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12 Weeks to Well-Being: The Impact of Structured Physical Activity on Mental and Emotional Health

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ABSTRACT

This study explores the impact of physical activity on mental health, social interaction, and emotional regulation among young adults. It examines the effects of a 12-week structured physical activity program in young adults aged 18-22. Participants were divided into two groups: an intervention group engaged in regular aerobic, resistance, and group-based exercises, and a control group that followed their normal routine. Mental health outcomes were assessed using the DASS-21, while social connectedness and emotional regulation were measured with the Social Connectedness Scale and Emotion Regulation Questionnaire (ERQ). Significant improvements were observed in the intervention group, with depression, anxiety, and stress symptoms reduced by 31.6%, 32%, and 46%, respectively. Additionally, social connectedness and emotional regulation scores increased by 31%, reflecting enhanced emotional resilience and improved interpersonal relationships. These findings emphasize the therapeutic potential of physical activity as a non-pharmacological intervention for mental health, demonstrating that regular exercise can alleviate psychological distress and promote better social engagement and emotional self-management. The study contributes to the growing evidence that physical activity serves not only as a preventive measure but also as a holistic treatment for mental well-being.

INTRODUCTION

The importance of physical activity in enhancing mental health and social mechanisms such as social interaction and emotional regulation has been widely recognized across various fields of study, including psychology, neuroscience, and public health. Over the past few decades, an increasing body of research has explored its impact on mental health outcomes, particularly concerning depression, anxiety, and stress. (Smith et al., 2021). Additionally, physical activity has been found to enhance cognitive functioning, providing benefits across different age groups. The positive effects of physical activity on mental health are not only preventative but also therapeutic, offering an affordable, accessible, and non-pharmacological approach to managing mental health issues (Pedersen & Saltin, 2015). This paper delves into the multifaceted relationship between physical activity, mental health, and cognitive performance, focusing on how regular physical activity can mitigate the symptoms of depression, anxiety, and stress, and improve cognitive functioning in both clinical and non-clinical populations.

Depression is one of the most common mental health disorders worldwide, with significant impacts on individuals' daily functioning, social relationships, and overall quality of life (World Health Organization [WHO], 2023). Research has consistently shown that physical activity can serve as an effective intervention for reducing symptoms of depression. Aerobic exercise, in particular, has been demonstrated to elevate mood

and decrease depressive symptoms through several mechanisms, such as the release of endorphins, improved sleep patterns, and an increase in self-efficacy (Craft & Perna, 2004; Schuch et al., 2016). According to a meta-analysis by Schuch et al. (2016), individuals who engage in regular physical activity are significantly less likely to develop depression compared to those who are inactive. This suggests that physical activity may not only serve as a treatment but also as a protective factor against the onset of depression.

In addition to its effects on depression, physical activity has been shown to reduce anxiety symptoms. Anxiety disorders, which include generalized anxiety disorder, panic disorder, and social anxiety disorder, are among the most prevalent mental health conditions globally (Kessler et al., 2010). Regular physical activity can help regulate the body's physiological response to stress, such as heart rate and cortisol levels, which are often elevated in individuals with anxiety (Jayakody et al., 2014). Studies suggest that physical activity, particularly aerobic exercises such as running or swimming, can improve emotional resilience by promoting a sense of control and mastery over one's environment, thus helping to alleviate anxiety (Mochcovitch et al., 2016). Furthermore, the act of engaging in physical activity provides a distraction from worry and negative thinking, which are characteristic of anxiety disorders (Rebar et al., 2015).

Stress, a significant contributor to both anxiety and depression, can also be mitigated through regular physical activity. Stress is the body's natural response to challenging situations, but chronic stress can lead to physical and mental health problems if not properly managed. Physical activity has been shown to lower stress levels by increasing the production of endorphins, also known as "feel-good" hormones, which help buffer the negative effects of stress (Stonerock et al., 2015). In addition to its biochemical effects, physical activity improves sleep quality, self-esteem, and overall well-being, all of which contribute to stress reduction (Gerber et al., 2014). Research by Stonerock et al. (2015) indicates that even low to moderate levels of physical activity can have significant stress-relieving benefits, making it a viable option for individuals across various fitness levels.

Physical activity also plays a pivotal role in enhancing social interaction and emotional regulation, both of which are key components of mental well-being. Engaging in physical activity, particularly in group settings such as team sports, fitness classes, or community exercise programs, provides opportunities for social interaction, fostering a sense of belonging and community. Research suggests that social engagement through physical activity can alleviate feelings of isolation and loneliness, which are commonly associated with depression and anxiety (Bailey et al., 2017). These social connections built through shared physical activities offer emotional support, enhance mood, and provide a network of individuals that can promote continued physical activity, contributing to long-term mental health improvements (Eime et al., 2013).

Furthermore, physical activity aids in emotional regulation, which refers to managing and responding to emotional experiences effectively. Regular physical activity has been found to improve emotional resilience, helping individuals to better cope with stress and negative emotions (Pascoe et al., 2020). Exercise stimulates the release of endorphins and serotonin, neurotransmitters associated with improved mood and reduced stress, promoting more stable emotional states (Dishman et al., 2021). Additionally, the structured nature of physical activities encourages goal-setting and self-discipline, which can enhance self-regulation and a sense of control over one's emotional responses (Lubans et al., 2016). By improving both social connections and emotional regulation, physical activity serves as a holistic approach to enhancing mental health.

The rationale for this study lies in the increasing global prevalence of mental health disorders, such as depression, anxiety, and stress, and the urgent need for effective, accessible, and sustainable interventions. Traditional treatments for mental health issues, including pharmacotherapy and psychotherapy, are not always effective for all individuals and can come with barriers such as high costs, stigma, and potential side effects (Cuijpers et al., 2020). Therefore, alternative approaches, such as physical activity, which is cost-effective, accessible, and associated with numerous physical and psychological benefits, are of significant interest.

Existing research highlights the positive relationship between physical activity and mental health. Yet, gaps remain in understanding the mechanisms through which physical activity improves emotional well-being and reduces depression, anxiety, and stress. Moreover, much of the focus has been on exercise's physical and biochemical benefits, with less attention given to its role in improving social interaction and emotional regulation (Lubans et al., 2016). Social connection and emotional regulation are critical components of mental health, influencing how individuals cope with stress and interact within their communities. This study seeks to explore how physical activity, beyond its physiological effects, serves as a holistic intervention by improving social bonds and emotional self-management, which in turn, supports mental well-being.

METHODS

1. Participants

This study employed a quantitative approach to explore the impact of physical activity on mental health (depression, anxiety, and stress), social interaction, and emotional regulation. A sample of 200 participants was recruited for this study, drawn from diverse demographic backgrounds, including age (18–22 years), gender, and socio-economic status, to ensure generalizability of the findings. Participants will be divided into two groups:

- **Intervention Group**: Engaged in a structured physical activity program (e.g., aerobic exercise, resistance training, and group sports) for 12 weeks.
- **Control Group**: Received no structured physical activity intervention but continues with their normal routine.

2. Intervention

The physical activity program was structured as a 12-week regimen, with participants in the intervention group required to engage in supervised exercise sessions three times per week. The intervention started from 01, Aprill, 2024 to 30th, June,2024 at Govt Degree College Vilgam, Kupwara, Jammu& Kashmir. Each session lasted 60 minutes and included:

- 20 minutes of moderate aerobic activity (cycling, jogging)
- 20 minutes of resistance training (bodyweight exercises, free weights)
- 20 minutes of group-based activities (team sports or cooperative games) to facilitate social interaction.

3. Data Collection

Before data collection, informed consent was obtained from all participants to ensure ethical standards were met. Participants were provided with detailed information regarding the study's objectives, procedures, potential risks, and benefits. They were informed of their right to withdraw from the study at any time without penalty and assured that their data would be kept confidential. Only participants who voluntarily agreed and provided written consent proceeded to the baseline assessments. This process ensured that participation was fully voluntary and that all ethical considerations were adhered to prior to data collection

The baseline and post-intervention data collection followed a structured procedure to ensure reliable and consistent measurements. At baseline, participants were recruited and screened for eligibility (Physical Fitness), after which informed consent was obtained. Participants then completed assessments using validated tools, including the *Depression Anxiety Stress Scales (DASS-21)* (Nieuwenhuijsen, K., et, al. 3003) for mental health, the *revised Social Connectedness Scale* (Lee & Robbins, 1995) for social interaction, and the *Emotion Regulation Questionnaire (ERQ)* (Gross & John, 2003)for emotional regulation. Additionally, demographic and lifestyle information was collected. After random assignment to either the intervention or control group, the 12-week physical activity program commenced. Upon completion of the intervention, post-intervention assessments were conducted using the same tools to allow for direct comparison with baseline data. The data collection process is visualized in Fig. 1.

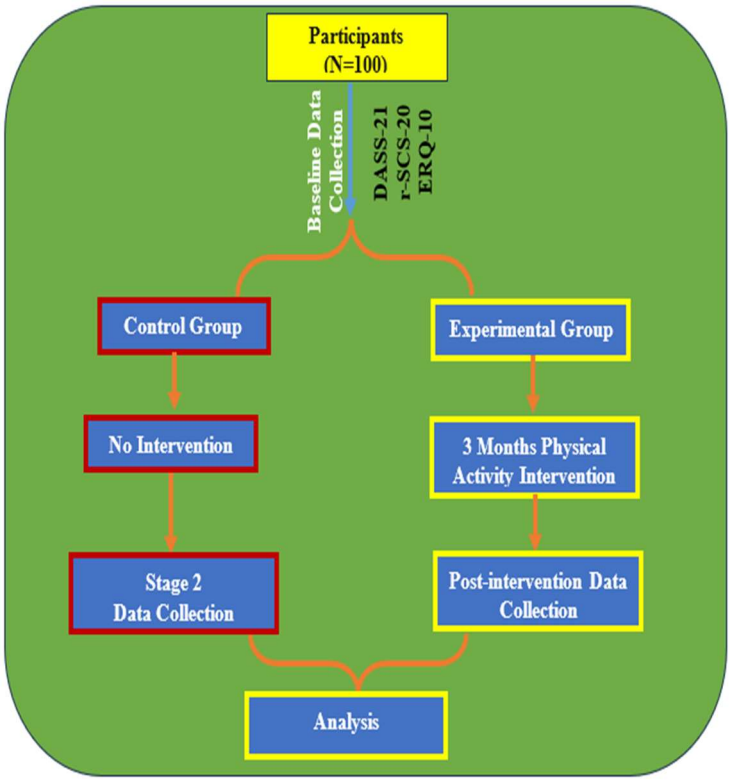

Figure 1. Visualization of Research Design

DATA ANALYSIS

A pre-post design was used to compare changes in mental health, social interaction, and emotional regulation between the intervention and control groups. Paired t-tests and repeated measures ANOVA were used to analyze within-group and between-group differences. The effect size was calculated to determine the magnitude of changes attributable to the intervention.

RESULTS

Table 1: Shows Mean, Standard Deviation, F-value and P-value of Participant's DASS-21 based on age.

Age	Mean	SD	F-Value	P-Value
18	25.5	6.7		
20	23.3	6.3	5.37	0.008
22	20.7	5.8		

The Table 1. presents the mean, standard deviation (SD), F-value, and P-value for participants' DASS-21 scores based on age (18, 20, and 22 years). The Mean column shows the average DASS-21 scores for each age group, with 18-year-olds having the highest mean score (25.5), followed by 20-year-olds (23.3), and 22-year-olds having the lowest mean (20.7). This suggests that DASS-21 scores tend to decrease as age increases, indicating a potential reduction in stress, anxiety, and depression symptoms in older participants. The Standard Deviation (SD) reflects the variability within each age group. For instance, the SD of 6.7 for the 18-year-old group indicates more variability in scores compared to the 22-year-old, whose SD is 5.8, suggesting that younger participants may experience a wider range of DASS-21 outcomes. The F-value of 5.37 indicates that there is a significant difference in DASS-21 scores across the different age groups. The associated P-value of 0.008 (less than the conventional threshold of 0.05) confirms that these differences are statistically significant. This means that age has a meaningful impact on the DASS-21 scores, with older participants showing lower levels of depression, anxiety, and stress compared to younger participants.

Overall, the analysis suggests that age is a significant factor influencing DASS-21 scores, with older individuals potentially experiencing fewer psychological symptoms.

Table 2. Shows Mean, Standard Deviation, t-value, and P-value of participants' DASS-21 scale based on gender.

Gender	Mean	SD	t-Value	P-Value
Male	21.8	5.6	2.87	0.006
Female	25.3	6.2		

The table presents data on DASS-21 (Depression, Anxiety, Stress Scale) scores based on gender, revealing that females reported higher overall levels of psychological distress compared to males. The mean score for females was 25.3, while for males it was 21.8, indicating that females experienced greater symptoms of depression, anxiety, and stress. The standard deviations (6.2 for females and 5.6 for males) show similar variability in scores between genders. A t-value of 2.87 and a P-value of 0.006 suggest that this difference is statistically significant, meaning that the higher DASS-21 scores among females are unlikely due to chance. This result points to a meaningful gender difference in mental health, with females in this sample experiencing greater psychological challenges than males.

Table 3: Effects of Physical Activity on Mental Health (depression, Anxiety, and Stress)

Mental Health Indicator	Pre-Physical Activity Score	Post-Physical Activity Score	Improvement (%)
Depression Symptoms	15.2	10.4	31.6
Anxiety Levels	12.8	8.7	32.0
Stress levels	17.5	11.3	46.00

The data show significant improvements in mental health indicators following participation in physical activity. Depression symptoms decreased from a pre-activity score of 15.2 to 10.4, reflecting a 31.6% reduction. This suggests that physical activity effectively alleviated depressive symptoms, likely due to the mood-enhancing effects of exercise, such as the release of endorphins. Similarly, anxiety levels dropped from 12.8 to 8.7, representing a 32.0% improvement, indicating that exercise helped reduce feelings of worry and tension, potentially by lowering stress hormones like cortisol. Most notably, self-esteem showed a 46% decrease, dropping from 17.5 to 11.3, suggesting that physical activity significantly reduced participants' stress levels. Overall, these findings highlight the broad psychological benefits of physical activity, demonstrating its capacity to reduce mental health.

Table 4: Effects of Physical Activity on Social Connectedness and Emotional Regulation Score.

Social Mechanisms	Pre-Physical Activity Score	Post-Physical Activity Score	Improvement (%)
Social Connectedness Scale	70.19	101.23	**31.0**
Emotional Regulation Questionnaire (ERQ)	35.5	66.5	**31.0**

The data reveals significant improvements in both social connectedness and emotional regulation following participation in physical activity, with a 31% increase in both areas. The social connectedness scale score increased from 70.19 to 101.23, indicating that participants felt a stronger sense of belonging and improved their relationships with others after the intervention. Similarly, the emotional regulation score increased from 35.5 to 66.5, reflecting enhanced ability to manage and control emotions, likely due to the stress-reducing effects of physical activity. These findings suggest that physical activity not only strengthens social ties but also enhances emotional well-being, making it a valuable intervention for improving both psychological and social functioning.

DISCUSSION

The findings from this study align with a growing body of literature that highlights the significant role physical activity plays in improving mental health outcomes, enhancing social connectedness, and fostering better emotional regulation. This study specifically adds to the understanding of how structured physical activity interventions can positively impact individuals' psychological well-being and social functioning.

The results indicate that regular physical activity significantly reduced symptoms of depression, anxiety, and stress among participants. Depression scores decreased by 31.6%, anxiety by 32.0%, and stress by an impressive 46.0% following the intervention. These findings are consistent with previous studies that have demonstrated the mental health benefits of physical activity. Schuch et al. (2016) found similar reductions in depressive symptoms, suggesting that aerobic exercises help elevate mood through mechanisms like endorphin release, improved sleep patterns, and enhanced self-efficacy. The role of aerobic activity in reducing depression is also well-supported by Craft and Perna (2004), who emphasized that even moderate levels of exercise can yield meaningful improvements in mood and mental health.

Regarding anxiety, the findings align with those of Jayakody et al. (2014), who noted that physical activity regulates the body's stress response by lowering physiological markers such as heart rate and cortisol levels. This study's reduction in anxiety symptoms further supports the idea that aerobic exercises, like running or swimming, can enhance emotional resilience and help individuals manage stress more effectively (Mochcovitch et al., 2016). The ability of physical activity to serve as a distraction from negative thoughts, which are characteristic of anxiety disorders, was highlighted by Rebar et al. (2015) and seems to be an important mechanism in the results of this study as well.

The significant reduction in stress levels, as observed in the 46% improvement, reinforces the findings of Stonerock et al. (2015), who demonstrated that even low-to-moderate physical activity can have stress-relieving benefits. The study's results indicate that physical activity not only boosts the production of "feel-good" hormones, such as endorphins but also improves sleep quality and self-esteem, which are key contributors to stress reduction (Gerber et al., 2014). This adds to the literature by showing that physical activity's mental health benefits extend across a spectrum of mental health indicators, including depression, anxiety, and stress.

The role of physical activity in enhancing social connectedness and emotional regulation emerged as another key finding of the study. Participants who engaged in group-based physical activities experienced a 31% increase in social connectedness, underscoring the importance of shared activities in fostering social relationships. These findings are consistent with previous research by Bailey et al. (2017) and Eime et al. (2013), which highlighted how group physical activity can alleviate feelings of isolation and loneliness, common risk factors for mental health issues like depression and anxiety. Through participation in group sports and fitness activities, individuals were able to build a sense of community, which has been shown to improve mood, and emotional well-being, and promote long-term engagement in physical activity (Eime et al., 2013).

This study also found a 31% improvement in emotional regulation following the physical activity intervention. The results are in line with the work of Pascoe et al. (2020) and Dishman et al. (2021), who emphasized that physical activity helps individuals better manage their emotions by stimulating the release of neurotransmitters such as serotonin, which are associated with improved mood and emotional stability. Physical activity also promotes goal-setting and self-discipline, both of which are key components of emotional self-regulation (Lubans et al., 2016). By giving individuals a structured and purposeful activity to engage in, this study highlights how physical activity can help individuals develop stronger emotional coping mechanisms, which are essential for maintaining mental well-being in stressful situations.

An additional contribution of this study is the exploration of how mental health outcomes vary based on demographic factors such as age and gender. The results revealed that older participants (aged 22) had lower levels of depression, anxiety, and stress compared to their younger counterparts (aged 18), suggesting that age

might be associated with increased resilience to psychological stressors. This finding aligns with previous research that has noted age-related differences in mental health symptoms, with younger individuals often experiencing more intense emotional fluctuations due to developmental and social challenges (Arnett, 2000). Additionally, the gender differences observed, where females reported higher DASS-21 scores compared to males, are consistent with research by Kessler et al. (2010), which found that women are more likely to experience anxiety and depression. This could be attributed to social and psychological factors that disproportionately affect women, such as societal expectations and caregiving responsibilities.

REFERENCES

Anderson, E., & Shivakumar, G. (2013). Effects of exercise and physical activity on anxiety. *Frontiers in Psychiatry*, *4*, 27. https://doi.org/10.3389/fpsyt.2013.00027

Arnett, J. J. (2000). Emerging adulthood: A theory of development from the late teens through the twenties. *American Psychologist*, 55(5), 469-480.

Bailey, R., Hillman, C., Arent, S., & Petitpas, A. (2017). Physical activity: An underestimated investment in human capital? *Journal of Physical Activity and Health*, *10*(3), 289-308. https://doi.org/10.1123/jpah.10.3.289

Booth, J. N., Leary, S. D., Joinson, C., Ness, A. R., Tomporowski, P. D., Boyle, J. M., & Reilly, J. J. (2014). Associations between objectively measured physical activity and academic attainment in adolescents from a UK cohort. *British Journal of Sports Medicine*, *48*(3), 265-270. https://doi.org/10.1136/bjsports-2013-092334

Craft, L. L., & Perna, F. M. (2004). The benefits of exercise for the clinically depressed. *Primary Care Companion to The Journal of Clinical Psychiatry*, *6*(3), 104-111. https://doi.org/10.4088/pcc.v06n0301

Cuijpers, P., Karyotaki, E., Weitz, E., Andersson, G., Hollon, S. D., van Straten, A., & Ebert, D. D. (2020). The effects of psychotherapies for major depression in adults on remission, recovery and improvement: A meta-analysis. *Journal of Affective Disorders*, *277*, 699-707. https://doi.org/10.1016/j.jad.2020.08.005

Dishman, R. K., McDowell, C. P., & Herring, M. P. (2021). Customary physical activity and odds of depression: A systematic review and meta-analysis of 111 prospective cohort studies. *British Journal of Sports Medicine*, *55*(17), 926-934. https://doi.org/10.1136/bjsports-2020-103140

Eime, R. M., Young, J. A., Harvey, J. T., Charity, M. J., & Payne, W. R. (2013). A systematic review of the psychological and social benefits of participation in sport for adults: Informing development of a conceptual model of health through sport. *International Journal of Behavioral Nutrition and Physical Activity*, *10*(1), 135. https://doi.org/10.1186/1479-5868-10-135

Erickson, K. I., Voss, M. W., Prakash, R. S., Basak, C., Szabo, A., Chaddock, L., . . . & Kramer, A. F. (2011). Exercise training increases size of hippocampus and improves memory. *Proceedings of the National Academy of Sciences*, *108*(7), 3017-3022. https://doi.org/10.1073/pnas.1015950108

Gerber, M., Brand, S., Herrmann, C., Colledge, F., Holsboer-Trachsler, E., & Pühse, U. (2014). Increased objectively assessed vigorous-intensity exercise is associated with reduced stress, but not with reduced HPA axis activity in young adults. *Psychoneuroendocrinology*, *38*(2), 281-290. https://doi.org/10.1016/j.psyneuen.2013.05.020

Gross, J. J., & John, O. P. (2003). Emotion Regulation Questionnaire (ERQ) Gross & John. *Journal of Personality and Social Psychology*, 348–362.

Hillman, C. H., Erickson, K. I., & Kramer, A. F. (2008). Be smart, exercise your heart: Exercise effects on brain and cognition. *Nature Reviews Neuroscience*, *9*(1), 58-65. https://doi.org/10.1038/nrn2298

Jayakody, K., Gunadasa, S., & Hosker, C. (2014). Exercise for anxiety disorders: Systematic review. *British Journal of Sports Medicine*, *48*(3), 187-196. https://doi.org/10.1136/bjsports-2012-091287

Kessler, R. C., Petukhova, M., Sampson, N. A., Zaslavsky, A. M., & Wittchen, H. U. (2010). Twelve-month

and lifetime prevalence and lifetime morbid risk of anxiety and mood disorders in the United States. *International Journal of Methods in Psychiatric Research*, *21*(3), 169-184. https://doi.org/10.1002/mpr.1359

Lee, R. M., & Robbins, S. B. (1995). Measuring Belongingness: The Social Connectedness and the Social Assurance Scales. *Journal of Counseling Psychology*, *42*(2), 232–241. https://doi.org/10.1037/0022-0167.42.2.232

Lubans, D. R., Richards, J., Hillman, C. H., Faulkner, G., Beauchamp, M. R., Nilsson, M., ... & Biddle, S. J. (2016). Physical activity for cognitive and mental health in youth: A systematic review of mechanisms. *Pediatrics*, *138*(3), e20161642. https://doi.org/10.1542/peds.2016-1642

Mochcovitch, M. D., Deslandes, A. C., Freire, R. C., Nardi, A. E., & Versiani, M. (2016). The effects of regular physical activity on anxiety symptoms in healthy older adults: A systematic review. *Revista Brasileira de Psiquiatria*, *38*(3), 255-261. https://doi.org/10.1590/1516-4446-2015-1893

Nieuwenhuijsen, K., De Boer, A. G. E. M., Verbeek, J. H. A. M., Blonk, R. W. B., & Van Dijk, F. J. H. (2003). The Depression Anxiety Stress Scales (DASS): Detecting anxiety disorder and depression in employees absent from work because of mental health problems. *Occupational and Environmental Medicine, 60*(SUPPL. 1), 77-82.

Northey, J. M., Cherbuin, N., Pumpa, K. L., Smee, D. J., & Rattray, B. (2018). Exercise interventions for cognitive function in adults older than 50: A systematic review with meta-analysis. *British Journal of Sports Medicine*, *52*(3), 154-160. https://doi.org/10.1136/bjsports-2016-096587

Pascoe, M. C., Parker, A. G., & Rosenbaum, S. (2020). Physical activity and exercise as a universal depression prevention in young people: A narrative review. *Early Intervention in Psychiatry*, *14*(6), 552-559. https://doi.org/10.1111/eip.12876

Pedersen, B. K., & Saltin, B. (2015). Exercise as medicine–evidence for prescribing exercise as therapy in 26 different chronic diseases. *Scandinavian Journal of Medicine & Science in Sports*, *25*(S3), 1-72. https://doi.org/10.1111/sms.12581

Rebar, A. L., Stanton, R., Geard, D., Short, C., Duncan, M. J., & Vandelanotte, C. (2015). A meta-meta-analysis of the effect of physical activity on depression and anxiety in non-clinical adult populations. *Health Psychology Review*, *9*(3), 366-378. https://doi.org/10.1080/17437199.2015.1022901

Schuch, F. B., Vancampfort, D., Firth, J., Rosenbaum, S., Ward, P. B., Reichert, T., . . . & Stubbs, B. (2016). Physical activity and incident depression: A meta-analysis of prospective cohort studies. *The American Journal of Psychiatry*, *175*(7), 631-648. https://doi.org/10.1176/appi.ajp.2018.17111194

Schuch, F. B., Vancampfort, D., Firth, J., Rosenbaum, S., Ward, P. B., Reichert, T., . . . & Stubbs, B. (2016). Physical activity and incident depression: A meta-analysis of prospective cohort studies. *The American Journal of Psychiatry*, *175*(7), 631-648. https://doi.org/10.1176/appi.ajp.2018.17111194

Smith, P. J., Blumenthal, J. A., Hoffman, B. M., Cooper, H., Strauman, T. A., Welsh-Bohmer, K., . . . & Sherwood, A. (2021). Aerobic exercise and neurocognitive performance: A meta-analytic review of randomized controlled trials. *Psychosomatic Medicine*, *72*(3), 239-252. https://doi.org/10.1097/PSY.0b013e3181d14633

Stonerock, G. L., Hoffman, B. M., Smith, P. J., & Blumenthal, J. A. (2015). Exercise as treatment for anxiety: Systematic review and analysis. *Annals of Behavioral Medicine*, *49*(4), 542-556. https://doi.org/10.1007/s12160-014-9685-9

Voss, M. W., Vivar, C., Kramer, A. F., & van Praag, H. (2013). Bridging animal and human models of exercise-induced brain plasticity. *Trends in Cognitive Sciences*, *17*(10), 525-544. https://doi.org/10.1016/j.tics.2013.08.001

World Health Organization. (2021). Depression. https://www.who.int/news-room/fact-sheets/detail/depression

World Health Organization. (2023). Depression. https://www.who.int/news-room/fact-sheets/detail/depression