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Article

Physical activity and mental health: Exploring the role of movement and posture in reducing stress and enhancing well-being

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Abstract: In recent years, mental health issues such as stress, anxiety, and depression have become increasingly prevalent worldwide, necessitating the exploration of practical and accessible interventions. This paper investigates the role of physical activity and posture in reducing stress and enhancing mental well-being, focusing on everyday movements and body alignment. Drawing on existing research, we explore the neurochemical and psychological mechanisms by which physical activity influences mental health, emphasizing the impact of both moderate and high-intensity exercises. The role of proper posture in managing stress and promoting relaxation is examined, focusing on postural interventions such as ergonomic adjustments and mindfulness practices. A case study conducted in Shanghai, China, assesses the effectiveness of a workplace-based intervention involving physical activity and posture correction among employees with high stress levels. In the 12-week intervention, participants in the intervention group experienced a 25% reduction in perceived stress, a 30% decrease in anxiety, and a 20% reduction in depressive symptoms. Physiological markers also improved, with a 15% increase in heart rate variability (HRV) and an 18% reduction in cortisol levels. In contrast, the control group showed no significant changes. These findings underscore the value of integrating regular physical activity and posture correction into daily routines to enhance psychological and physiological well-being. The study concludes with practical recommendations for incorporating these interventions into workplace and personal environments to promote long-term mental health.

Keywords: physical activity; posture; stress reduction; mental health; anxiety; depression; workplace intervention; heart rate variability; cortisol

1. Introduction

In recent years, Mental Health (MH) issues have become a significant concern worldwide, with increasing numbers of people experiencing stress, anxiety, and depression [1,2]. The pressures of modern life, characterized by hectic work schedules, social obligations, and digital overload, have contributed to this rise in MH disorders [3]. As a result, there is an urgent need to explore practical, accessible, and sustainable solutions to promote mental well-being [4]. One promising area of focus is the role of Physical Activity (PA), which encompasses not only traditional forms of exercise but also everyday movements and posture [5,6]. A growing body of research suggests that regular PA can substantially improve MH, including stress reduction, enhanced mood, and improved cognitive function [7–10].

The link between PA and mental well-being is not new, yet it continues to gain scientific validation [11]. Traditionally, PA has been recognized for its physical health benefits, such as improving cardiovascular function and reducing the risk of chronic diseases [12,13]. However, recent studies show that its impact on MH is equally

important [14–16]. Movement and posture, often overlooked in the discussion of MH, play crucial roles in shaping our emotional states and managing stress levels [17,18]. By investigating how specific types of movement and posture influence mental well-being, this paper seeks to provide a deeper understanding of how physical activity contributes to mental health beyond its physical benefits.

The primary aim of this paper is to explore the connection between PA, movement, posture, and MH, with a particular focus on stress reduction and overall well-being. The paper will review existing research on the subject, examining the neurochemical and psychological mechanisms through which PA influences mental states. Furthermore, it will analyze the specific roles that various types of movement and posture play in mitigating stress and enhancing mood. Through this exploration, the paper aims to highlight how deliberate exercise and simple adjustments to posture can be leveraged as practical tools for improving MH. It also aims to outline actionable recommendations for integrating movement and posture practices into daily life to promote long-term well-being [19–20].

By addressing these aspects, the paper seeks to answer several key questions: How does PA impact MH, and in what ways do movement and posture specifically contribute to stress reduction? What types of PA are most beneficial for MH, and how can individuals implement these practices in their routines? These questions form the foundation of the analysis, aiming to provide a comprehensive understanding of the multifaceted relationship between PA and MH.

The paper is organized as follows: Section 2 reviews existing solutions for managing stress and MH, including traditional approaches such as medication and therapy and the emerging role of PA. Section 3 explores the scientific basis for the link between PA and MH, highlighting neurochemical and psychological mechanisms. Section 4 examines the specific role of different types of movement in reducing stress, while Section 5 focuses on the impact of posture on MH and stress management. Section 6 presents a case study from Shanghai, China, to illustrate the practical application of these concepts in a real-world setting. Finally, the paper concludes with recommendations for integrating physical activity and posture correction into daily life to promote long-term well-being. Section 7 concluded the paper.

2. Existing solutions and limitations

2.1. Traditional approaches to managing stress and MH

For many years, the most common interventions for managing stress and MH disorders have been medication and therapy [21]. Prescription medications, such as antidepressants and anti-anxiety drugs, are widely used to alleviate the symptoms of MH conditions. These medications work by altering brain chemistry, often targeting neurotransmitters like serotonin and dopamine, which play a critical role in mood regulation. Alongside medication, therapy—particularly cognitive-behavioral therapy (CBT)—has become a cornerstone of MH treatment [22–25]. Therapy helps individuals identify and modify negative thought patterns and behaviors that contribute to stress, anxiety, and depression.

However, both medication and therapy come with limitations. Medications, while effective for some, often come with side effects, such as fatigue, weight gain, or

emotional blunting. These side effects can reduce some individuals' overall quality of life, leading them to discontinue use or seek alternative treatments. Furthermore, medication alone does not address the root causes of MH issues but instead focuses on symptom management. Another critical issue is accessibility. Therapy, particularly in-person counseling, can be expensive and is often not covered comprehensively by insurance [26]. In many regions, there are long waiting times to access therapy, and for individuals in rural or underserved areas, professional MH services may be out of reach entirely. This creates a significant barrier to care, pushing the need for alternative or complementary approaches that are more accessible and sustainable.

2.2. Physical activity as an emerging intervention

PA has emerged as a promising intervention for managing stress and improving MH in recent years. Unlike medication and therapy, which often require professional oversight and carry the potential for side effects, physical activity is generally safe, widely accessible, and can be incorporated into daily life without specialized support. Typical forms of PA studied in the context of MH include aerobic exercises, such as walking, jogging, and cycling, as well as mind-body practices like yoga and tai chi. These activities have been shown to improve mood, reduce symptoms of anxiety and depression, and promote overall psychological well-being. PA works by triggering a range of beneficial neurochemical responses, including releasing endorphins (the brain's "feel-good" chemicals) and reducing cortisol, a hormone associated with stress [27–30].

Despite these benefits, the application of PA as an MH intervention still faces several challenges. One of the primary limitations is the lack of personalization in many PA programs. Current research often focuses on generalized recommendations, such as exercising for 30 min daily, without considering the diverse needs of individuals with different MH conditions, physical abilities, or personal preferences [31–35]. For instance, what works for someone dealing with mild anxiety may not be suitable for someone experiencing severe depression. Additionally, many studies on PA and MH focus on specific demographics, such as younger or healthier populations, leaving a gap in understanding how these interventions work for older adults or those with co-occurring physical health conditions. Moreover, adherence to PA routines can be difficult for individuals struggling with severe MH issues, where symptoms like fatigue, lack of motivation, or physical limitations may impede their ability to engage in regular exercise.

3. The link between PA and MH

3.1. Scientific basis

Both theoretical frameworks and empirical studies have widely supported the connection between PA and MH improvements. Several psychological and biological theories suggest that engaging in regular PA has a profound effect on mental well-being. The neurobiological perspective posits that exercise stimulates brain regions that play a role in mood regulation, stress response, and cognitive function. From a psychological standpoint, the self-determination theory (**Figure 1**) emphasizes how

PA enhances intrinsic motivation, improving mood and emotional well-being. Additionally, the biopsychosocial model (**Figure 2**) of health suggests that PA influences mental health through an interaction of biological, psychological, and social factors. Numerous longitudinal and cross-sectional studies have provided strong evidence that regular PA leads to significant reductions in the symptoms of stress, anxiety, and depression and promotes a sense of well-being.

One of the seminal studies in this area is the Harvard Alumni Health Study, which tracked the MH outcomes of participants over an extended period and found that PA individuals were less likely to suffer from depression compared to those who were inactive. Similar studies have demonstrated that regular PA is associated with lower levels of psychological distress, even when accounting for other lifestyle factors such as diet and social support. These findings suggest that PA can serve as a preventive measure and a therapeutic intervention for MH challenges.

Figure 1. Self-determination theory.

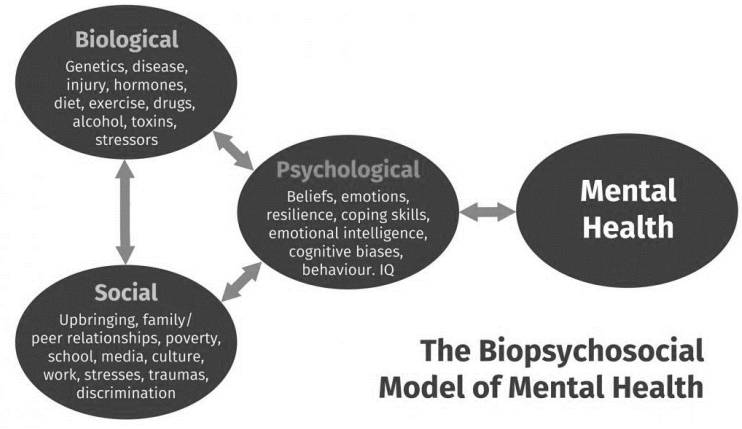


Figure 2. Biopsychosocial model.

3.2. Neurochemical changes

One of the primary mechanisms PA impacts MH is through neurochemical changes in the brain. When individuals engage in exercise, the body releases endorphins, neurotransmitters known for reducing pain and creating a feeling of euphoria, often referred to as the "runner's high". This endorphin release helps to reduce feelings of stress and can contribute to an improved overall mood. In addition to endorphins, exercise also affects the regulation of dopamine and serotonin, two

neurotransmitters that play crucial roles in mood stabilization and the management of anxiety and depression.

Dopamine is often associated with the brain's reward system and is critical for motivation and pleasure. Regular PA can boost dopamine levels, thereby improving mood and increasing motivation. Similarly, serotonin, which regulates mood, sleep, and appetite, is significantly influenced by exercise. Higher serotonin levels are associated with reduced feelings of depression and anxiety, and regular exercise has been shown to elevate these levels, leading to long-term improvements in emotional stability.

Another significant neurochemical change is the reduction of cortisol, a hormone produced in response to stress. Elevated cortisol levels over time are linked to chronic stress, anxiety, and depression. Exercise, particularly aerobic activities, has been shown to reduce baseline cortisol levels, alleviating stress's physiological effects. By lowering cortisol, PA provides both an immediate and sustained reduction in stress, contributing to better MH.

3.3. Psychological benefits

In addition to neurochemical changes, PA activity offers a range of psychological benefits that contribute to improved MH. One of the most immediate benefits is an improvement in mood. Engaging in PA, even briefly, can result in an enhanced sense of well-being due to the release of mood-enhancing chemicals like endorphins and dopamine. This mood elevation is often sustained beyond the duration of the activity, providing long-term psychological benefits.

PA also contributes to higher self-esteem and improved self-efficacy. Regular engagement in exercise allows individuals to set and achieve goals, which fosters a sense of accomplishment and self-worth. As individuals witness their physical abilities improve, they often experience a corresponding boost in confidence. Additionally, the mastery of physical skills, whether in strength training, yoga, or cardiovascular fitness, enhances an individual's sense of control over their body and mind, further supporting emotional well-being.

Beyond mood and self-esteem, PA has been shown to improve cognitive function. Regular exercise enhances brain plasticity, supporting cognitive processes such as memory, attention, and problem-solving. This cognitive boost is significant for individuals experiencing stress or depression, as MH disorders often impair cognitive functioning. Improved cognition helps manage the mental demands of daily life and contributes to a more positive outlook on future challenges.

Lastly, PA has been consistently linked to a reduction in symptoms of anxiety and depression. Many forms of exercise, especially aerobic activities like running and cycling, have decreased anxiety by promoting relaxation, reducing muscle tension, and providing a mental distraction from stressful thoughts. In the case of depression, PA acts as both a preventive measure and a treatment. Exercise stimulates the production of neurotrophic factors, which promote brain cell growth and repair, potentially reversing some of the neurological effects of depression. Over time, these biological and psychological benefits combine to create a more balanced emotional state, reducing the severity and frequency of depressive episodes.

4. Role of movement in reducing stress

4.1. Types of movement

PA, in various forms and intensities, plays a key role in stress reduction. Understanding how different types of movement contribute to stress relief allows individuals to select activities that suit their preferences and needs. Two primary categories of exercise—moderate intensity and high intensity—are particularly relevant when discussing movement's impact on MH.

Moderate-intensity exercises, such as walking, jogging, cycling, and swimming, are accessible to many individuals and have consistently been associated with stress relief. These activities are characterized by sustained movement that raises the heart rate but does not push the body to its limits. Moderate-intensity exercises are ideal for individuals who prefer less physically demanding activities but still wish to experience the MH benefits of physical activity. Walking, for example, is one of the simplest and most common forms of movement, providing physical health benefits and an opportunity to clear the mind and reduce stress. Studies have shown that even brief sessions of moderate-intensity exercise, such as a 30 min walk, can significantly reduce symptoms of stress and anxiety.

On the other hand, high-intensity exercises, such as strength training, High-Intensity Interval Training (HIIT), and intense cardiovascular activities, provide a more vigorous workout. High-intensity exercises elevate heart rate rapidly and can lead to more pronounced and immediate changes in neurochemistry, such as the release of endorphins and a more dramatic reduction in cortisol. These forms of exercise are often favored by individuals looking for quick and impactful stress relief or who enjoy the physical challenge of pushing their bodies. While high-intensity exercises require more effort, they can produce a more intense sense of accomplishment, improving mental well-being.

4.2. Impact on stress reduction

Movement, regardless of intensity, offers both short-term stress relief and contributes to long-term mental resilience (**Figure 3**). In the short term, engaging in PA promotes the release of neurochemicals like endorphins and reduces muscle tension, which can quickly lower feelings of stress and anxiety. This immediate effect is often called a "Stress Buffer" because it mitigates the body's physical response to stressors, providing a sense of calm and well-being following a workout. For example, moderate-intensity exercises such as jogging have been shown to reduce anxiety symptoms within minutes after completion. In contrast, high-intensity exercises like HIIT can produce a greater sense of relaxation due to the pronounced endorphin release following intense physical exertion.

In the long term, regular physical activity builds mental resilience, making individuals better equipped to handle stress in the future. This is primarily due to the repeated stimulation of the body's stress-response systems during exercise, which trains the body and mind to recover more efficiently from stress. Over time, this consistent exposure to controlled stressors (through exercise) enhances an individual's ability to cope with stress in other areas of life. Furthermore, physical activity

improves sleep quality, reduces chronic inflammation, and supports cognitive function, contributing to better stress management and overall MH.

Numerous studies support the role of PA in reducing stress by examining changes in stress biomarkers such as heart rate variability (HRV) and cortisol levels. HRV, which measures the variation in time between heartbeats, is an essential indicator of the body's ability to adapt to stress. Higher HRV is associated with greater resilience and a more balanced autonomic nervous system. Studies have found that individuals who engage in regular PA, particularly aerobic exercises like jogging or cycling, tend to have higher HRV, indicating a more robust stress-response system. Similarly, PA has been shown to reduce cortisol levels, particularly after moderate to high-intensity workouts. Lower baseline cortisol levels suggest that the body is better able to regulate its stress response, preventing chronic stress from accumulating and leading to mental health issues like anxiety or depression.

4.3. Movement frequency and duration

While the types and intensities of movement vary, research suggests that certain thresholds for movement frequency and duration maximize the stress-reducing benefits of exercise. For moderate-intensity exercises, individuals generally should engage in at least 150 min per week (roughly 30 min per day, five days a week). This activity level has been shown to provide substantial benefits for MH, including reduced stress, improved mood, and excellent emotional stability. For individuals who prefer high-intensity activities, the recommended duration is lower—75 min per week of vigorous exercise is considered sufficient to achieve similar MH benefits.

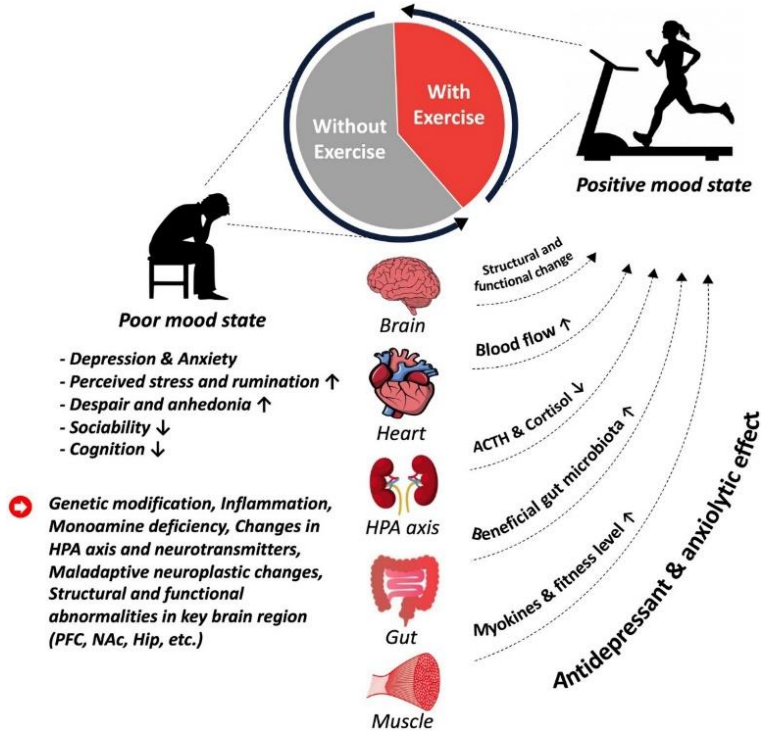


Figure 3. Exercise potentials (22).

It's important to note that the stress-reducing effects of PA are often cumulative. While a single exercise session can relieve immediate stress, regular and consistent

movement is necessary to maintain long-term benefits. Shorter, more frequent bouts of activity are often more effective than sporadic intense sessions. For example, taking a brisk 10-minute walk several times throughout the day may provide more sustained stress reduction than a single exercise session once a week. Additionally, incorporating movement into daily routines, such as taking the stairs or stretching exercises during breaks, can help individuals manage stress continuously without requiring significant time commitments.

5. Role of posture in mental well-being

5.1. Connection between posture and emotion

Body posture plays a significant role in shaping emotional and mental states, and research has increasingly highlighted the connection between posture and psychological well-being. How individuals hold themselves physically can influence their mood, self-confidence, and how they respond to stress. For example, power posing, a concept popularized by social psychologist Amy Cuddy (**Figure 4**), suggests that adopting expansive, open postures—such as standing tall with shoulders back—can enhance feelings of power and self-assurance. Studies have found that individuals who engage in power posing for as little as two minutes experience a temporary boost in confidence and are better able to handle stressful situations.

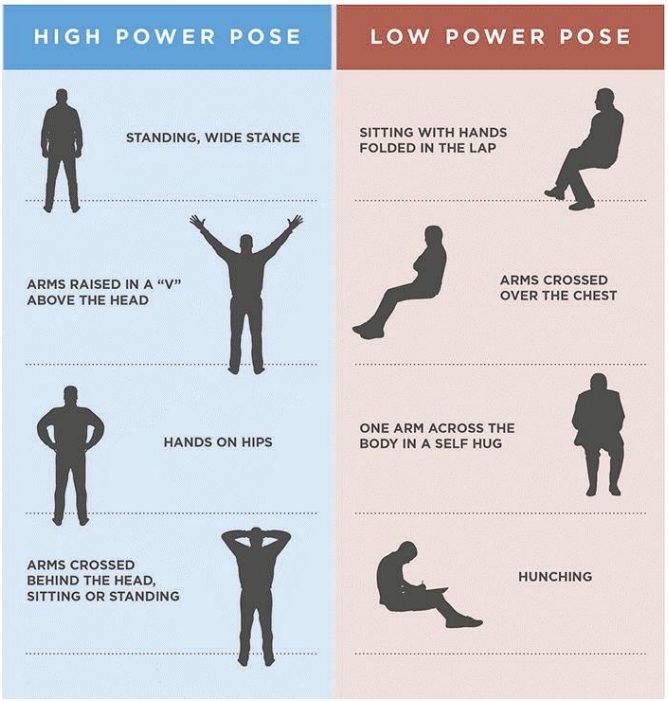


Figure 4. Amy Cuddy (Bio + Contributions to Psychology).

Conversely, slouching or adopting closed, hunched postures is associated with negative emotional states. Slumped postures are often linked to sadness, fatigue, or low self-esteem. Research indicates that individuals who maintain poor posture, such as slouching while sitting or standing, are more likely to report feelings of anxiety and depression. This connection between posture and emotion may be partly due to the influence of posture on breathing patterns and muscle tension, which can affect how

stress is processed in the body. When someone slouches, they are more likely to experience shallow breathing and increased tension in the shoulders and neck, which can exacerbate feelings of anxiety or discomfort.

5.2. Posture and stress reduction

Maintaining proper posture can play an essential role in stress reduction by promoting physical relaxation and reducing the physiological symptoms of stress. When individuals maintain an aligned and upright posture, their body is better able to function efficiently, with less strain on muscles and joints. This helps reduce the physical tension that often accompanies stress. For example, sitting or standing with a straight spine allows the diaphragm to expand fully, facilitating deep, calm breathing. Deep breathing is a well-documented relaxation technique that activates the parasympathetic nervous system, which helps counteract the body's stress response.

Proper posture can also promote a sense of mental calm and focus. Mindfulness practices (**Figure 5**), such as meditation and deep breathing, emphasize the importance of maintaining an aligned posture to enhance the meditative experience. These practices reinforce the connection between posture and the mind; a relaxed yet attentive posture facilitates better mental clarity, reduces stress, and allows individuals to stay grounded in the present moment. Similarly, yoga, which integrates movement, posture, and breath, underscores the link between proper body alignment and mental well-being. Many yoga poses are designed to open the chest, lengthen the spine, and promote balance, all supporting physical relaxation and mental stress reduction. Yoga's emphasis on mindful posture helps individuals become more aware of how they carry tension in their bodies, allowing them to release it and reduce stress consciously.

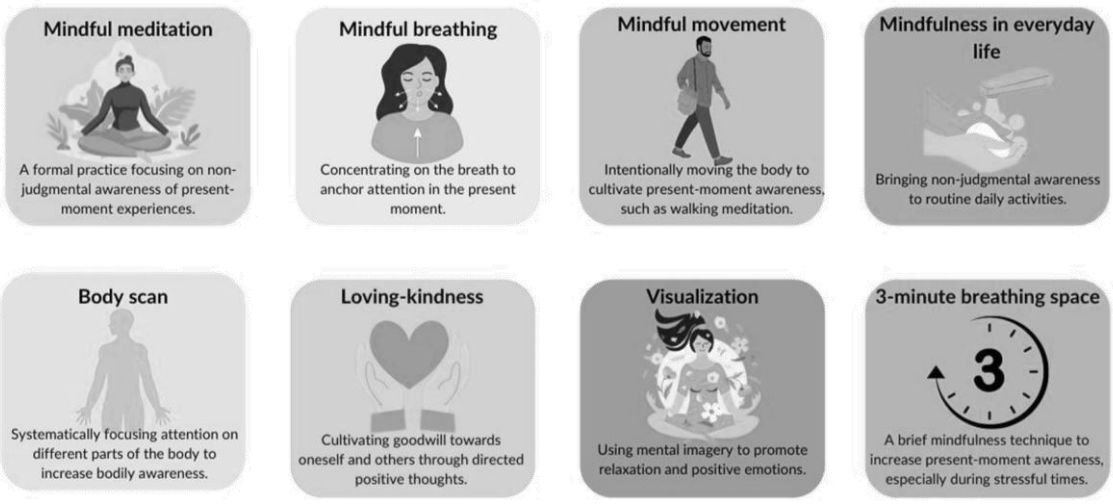


Figure 5. Mindfulness practices (https://www.simplypsychology.org/what-is-mindfulness.html).

5.3. Postural interventions

A range of postural interventions can be employed to improve posture and support mental well-being. These techniques are designed to help individuals become

more mindful of their body alignment and adopt postures that reduce physical strain and promote emotional balance.

One of the most straightforward interventions involves ergonomic adjustments to workspaces and daily environments. Many individuals spend long hours sitting at desks or using electronic devices, often leading to poor posture and increased physical tension. Ergonomic adjustments, such as using chairs with lumbar support, adjusting monitor heights to maintain an upright neck position, and ensuring that feet are flat on the ground when seated, can help prevent slouching and the physical discomfort that comes with it. These changes can reduce the physical effects of stress, improve focus, and reduce mental fatigue during work.

Another effective postural intervention is physical therapy, which can help individuals correct long-term postural issues that may contribute to stress and discomfort. Physical therapists often work with individuals to strengthen the muscles that support proper posture, such as the core and back muscles. By developing a stronger foundation, individuals can more easily maintain proper posture throughout the day, reducing the physical tension associated with stress. Additionally, physical therapy may include exercises that focus on body awareness and alignment, helping individuals to become more conscious of their posture and its impact on their mental state.

Lastly, mindfulness-based practices, such as yoga and tai chi, can be considered postural interventions that combine physical alignment with mental awareness. These practices encourage participants to focus on body posture while engaging in slow, controlled movements and deep breathing. By regularly practicing mindful posture in these contexts, individuals can carry the benefits of proper posture into their daily lives, improving emotional regulation and stress management.

In conclusion, posture plays a critical role in influencing mental well-being, with research supporting the idea that proper body alignment can reduce stress and enhance emotional states. Postural interventions, ranging from ergonomic adjustments to mindfulness-based practices, offer practical strategies for improving physical health and mental resilience. By becoming more mindful of posture, individuals can reduce stress's physical and emotional impacts, promoting long-term mental well-being.

6. Case study: The role of PA and Posture in MH—a study from Shanghai, China

6.1. Background and context

Shanghai, one of China's most populous and rapidly urbanizing cities, faces unique challenges related to MH. With its fast-paced lifestyle, dense population, and high work demands, residents often experience heightened levels of stress, anxiety, and other MH issues. The competitive work culture, long commuting hours, and high expectations for success contribute to a widespread experience of chronic stress among the working population. In recent years, there has been growing interest in addressing MH problems through alternative approaches, including PA and posture correction, as these methods are cost-effective and accessible in urban environments.

This case study focuses on a workplace-based intervention designed to improve mental well-being through a combination of moderate-intensity PA and posture correction in a technology company in Shanghai. The intervention targeted employees who reported high stress levels and sedentary lifestyles daily in the tech industry due to long hours spent at desks and in front of computers.

6.2. Study design and participants

The study involved 100 employees, aged between 25 and 45, who worked in a major technology firm in Shanghai. All participants self-reported high-stress levels based on the Perceived Stress Scale (PSS) and showed signs of sedentary behavior (sitting for more than 6 hours per day). The participants were divided into two groups: Intervention and control groups.

The intervention group participated in a 12-week program that combined:

- Moderate-Intensity PA: Participants were required to walk, light jogging, or cycle for at least 30 minutes five days a week.
- Postural Training and Ergonomic Adjustments: The company implemented ergonomic changes to workstations, such as providing adjustable chairs and desks, and participants attended weekly posture training sessions where they learned to maintain proper alignment while sitting and standing.

The control group continued their routines without any changes to PA or posture. Both groups were monitored for MH outcomes at the beginning and end of the study using standardized measures like the Beck Depression Inventory (BDI) and the State-Trait Anxiety Inventory (STAI), along with physiological stress markers like heart rate variability (HRV) and cortisol levels.

6.3. Apparatus

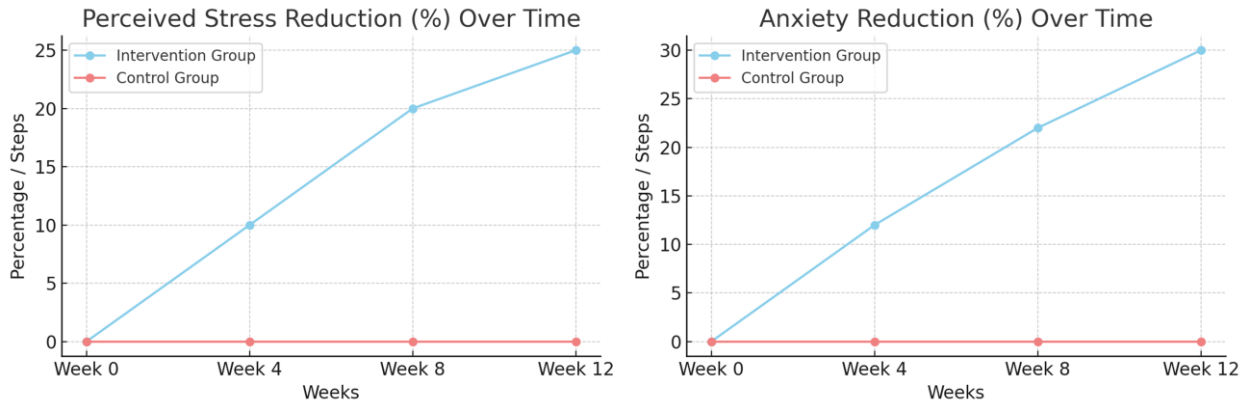
A combination of tools and equipment was used to track psychological and physiological changes in participants to measure the impact of the PA and posture intervention effectively. The apparatus for this study included:

1) Wearable Fitness Trackers: Each participant in the intervention group was provided with a wearable fitness tracker (e.g., Fitbit or Xiaomi Mi Band) to monitor their daily PA. These devices tracked metrics such as:
    - Steps Taken
    - Distance covered during walks or jogs
    - Active minutes
    - HRV, which is a key indicator of stress levels and autonomic function
2) Ergonomically Adjustable Workstations: To support the posture training component, the company outfitted the intervention group with ergonomically adjustable workstations. These included:
    - Height-adjustable desks to allow alternating between sitting and standing
    - Ergonomic office chairs with lumbar support to promote proper spinal alignment
    - Monitor risers to keep screens at eye level, reducing neck strain
3) HRV Monitors: HRV monitors were used to assess the physiological stress responses of participants. This data was collected both during the workday and

after exercise sessions to analyze changes in autonomic nervous system function. Higher HRV readings are associated with better stress resilience and recovery.

4) Cortisol Saliva Test Kits: Saliva samples were collected from participants at the beginning and end of the study to measure cortisol levels, a biological marker of stress. The samples were analyzed in a laboratory to assess the impact of PA and posture training on the participants' stress hormone levels.
5) Psychological Assessment Tools:
    - Perceived Stress Scale (PSS): This widely used self-report scale measured participants' perceived stress levels. It consists of 10 questions designed to assess the extent to which life situations are perceived as stressful.
    - Beck Depression Inventory (BDI): A 21-item self-report questionnaire used to evaluate the severity of depression symptoms in participants.
    - State-Trait Anxiety Inventory (STAI): This tool measured state and trait anxiety in participants, differentiating between temporary anxiety experienced at a particular moment (state anxiety) and more chronic anxiety tendencies (trait anxiety).
6) Postural Training Equipment: During the weekly posture training sessions, participants were guided through exercises designed to improve alignment and body awareness. The apparatus used included:
    - Yoga mats for practicing posture-related movements
    - Stability balls to engage core muscles and improve balance
    - Resistance bands to perform exercises that strengthened the back and shoulder muscles, helping participants maintain better posture throughout the day

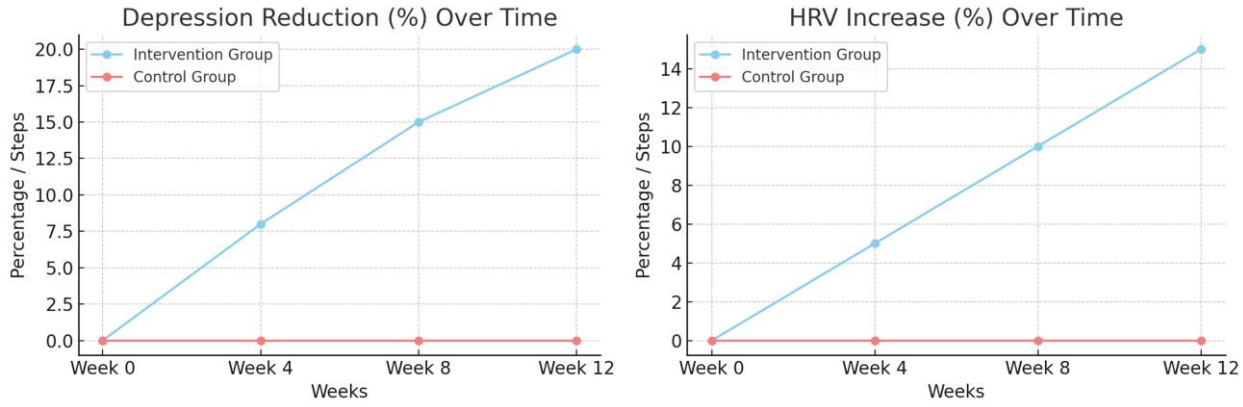
As shown in **Figure 6a** the perceived Stress throughout the 12-week intervention, participants in the intervention group experienced a steady reduction in perceived stress, with a 25% decrease by week 12. This gradual improvement suggests that regular engagement in PA and posture correction helped participants manage and lower their stress levels. In contrast, the control group, which did not participate in the intervention, showed no changes in perceived stress levels, reinforcing the effectiveness of the intervention. As measured through the State-Trait Anxiety Inventory (STAI), shown in **Figure 6b**, anxiety levels display significant improvement in the intervention group, with a 30% reduction by week 12. The gradual decrease in anxiety symptoms reflects the cumulative MH benefits of consistent physical movement and better posture. The control group remained unaffected, highlighting the lack of change in anxiety without intervention.



(a) **(b)**

Figure 6. Steady Reduction in Perceived Stress. **(a)** Perceived stress reduction over time; **(b)** Anxiety reduction over time.

The intervention group demonstrated a steady decline in depressive symptoms (**Figure 7a**), reaching a 20% reduction by the end of the study. This suggests that PA and posture training provided MH benefits that extended beyond immediate mood improvements, helping to alleviate depressive tendencies over time. The control group, on the other hand, showed no reduction in depression, underscoring the importance of the PA for MH. As shown in **Figure 7b**), participants in the intervention group saw a 15% improvement in HRV by the end of the study. HRV is a key indicator of how well the body manages stress, and the gradual increase in HRV reflects enhanced resilience to stress. The control group, however, showed no improvement in HRV, indicating that the absence of PA and posture intervention had no positive impact on physiological stress responses.

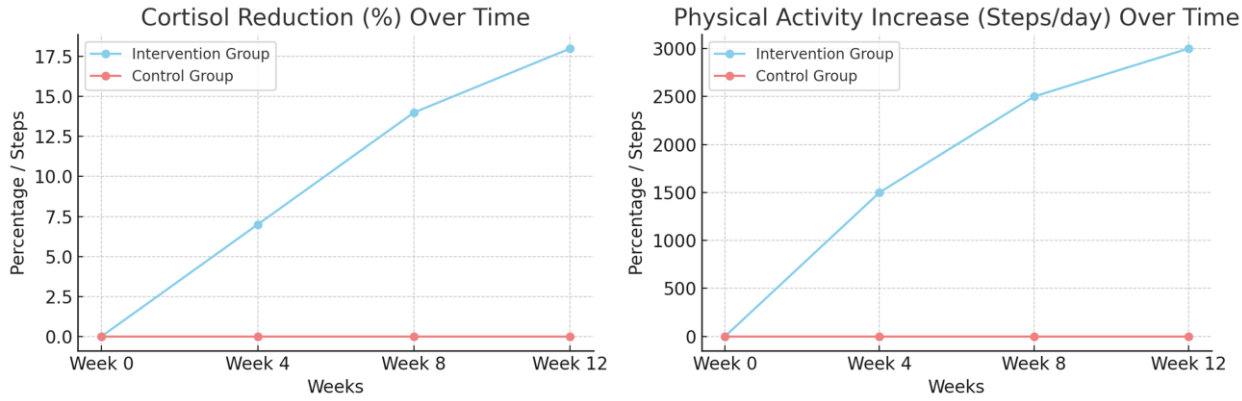


(a) **(b)**

Figure 7. Depressive Symptoms. **(a)** Depression reduction; **(b)** HRV increase.

In the analysis of cortisol reduction (**Figure 8a**) by week 12, cortisol levels—a physiological marker of stress—decreased by 18% in the intervention group. This reduction suggests that regular PA and improved posture helped mitigate the body's stress response, lowering cortisol production. The control group exhibited no change in cortisol levels, showing that physiological stress responses remained unaddressed without intervention. For the PA increase analysis (**Figure 8b**), the intervention group

significantly increased their PA over time, reaching an average of 3000 additional steps per day by week 12. This increase in daily movement was a pivotal contributor to the MH benefits observed in the study, as physical activity is closely linked to reductions in stress, anxiety, and depression. The control group did not increase their physical activity and saw no such improvements.



(a) **(b)**

Figure 8. Analysis of Cortisol Reduction. **(a)** Cortisol reduction; **(b)** Physical activity.

7. Conclusion and future work

This study highlights the significant role that physical activity and posture play in reducing stress and enhancing MH. The literature review and the Shanghai-based case study findings demonstrate that regular engagement in PA—whether moderate or high-intensity—can lead to meaningful improvements in psychological well-being. Moreover, proper posture, often overlooked in MH discussions, substantially influences emotional states and stress management. The combination of PA and posture correction, as seen in the workplace intervention, led to reductions in perceived stress, anxiety, and depression, as well as physiological improvements such as higher heart rate variability and lower cortisol levels. The implications of this research are far-reaching, particularly in urban environments where stress levels are high and sedentary lifestyles are typical. By incorporating regular movement and mindful posture adjustments into daily routines, individuals can experience short-term stress relief and long-term mental resilience. This approach offers a low-cost, accessible alternative or complement to traditional MH treatments, such as medication or therapy.

Future research should explore how these interventions can be tailored to specific populations, considering individual differences in MH conditions and physical abilities. Overall, PA and posture correction are potent tools that can be leveraged to promote mental well-being in both personal and professional settings.

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visualization, TL, FL, LZ and CM; supervision, TL, FL, LZ and CM; project administration, TL, FL, LZ and CM; funding acquisition, TL, FL, LZ and CM. All authors have read and agreed to the published version of the manuscript.

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