, 13, 36]. Integrating these dimensions allows researchers and practitioners to design comprehensive interventions that enhance well-being and life satisfaction for this growing population.

In examining the multifaceted nature of well-being among middle-aged and older adults, it is crucial to consider the various factors that contribute to their overall quality of life. Figure 2 illustrates this hierarchical structure, categorizing these factors into four primary domains: Physical Health and Activity, Mental Health and Emotional Well-being, Social Connections and Community Engagement, and Environmental and Socio-economic Factors. Each of these categories is further dissected into technological, social, lifestyle, and economic influences. This segmentation underscores the intricate interconnectedness of these elements, which collectively play a significant role in enhancing life satisfaction and well-being. By understanding this comprehensive framework, researchers and practitioners can better address the diverse needs of this demographic, ultimately fostering improved health outcomes and quality of life.

3 Well-being and Quality of Life in Middle Age and Older Adults

3.1 Physical Health and Activity

Physical health and activity are pivotal in shaping the well-being and quality of life of middle-aged and older adults, influenced by technological, social, and environmental factors. As illustrated in Figure 3, these influences can be categorized into three main areas: technological impacts, social and environmental factors, and lifestyle activities. Each category highlights significant contributions from recent studies, emphasizing the role of technology, social media, and lifestyle choices in shaping well-being and quality of life.

Regular physical activity is crucial for health and life satisfaction, with technologies like robotic arms and virtual agents enhancing daily activities and companionship, especially for those with cognitive impairments [37]. The PERMA model underscores the importance of Positive Emotion in linking physical health and activity to well-being [38]. High-fidelity virtual reality environments promote cognitive functions and well-being through immersive experiences [39], while machine learning applications aid in managing chronic diseases among geriatric patients [32]. Social media sentiment analysis offers insights into public perceptions of physical health and activity, contributing to societal

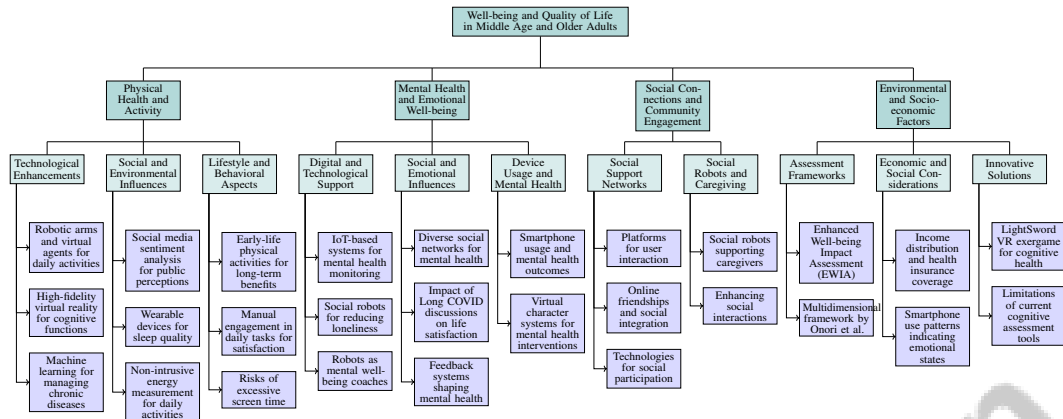


Figure 2: This figure illustrates the hierarchical structure of well-being and quality of life factors for middle-aged and older adults, categorized into Physical Health and Activity, Mental Health and Emotional Well-being, Social Connections and Community Engagement, and Environmental and Socio-economic Factors. Each category is further divided into technological, social, lifestyle, and economic influences, highlighting the interconnectedness of these elements in enhancing life satisfaction and well-being.

well-being [6]. Wearable devices improve sleep quality, a vital aspect of well-being [40], while systems like DyMand use smartwatches for real-time data collection on physical proximity and voice activity to inform health interventions [41]. Non-intrusive energy measurement techniques infer daily activities from consumption patterns, providing valuable insights into user well-being [42]. Early-life physical activities, such as participation in high school sports, offer long-term health benefits, including reduced risks of obesity and chronic pain [43]. Lifetime exposures, including education and job types, necessitate personalized cognitive health interventions [28]. Manual engagement in daily tasks, such as coffee-making, enhances user satisfaction and stimulation, improving well-being [44]. However, excessive screen time poses risks like myopia and sleep disorders, requiring a balanced approach to technology use [27].

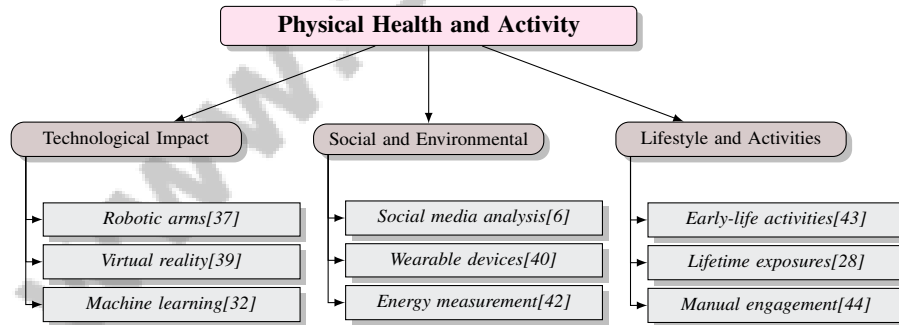


Figure 3: This figure illustrates the key influences on physical health and activity for middle-aged and older adults, categorized into technological impacts, social and environmental factors, and lifestyle activities. Each category highlights significant contributions from recent studies, emphasizing the role of technology, social media, and lifestyle choices in shaping well-being and quality of life.

3.2 Mental Health and Emotional Well-being

Mental health and emotional well-being are critical determinants of life satisfaction in middle-aged and older adults, necessitating robust support systems for emotional stability. Digital technologies, particularly IoT-based systems, play a vital role in monitoring mental health, delivering continuous support, and facilitating preventive care [45]. The PERMA model identifies Engagement and Relationships as essential components for fostering mental health and emotional well-being [38]. Diverse social networks positively influence mental health, reducing reliance on antidepressants and

emphasizing the importance of social connections [10]. Social robots alleviate loneliness and enhance mental well-being, improving life satisfaction among older adults [11]. Negative emotional responses related to Long COVID discussions on platforms like Twitter highlight the impact of mental health on life satisfaction [46], necessitating targeted interventions. Decline in cognitive inhibition affects quality of life, requiring focused strategies [47]. Robots as mental well-being coaches show promise in enhancing mental health through mindfulness and positive psychology practices [48]. Feedback systems and social media interactions shape user mental health, particularly concerning self-esteem and depression [27]. Sharing mental health data with social robots indicates potential benefits for mental healthcare [49]. The relationship between smartphone usage and mental health outcomes is crucial for understanding device use implications on well-being [20]. Emotional responses and engagement from virtual character systems influence mental health and motivation, highlighting the role of extended reality environments in interventions [7].

3.3 Social Connections and Community Engagement

Social connections and community engagement are vital for enhancing quality of life and well-being among middle-aged and older adults. Social support networks, facilitated by platforms designed to enhance user interaction, are essential for maintaining life satisfaction and emotional well-being, particularly for those facing isolation [50]. Online friendships significantly enhance life quality, with the core-peripheral model illustrating how digital interactions promote social integration [30]. Technologies designed for social participation enable older adults to remain actively engaged within their communities, improving life satisfaction [12]. Social robots, such as CloudIA, support caregivers and enhance social interactions, reducing isolation and improving life quality [4]. By fostering social interactions, these technologies contribute to the emotional and social well-being of older adults, thereby enhancing their overall quality of life.

3.4 Environmental and Socio-economic Factors

Environmental and socio-economic factors significantly shape the well-being and quality of life of middle-aged and older adults. The Enhanced Well-being Impact Assessment (EWIA) framework evaluates the effects of autonomous and intelligent systems on well-being, emphasizing the integration of technological and environmental changes [51]. Traditional economic indicators like GDP inadequately capture well-being, prompting calls for incorporating social capital and environmental considerations [52]. The multidimensional framework proposed by Onori et al. seeks to capture complex relationships affecting well-being often overlooked by conventional methods [53]. Variability in interpreting well-being-related terms highlights the challenges of assessing quality of life across diverse socio-economic contexts [54]. The FF-VDFR model provides insights into how socio-economic and environmental factors influence health outcomes [55]. Income distribution and social inequality impact health insurance coverage, highlighting the need for policies prioritizing equitable healthcare access [56]. Smartphone use patterns, such as nightly mobile phone use and ringer settings, are more indicative of emotional states than overall usage intensity [57]. Reliance on sensor data to predict job performance underscores the need for careful consideration of environmental and socio-economic variables [58]. Limitations of current cognitive assessment tools, such as the MMSE, in capturing nuanced cognitive differences highlight the need for comprehensive approaches to understanding cognitive health [28]. Innovative solutions like the LightSword VR exergame demonstrate potential in addressing these limitations [47].

4 Activities of Daily Living (ADL) and Their Impact

4.1 Significance of ADL in Maintaining Independence

Activities of Daily Living (ADL), encompassing tasks such as bathing, dressing, eating, and mobility, are fundamental for older adults' independence, serving as indicators of functional ability and well-being. The ability to perform ADL independently fosters mental health, autonomy, and life satisfaction, enhancing self-efficacy and control [59]. Technological advancements, such as the Ambient Assisted Living (AAL) System, support ADL by monitoring physical and physiological parameters, detecting emergencies, and facilitating non-medical assistance [8]. Robotic assistance, exemplified by social companion robots and CloudIA, aids in cognitive assessment and socialization, reducing loneliness and improving social interactions [4, 34]. Social network structures further

contribute to mental health and independence, offering frameworks for social support and interaction [10].

4.2 Technological Integration in ADL Assessments

Benchmark	Size	Domain	Task Format	Metric
DAMMI[60]	14,631	Ambient Assisted Living	Activity Recognition	Accuracy, F1-score
WellDunn[61]	6,373	Mental Health	Multi-label Classification	F1, MCC
CCID[62]	13,450	Cancer Communication	Behavior Classification	Unweighted Average Recall
WELLXPLAIN[17]	72,813	Mental Health	Multi-class Classification	F1-score, Accuracy
COVID-Wellbeing[29]	1,000,000	Mental Health	Search Intensity Analysis	Difference-in-Differences, Regression Discontinuity Design
SWB-PI[63]	82	Social Progress	Indicator Comparison	Subjective Well-Being Index, Genuine Progress Indicator
fusionACS[64]	1,300,000	Energy Consumption	Data Fusion	Accuracy, F1-score
Tesseract[58]	757	Job Performance	Predictive Analysis	Kendall's

Table 1: This table presents a comprehensive overview of various benchmarks used in the assessment of activities of daily living (ADL) and related domains. It includes information on the benchmark name, size, domain, task format, and evaluation metrics, highlighting the diversity and scope of datasets utilized in technological integration for ADL assessments.

The integration of technology into ADL assessments marks a transformative shift in evaluating and supporting older adults' functional abilities. Advanced systems, such as animated virtual characters, enhance ADL assessments and promote physical activity [7]. Mobile applications and user interfaces improve mental health and social engagement, facilitating communication and access to health services [9, 1]. Smartphone interventions highlight technology's dual role in ADL assessments through push factors restricting access and pull factors encouraging meaningful usage [20]. Inertial, physiological, and environmental sensors are crucial for human activity recognition (HAR), providing insights into daily activities and enabling timely interventions. Mobile sensing technologies capture real-time emotional and behavioral data, leveraging machine learning for improved clinical decision-making [65, 66, 67]. IoT and Knowledge Graphs enhance ADL through improved mental health management, promoting personalized healthcare and preventive strategies. Vision-based systems analyze video data from care centers, facilitating precise evaluations of functional abilities [65, 31, 60, 45]. Table 1 provides a detailed overview of representative benchmarks employed in the technological integration of activities of daily living (ADL) assessments, emphasizing their applications across different domains and task formats.

Intelligent interactive technologies, including robotic systems and conversational agents, transform mental health care by automating assessments and enhancing psychological treatments, particularly for individuals with dementia. These innovations provide non-judgmental support and enhance user engagement, though challenges like accurate sensing and data privacy remain [31, 68, 25, 69].

4.3 Innovative Interventions and ADL

Innovative interventions leveraging technological advancements aim to enhance physical and cognitive function in older adults. Virtual and augmented reality (VR/AR) technologies offer promising avenues for improving communication and emotional connection, simulating real-world scenarios for ADL task practice [70]. Customized virtual reality interventions, like the LightSword system, maintain user engagement through adjustable difficulty levels and cognitive activation paradigms, promoting sustained participation and improved outcomes [47]. Gamification techniques enhance motivation and enjoyment in rehabilitation, though further research is needed to explore long-term effectiveness and scalability, addressing access and affordability challenges. Initial findings suggest significant potential for these technologies to improve ADL and enhance older adults' quality of life.

4.4 Challenges and Barriers in ADL Implementation

Implementing ADL strategies faces several challenges and barriers, including the loss of human interaction integral to doctor-patient relationships, which technologies struggle to replicate [71]. High costs and complex designs of current ADL assessment systems limit accessibility, requiring new

hardware and infrastructure investments [72]. The reliance on labeled datasets for training ADL systems poses another challenge, though the emergence of ADL-LLM, capable of zero-shot recognition, offers a solution by reducing dependency on extensive labeled datasets [73]. This capability enhances ADL systems' adaptability and efficiency, potentially overcoming critical implementation barriers.

4.5 Future Directions in ADL Research

Future ADL research should focus on developing more objective data collection methods to improve assessment accuracy and reliability, considering broader demographics to ensure interventions are inclusive [36]. Exploring dynamic segmentation strategies and open-world activity recognition presents promising avenues for enhancing ADL systems' adaptability [73]. Integrating machine learning models tailored for multiple chronic conditions is crucial for advancing ADL research, seamlessly integrating into clinical workflows to support older adults with complex health needs [32]. Expanding social network platform features and evaluating user satisfaction can inform innovative interventions to enhance ADL, fostering social engagement and support [50]. Incorporating contextual user information and psychological features influencing happiness is essential for improving ADL, enabling personalized interventions that enhance life satisfaction and independence [74]. These research directions underscore the need for a multidisciplinary approach to ADL, integrating technological, psychological, and social dimensions to support older adults' well-being and autonomy.

5 Gerontology: An Interdisciplinary Approach

5.1 Gerontology: An Interdisciplinary Field

Gerontology is a comprehensive field that integrates insights from technology, healthcare, psychology, and social sciences to address the complexities of aging. This multidisciplinary approach is crucial for devising strategies that improve the well-being and quality of life of older adults. Nyman [6] demonstrates how merging data science with gerontology can yield innovative solutions for assessing welfare in aging populations through real-time analytics, offering new perspectives on the socio-economic and emotional dimensions of aging. Furthermore, Parry [33] highlights the importance of diverse methodologies in social media usage (SMU) research to accurately capture older adults' experiences in digital contexts, which is vital for evaluating the impact of social media on their well-being and social integration.

Technological advancements, such as social robotics and mobile health applications, play a significant role in gerontology by enhancing social engagement and healthcare delivery. These technologies help overcome barriers to social participation, reduce loneliness, and promote well-being among aging populations. Socially assistive robots, for instance, support cognitive, physical, and emotional health, while mobile apps facilitate virtual group activities. Pervasive technologies are also being developed for personalized care in dementia, showcasing technology's potential to enhance active living and wellness in older adults [31, 12, 75, 25, 49]. These solutions not only provide companionship but also enable remote health monitoring and personalized care, fostering independence and life satisfaction.

5.2 Interdisciplinary Frameworks in Gerontology

Interdisciplinary frameworks are essential in gerontology for integrating diverse methodologies and technological innovations to address the complex challenges of aging. These frameworks provide a holistic understanding of aging by combining insights from healthcare, technology, psychology, and social sciences. Fraser's framework for speech analysis in smart home environments exemplifies the integration of cognitive and technological research to enhance cognitive health monitoring in older adults [76]. Speech analysis allows for continuous, non-intrusive monitoring of cognitive health, aiding in early detection of cognitive decline and personalized care plans. By analyzing speech data, researchers can detect indicators of cognitive and emotional well-being, such as anxiety and mood, thereby promoting independence and improving quality of life [77, 76, 78].

Advanced data analytics and machine learning are increasingly utilized within these frameworks to analyze complex datasets, enabling predictive models for health outcomes and social behaviors in older adults. These models are particularly beneficial in geriatric clinical care, where machine learning enhances chronic disease management by integrating diverse data sources. Explainable artificial intelligence (XAI) in e-health interfaces further promotes user engagement by providing

transparent insights, crucial for effective health monitoring and intervention. This comprehensive approach aids in identifying health risks such as undernutrition and tailoring interventions to older adults' specific needs [15, 32, 58, 36, 17].

5.3 Integration of Technology and Gerontology

The integration of technology into gerontological research and practice is vital for addressing the multifaceted challenges of aging. Advanced technologies such as facial analysis, activity detection, and social interaction monitoring are incorporated into automated systems to enhance the assessment and support of older adults' well-being [16]. These systems provide comprehensive insights into the physical and social dimensions of aging, facilitating targeted interventions that promote independence and quality of life.

Machine learning and tangible interfaces are pivotal in mental health technologies, offering new avenues for supporting cognitive and emotional well-being among older adults [65]. The application of large language models for mental health coaching exemplifies technology's integration into gerontological practice, providing personalized support and improving mental health outcomes [79]. The Internet of Things (IoT) and Knowledge Graphs offer innovative solutions for monitoring and managing well-being, enabling real-time data collection and analysis to support proactive mental health interventions [45].

Extended Reality (XR) technology enhances mental health research and practice by creating immersive environments for therapy and rehabilitation, offering novel support approaches for older adults facing cognitive decline or social isolation [80]. Social robots collect mental health data and provide companionship, addressing loneliness and enhancing mental well-being [49]. Information and Communication Technology (ICT) is crucial for improving older adults' quality of life by supporting social engagement and healthcare access [1]. Integrating ICT into gerontological research enables comprehensive strategies that address the diverse needs of aging populations.

5.4 Social and Economic Perspectives

Social and economic perspectives in gerontological studies provide critical insights into factors influencing older adults' well-being and quality of life. The interplay between social capital and economic stability is pivotal in understanding aging experiences and outcomes. Social capital significantly impacts mental health and social engagement, with robust social networks alleviating loneliness and enhancing life satisfaction [10]. Economic stability is another essential determinant of quality of life, with socio-economic disparities in income distribution and healthcare access profoundly affecting health outcomes and life satisfaction [3]. Addressing these disparities is crucial for equitable healthcare policies and social support systems that meet the needs of economically disadvantaged older adults.

Technological advancements shape social and economic perspectives in gerontology. The integration of ICT improves healthcare access and social networks, enhancing older adults' quality of life [1]. These technologies offer innovative solutions for overcoming barriers to social interaction and healthcare access, especially for those in remote or underserved areas. Utilizing mobile phone data to assess socio-economic development and its impact on quality of life illustrates technology's potential to provide real-time insights into older populations' well-being [21]. This approach underscores the importance of incorporating technological tools in gerontological research to capture the dynamic interplay of social and economic factors.

6 Strategies for Enhancing Well-being and Quality of Life

6.1 Healthcare and Technological Interventions

Healthcare and technological interventions are pivotal in enhancing the well-being of middle-aged and older adults, offering a spectrum of strategies from personalized healthcare plans to advanced technological solutions. Socially assistive robots (SARs) exemplify this, providing tailored interactions that foster user engagement and trust, significantly aiding socially isolated individuals, particularly during the COVID-19 pandemic [11]. Additionally, robots designed for physical exercise play a crucial role in maintaining the physical health of older adults [37]. The Feel Good Factor (FGF) intervention and

'Well-being Hacks with Virtual Characters' method leverage technology to deepen understanding and engagement in well-being exercises, showcasing virtual environments' potential in healthcare [6, 7]. Effective interventions balance user autonomy with mitigating excessive smartphone use, suggesting a dual approach incorporating both push and pull factors [20].

6.2 Community Support and Social Engagement

Community support and social engagement are essential for enhancing the quality of life among middle-aged and older adults, fostering belonging and mitigating isolation, crucial for mental and emotional well-being. Community networks, often supported by informal caregivers, provide vital resources, leveraging technology to enhance care accessibility and overall well-being [31]. Integrating technology into community support systems offers innovative solutions to enhance social engagement, addressing participation barriers through applications like virtual training programs and interactive platforms, reducing loneliness and cognitive decline risks [31, 12, 35, 50, 81]. Informal caregivers, utilizing advanced technologies, can access tools that enhance care quality for dementia patients, including remote monitoring systems and assistive devices, alleviating caregiver burdens while ensuring older adults remain connected to their communities [31, 81].

6.3 Cognitive and Mental Health Interventions

Cognitive and mental health interventions are crucial for middle-aged and older adults, focusing on preserving cognitive function and emotional stability. Intelligent interactive technologies highlight the need for emotionally aware systems that adapt to users' mental states, ensuring active participation in mental health management [68]. WELLXPLAIN enhances mental health assessments through social media analysis, providing insights into emotional and cognitive states [17]. Machine learning advancements, such as loneliness forecasting, facilitate timely mental health interventions by identifying individuals at risk of social isolation [67]. Interventions targeting loneliness through social media communications analysis foster social connections and alleviate isolation [82]. Future research should broaden cognitive assessments to include lifetime exposures, like leisure activities and social networks, to inform effective intervention strategies [28]. Music consumption patterns offer insights into using music for emotional regulation and well-being, indicating potential music-based interventions in cognitive health strategies [83]. Personal data sculptures, enhancing self-reflection and awareness, motivate users to engage in self-care and improve mental well-being [84].

6.4 Innovative Design and User-Centered Approaches

Innovative design and user-centered approaches are vital for developing interventions that enhance the well-being and quality of life for older adults. These strategies integrate user needs and preferences into the design process, ensuring interventions are effective and engaging. Positive personas foster collaboration and improve decision-making during design, creating solutions that resonate with users' aspirations [85]. Hybrid automation solutions represent significant advancements, balancing user engagement with operational efficiency, maintaining user involvement while leveraging automation for enhanced convenience [44]. Future research should explore integrating hybrid automation and user-centered design principles to develop interventions that enhance efficiency and foster engaging user experiences. This is crucial given advancements in affective robotics, which support human well-being. Design factors promoting meaningful interactions, such as intuitive interfaces and transparent communication, can better address diverse user needs, including older adults. Understanding experiential costs associated with automation informs strategies that balance convenience with preserving enjoyable human experiences [74, 86, 36, 44]. Prioritizing user needs and incorporating positive personas into the design process can significantly enhance older adults' quality of life, supporting their independence and well-being.

6.5 Ethical and Policy Considerations

Strategies to enhance older adults' well-being necessitate careful consideration of ethical and policy aspects to ensure interventions are effective and respectful of individual rights. Ethical considerations are crucial in developing technologies supporting mental health, such as virtual character systems and robotic coaches, which must prioritize user privacy and data protection [8]. Designers are encouraged to establish principles addressing ethical considerations, ensuring interventions cater to

diverse user needs [9]. Policy considerations must address socio-economic conditions impacting well-being, as economic inequality and community ties significantly influence life satisfaction [5]. Future research should explore these implications to inform policy interventions promoting equitable access to resources and support systems. Interdisciplinary collaboration is emphasized, particularly in understanding social media usage and well-being, despite limitations like a lack of comprehensive understanding of long-term effects and intervention strategies [33, 20].

7 Conclusion

This survey highlights the necessity of adopting a comprehensive approach to aging, emphasizing the integration of physical, mental, and social well-being to enhance the quality of life for middle-aged and older adults. The intricate interplay among these components is crucial, as demonstrated by the impact of social capital on mental health, underscoring the importance of nurturing social connections. Technological advancements, such as IoT solutions and social robots, offer promising avenues for supporting both mental health and daily activities by providing practical assistance and emotional support. Additionally, real-time sentiment analysis emerges as a contemporary tool for assessing well-being, indicating the need for future research to explore its relevance within aging populations.

Future studies should focus on expanding datasets and refining methodologies to enhance the precision of subjective well-being indicators, aiming to better capture the subtleties of emotional states. The cultural acceptance of social robots and the long-term impacts of human-robot interactions in a post-pandemic context also warrant further investigation. The use of mobile phone data for tracking socio-economic development presents new opportunities for understanding behavioral measures and their influence on well-being, highlighting the potential of innovative data sources in gerontological research.

Progress in robot design, particularly in facial feature enhancements, should be pursued to improve interaction quality and assess perceptual differences across age groups. Moreover, future research should aim to integrate novel methodologies, examine effect heterogeneity, and promote interdisciplinary collaboration to strengthen the validity and applicability of findings in aging research.

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