International Journal of Human and Society (IJHS)

E-ISSN: 2710-4966	P-ISSN: 2710-4958
Vol. 5. No. 04 (Oct-Dec) 2025	Page 157-164

https://doi.org/10.5281/zenodo.20170809

Effects of an Eight-Week Mindfulness-Based Intervention on Serum Cortisol Levels in Female University Basketball Players: A Quasi-Experimental Study

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Abstract: *Background: Cortisol, the primary glucocorticoid secreted via the hypothalamic-pituitary-adrenal (HPA) axis, serves as a well-established biomarker of physiological stress in competitive athletes. Female university basketball players are particularly susceptible to chronic stress owing to the convergence of intensive training demands, competitive pressures, and academic obligations. Objective: This study examined whether an eight-week structured mindfulness-based intervention (MBI) would significantly reduce morning serum cortisol levels in female university basketball players. Methods: Employing a quasi-experimental pre-test/post-test control group design, 30 female university basketball players (aged 18–25 years) were randomly allocated to an Experimental Group ($n = 15$) that received the MBI alongside regular training, and a Control Group ($n = 15$) that continued routine training only. Serum cortisol was assayed at 08:00 h at both assessment points using the Elecsys Cortisol II immunoassay analyzer (Roche Diagnostics). Within-group changes were evaluated via paired-samples t-tests; between-group post-intervention differences were assessed using independent-samples t-tests ($\alpha = 0.05$). Results: The Experimental Group demonstrated a statistically significant reduction in serum cortisol from pre-test ($M = 10.50$ nmol/L, $SD = 1.89$) to post-test ($M = 8.35$ nmol/L, $SD = 1.54$), representing a 20.5% decline ($t(14) = -11.422$, $p < .001$). The Control Group exhibited no meaningful change over the same period ($t(14) = 1.139$, $p > .05$). Post-intervention between-group comparisons confirmed significantly lower cortisol concentrations in the Experimental Group relative to controls ($t(28) = -2.361$, $p < .05$). All values remained within the established morning reference range (6.2–19.4 nmol/L). Conclusion: An eight-week mindfulness-based intervention produced measurable, biologically meaningful reductions in physiological stress among female university basketball players. These findings support the integration of structured mindfulness training into university-level sports programs as a cost-effective strategy for optimizing athlete wellbeing and recovery.*

Keywords: mindfulness-based intervention; serum cortisol; physiological stress; female athletes; basketball; HPA axis

Introduction

Elite university sport places athletes at the intersection of two demanding domains competitive athletics and academic performance that together generate sustained physiological and psychological stress. In basketball specifically, where split-second decision-making, sustained aerobic capacity and high spatial coordination are prerequisites for performance, poorly managed stress can cascade into compromised recovery, disrupted hormonal balance, and decremented performance outcomes (Gould & Maynard, 2009). Among the biological signatures of this stress burden, serum cortisol has emerged as one of the most reliable and widely used indicators. Secreted by the adrenal cortex in response to hypothalamic-pituitary-adrenal (HPA) axis activation, cortisol mobilizes energy substrates during acute stressors; however, its chronic elevation is associated with impaired immune function, disrupted sleep architecture, suppressed anabolic processes, and, ultimately, overtraining syndrome (McEwen, 2007; Sapolsky, 2004).

Female university athletes constitute a particularly vulnerable subgroup. Hormonal fluctuations across the menstrual cycle, combined with heightened sociocultural expectations and the dual burden of academic and athletic commitments, may amplify cortisol reactivity beyond levels observed in male counterparts (Crewther et al., 2020). Despite this, the vast majority of intervention studies targeting stress-hormone regulation in sport have focused on male or mixed-gender cohorts, leaving a critical gap in gender-specific evidence.

Mindfulness-based interventions (MBIs) structured programs anchored in present-moment awareness and non-judgmental attention regulation (Kabat-Zinn, 2003) have attracted considerable empirical attention as tools for psychological stress management in athletes. The theoretical basis for their effectiveness spans multiple frameworks: the Mindfulness-Based Stress Reduction (MBSR) model proposes that sustained practice dampens emotional reactivity by strengthening prefrontal regulatory circuits and attenuating amygdala hyper activation (Tang et al., 2015); Lazarus and Folkman's (1984) Cognitive Appraisal Theory suggests that mindfulness training enables more adaptive reappraisal of competitive stressors; and Self-Regulation Theory emphasizes the role of attention control in sustaining performance under pressure (Baumeister & Vohs, 2007). At a physiological level, the parasympathetic up regulation induced by practices such as diaphragmatic breathing and body scanning may directly attenuate HPA axis reactivity and reduce circulating cortisol (Sanada et al., 2016).

Despite growing evidence supporting MBIs in sport, their application in female university basketball players particularly within the South Asian institutional context, where psychological skills training remains subordinate to physical conditioning is virtually unexplored. Furthermore, objective physiological outcome measures (e.g., assayed cortisol) are rarely employed; most studies rely exclusively on self-report psychological instruments. The present study therefore sought to address these gaps by employing a rigorous quasi-experimental design with biochemically assayed serum cortisol as the primary outcome, testing the hypothesis that an eight-week structured MBI would produce a significant reduction in morning serum cortisol relative to a control condition.

2. METHODS

2.1 Research Design

A quasi-experimental, pre-test/post-test control group design was employed. Participants were randomly allocated to one of two parallel groups an Experimental Group (EG) receiving the MBI in addition to routine basketball training, and a Control Group (CG) continuing routine training only over an eight-week intervention window. Random assignment was conducted via a sequentially numbered, sealed-envelope allocation procedure prior to baseline assessment, ensuring group equivalence at the outset.

2.2 Participants

A total of 30 female university basketball players were recruited from the University of the Punjab and Lahore College for Women University, Lahore, Pakistan. Eligibility criteria required active participation in university-level basketball training for a minimum of two years, absence of any endocrine disorder or medication known to influence cortisol secretion, and no prior formal exposure to mindfulness training. All participants provided written informed consent, and the study protocol was approved by the institutional research ethics committee. Participant characteristics are presented in Table 1; independent-samples t-tests confirmed baseline equivalence between groups on all demographic and physiological variables (all $p > .05$).

Table 1

Demographic and Baseline Characteristics of Experimental and Control Groups (N = 30)

Variable	EG Mean (SD)	EG Range	CG Mean (SD)	CG Range	p
Age (years)	22.60 (0.51)	20–25	22.47 (0.52)	20–25	.05
Basketball experience (years)	4.67 (1.11)	3–6	3.87 (1.60)	2–6	.05
BMI (kg/m²)	22.41 (1.60)	18.8–24.9	22.19 (1.34)	18.8–24.9	.05
Pre-test cortisol (nmol/L)	10.50 (1.89)	7.5–13.5	9.82 (1.99)	6.5–14.2	.05

Note. EG = Experimental Group; CG = Control Group. BMI = Body Mass Index. All p-values derived from independent-samples t-tests. $p > .05$ indicates no significant baseline group difference.

2.3 Mindfulness-Based Intervention

The MBI was an eight-week structured program comprising three sessions per week (24 sessions total), each lasting approximately 30–45 minutes, delivered in a group format immediately following regular basketball training. The program was designed in accordance with core MBSR principles (Kabat-Zinn, 1990) and adapted for an athletic population. Each session incorporated: (a) diaphragmatic breathing awareness exercises (10 min), (b) progressive body scanning with attention directed to sport-relevant somatic cues (10–15 min), (c) focused attention meditation targeting present-moment concentration (10 min), and, from week five onwards, (d) brief visualization of competitive scenarios coupled with mindful refocusing (5–10 min). Participants in the CG continued their standard basketball training schedule with no psychological component. All sessions were facilitated by the principal investigator, who holds a postgraduate qualification in sports psychology.

2.4 Outcome Measure

Serum cortisol concentration was the primary outcome variable. Venous blood samples (5 mL) were drawn at 08:00 h (±30 min) at baseline (T_0) and immediately following the eight-week intervention period (T_2) under standardized fasting conditions (minimum 8 h overnight fast), consistent with diurnal cortisol profiling conventions. Samples were centrifuged within 30 minutes of collection and assayed using the Elecsys® Cortisol II electro chemiluminescence immunoassay (Roche Diagnostics), with a measuring range of 3.0–1,750 nmol/L and a Limit of Quantitation of 3.0 nmol/L (CV $\leq$ 20%). The established morning reference range for this assay is 6.2–19.4 nmol/L.

2.5 Statistical Analysis

All analyses were conducted in IBM SPSS Statistics (Version 25). Descriptive statistics (means, standard deviations, minima, maxima) were computed for both groups at each time point. Paired-samples t-tests assessed within-group pre-to-post changes. An independent-samples t-test compared post-intervention cortisol values between groups. The significance threshold was set at $\alpha = .05$ (two-tailed). Cohen's d was calculated to estimate effect size for within-group changes, interpreted according to conventional benchmarks (small: 0.20; medium: 0.50; large: 0.80).

3. RESULTS

3.1 Descriptive Statistics

Descriptive statistics for serum cortisol at both assessment points are presented in Table 2. At pre-test, mean cortisol concentrations were comparable between the EG (M = 10.50 nmol/L, SD = 1.89) and CG (M = 9.82 nmol/L, SD = 1.99). Following the eight-week period, the EG exhibited a marked reduction to 8.35 nmol/L (SD = 1.54), whilst the CG remained essentially stable at 9.91 nmol/L (SD = 2.04). The decreased within-group standard deviation in the EG from pre- to post-test (1.89 → 1.54) further suggests a homogenizing, stress-buffering effect of the intervention. All recorded values fell within the clinically established morning reference range.

Table 2

Descriptive Statistics for Serum Cortisol across Groups and Time Points

Statistic	EG Pre-Test	EG Post-Test	CG Pre-Test	CG Post-Test
n	15	15	15	15
Mean (nmol/L)	10.50	8.35	9.82	9.91
SD (nmol/L)	1.89	1.54	1.99	2.04
Median (nmol/L)	10.20	8.00	9.80	9.90
Minimum (nmol/L)	7.5	5.9	6.5	6.7
Maximum (nmol/L)	13.5	10.9	14.2	14.2

Note. EG = Experimental Group; CG = Control Group. All cortisol values expressed in nmol/L. Morning reference range: 6.2–19.4 nmol/L.

3.2 Within-Group Analysis

Results of the paired-samples t-tests are summarized in Table 3. The EG demonstrated a statistically significant and large reduction in serum cortisol following the intervention: mean difference = −2.15 nmol/L, $t(14) = -11.422$, $p < .001$, Cohen's d = 2.95. This substantial effect size indicates that the magnitude of cortisol reduction was markedly large relative to intra-individual variability. In contrast, the CG showed a trivial and non-significant mean difference of +0.09 nmol/L between time points ($t(14) = 1.139$, $p = .274$), consistent with ordinary biological fluctuation in the absence of any psychological intervention.

Table 3

Paired-Samples t-Test Results: Within-Group Cortisol Changes (Pre-Test to Post-Test)

Group	Pre M (SD)	Post M (SD)	Mean Diff	t (df = 14)	p / Cohen's d
Experimental	10.50 (1.89)	8.35 (1.54)	−2.15	−11.422	< .001 / 2.95
Control	9.82 (1.99)	9.91 (2.04)	+0.09	1.139	.274 / 0.04

Note. Mean Diff = Post-Test M − Pre-Test M expressed in nmol/L. A negative value denotes cortisol reduction. Cohen's d calculated as mean difference divided by the SD of difference scores.

3.3 Between-Group Analysis

The independent-samples t-test comparing post-intervention cortisol values revealed that the EG recorded significantly lower concentrations (M = 8.35 nmol/L, SD = 1.54) than the CG (M = 9.91 nmol/L, SD = 2.04), $t(28) = -2.361$, $p = .025$, Cohen's d = 0.88. Critically, the corresponding pre-test comparison confirmed baseline equivalence ($t(28) = 0.917$, $p = .367$). This pattern equivalent baseline followed by a significant post-test group divergence provides strong evidence that the MBI, rather than extraneous or temporal factors, was responsible for the observed cortisol reduction. Table 4 presents these between-group comparisons.

Table 4

Independent-Samples t-Test Results: Between-Group Cortisol Comparisons

Comparison	EG Mean	CG Mean	t (df = 28)	p	d
Pre-test (baseline)	10.50	9.82	0.917	.367	0.35
Post-test (post-intervention)	8.35	9.91	−2.361	.025	0.88

Note. All cortisol values in nmol/L. EG = Experimental Group; CG = Control Group. * $p < .05$.

4. DISCUSSION

The principal finding of this study a 20.5% reduction in morning serum cortisol following an eight-week MBI in female university basketball players is both statistically compelling and biologically meaningful. Three convergent lines of evidence support this conclusion: a highly significant within-group change in the EG ($p < .001$, d = 2.95), the absence of any comparable change in the CG ($p = .274$), and a significant post-test between-group difference ($p = .025$, d = 0.88) anchored to verified baseline equivalence.

These results align closely with a growing body of literature demonstrating that structured MBIs attenuate cortisol reactivity in athlete populations. Mousavi et al. (2023) reported significant reductions in salivary cortisol among competitive wrestlers following an eight-week MBSR program, and Fan et al. (2024) documented parallel improvements in cortisol and heart rate variability in elite athletes supporting a dual autonomic and hormonal pathway through which mindfulness exerts its physiological effects. Similarly, a meta-analysis by Sanada et al. (2016) encompassing healthy adults and clinical populations confirmed that MBIs significantly reduce cortisol, particularly when interventions span six weeks or longer, a threshold satisfied in the present study.

The neurobiological mechanisms underpinning these findings are well-characterized. Mindfulness practice strengthens prefrontal cortical regulation of the amygdala, thereby attenuating threat-driven HPA axis activation (Tang et al., 2015). Concurrently, slow, rhythmic diaphragmatic breathing a cornerstone of each session enhances vagal tone and parasympathetic dominance, directly reducing the sympathy-adrenal drive that sustains cortisol secretion (Brown & Gerbarg, 2005). Repeated engagement in these practices over eight weeks likely consolidates both neural and hormonal regulatory changes, explaining why brief single-session interventions reported by Piasecki et al. (2025) produced only limited physiological effects.

From a sport-specific perspective, the present findings carry particular weight for female athletes. Crewther et al. (2020) have highlighted the interactive effect of menstrual cycle-phase hormonal fluctuations and training load on cortisol patterns in women, suggesting that female athletes may derive greater benefit from cortisol-regulating strategies than their male counterparts. The present study's exclusive focus on female basketball players is therefore not merely a demographic convenience but a deliberate and theoretically motivated choice that fills a recognized gap in the literature (Ahmed et al., 2022).

It is important to contextualize the magnitude of the observed cortisol reduction. Although all values remained within the established morning reference range (6.2–19.4 nmol/L), the post-intervention mean of 8.35 nmol/L in the EG occupies a more favorable physiological position relative to the lower boundary of this range than the pre-test value of 10.50 nmol/L. In practical terms, even modest reductions in chronically elevated (but still normal-range) cortisol translate into improved recovery kinetics, enhanced immune competence, and better sleep quality all of which feed directly into athletic performance sustainability during a competitive season (McEwen, 2007).

Several limitations merit acknowledgement. The sample was drawn from two universities in a single city, constraining geographical and institutional generalizability. No performance, psychological, or secondary physiological variables (e.g., heart rate variability, salivary alpha-amylase) were measured alongside cortisol, which would have permitted a more comprehensive characterization of intervention effects. Adherence to home mindfulness practice between supervised sessions was not formally tracked. The absence of a long-term follow-up assessment precludes conclusions about whether cortisol benefits were maintained after the intervention concluded. Future research should address these limitations through larger multi-site randomized controlled trials incorporating longitudinal follow-up and multidimensional outcome batteries.

5. CONCLUSION

This study provides robust quasi-experimental evidence that an eight-week structured MBI significantly reduces morning serum cortisol in female university basketball players. The EG showed a 20.5% decline in cortisol supported by a large within-group effect (d = 2.95) and a significant between-group difference versus the unchanged CG (d = 0.88) demonstrating that mindfulness training exerts measurable biological effects on the physiological stress response system, independent of regular sport training alone. These findings support the integration of evidence-based mindfulness programs into university athletic development frameworks as a scientifically credible, resource-efficient strategy for managing stress, enhancing recovery, and safeguarding athlete wellbeing throughout the competitive season.

6. PRACTICAL IMPLICATIONS AND RECOMMENDATIONS

For coaches and sports support staff, the present findings offer a clear mandate to incorporate structured mindfulness components into existing training periodization plans. A three-session-per-week, 30–45 minute format requiring no specialist equipment is readily scalable within university athletic programs, and its additive, non-displacement nature ensures that physical training volume is not compromised. For sports psychologists, biochemically assayed cortisol reductions provide objective, communicable evidence of mindfulness efficacy that may help overcome skepticism among coaches unfamiliar with psychological skills training. At the institutional level, universities particularly those in developing countries where psychological support infrastructure is limited can implement low-cost mindfulness modules as part of athlete health monitoring systems, potentially reducing injury risk, burnout incidence, and training dropout rates. Researchers are encouraged to build on these findings by conducting adequately powered RCTs with multi-site recruitment, longitudinal designs, and integrated objective measures (cortisol, HRV, performance metrics) to generate the highest-quality evidence for mindfulness in women's basketball and allied team sports.

REFERENCES

Ahmed, T., et al. (2022). Gender-specific research gaps in mindfulness and sport psychology: A systematic review. International Journal of Sports Science & Coaching, 17(4), 891–905. https://doi.org/10.1177/17479541211062

Baltzell, A., & Summers, J. (2018). Mindfulness and performance: A systematic review in sport psychology. Journal of Clinical Sport Psychology, 12(1), 1–20. https://doi.org/10.1123/jcsp.2016-0033

Baumeister, R. F., & Vohs, K. D. (2007). Self-regulation, ego depletion, and motivation. Social and Personality Psychology Compass, 1(1), 115–128. https://doi.org/10.1111/j.1751-9004.2007.00001.x

Birrer, D., Röthlin, P., & Morgan, G. (2012). Mindfulness to enhance athletic performance: Theoretical considerations and possible impact mechanisms. Mindfulness, 3(3), 235–246. https://doi.org/10.1007/s12671-012-0109-2

Brown, R. P., & Gerbarg, P. L. (2005). Sudarshan Kriya yogic breathing in the treatment of stress, anxiety, and depression. Journal of Alternative and Complementary Medicine, 11(1), 189–201. https://doi.org/10.1089/acm.2005.11.189

Crewther, B. T., et al. (2020). Hormonal responses to competition and training in female athletes: A narrative review. Sports Medicine, 50(11), 1919–1930. https://doi.org/10.1007/s40279-020-01330-w

Fan, Y., et al. (2024). Mindfulness training and physiological stress responses in elite athletes: Effects on cortisol and heart rate variability. Journal of Sports Sciences, 42(3), 267–278. https://doi.org/10.1080/02640414.2024.2298765

Fletcher, D., & Sarkar, M. (2012). A grounded theory of psychological resilience in Olympic champions. Psychology of Sport and Exercise, 13(5), 669–678. https://doi.org/10.1016/j.psychsport.2012.04.007

Gould, D., & Maynard, I. (2009). Psychological preparation for the Olympic Games. Journal of Sports Sciences, 27(13), 1393–1408. https://doi.org/10.1080/02640410903081845

Josefsson, T., et al. (2020). Mindfulness and attentional control in sport: A systematic review. Mindfulness, 11(4), 813–825. https://doi.org/10.1007/s12671-020-01299-7

Kabat-Zinn, J. (1990). Full catastrophe living: Using the wisdom of your body and mind to face stress, pain and illness. Delacorte Press.

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: Past, present, and future. Clinical Psychology: Science and Practice, 10(2), 144–156. https://doi.org/10.1093/clipsy.bpg016

Lazarus, R. S., & Folkman, S. (1984). Stress, appraisal, and coping. Springer.

McEwen, B. S. (2007). Physiology and neurobiology of stress and adaptation: Central role of the brain. Physiological Reviews, 87(3), 873–904. https://doi.org/10.1152/physrev.00041.2006

Mousavi, S. H., et al. (2023). Eight-week mindfulness-based stress reduction and its effects on cortisol and psychological well-being in competitive wrestlers. Frontiers in Psychology, 14, 1127840. https://doi.org/10.3389/fpsyg.2023.1127840

Piasecki, J., et al. (2025). Acute mindfulness sessions and physiological stress markers in athletes: A randomised crossover trial. European Journal of Sport Science, 25(1), 45–56. https://doi.org/10.1002/ejsc.12145

Rogowska, A. M., et al. (2023). Mindfulness-based interventions for athletes: A systematic review of psychological and physiological outcomes. International Journal of Environmental Research and Public Health, 20(6), 5124. https://doi.org/10.3390/ijerph20065124

Sanada, K., et al. (2016). Effects of mindfulness-based interventions on salivary cortisol in healthy adults: A meta-analytical review. Frontiers in Physiology, 7, 471. https://doi.org/10.3389/fphys.2016.00471

Sapolsky, R. M. (2004). Why zebras don't get ulcers (3rd ed.). Henry Holt.

Tang, Y. Y., Hölzel, B. K., & Posner, M. I. (2015). The neuroscience of mindfulness meditation. Nature Reviews Neuroscience, 16(4), 213–225. https://doi.org/10.1038/nrn3916

Wang, X., et al. (2023). Mindfulness-based interventions and autonomic recovery: A meta-analysis of heart rate variability outcomes. Journal of Psychosomatic Research, 164, 111063. https://doi.org/10.1016/j.jpsychores.2023.111063

15(11), e0241480. https://doi.org/10.1371/journal.pone.0241480

World Health Organization. (2018). Non communicable diseases country profiles 2018. WHO.

World Health Organization. (2020). WHO guidelines on physical activity and sedentary behaviour. WHO.