

REVIEW ARTICLE

Impact of Early Morning Hatha Yoga on Psychological PMS Symptoms: Anxiety, Irritability, and Mood Swings a Meta-Analytic Review

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ABSTRACT

Premenstrual syndrome (PMS) commonly includes psychological symptoms anxiety, irritability, mood swings that impair daily functioning for many women. Mind-body practices such as Hatha yoga are widely used to reduce stress and mood symptoms, but the physiological mechanisms that might explain benefits for premenstrual psychological complaints remain incompletely synthesized. This review/meta-analytic narrative examines randomized trials, controlled studies, and mechanistic research (n = 30 key papers from PubMed/Google Scholar) on (1) effects of yoga (particularly Hatha/early morning practice) on psychological PMS symptoms and (2) two candidate physiological mediators: the cortisol awakening response (CAR) and serotonergic modulation (tryptophan-serotonin pathway). Across clinical trials and systematic reviews, yoga interventions (including Hatha-format asanas combined with breathwork and brief meditative elements) were associated with moderate reductions in emotional PMS symptoms and improved quality of life compared with controls or alternative exercise (e.g., aerobic), with several randomized controlled trials reporting statistically significant improvements (Erdoğan *et al.*, 2024; Pal *et al.*, 2022; Ranga, 2024). Mechanistic evidence indicates that (a) mind-body interventions can modulate HPA-axis activity including alterations in diurnal cortisol patterns and CAR, and (b) exercise and yoga may influence peripheral markers and upstream metabolism of tryptophan/serotonin, potentially stabilizing mood during luteal phases. However, studies vary in methodology (intervention timing, yoga style intensity, outcome measures, saliva/plasma sampling protocols), and direct trials that concurrently measure PMS symptom changes, CAR, and serotonin metabolites during early-morning Hatha yoga interventions are scarce. We conclude that early morning Hatha yoga is a promising, low-risk intervention for psychological PMS symptoms, potentially acting via CAR normalization and serotonergic pathways, but high-quality trials with standardized CAR and neurochemical measures timed to menstrual cycle phases are needed.

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KEYWORDS

• Anxiety • Mood Swings • Neurochemicals • Cortisol Response • PMS • Yoga

INTRODUCTION

Premenstrual syndrome (PMS) affects a substantial proportion of menstruating individuals and often includes emotional and behavioral symptoms such as anxiety, irritability, and mood instability. These psychological symptoms contribute heavily to functional impairment and are frequent targets for nonpharmacological interventions (Pearce *et al.*, 2020; Dal Brun *et al.*, 2023). Hatha yoga an umbrella term for posture (āsana) practice combined with breath regulation (prāṇāyāma) and often simple mindfulness is commonly delivered in the morning and is hypothesized to influence both psychophysiological arousal and neurochemical systems relevant to mood regulation (Hofmann *et al.*, 2016; Padmavathi *et al.*, 2023). This review synthesizes clinical and mechanistic literature with a special focus on two biological axes likely to mediate yoga's effects on psychological PMS symptoms: (1) the cortisol awakening response (CAR), an early-morning HPA-axis spike implicated in daily arousal and anxiety, and (2) serotonergic modulation via tryptophan metabolism and peripheral serotonin markers.

METHODS LITERATURE IDENTIFICATION AND SELECTION

A focused search was performed using PubMed and Google Scholar to locate randomized controlled trials (RCTs), systematic reviews, meta-analyses, and mechanistic studies linking yoga (particularly Hatha or comparable regimes) to PMS psychological outcomes, CAR, and serotonin/tryptophan metabolism. From the broad search we selected 30 representative, peer-reviewed studies that together: (a) assessed yoga interventions (mostly Hatha or Hatha-derived formats) for PMS or mood/anxiety outcomes; (b) examined cortisol diurnal patterns or CAR after yoga/exercise; or (c) investigated serotonin/tryptophan changes related to yoga/exercise or mind-body interventions. Priority was given to RCTs, recent systematic reviews/meta-analyses, and high-quality mechanistic papers. The

final set includes clinical RCTs and systematic reviews of yoga in PMS (e.g., Erdoğan *et al.*, 2024; Pal *et al.*, 2022; Ranga, 2024), studies of yoga on cortisol/diurnal patterns (Curtis *et al.*, 2011; Cahn *et al.*, 2017; Corey *et al.*, 2014), research on exercise and CAR (Anderson *et al.*, 2017; Drogos *et al.*, 2019), and serotonergic/tryptophan metabolism literature (Jenkins *et al.*, 2016; Badawy, 2018; Lee *et al.*, 2014).

SUMMARY OF SELECTED STUDIES

Below are concise critical summaries of each selected study/source, grouped by theme. Each mini-review lists main methods, key findings, and relevance to early-morning Hatha yoga and psychological PMS symptoms.

A. Systematic reviews and meta-analyses on yoga (PMS, mood, anxiety)

1. **Ranga (2024)**'s recent meta-analysis pooled RCTs of yoga for PMS and reported an overall beneficial effect of yoga on emotional, behavioral, and (to a lesser extent) physical PMS symptoms, concluding yoga is effective though study heterogeneity is significant. This directly supports yoga as a candidate intervention for PMS psychological symptoms.
2. **Pal *et al.* (2022)** included multiple trials and found yoga beneficial across several PMS subdomains; the authors noted heterogeneity in protocols (type/duration/timing of yoga) and called for standardized interventions. The review compared yoga favorably to other interventions such as calcium and aerobic exercise in some cohorts.
3. **Hofmann *et al.* (2016)** focused on anxiety outcomes across Hatha yoga trials in diverse populations, the meta-analysis found evidence that Hatha yoga reduces anxiety symptoms versus controls, a finding of clear relevance for PMS-related anxiety. The analysis is helpful in generalizing anxiety reduction effects to women with PMS.

4. **Pearce *et al.* (2020)** pooled exercise trials (aerobic, yoga, resistance) and concluded that exercise reduces PMS symptoms overall; subgroup analyses suggested yoga might be especially effective for emotional symptoms. The review supports exercise—including yoga—as beneficial, though it highlighted variable study quality.
 5. **JC D. Dal Brun *et al.* (2023)** although methodological, this paper summarizes PMDD/PMS clinical features and the feasibility of virtual yoga delivery relevant to implementing early-morning classes remotely.
- B. Randomized controlled trials and controlled studies of yoga for PMS/related outcomes**
6. **Erdoğan *et al.* (2024)** conducted a study in a university-based RCT (n=80), participants practising yoga experienced significant reductions in premenstrual symptoms and perceived stress relative to controls; improvements persisted at follow-up. This trial provides contemporary randomized evidence for yoga's emotional benefits in menstrual populations.
 7. **Bharati *et al.* (2016)** found both yoga and calcium reduced PMS symptom frequency/severity; yoga produced significant improvements in emotional/behavioral symptoms, suggesting nonpharmacological value.
 8. **Vaghela *et al.* (2019)** compared aerobic exercise and yoga and reported a greater reduction in PMS symptoms in the yoga group than in aerobic exercise, particularly for emotional symptoms supporting yoga's specific utility for mood components.
 9. **Curtis *et al.* (2011)** conducted in a pain population, this controlled study observed reductions in total cortisol and psychological distress following an 8-week yoga program, suggesting HPA-axis modulation by yoga a mechanistic link relevant to PMS mood symptoms.
 10. **Lee *et al.* (2014)** reported maintenance/increase of serum serotonin and BDNF after 12 weeks of yoga versus declines in controls; depression scores were stabilized in the yoga group providing direct evidence for yoga-related peripheral serotonergic effects.
 11. **Corey *et al.* (2014)** found differences in diurnal cortisol outcomes between restorative yoga and stretching groups, underscoring that not all movement practices have identical HPA-axis effects; yoga can alter cortisol patterns, but direction and magnitude depend on style and context.
 12. **Karimi & Yazdani Noori (2015)** conducted a controlled study in athletes showed increased plasma serotonin and improved mood state after an 8-week yoga program supporting the biological plausibility of serotonergic modulation.
 13. **Moszeik *et al.* (2025)** trials of guided relaxation/yoga nidra have included CAR measurements, illustrating feasibility for combining subjective mood outcomes and CAR sampling in intervention trials.
 14. **Ranga (2024)** multiple RCTs included in Ranga's analysis support yoga's efficacy for both emotional and behavioural PMS symptoms; important for aggregated effect estimates.
- C. Exercise, CAR, and diurnal cortisol literature (mechanistic)**
15. **Fries *et al.* (2009)** gave foundational description and theoretical framing of CAR as a distinct HPA-axis component; CAR has been linked to anticipatory stress and daily preparedness. This is the core reference for CAR biology.
 16. **Anderson *et al.* (2017)** summarized heterogeneous effects of exercise programs on CAR; acute and chronic exercise can modify CAR but direction depends on intensity, timing (morning vs evening), and participant characteristics. This highlights why early-morning yoga could plausibly influence CAR and morning anxiety.
 17. **Drogos *et al.* (2019)** observed increases in CAR after sustained aerobic training, showing that sustained activity can augment the morning cortisol surge in some contexts (important caution: CAR increases are not uniformly beneficial).
 18. **Cahn *et al.* (2017)** reported increases in both BDNF and the magnitude of CAR after intensive mind-body retreat practices, indicating that concentrated

practice can upregulate some morning neuroendocrine markers. Context and intensity matter.

19. **Stalder *et al.* (2025)** Recent syntheses clarify that both blunted and exaggerated CARs can be associated with different psychopathologies (e.g., blunted CAR with chronic fatigue; exaggerated CAR with anticipatory anxiety), so interpretation must be nuanced when viewing CAR changes post-intervention.
 20. **Corey *et al.* & De Nys (2014; 2022)** Broader literature on diurnal cortisol slope and exercise shows inconsistent but modifiable patterns, depending on timing and exercise type again emphasizing protocol standardization.
- D. Serotonin, tryptophan metabolism, and yoga/exercise**
21. **Jenkins *et al.* (2016)** did a comprehensive review that manipulating tryptophan availability influences mood and cognition; tryptophan is the biochemical substrate for serotonin synthesis and is modulated by exercise and diet. This underpins the biological plausibility of yoga/exercise influencing serotonergic tone.
 22. **Badawy (2018)** summarized pathways (kynurenine vs serotonin) and how physiological states and interventions can shift tryptophan flux, affecting mood. Exercise and hormonal status (e.g., estrogen) interact with tryptophan metabolism highly relevant for menstrual cycle contexts.
 23. **Basso & Suzuki (2017)** said that acute bouts of physical activity can produce transient increases in serotonin, norepinephrine, and other monoamines, which correspond with short-term mood elevation mechanism that may explain immediate mood benefits from morning yoga.
 24. **Lee *et al.* (2014)** trial's finding that yoga-maintained serum serotonin vs declines in controls provides direct human evidence that regular yoga can influence peripheral serotonin markers and mood outcomes.
 25. **Karimi & Yazdani Noori (2015)** found increases in plasma serotonin with yoga training, paired with improved mood profiles supporting cross-population generalizability.
 26. **Padmavathi *et al.* (2023)** highlights clinical studies where yoga correlated with improved mood and in some studies increased peripheral serotonin or imaging-based changes in brain circuitry. This links clinical mood benefit and biochemical/neuroimaging evidence.
 27. **Badawy (2018)** emphasize that peripheral serotonin is largely produced in the gut; exercise and dietary patterns modulate tryptophan availability, and mind-body practices may indirectly influence gut-brain signaling via autonomic and HPA modulation. These pathways are plausible mediators for PMS mood changes.
- E. Translational and contextual studies (delivery, timing, population specifics)**
28. **Moon *et al.* (2023)** found that short-term interventions combining gentle physical activity (beach yoga) and walking produced CAR changes in older women, demonstrating practicality of measuring CAR in women's health interventions. This hints at feasibility for PMS-focused CAR sampling.
 29. **Daubenmier *et al.* (2011)** improved anxiety and eating-related outcomes but did not uniformly change CAR, illustrating the complexity of translating subjective improvements into CAR changes. Outcomes may differ by intervention content and population.
 30. **Ayyub *et al.* (2024)** reiterates that regular physical activity (including yoga) reduces PMS symptoms; the authors underscore the need for cycle-phase-specific outcome measurement and reporting.

INTEGRATION: DOES EARLY MORNING HATHA YOGA REDUCE ANXIETY/IRRITABILITY/MOOD SWINGS IN PMS CLINICAL EVIDENCE SYNTHESIS

1. Clinical efficacy

Taken together, randomized trials and systematic reviews/meta-analyses indicate

that yoga interventions reduce PMS symptoms, with consistent effects on the emotional/psychological subdomain (anxiety, irritability, mood swings). Multiple RCTs (Erdoğan *et al.*, Bharati *et al.*, Vaghela *et al.*) reported statistically significant reductions in premenstrual emotional symptoms versus controls, and meta-analyses (Ranga, Pal, Pearce) confirm an aggregated beneficial effect despite heterogeneity. Hatha yoga-focused analyses of anxiety reduction (Hofmann *et al.*, 2016) are congruent with PMS-specific findings, suggesting portability of anxiety reduction mechanisms across populations.

2. Early morning practice: rationale and practical benefits

Morning practice is often advocated for several reasons: it may align with the natural cortisol awakening response (CAR) and shape early-day physiological arousal, it increases the likelihood of adherence and consistent daily routine, and acute exercise in the morning can produce immediate mood elevations (Basso & Suzuki, Healthline summaries). However, few trials explicitly contrast morning vs evening yoga for PMS outcomes. Indirect evidence suggests that morning activity can influence diurnal HPA-axis dynamics and daily mood trajectories, offering a plausible advantage for morning (awakening/timed) Hatha practice.

MECHANISTIC PATHWAYS: CAR AND SEROTONERGIC MODULATION

1. Cortisol Awakening Response (CAR)

The CAR is a pronounced rise in cortisol within 30-45 minutes after awakening and reflects HPA-axis reactivity linked to anticipation of the upcoming day (Fries *et al.*, 2009; Stalder *et al.*, 2025). CAR has been associated with morning anxiety and with vulnerability to stress in some contexts. Interventions can alter CAR, but directionality is complex: intensive retreats have increased CAR (Cahn *et al.*, 2017), chronic aerobic training increased CAR in older adults (Drogos *et al.*, 2019), while some mind-body programs show reductions or no change depending on study design (Anderson *et al.*, 2017; Daubenmier *et al.*, 2011). For PMS, where morning anxiety or anticipatory distress may contribute transiently to luteal-phase mood volatility, yoga-related

normalization (either attenuation of an exaggerated CAR or restoration of a blunted CAR) could mediate mood stabilization. However, direct trials linking CAR change to PMS symptom improvement after morning Hatha yoga are lacking; most studies measured either CAR or PMS outcomes, but not both simultaneously in a menstrual-timed design.

2. Serotonin and tryptophan metabolism

Serotonin (5-HT) is centrally implicated in mood regulation and in the pathophysiology of PMS/PMDD; many pharmacotherapies (SSRIs) target serotonergic signaling. Exercise can acutely increase brain serotonin availability (via increased free tryptophan crossing the blood-brain barrier), and chronic physical activity may alter peripheral serotonin and BDNF markers (Basso & Suzuki, 2017; Jenkins *et al.*, 2016; Lee *et al.* 2014). Human trials reported maintenance or increases in peripheral serotonin after yoga (Lee *et al.* 2014, Karimi & Yazdani Noori, 2015), and reviews (Badawy, Jenkins) articulate plausible biochemical pathways where tryptophan flux is modulated by activity, hormonal state, and inflammation. For PMS, where luteal-phase sensitivity to serotonergic fluctuations is hypothesized, yoga's influence on tryptophan-serotonin pathways offers a biologically plausible mechanism for emotional symptom reduction. Nonetheless, robust direct evidence (central serotonergic imaging or CSF measures timed to cycle and paired with yoga interventions) is still sparse.

DISCUSSION PUTTING EVIDENCE AND MECHANISMS TOGETHER

1. How early morning Hatha yoga might help psychological PMS symptoms

1. **Acute mood elevation from exercise-related monoamine release.** Short morning Hatha sessions combining gentle flow and pranayama may cause immediate increases in serotonin, norepinephrine, and dopamine, leading to transient mood uplift during the vulnerable luteal phase (Basso & Suzuki, 2017).
2. **HPA-axis modulation through CAR normalization.** Repeated morning yoga may modify CAR dynamics, either reducing an exaggerated CAR associated with anticipatory anxiety or restoring a healthy CAR pattern when blunted,

thereby stabilizing morning-related anxiety that compounds overall mood instability (Fries *et al.*, 2009; Anderson *et al.*, 2017).

3. **Chronic neuroplastic/biochemical changes.** Longer programs (8-12 weeks) show maintenance/increases in peripheral serotonin and BDNF, which correlate with mood stabilization and reduced depressive symptoms plausible contributors to longer-term alleviation of PMS mood swings (Lee *et al.*, 2014; Cahn *et al.*, 2017).
4. **Autonomic and interoceptive regulation.** Breathwork and mindful attention during Hatha practice lower sympathetic tone and enhance vagal control, reducing physiological arousal that underlies irritability and anxiety (Padmavathi *et al.*, 2023).

LIMITATIONS AND HETEROGENEITY IN THE LITERATURE

- **Heterogeneous interventions.** “Yoga” spans restorative, dynamic Hatha, and meditative forms; intensity, sequence, and session timing (morning vs evening) differ widely across studies (Pal *et al.*, 2022).
- **Inconsistent outcome timing relative to cycle.** Few trials precisely timed symptom or biomarker assessment to menstrual cycle phases; luteal-phase sampling is crucial for PMS research (Ayyub *et al.*, 2024).
- **Sparse concurrent biomarker + symptom measurement.** Only limited studies measured CAR or serotonin markers alongside validated PMS scales within the same trial, so mediator analyses remain mostly inferential (Curtis *et al.*, 2011; Lee *et al.*, 2014).
- **CAR interpretation complexity.** CAR increases are not universally “good” they can reflect either healthy responsiveness or maladaptive anticipatory stress depending on context; thus, trials need careful clinical interpretation (Stalder *et al.*, 2025; Fries *et al.*, 2009).

PRACTICAL RECOMMENDATIONS FOR RESEARCHERS AND CLINICIANS

1. **Designs:** Future RCTs should (a) specify yoga style (Hatha āsana + pranayama), (b) standardize session timing (early morning, e.g., within 30 minutes of awakening), and (c) ensure adequate dose (≥8-12 weeks; 3-5 sessions/week recommended in many trials). Evidence suggests 8-12 weeks yields peripheral biochemical changes in many studies (Lee *et al.*, 2014; Curtis *et al.*, 2011).
2. **Outcomes:** Combine validated PMS symptom scales (emotional subscales), daily symptom diaries timed to menstrual cycle, and objective biomarkers (salivary CAR sampling at awakening + 30 min; peripheral tryptophan/serotonin markers) measured across follicular and luteal phases to permit mediation analyses. Foundational CAR protocols are available (Fries *et al.*, 2009; Stalder *et al.*, 2025).
3. **Comparator arms:** Include active controls (stretching, aerobic exercise) and a non-intervention control to determine specificity; several trials showed yoga may outperform aerobic exercise for emotional PMS symptoms (Vaghela *et al.*, 2019; Bharati *et al.*, 2016).
4. **Mechanistic sampling considerations:** For CAR, collect 3-4 saliva samples across awakening period using standardized collection devices; for serotonergic measures, include plasma free tryptophan and serotonin (with diet/fasting control) or, ideally, neuroimaging endpoints where feasible. Use of BDNF may be an informative adjunct (Cahn *et al.*, 2017; Lee *et al.*, 2014).
5. **Population and delivery:** Recruit participants with clinically significant PMS (validated criteria) and consider scalability via online morning sessions (evidence supports virtual delivery feasibility), especially for students and working populations (Dal Brun *et al.*, 2023; Moszeik *et al.*, 2025).

CONCLUSIONS

The available randomized trials and systematic reviews support the conclusion that yoga including Hatha-style practices reduces

psychological PMS symptoms (anxiety, irritability, mood swings). Mechanistically, early morning Hatha yoga is plausible as a modulator of both the cortisol awakening response and serotonergic systems: CAR can be altered by timing and intensity of morning activity, and regular yoga has been associated with peripheral serotonin maintenance or increases in multiple trials. However, direct high-quality trials specifically testing early-morning Hatha yoga in luteal-timed designs with concurrent CAR and serotonergic assays are limited. To move from plausibility to firm mechanistic evidence, future RCTs must integrate precise menstrual timing, standardized morning-practice protocols, and simultaneous measurement of subjective and objective mediators.

LIMITATIONS OF THIS REVIEW

This article synthesized selected peer-reviewed papers identified via PubMed/Google Scholar and prioritized randomized trials, systematic reviews, and mechanistic studies. It is not a quantitative meta-analysis with pooled effect sizes computed here; rather it is a structured narrative/meta-analytic review integrating clinical and mechanistic evidence. The literature base exhibits heterogeneity in interventions, outcome timing, and biomarker protocols limitations acknowledged in multiple source reviews.

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