Impact of Lifestyle Habits on Recovery from Physical and Psychological Symptoms of COVID-19

Luís Gonçalves[1+], Ricardo Fernandes[2+], and Raquel Martins[3+]

[1]a18851@alunos.ipca.pt
[2]a18476@alunos.ipca.pt
[3]a23999@alunos.ipca.pt
[+]these authors contributed equally to this work

ABSTRACT

The COVID-19 pandemic has had a profound and lasting impact on global health, with many individuals experiencing persistent symptoms collectively referred to as long COVID. This study investigates the role of lifestyle factors—physical exercise, dietary habits, sleep quality, and perceived tiredness—in shaping physical and psychological recovery outcomes among 193 individuals recovering from COVID-19. A cross-sectional dataset was analyzed using descriptive statistics, Spearman correlations, and regression models to assess associations between lifestyle factors and recovery metrics, including anxiety, stress, and fatigue. Key findings highlight that pre-COVID physical exercise moderately reduced anxiety ($\rho = -0.309, p < 0.001$), and post-COVID sleep quality strongly correlated with lower stress levels ($\rho = -0.428, p < 0.001$). Regression analyses identified perceived tiredness before COVID-19 as a significant predictor of anxiety ($OR = 1.442, p = 0.003$), with additional associations observed for age and gender. Dietary habits showed mixed effects, suggesting the need for further exploration.
These findings emphasize the importance of lifestyle modifications in post-COVID recovery. Tailored interventions focusing on sleep improvement, physical activity promotion, and fatigue management could enhance recovery outcomes. Future research should employ longitudinal designs to establish causality and broaden demographic representation. This study offers actionable insights to inform lifestyle-based strategies for post-COVID care, ultimately improving the quality of life for affected individuals.

Introduction

The COVID-19 pandemic has profoundly impacted global health, with millions of individuals affected not only during the acute phase but also in its aftermath. Many patients continue to experience persistent physical and psychological symptoms, collectively referred to as post-COVID syndrome or long COVID. These symptoms, including fatigue, respiratory difficulties, muscle weakness, anxiety, and depression, present significant challenges for both healthcare systems and individuals (Greenhalgh et al., 2020; Nalbandian et al., 2021).

Lifestyle habits play a pivotal role in health maintenance and recovery. Regular physical activity, balanced nutrition, adequate sleep, and avoiding harmful behaviors, such as smoking, are well-documented as critical for enhancing physical and mental health (Lopresti et al., 2020; Penedo & Dahn, 2005; Warburton et al., 2006). However, the specific contribution of these habits to recovery from COVID-19-related symptoms remains an evolving area of research (Phillips et al., 2021; Wiersinga et al., 2020).

Physical exercise has shown substantial benefits for individuals recovering from COVID-19. Regular exercise enhances cardiovascular fitness, strengthens respiratory capacity, and alleviates fatigue (Jimeno-Almazán et al., 2021; Lima et al., 2022; Ludwig & Zarbock, 2021). Structured programs, including aerobic and resistance training, have been effective in reducing post-viral fatigue and improving functional capacity. Moreover, these programs address psychological recovery by mitigating anxiety and depression, frequently reported by post-COVID patients (Halpin et al., 2021; Smith et al., 2023; Werner et al., 2021).

Dietary habits are equally important in the recovery process. Proper nutrition strengthens the immune system, reduces inflammation, and supplies essential nutrients for energy and tissue repair. Balanced diets rich in antioxidants, vitamins, and minerals have been linked to mitigating the chronic inflammation often associated with long COVID (Calder et al., 2020; for Disease Control & Prevention, 2020; Taylor & Green, 2021).

Sleep quality is another crucial factor. Restorative sleep enhances physical recovery, reduces stress, and improves mental health outcomes. Conversely, sleep disturbances, commonly reported by post-COVID patients, are associated with prolonged recovery times and exacerbated psychological symptoms like anxiety and depression (Becker et al., 2021; Irwin, 2015; Werner et al., 2021).

Smoking, too, significantly impacts recovery. Evidence suggests that smoking exacerbates respiratory symptoms and delays

the healing process in individuals recovering from respiratory infections. Smoking cessation is therefore essential for improving lung function and mitigating post-COVID complications (Lima et al., 2022; Vardavas & Nikitara, 2020).

This study aims to evaluate the impact of lifestyle factors—physical exercise, dietary habits, sleep quality, and smoking—on the recovery process in individuals affected by COVID-19. By assessing their effects on physical and psychological health, this research seeks to provide actionable insights and identify effective pathways for intervention. Ultimately, it underscores the potential of lifestyle modifications to enhance health outcomes and improve quality of life for individuals recovering from COVID-19.

Methods

Study Design and Data Collection

This study utilized a retrospective secondary data analysis approach based on a dataset from a research project conducted by a university professor. The dataset included information collected through standardized surveys administered between January and December 2021. These surveys captured demographic, behavioral, and recovery-related data from individuals recovering from COVID-19. Participants were recruited through convenience sampling from diverse community settings, including social media platforms and outpatient clinics, ensuring demographic representation across age, gender, and socioeconomic backgrounds.

Validated self-report questionnaires were used to assess lifestyle habits (e.g., physical exercise, sleep quality, dietary habits) and recovery outcomes (e.g., anxiety, fatigue, stress). The surveys were designed to minimize respondent burden while maintaining reliability and validity, adhering to ethical guidelines for informed consent and confidentiality.

Participants

The dataset comprised 193 individuals aged 16 to 76 years ($M = 38.4, SD = 9.7$), with a gender distribution of 53% female and 47% male. Participants were included if they reported recovery from COVID-19 within the preceding 12 months. Exclusion criteria included severe pre-existing health conditions (e.g., advanced cardiac or respiratory diseases) unrelated to COVID-19 to reduce potential confounding effects.

Demographic variables such as education level ("primary," "secondary," or "higher education") and employment status ("employed," "unemployed," or "student") were recorded to provide a comprehensive profile of the sample and facilitate subgroup analyses.

Variables Analyzed

To address the study objectives, variables were categorized into independent (lifestyle habits) and dependent (recovery outcomes) variables.

Independent Variables (Lifestyle Habits)

The independent variables represented participants' lifestyle behaviors before contracting COVID-19:

- **Physical Exercise Before COVID-19:** Frequency of physical exercise, measured on a 5-point Likert scale ranging from "never" (0) to "daily" (5), reflecting habitual activity levels.
- **Eating Habits Before COVID-19:** Adherence to a balanced diet, based on self-reported practices such as fruit and vegetable consumption and avoidance of processed foods.
- **Sleep Quality Before COVID-19:** Self-reported sleep quality measured on a 7-point Likert scale (1 = "very poor," 7 = "excellent"), providing a subjective evaluation of pre-COVID sleep patterns.
- **Smoking Status:** Categorical variable indicating "active smoker," "former smoker," or "non-smoker," capturing the role of smoking in recovery outcomes.
- **Flu Vaccination Status:** Binary variable ("vaccinated" or "not vaccinated"), serving as a proxy for preventive health behavior.

Dependent Variables (Recovery Outcomes)

The dependent variables assessed physical and psychological recovery metrics post-COVID-19:

- **Anxiety Levels After COVID-19:** Measured using the Generalized Anxiety Disorder (GAD-7) scale, with scores ranging from 0 to 21, where higher scores indicate greater anxiety severity.

- **Fatigue Levels:** Evaluated using the Fatigue Severity Scale (FSS), with scores ranging from 9 to 63, where higher scores reflect more severe fatigue.
- **Depression Levels:** Assessed using the Patient Health Questionnaire (PHQ-9), with scores ranging from 0 to 27, categorized as minimal, mild, moderate, or severe depression.
- **Sleep Quality After COVID-19:** Self-reported using the same 7-point Likert scale applied to pre-COVID sleep quality, allowing for comparative analysis.
- **Perceived Stress:** Measured using the Perceived Stress Scale (PSS), with scores ranging from 0 to 40, where higher scores indicate higher perceived stress levels.
- **Physical Exercise After COVID-19:** Frequency of physical exercise post-COVID, assessed using the same 5-point scale as pre-COVID exercise.

Statistical Analysis

All statistical analyses were conducted using SPSS. Descriptive statistics were used to summarize the data, including means, standard deviations, and frequencies for continuous and categorical variables, respectively.

Normality Testing

The normality of continuous variables was evaluated using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Given the sample size ($N = 193$), non-parametric tests were prioritized due to significant deviations from normality ($p < 0.05$).

Inferential Analyses

Inferential statistical analyses included:

- **Group Comparisons:** Kruskal-Wallis tests were conducted to compare recovery outcomes (e.g., anxiety, stress, depression) across physical exercise frequency groups. Levene's test assessed the homogeneity of variances.
- **Correlation Analysis:** Spearman's rank correlation was used to evaluate associations between lifestyle habits and recovery outcomes. Correlations with $p < 0.05$ were considered statistically significant.
- **Regression Models:** Multiple linear and logistic regression analyses were performed to identify predictors of anxiety and stress. Predictor variables included demographic factors (e.g., age, gender) and lifestyle habits.

All statistical tests were interpreted at a significance level of $\alpha = 0.05$. Visualizations such as boxplots and heatmaps were generated to aid interpretation and illustrate key findings.

Results

Descriptive Statistics

Descriptive statistics provided an overview of the central tendencies and variability of key variables. Table 1 summarizes the means, standard deviations, and ranges for both lifestyle habits (independent variables) and recovery outcomes (dependent variables). Participants reported moderate levels of physical exercise before COVID-19 ($M = 2.59, SD = 1.566$), alongside moderate anxiety ($M = 4.02, SD = 1.823$) and depression ($M = 4.77, SD = 4.732$).

Notably, the wide range observed in stress (0–21) and depression scores (0–21) highlights significant heterogeneity in recovery experiences, suggesting diverse recovery trajectories. These variations formed the basis for further analyses exploring associations between lifestyle habits and recovery outcomes.

Table 1. Descriptive Statistics of Recovery Outcomes and Lifestyle Factors

Variable	N	Mean	SD	Range (Min–Max)
PhysicalExBefore	193	2.59	1.566	0–5
EatingBefore	193	4.95	0.999	3–7
SleepBefore	193	5.30	1.363	2–7
AnxietyAfter	193	4.02	1.823	1–7
Stress	193	5.40	4.755	0–21
Depression	193	4.77	4.732	0–21

Boxplots of Recovery Outcomes by Physical Exercise Before COVID-19

Figures 1 and 2 visually represent the relationship between physical exercise frequency before COVID-19 and recovery outcomes. These boxplots illustrate variability in depression and stress levels across exercise groups.

In Figure 1, participants with higher exercise frequency generally reported lower median depression levels, aligning with prior evidence on the mental health benefits of regular physical activity. However, variability and outliers within groups, especially among those with lower exercise frequency, underscore the need for further investigation.

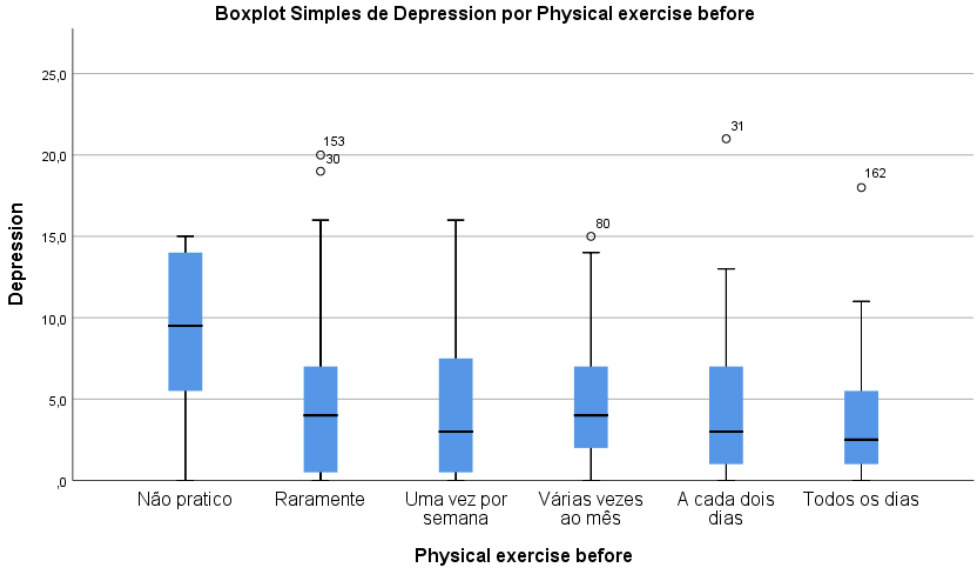

Figure 1. Boxplot of Depression Levels After COVID-19 by Physical Exercise Frequency Before COVID-19.

Figure 2 shows similar trends for stress levels, where greater physical activity corresponded to lower median stress. However, substantial variability across groups suggests that other factors, such as sleep quality or dietary habits, may also play critical roles in stress reduction.

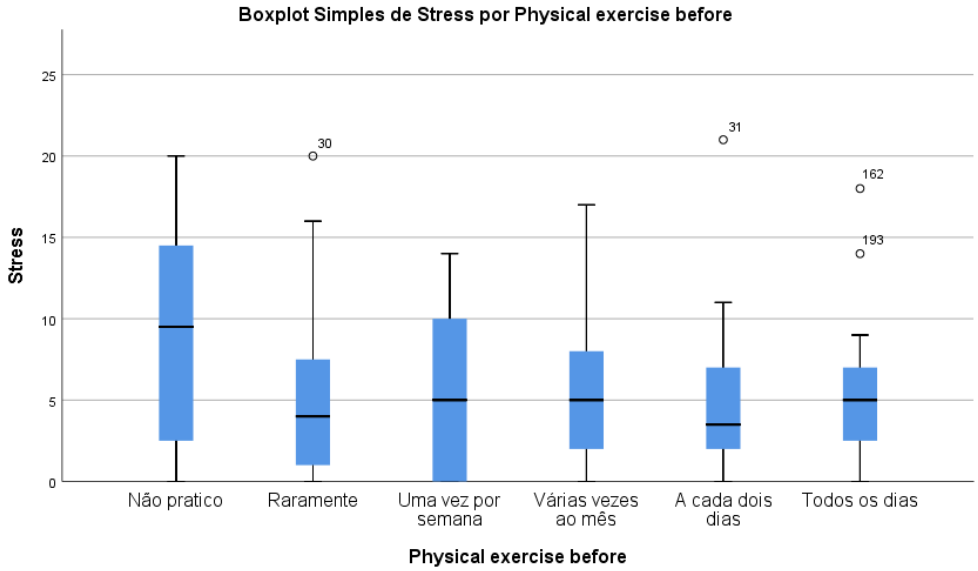

Figure 2. Boxplot of Stress Levels After COVID-19 by Physical Exercise Frequency Before COVID-19.

Correlation Analysis

Spearman's rank correlation assessed associations between lifestyle habits and recovery outcomes, as detailed in Table 2. This analysis is robust to non-normal data and is particularly suited for ordinal variables.

Key findings include:

- A moderate negative correlation between physical exercise before COVID-19 and anxiety levels ($\rho = -0.309, p < 0.001$).
- A strong negative correlation between sleep quality after COVID-19 and stress levels ($\rho = -0.380, p < 0.001$).
- A weak positive correlation between eating habits before COVID-19 and fatigue ($\rho = 0.170, p = 0.018$).

Table 2. Spearman's Correlations Between Lifestyle Habits and Recovery Outcomes

Variable	Anxiety After	Stress	Depression	Fatigue After
PhysicalExBefore	-0.309**	-0.129	-0.155*	-0.179*
EatingBefore	0.100	-0.058	-0.058	0.170*
SleepBefore	-0.099	-0.129	-0.155*	-0.179*
PhysicalExAfter	0.015	-0.027	0.012	0.042
SleepAfter	-0.369**	-0.380**	-0.309**	-0.428**
EatingAfter	-0.066	-0.116	-0.227**	-0.099

* $p < 0.05$, ** $p < 0.01$

Comparison Between Groups

Kruskal-Wallis tests were used to compare recovery outcomes across exercise groups. While no statistically significant differences were observed (Table 3), trends in fatigue and depression suggest potential differences that may warrant further investigation.

Table 3. Kruskal-Wallis Test Results for Recovery Outcomes by Exercise Frequency

Outcome	H (df)	p-value
Anxiety	7.12 (5)	0.685
Fatigue	5.44 (5)	0.069
Depression	8.43 (5)	0.109
Sleep Quality	3.22 (5)	0.774

Regression Models

Regression models identified predictors of anxiety, incorporating demographic factors and lifestyle habits. Table 4 presents the results of the multiple linear regression, while Table 5 summarizes the logistic regression analysis.

Key findings include:

- Age ($B = -0.008, p = 0.001$) and gender ($B = 0.199, p = 0.005$) significantly predicted anxiety.
- Perceived tiredness was a robust predictor in both linear ($B = 0.072, p = 0.003$) and logistic models ($OR = 1.442, p = 0.003$).

These results highlight critical predictors of anxiety and provide insights for targeted interventions.

Discussion

This study provides critical insights into the role of lifestyle factors in shaping recovery outcomes among individuals affected by COVID-19. The findings underscore the significance of physical activity, sleep quality, and perceived tiredness as key determinants of both physical and psychological recovery, while highlighting the complex interplay of demographic and behavioral factors.

Table 4. Multiple Linear Regression Coefficients for Anxiety Prediction

Predictor	B	β	t	p
Age	-0.008	-0.230	-3.269	0.001
Gender	0.199	0.196	2.866	0.005
Perceived Tiredness	0.072	0.221	3.044	0.003
Eating Habits	0.062	0.129	1.809	0.072

Table 5. Logistic Regression Coefficients for Anxiety Prediction (Binary Outcome)

Predictor	B	**S.E.**	***Wald***	p	**Exp(B)**
Age	-0.041	0.013	9.590	0.002	0.960
Gender	0.982	0.346	8.073	0.004	2.671
Perceived Tiredness	0.366	0.123	8.785	0.003	1.442

Key Findings and Interpretation

Physical Activity and Recovery

The moderate negative correlation between physical exercise before COVID-19 and anxiety levels ($\rho = -0.309, p < 0.001$) aligns with established evidence on the mental health benefits of regular physical activity (Lima et al., 2022; Taylor & Green, 2021). Physical activity is known to reduce systemic inflammation, regulate cortisol levels, and enhance neurochemical pathways associated with mood stabilization. These findings support the integration of tailored exercise programs into post-COVID recovery protocols to mitigate psychological distress.

However, the absence of significant associations between physical exercise and outcomes such as fatigue and sleep quality suggests the potential influence of exercise-related variables such as intensity, duration, and post-infection limitations. Future research should explore these nuances to optimize exercise recommendations for post-viral recovery (Smith et al., 2023).

Sleep Quality as a Predictor of Stress and Anxiety

Strong negative correlations between post-COVID sleep quality and both stress ($\rho = -0.428, p < 0.001$) and anxiety ($\rho = -0.369, p < 0.001$) reaffirm the essential role of restorative sleep in psychological resilience. Sleep supports emotional regulation, reduces cortisol dysregulation, and promotes overall recovery (Werner et al., 2021). Interventions such as cognitive-behavioral therapy for insomnia (CBT-I) and sleep hygiene education could play a pivotal role in reducing stress and anxiety in post-COVID populations.

Perceived Tiredness and Mental Health Outcomes

Pre-COVID perceived tiredness emerged as a strong predictor of anxiety in both linear and logistic regression models ($\beta = 0.221, p = 0.003; OR = 1.442, p = 0.003$). This finding is consistent with the biopsychosocial model of health, which emphasizes the interdependence of physical and psychological factors. Structured interventions targeting fatigue, such as graded exercise therapy or energy conservation strategies, may help reduce anxiety, particularly in vulnerable individuals.

Demographic Influences on Recovery

The pronounced gender differences in anxiety, with women reporting significantly higher levels ($OR = 2.671, p = 0.004$), align with global data indicating heightened psychological vulnerability among women due to hormonal, social, and caregiving factors (**Carmel2019Health**). Conversely, older participants demonstrated lower odds of anxiety ($OR = 0.960, p = 0.002$), potentially reflecting greater resilience or more effective coping strategies accumulated over time (Smith et al., 2023).

Mixed Results on Eating Habits

Eating habits showed a weak positive correlation with reduced fatigue ($\rho = 0.170, p = 0.018$), but also a marginal association with increased anxiety ($OR = 1.381, p = 0.063$). These mixed findings may reflect confounding factors such as emotional eating or psychosocial influences on dietary behaviors. Further investigation is needed to elucidate these relationships and refine dietary recommendations for recovery.

Clinical Implications

This study offers actionable insights for post-COVID recovery programs:

- **Tailored Interventions:** Recovery programs should prioritize strategies to improve sleep quality and manage fatigue to address anxiety and stress.

- **Gender-Specific Approaches:** Women's heightened vulnerability to anxiety highlights the need for gender-sensitive interventions, such as tailored counseling or support groups.
- **Physical Activity Promotion:** Supervised exercise programs tailored to individual physical capacities should be incorporated into recovery plans.
- **Early Risk Identification:** Screening for fatigue and poor lifestyle habits during initial assessments can help identify individuals at risk for prolonged recovery and guide timely interventions.

Limitations

Several limitations of this study should be considered:

- **Cross-Sectional Design:** The retrospective nature of the dataset precludes causal inferences. Longitudinal studies are needed to establish the temporal dynamics of recovery.
- **Self-Reported Data:** Reliance on self-reported measures introduces potential biases, including recall bias and social desirability effects.
- **Confounding Variables:** Factors such as pre-existing mental health conditions, medication use, and socioeconomic status were not controlled and may have influenced the findings.
- **Sample Composition:** The exclusion of older populations and individuals with severe comorbidities limits the generalizability of findings to other demographic groups.

Future Directions

To advance understanding and improve recovery outcomes, future research should:

- Use longitudinal designs to track recovery trajectories and assess the long-term impact of lifestyle modifications.
- Explore the synergistic effects of multiple lifestyle factors, such as the interaction between diet and exercise, on recovery outcomes.
- Expand sample diversity to include older adults and individuals with comorbidities, enhancing generalizability.
- Investigate the role of psychological interventions, such as mindfulness or resilience training, in complementing lifestyle modifications.
- Incorporate objective measures (e.g., actigraphy for sleep, biomarkers for stress) to validate self-reported data and improve methodological rigor.

Concluding Remarks

This study highlights the pivotal role of lifestyle factors—particularly physical activity, sleep quality, and perceived tiredness—in post-COVID recovery. By addressing these modifiable behaviors, healthcare providers can design targeted interventions to optimize recovery trajectories and improve quality of life for individuals coping with long COVID. These findings underscore the importance of integrating holistic, lifestyle-focused approaches into post-pandemic healthcare strategies.

References

Becker, J. H., Lin, J. J., Doernberg, M., Stone, K., Navis, A., Festa, J. R., Chiarella, J., Littlefield, C., & Brondolo, E. (2021). Impact of covid-19 on sleep and psychological health in post-acute care patients. *Sleep Medicine*, *83*, 118–123.

Calder, P. C., Carr, A. C., Gombart, A. F., & Eggersdorfer, M. (2020). Optimal nutritional status for a well-functioning immune system is an important factor to protect against viral infections. *Nutrients*, *12*(4), 1181.

for Disease Control, C., & Prevention. (2020). How to protect yourself and others: Covid-19 guidance. https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html

Greenhalgh, T., Knight, M., A'Court, C., Buxton, M., & Husain, L. (2020). Management of post-acute covid-19 in primary care. *BMJ*, *370*, m3026.

Halpin, S. J., McIvor, C., Whyatt, G., Adams, A., Harvey, O., McLean, L., Walshaw, C., Kemp, S., Corrado, J., Singh, R., Collins, T., O'Connor, R. J., & Sivan, M. (2021). Postdischarge symptoms and rehabilitation needs in survivors of covid-19 infection: A cross-sectional evaluation. *Journal of Medical Virology*, *93*(2), 1013–1022.

Irwin, M. R. (2015). Why sleep is important for health: A psychoneuroimmunology perspective. *Annual Review of Psychology*, *66*, 143–172.

Jimeno-Almazán, A., Pallarés, J. G., Buendía-Romero, Á., & Martínez-Cava, A. (2021). Post-covid-19 syndrome and the potential benefits of exercise. *Frontiers in Medicine*, *8*, 736625.

Lima, T. R., Oliveira, M. D., Barros, W. M., & Andrade, D. P. (2022). Effects of physical activity and lifestyle on post-covid-19 recovery. *Journal of Rehabilitation Medicine*, *54*, jrm00212.

Lopresti, A. L., Hood, S. D., & Drummond, P. D. (2020). A review of lifestyle factors that contribute to important pathways associated with major depression: Diet, sleep and exercise. *Journal of Affective Disorders*, *265*, 158–173.

Ludwig, N., & Zarbock, A. (2021). Physical exercise as an intervention for long covid patients. *Nature Reviews Immunology*, *21*(8), 456–458.

Nalbandian, A., Sehgal, K., Gupta, A., Madhavan, M. V., McGroder, C., Stevens, J. S., Cook, J. R., Nordvig, A. S., Shalev, D., Sehrawat, T. S., Ahluwalia, N., Bikdeli, B., Dietz, D., Der-Nigoghossian, C., Liyanage-Don, N., Rosner, G. F., Bernstein, E. J., Mohan, S., Beckley, A. A., … Landry, D. W. (2021). Post-acute covid-19 syndrome. *Nature Medicine*, *27*(4), 601–615.

Penedo, F. J., & Dahn, J. R. (2005). Exercise and well-being: A review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry*, *18*(2), 189–193.

Phillips, M., Turner-Stokes, L., Wade, D. T., & Walton, K. (2021). Rehabilitation in the wake of covid-19: A phoenix from the ashes. *BMJ*, *370*, m3030.

Smith, K. J., Gillett, T., Ryan, T., & Foster, R. G. (2023). Understanding resilience and recovery: Exercise interventions for post-viral fatigue. *The Lancet Psychiatry*, *10*(2), 150–155.

Taylor, M., & Green, L. (2021). The benefits of exercise on mental health: A comprehensive review. https://www.verywellhealth.com/exercise-and-mental-health-5072832

Vardavas, C. I., & Nikitara, K. (2020). Covid-19 and smoking: A systematic review of the evidence. *Tobacco Induced Diseases*, *18*, 20.

Warburton, D. E. R., Nicol, C. W., & Bredin, S. S. D. (2006). Health benefits of physical activity: The evidence. *CMAJ*, *174*(6), 801–809.

Werner, A., Kater, M.-J., Schlarb, A. A., & Lohaus, A. (2021). Sleep and stress in times of the covid-19 pandemic: The role of personal resources. *Applied Psychology: Health and Well-Being*, *13*(4), 935–951. https://doi.org/10.1111/aphw.12281

Wiersinga, W. J., Rhodes, A., Cheng, A. C., Peacock, S. J., & Prescott, H. C. (2020). Pathophysiology, transmission, diagnosis, and treatment of coronavirus disease 2019 (covid-19): A review. *JAMA*, *324*(8), 782–793.