

Effectiveness of Mindfulness-Based Yoga Versus Traditional Aerobic Exercise on Serum Cortisol and Perceived Stress Levels

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Abstract

Stress is a common health concern associated with academic pressure, professional responsibilities, and changing lifestyles. Regular physical activity and mind-body practices are widely used to improve psychological well-being and regulate physiological responses to stress. This review examines the effectiveness of mindfulness-based yoga and traditional aerobic exercise in relation to serum cortisol and perceived stress levels, with particular attention to their potential application among young adults and college students. Mindfulness-based yoga integrates physical postures, breathing techniques, relaxation, and focused attention, whereas aerobic exercise involves continuous or repeated rhythmic physical activities that increase cardiovascular demand. Published studies suggest that both approaches can reduce perceived psychological stress. Yoga-based interventions have also demonstrated favourable changes in cortisol regulation, although findings differ according to the type of intervention and cortisol measurement. Evidence concerning aerobic exercise indicates potential benefits for stress regulation, but hormonal responses are influenced by exercise intensity, duration, and recovery. Direct comparative evidence remains limited, particularly for serum cortisol outcomes. The findings suggest that both practices may contribute to stress management, although the available evidence does not establish the universal superiority of either approach. Further controlled studies involving standardized exercise protocols and consistent cortisol measurement procedures are needed.

Keywords: Mindfulness-Based Yoga, Aerobic Exercise, Serum Cortisol, Perceived Stress, Stress Management, Cortisol Regulation, College Students.

1. Introduction

Stress is a common physiological and psychological response to demanding or challenging situations. Although short-term stress responses help individuals adapt to immediate demands, prolonged or repeated stress can negatively affect emotional well-being, sleep, concentration, and physical health. College students and young adults are particularly exposed to academic responsibilities, examinations, social expectations, and lifestyle changes, making stress management an important health consideration.

The human stress response is regulated partly through the hypothalamic-pituitary-adrenal (HPA) axis. When the body encounters a stressful situation, this system contributes to the release of cortisol, a glucocorticoid hormone involved in energy regulation, metabolism, and adaptation to stress. However, cortisol secretion follows a daily rhythm and is influenced by

several physiological and behavioural factors. Consequently, an increased or decreased cortisol concentration cannot always be interpreted as an independent measure of psychological stress.

Stress is also evaluated through psychological assessment tools. Cohen et al. [1] introduced the Perceived Stress Scale (PSS), which measures how unpredictable, uncontrollable, and overwhelming individuals perceive their life circumstances to be. The scale has become an important instrument for assessing subjective stress in health-related research.

Mindfulness-based yoga and traditional aerobic exercise are two commonly used non-pharmacological approaches to stress management. Yoga combines physical postures, controlled breathing, body awareness, and relaxation. Mindfulness-oriented yoga practices place additional emphasis on present-moment attention and awareness of bodily sensations. Aerobic exercise generally includes activities such as brisk walking, jogging, cycling, swimming, and continuous rhythmic movements performed at an intensity sufficient to increase heart rate and breathing.

Both approaches may influence psychological well-being and physiological stress responses through different but partly overlapping mechanisms. Yoga is frequently associated with relaxation, attention regulation, and autonomic nervous system activity, whereas aerobic exercise supports cardiovascular fitness and may improve psychological resilience through regular physical training.

Pascoe and Bauer [2] reviewed randomized controlled trials and reported preliminary evidence supporting the effects of yoga on physiological stress regulation and mood-related outcomes. Subsequent research has continued to examine the role of yoga and other stress-management interventions in cortisol regulation.

Despite increasing research interest, the relative effectiveness of mindfulness-based yoga and traditional aerobic exercise remains uncertain. Differences in intervention design, participant characteristics, exercise intensity, and cortisol measurement methods make direct comparisons difficult.

This review examines published evidence concerning the effects of mindfulness-based yoga and aerobic exercise on serum cortisol and perceived stress levels, identifies their similarities and differences, and discusses the methodological considerations necessary for evaluating their effectiveness.

2. Review Methodology

A narrative review approach was used to examine published evidence concerning yoga-based practices, traditional physical exercise, cortisol regulation, and perceived psychological stress. Relevant peer-reviewed studies were identified through scholarly sources, including PubMed and academic journal publications.

Studies involving yoga, mindfulness practices, aerobic or circuit-based physical exercise, and stress-related outcomes were considered relevant. Particular attention was given to randomized

controlled trials, systematic reviews, and meta-analyses that evaluated cortisol concentrations, perceived stress, or both.

Research involving college students and young adults was considered especially useful, while studies involving broader adult populations were included where they provided relevant physiological or psychological evidence.

The literature was examined according to three principal areas: the effects of yoga on stress-related outcomes, the effects of conventional exercise on stress regulation, and direct comparisons between yoga and exercise-based interventions.

Findings were interpreted qualitatively. Since the reviewed studies differed in populations, intervention protocols, biological specimens, and outcome assessments, no independent statistical meta-analysis was conducted.

3. Review of Related Literature

Yoga-based interventions and conventional exercise programmes have been investigated for their effects on mental health and biological indicators of stress. Existing research provides encouraging findings, although the magnitude and consistency of these effects differ across studies.

Pascoe and Bauer [2] conducted a systematic review of 25 randomized controlled studies examining yoga, physiological stress measures, and mood. Their review provided preliminary evidence that yoga may influence sympathetic nervous system activity and HPA-axis regulation. Reductions in symptoms of anxiety and depression were also reported across selected studies. However, differences in intervention methods and study quality limited definitive conclusions.

Pascoe et al. [3] conducted a meta-analysis involving 42 studies of yoga-based interventions and stress-related physiological outcomes. Compared with active control conditions, yoga interventions were associated with favourable changes in several physiological measures, including waking and evening cortisol. The findings suggested that yoga may support physiological stress regulation, although the included interventions and study populations were heterogeneous.

Alhawtmeh et al. [4] examined the effects of mindfulness meditation among 108 nursing students in a randomized controlled trial. The intervention involved five weekly mindfulness sessions, each lasting approximately 30 minutes. Significant reductions in serum cortisol and perceived stress were reported in the intervention group compared with the control condition. Although the intervention involved mindfulness meditation rather than yoga, the findings support the relevance of attention-based relaxation practices in stress-management research.

Rogerson et al. [5] investigated the effects of psychological stress-management interventions on cortisol levels through a systematic review and meta-analysis. The analysis included 58 studies with a combined sample of 3,508 participants. The findings indicated that stress-

management interventions could produce favourable changes in cortisol measures. Mindfulness and relaxation approaches demonstrated beneficial effects, although the results varied according to intervention characteristics and cortisol assessment methods.

Haag et al. [6] conducted a randomized clinical trial involving 158 medical and nursing students in Brazil. Participants were assigned to circuit training, yoga, or a control condition over eight weeks. Both active interventions were associated with reductions in self-reported stress. The yoga group demonstrated a statistically significant reduction in serum cortisol, whereas the circuit-training group did not show a significant change in this measure. The study provides direct evidence comparing yoga with a conventional exercise intervention, although circuit training should not be considered identical to continuous aerobic exercise.

These findings suggest that yoga-based practices and exercise interventions can contribute to psychological stress management. However, evidence concerning their comparative effects on serum cortisol remains limited. Differences in biological sampling, exercise intensity, intervention duration, and participant characteristics require careful consideration.

Table 1. Summary of Selected Research Studies

Author (Year)	Study Design / Focus	Main Findings
Pascoe and Bauer (2015) [2]	Systematic review of 25 randomized studies	Preliminary evidence of improved stress regulation and mood following yoga
Pascoe et al. (2017) [3]	Meta-analysis of 42 studies	Yoga was associated with favourable changes in cortisol and other physiological measures
Alhawtmeh et al. (2022) [4]	Randomized trial involving 108 nursing students	Mindfulness meditation reduced serum cortisol and perceived stress
Rogerson et al. (2024) [5]	Meta-analysis of 58 studies	Stress-management interventions produced favourable changes in cortisol outcomes
Haag et al. (2024) [6]	Randomized trial involving 158 students	Both exercise approaches reduced perceived stress; serum cortisol reduction was significant in the yoga group

4. Comparative Effects of Yoga and Aerobic Exercise

4.1 Effects on Serum Cortisol

Cortisol plays an important role in maintaining the body's response to physical and psychological demands. Its secretion is influenced by the HPA axis and varies throughout the day. Under typical daily conditions, cortisol concentrations are higher in the morning and decline gradually toward the evening.

Mindfulness-based yoga may influence cortisol regulation through controlled breathing, physical relaxation, attention regulation, and reduced psychological arousal. Yoga interventions generally combine gentle or moderate physical movement with practices intended to improve awareness and relaxation.

Pascoe et al. [3] reported favourable changes in waking and evening cortisol among participants receiving yoga-based interventions. Similarly, Alhawtmeh et al. [4] observed reductions in serum cortisol following mindfulness meditation among nursing students.

Traditional aerobic exercise also influences the HPA axis. However, cortisol responses depend strongly on the intensity and duration of physical activity. Vigorous or prolonged exercise can temporarily increase cortisol because the hormone supports energy availability during physical exertion. This response is not necessarily harmful and should be distinguished from long-term changes in resting cortisol regulation.

The findings of Haag et al. [6] are particularly relevant to the comparative evaluation of stress-management practices. Their study reported a significant reduction in serum cortisol following yoga training, while the circuit-training intervention did not produce a statistically significant within-group change in serum cortisol.

Nevertheless, these results should not be interpreted as evidence that yoga is always more effective than aerobic exercise. The study examined circuit training rather than a standardized continuous aerobic exercise programme, and within-group statistical significance alone does not establish superiority between interventions.

4.2 Effects on Perceived Stress

Perceived stress reflects an individual's psychological evaluation of daily demands and their ability to manage challenging situations. Unlike cortisol, which measures a physiological process, perceived stress represents subjective experiences of tension, pressure, and reduced control.

The Perceived Stress Scale developed by Cohen et al. [1] provides a structured approach to assessing these experiences. Its use enables researchers to evaluate psychological responses before and after stress-management interventions.

Mindfulness-based yoga encourages participants to observe breathing, bodily sensations, and emotional responses without excessive distraction. These practices may improve awareness of stressful experiences and support relaxation during demanding situations.

Existing research suggests that yoga and mindfulness-based interventions can reduce perceived stress [2]–[4]. Such benefits may be relevant to college students experiencing examination pressure, academic workload, and personal responsibilities.

Aerobic exercise can also improve perceived stress by providing opportunities for recreation, psychological relaxation, and improved physical fitness. Walking, jogging, cycling, and other

rhythmic activities may help individuals manage daily tension and develop consistent health routines.

Haag et al. [6] reported reductions in self-reported stress following both yoga and circuit-training interventions. This finding indicates that conventional exercise and yoga can each contribute to psychological stress management, even when their hormonal responses differ.

4.3 Physiological and Psychological Mechanisms

The possible stress-reducing effects of mindfulness-based yoga involve interactions among physical movement, controlled breathing, attention regulation, and relaxation.

Slow breathing and relaxation-oriented practices may influence autonomic nervous system activity and reduce physiological arousal. Mindfulness can also support awareness of thoughts and emotional responses, potentially reducing habitual reactions to stressful situations.

Aerobic exercise operates through a different combination of physiological processes. Repeated physical activity improves cardiorespiratory fitness, supports metabolic health, and may influence mood-related neurobiological processes. Regular participation can also provide a sense of achievement and improve confidence in physical abilities.

Although these approaches differ in emphasis, their mechanisms may overlap. Yoga involves physical activity, and aerobic exercise may also encourage psychological relaxation and focused attention.

Consequently, the outcomes of both interventions depend on programme design rather than their classification alone. An intense yoga session and a gentle walking programme may produce different physiological responses from those typically associated with their broader categories.

4.4 Influence of Training Duration and Intensity

The effectiveness of stress-management interventions depends partly on the frequency, intensity, duration, and consistency of participation.

Mindfulness-based yoga programmes may include postures, breathing exercises, meditation, and relaxation over repeated sessions. The relative contribution of each component may vary between programmes.

Traditional aerobic exercise programmes are commonly prescribed according to exercise intensity, session duration, and weekly frequency. Moderate-intensity activities may be suitable for general health promotion, while vigorous exercise requires additional consideration of individual fitness and recovery.

Cortisol measurements taken immediately after intense exercise may reflect the acute physiological response to physical exertion rather than changes in chronic psychological stress.

For meaningful comparison, yoga and aerobic exercise programmes should be evaluated using standardized intervention periods, appropriately matched physical activity exposure, and consistent biological sampling procedures.

Table 2. Comparison of Mindfulness-Based Yoga and Traditional Aerobic Exercise

Parameter	Mindfulness-Based Yoga	Traditional Aerobic Exercise
Primary approach	Postures, breathing, attention, relaxation	Continuous or rhythmic physical movement
Main physical demand	Varies from gentle to physically demanding	Commonly moderate to vigorous cardiovascular activity
Psychological emphasis	Mindfulness, awareness, relaxation	Fitness, movement, recreation
Perceived stress	Reductions reported in several studies	Reductions reported with regular participation
Cortisol response	Favourable changes reported, but findings vary	Depends on intensity, timing, and training adaptation
Immediate cortisol response	May be relatively modest in gentle sessions	Can increase after sufficiently intense exercise
Equipment	Generally minimal	Depends on the selected activity
Application	Stress management and general well-being	Fitness improvement and stress management

5. Discussion

The reviewed literature indicates that mindfulness-based yoga and conventional exercise can both contribute to stress management. However, the available evidence suggests that their psychological and physiological effects should be assessed separately.

Studies of yoga and mindfulness-based practices have reported reductions in perceived stress and favourable changes in cortisol measures. These findings support the potential usefulness of mind-body approaches for individuals experiencing psychological pressure.

Evidence concerning aerobic and conventional exercise also supports stress-related psychological benefits. Nevertheless, cortisol responses to exercise are more complex because physical exertion itself can stimulate cortisol secretion. A temporary increase following exercise should therefore not be interpreted as evidence of increased chronic psychological stress.

The randomized trial conducted by Haag et al. [6] provides an important comparison between yoga and circuit training. Although both interventions improved self-reported stress outcomes,

a significant reduction in serum cortisol was reported only in the yoga group. This observation raises important questions about whether different forms of physical activity influence subjective stress and physiological stress regulation through distinct mechanisms.

At the same time, interpretation requires caution. The absence of a statistically significant change within one exercise group does not independently demonstrate that another intervention is superior. Direct comparisons of between-group changes are necessary to establish comparative effectiveness.

Another important issue concerns the measurement of cortisol. Serum cortisol concentrations vary with the time of day, recent physical activity, sleep, medication use, and other individual factors. Blood sampling itself may also cause psychological discomfort in some participants. Therefore, standardized sampling conditions are essential when evaluating hormonal responses.

The distinction between serum and salivary cortisol must also be maintained. Although both are used in stress-related research, they do not represent identical biological measurements. Findings obtained through saliva sampling cannot automatically be generalized to serum cortisol concentrations.

For college students, both mindfulness-based yoga and aerobic exercise may be practical stress-management options. Yoga generally requires limited equipment and can be organized in relatively small spaces. Aerobic activities such as walking, jogging, and cycling are also accessible, although their practical requirements differ.

In Indian educational institutions, yoga may be particularly familiar because of its traditional and cultural significance. However, cultural acceptance alone does not demonstrate greater physiological effectiveness. Evidence-based programme selection should consider participant preferences, available facilities, health status, and desired outcomes.

The existing literature is limited by differences in intervention protocols, sample sizes, control conditions, cortisol collection procedures, and the use of different psychological assessment tools. Many studies also combine several yoga components, making it difficult to determine the independent effects of mindfulness, breathing, and physical postures.

Future comparative studies should employ randomized designs, clearly defined exercise programmes, appropriate active control groups, and consistent serum cortisol sampling schedules. Both perceived stress and cortisol should be assessed before and after interventions, preferably with follow-up evaluations to examine the persistence of any benefits.

6. Conclusion

Mindfulness-based yoga and traditional aerobic exercise are useful non-pharmacological approaches to promoting psychological well-being and managing stress. Existing research indicates that both methods may reduce perceived stress, although their effects on cortisol regulation can differ according to intervention characteristics and measurement conditions.

Yoga-based practices have shown favourable effects on several physiological stress indicators, including cortisol, while conventional exercise provides psychological benefits and supports physical fitness. However, the current evidence does not establish that either approach is consistently superior for reducing serum cortisol and perceived stress across all populations.

The effectiveness of both interventions depends on regular participation, training intensity, intervention duration, and individual characteristics. Mindfulness-based yoga may be particularly suitable for programmes emphasizing relaxation and attention regulation, while aerobic exercise can simultaneously address cardiovascular fitness and psychological well-being.

Further randomized comparative studies, particularly among Indian college students and young adults, are required to clarify the relative benefits of these approaches. Such research should use standardized serum cortisol measurements and validated perceived stress assessments to provide more reliable conclusions about their effectiveness.

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