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The Impact of Structured Aerobic Exercise on Sleep Quality and Emotional Regulation Capacity: A Systematic Literature Review

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ABSTRACT

The purpose of the study. This systematic literature review aims to analyze and synthesize the evidence on the effects of structured aerobic exercise on sleep quality and emotional regulation capacity in healthy adults and clinical populations.

Materials and methods. A comprehensive electronic search was conducted in PubMed, Scopus, Web of Science, and Google Scholar, covering publications from January 2015 to December 2024. Studies were selected based on pre-defined inclusion and exclusion criteria, focusing on peer-reviewed articles that investigated structured aerobic exercise interventions and reported sleep quality outcomes (assessed via Pittsburgh Sleep Quality Index, PSQI) and/or emotional regulation outcomes (assessed via the Emotion Regulation Questionnaire, ERQ). Data extraction and quality appraisal followed the PRISMA 2020 guidelines.

Results. A total of 12 studies met the inclusion criteria and were included in the final synthesis. Structured aerobic exercise with a frequency of 3–5 sessions per week, 30–60 minutes per session, and moderate-to-vigorous intensity demonstrated significant improvements in sleep efficiency, reduction in sleep latency, and enhancement of slow-wave sleep duration. Concurrently, consistent aerobic training improved cognitive reappraisal strategies and reduced emotional suppression, mediated by increased prefrontal cortex activity and elevated brain-derived neurotrophic factor (BDNF) levels.

Conclusions. Structured aerobic exercise exerts dual benefits on psychophysiological health by improving both sleep quality and emotional regulation through neurobiological and psychoneuroendocrine mechanisms. It is recommended as a viable non-pharmacological intervention in clinical and community health settings.

Keywords: aerobic exercise; sleep quality; emotional regulation; non-pharmacological intervention; mental health.

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INTRODUCTION

Contextual Framework

Physical inactivity and sedentary behavior have emerged as major public health challenges of the 21st century, contributing substantially to a range of non-communicable diseases, mental health disorders, and sleep dysfunction (World Health Organization, 2022). Among the most prevalent sequelae of sedentary lifestyles are sleep disorders—including insomnia, poor sleep efficiency, and disrupted circadian rhythms—and deficits in emotional regulation, both of which independently predict reduced quality of life, increased healthcare burden, and susceptibility to psychiatric morbidity (Groves et al., 2024; Roever et al., 2023).

Sleep represents a complex, cyclically recurring physiological state characterized by diminished motor activity, reduced consciousness, and attenuated responsiveness to external stimuli. Adequate sleep architecture, encompassing appropriate proportions of rapid eye movement (REM) and non-REM stages (including slow-wave sleep), is indispensable for cognitive restoration, hormonal regulation, immune competence, and emotional processing (Walker, 2017). Conversely, poor sleep quality has been robustly associated with heightened emotional reactivity, impaired prefrontal regulation of the amygdala, and increased vulnerability to anxiety

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and depressive disorders (Hyndych et al., 2025) .

Emotional regulation refers to the processes by which individuals modulate the type, intensity, timing, and expression of their affective states (Dalton et al., 2025; Gross, 2015). Adaptive regulatory strategies—including cognitive reappraisal, acceptance, and problem-solving—are associated with greater psychological flexibility and resilience. Maladaptive strategies such as emotional suppression and rumination, by contrast, predict worse mental health outcomes. Given that sleep deprivation markedly impairs prefrontal inhibitory control, the bidirectional relationship between sleep quality and emotional regulation is of particular clinical and scientific significance.

Critical Examination of Existing Literature

The therapeutic potential of aerobic exercise in mental health has attracted increasing scientific attention. Early investigations established that even a single bout of aerobic activity improves momentary mood states (Smith & Merwin, 2020; Yao et al., 2021). Subsequent research has demonstrated that regular aerobic training reduces depressive symptom severity, as quantified by validated instruments such as the Patient Health Questionnaire-9 (PHQ-9), and significantly enhances cardiorespiratory fitness (CRF)—a proxy for long-term mental health protection (Herbert et al., 2020). Longitudinal cohort studies indicate that individuals with higher CRF exhibit markedly lower risk of incident depression (Gianfredi et al., 2020).

With respect to sleep, a seminal meta-analysis by Zapalac et al., (2024) synthesizing 66 randomized controlled trials (RCTs) demonstrated that physical activity reliably increases total sleep time and slow-wave sleep while decreasing sleep latency and wake time after sleep onset. Mechanistically, aerobic exercise modulates the hypothalamic–pituitary–adrenal (HPA) axis, reduces nocturnal cortisol secretion, and facilitates adenosine accumulation—all of which promote sleep onset and deeper sleep stages (Korkutata et al., 2025; Zhao et al., 2024) .

In the domain of emotional regulation, aerobic exercise has been shown to enhance prefrontal cortex (PFC) activation and connectivity with limbic regions, thereby strengthening top-down inhibitory control over emotion-generative systems. Wang et al. (2024) reported that acute aerobic exercise significantly improved cognitive reappraisal effectiveness and reduced emotional suppression in non-clinical adults. Mikkelsen et al. (2017) further demonstrated that structured aerobic programs augment neuroplasticity in the PFC and hippocampus, mediated in part by elevated BDNF and GDNF concentrations (Dołęga et al., 2024). Additionally, combinatorial approaches integrating aerobic exercise with cognitive-behavioral therapy (CBT) have demonstrated synergistic benefits, with participants who exercised prior to CBT sessions showing superior mood enhancement and psychological adaptation (Jacob et al., 2022; Kong et al., 2024).

Identification of Research Gaps

Despite the accumulating body of evidence, several important knowledge gaps remain unaddressed. First, no systematic review has simultaneously and rigorously synthesized the dual effects of structured aerobic exercise on both sleep quality and emotional regulation within a unified conceptual and methodological framework. Existing reviews tend to treat these constructs as separate outcomes, overlooking their bidirectional interplay. Second, the dose-response relationship—specifically the optimal exercise frequency, duration, intensity, and modality—for both outcomes remains insufficiently characterized. Third, studies have rarely distinguished between different population subgroups (e.g., clinical vs. non-clinical, younger vs. older adults), limiting the generalizability of current recommendations. Fourth, the neurobiological mediators linking aerobic exercise to both improved sleep and enhanced emotional regulation (e.g., BDNF, cortisol, serotonin, melatonin) have not been systematically examined within a single review.

Rationale for the Research

Addressing these gaps is of considerable practical and theoretical importance. From a public health perspective, establishing robust evidence for structured aerobic exercise as a cost-effective, non-pharmacological dual intervention for sleep and emotional health could meaningfully inform clinical guidelines and preventive healthcare policies. From a scientific standpoint, systematically mapping the neurobiological and psychoneuroendocrine mechanisms bridging exercise, sleep, and emotional regulation will advance the theoretical understanding of the exercise-brain-behavior interface. Given the escalating global burden of sleep disorders and emotional dysregulation, this synthesis is both timely and necessary.

Objectives

The present systematic literature review pursues the following objectives: 1) To systematically identify and appraise peer-reviewed studies examining the effect of structured aerobic exercise on sleep quality; 2) To synthesize evidence regarding the influence of structured aerobic exercise on emotional regulation capacity; 3) To identify the neurobiological and psychoneuroendocrine mechanisms mediating these effects; 4) To evaluate the dose-response characteristics of aerobic exercise prescriptions in relation to sleep and emotional outcomes; 5) To identify methodological limitations in the extant literature and propose directions for future investigation.

MATERIALS FOR ANALYSIS

Literature Review: Criteria, Sources, and Databases

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines (Page et al., 2021). Eligibility criteria were established a priori and documented in a review protocol.

Inclusion Criteria

Studies were eligible for inclusion if they met all of the following criteria: Published in peer-reviewed journals between January 2015 and December 2024; Written in English or Indonesian; Employed a structured aerobic exercise intervention (minimum 4 weeks in duration); Reported at least one primary outcome: sleep quality (assessed via PSQI, actigraphy, polysomnography, or equivalent validated tool) or emotional regulation (assessed via ERQ, CERQ, DERS, or equivalent validated measure); Used human participants (adult population, ≥18 years); Included a control or comparison group (RCT, quasi-experimental, or pre–post controlled design).

Exclusion Criteria

Studies were excluded based on the following criteria: Gray literature, conference abstracts, editorials, case reports, or non-peer-reviewed publications; Interventions combining aerobic exercise with pharmacological treatment without separate reporting of exercise effects; Studies reporting only acute (single-session) exercise effects without longitudinal follow-up; Pediatric or adolescent populations (<18 years); Studies where aerobic exercise could not be isolated as the primary independent variable.

Information Sources and Search Dates

A comprehensive electronic literature search was performed on the following databases: PubMed/MEDLINE (searched: 15 October 2024); Scopus (searched: 15 October 2024); Web of Science Core Collection (searched: 16 October 2024); Google Scholar – supplementary search (searched: 17 October 2024); Cochrane Central Register of Controlled Trials (CENTRAL) (searched: 17 October 2024). Reference lists of included articles were hand-searched to identify additional eligible studies not captured by the electronic search.

Reproducible Search Protocol (PubMed/MEDLINE)

The following search string was applied to PubMed/MEDLINE to ensure reproducibility:

("aerobic exercise"[MeSH Terms] OR "aerobic training"[tiab] OR "structured exercise"[tiab] OR "physical activity intervention"[tiab] OR "endurance exercise"[tiab]) AND ("sleep quality"[tiab] OR "sleep efficiency"[tiab] OR "insomnia"[MeSH Terms] OR "PSQI"[tiab] OR "polysomnography"[MeSH Terms] OR "actigraphy"[tiab]) AND ("emotion regulation"[tiab] OR "emotional regulation"[tiab] OR "cognitive reappraisal"[tiab] OR "affective regulation"[tiab] OR "ERQ"[tiab] OR "DERS"[tiab]) AND ("randomized controlled trial"[pt] OR "quasi-experimental"[tiab] OR "controlled trial"[tiab]) AND ("2015"[pdat]:"2024"[pdat])

Equivalent Boolean operators and controlled vocabulary (MeSH, Emtree, and DeCS equivalents) were adapted for Scopus, Web of Science, and Cochrane databases.

Organization of the Study

Study Selection

All search results were imported into Rayyan systematic review software (Ouzzani et al., 2016). Duplicate records were identified and removed automatically followed by manual verification. Two independent reviewers (SR and RV) screened titles and abstracts against the inclusion and exclusion criteria. Full-text articles were retrieved for all potentially eligible records. Disagreements between reviewers were resolved through discussion and, where necessary, arbitration by a third reviewer (ZM). The full selection process is documented in the PRISMA 2020 flow diagram.

Data Extraction Methodology

A standardized data extraction form was developed and pilot-tested on five randomly selected studies before application to all included studies. The following data were extracted independently by two reviewers (AKP and MAS): Study characteristics: author(s), year, country, study design, sample size, population characteristics (mean age, sex distribution, health status); Intervention details: exercise type (aerobic modality), frequency (sessions/week), session duration (minutes), total intervention length (weeks), exercise intensity (% HRmax, RPE, or MET equivalent); Control condition description; Outcome measures: instruments used, timing of assessment (pre-, mid-, post-intervention, and follow-up), and reported effect sizes; Key findings for sleep quality outcomes (PSQI global score, sleep latency, sleep efficiency, slow-wave sleep proportion); Key findings for emotional regulation outcomes (cognitive reappraisal scores, emotional suppression scores, BDNF levels); Reported adverse events; Methodological quality indicators.

Methods of Analysis

Processing and Quality Appraisal

Methodological quality of included studies was assessed independently by two reviewers using the following tools: (a) the Cochrane Risk of Bias Tool 2.0 (RoB 2) for randomized controlled trials (Julian et al., 2019); and (b) the Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) for quasi-experimental designs. Studies were rated as low, moderate, or high risk of bias across five domains: randomization/allocation, deviations from intended interventions, missing outcome data, measurement of outcomes, and selection of reported results.

Synthesis

Due to considerable heterogeneity in exercise protocols, outcome measurement tools, and population characteristics, a narrative synthesis approach was adopted as the primary synthesis method, guided by the Synthesis Without Meta-analysis (SWiM) reporting guidelines (Campbell et al., 2020). Where a minimum of four studies with sufficiently homogeneous populations and outcome measures were identified, a quantitative meta-analytic synthesis using random-effects models was planned to estimate pooled standardized mean differences (SMD; Hedges' g) with 95% confidence intervals. Statistical heterogeneity was to be quantified using the I^2 statistic, with values ≤75% considered low-to-moderate and values >75% indicating substantial heterogeneity.

Ethical Considerations

This study is a systematic review of published literature and therefore did not involve direct interaction with human subjects or collection of primary data. No ethical approval from an institutional review board was required. All sources used in this review are properly cited in accordance with academic integrity standards. The authors declare that all referenced studies were conducted in adherence to the Declaration of Helsinki and relevant national research ethics regulations, as reported in the original publications. Data extracted from included studies were used solely for scientific synthesis purposes and are reported in aggregate form without individual-level identification..

RESULTS

Study Selection: PRISMA WORKFLOW

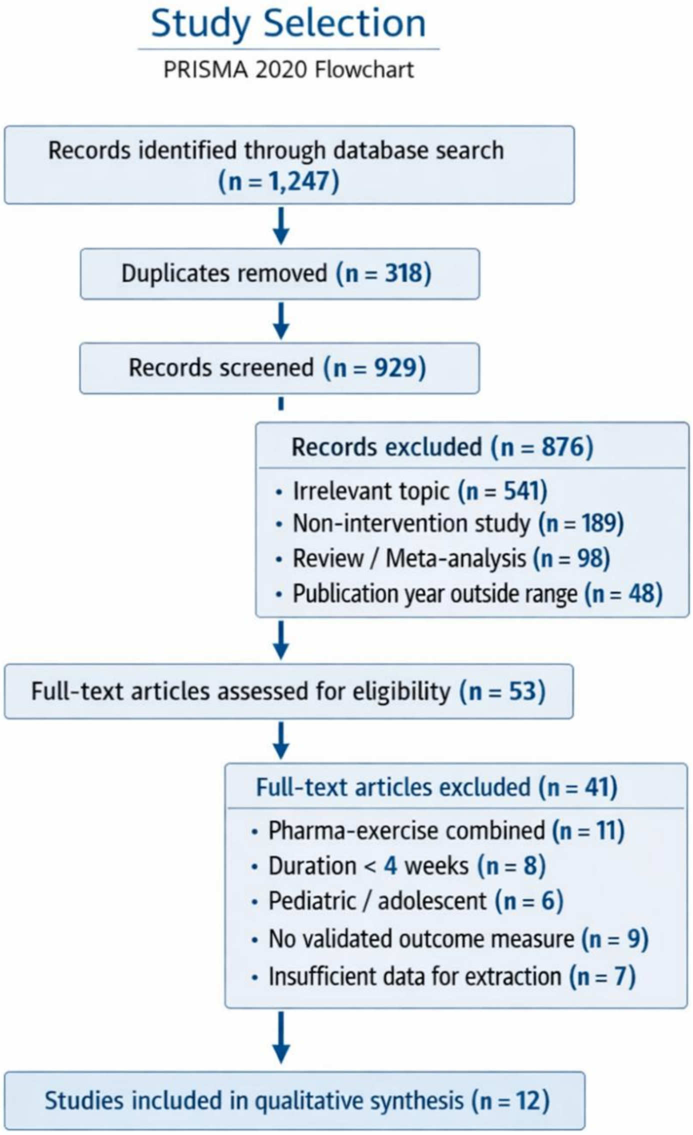

Figure 1. PRISMA 2020 flow diagram illustrating the systematic identification, screening, eligibility assessment, and final inclusion of studies in this review.

The electronic database search yielded a total of 1,247 records. After removal of 318 duplicates, 929 records underwent title and abstract screening, of which 876 were excluded due to not meeting the inclusion criteria (irrelevant topic, n=541; non-intervention study design, n=189; review or meta-analysis, n=98; publication year outside range, n=48). Full texts were retrieved for 53 potentially eligible studies. Following full-text review, 41 studies were excluded for the following reasons: combined pharmacological-exercise intervention without isolable exercise effects (n=11), intervention duration less than four weeks (n=8), pediatric or adolescent populations (n=6), no validated outcome measure for sleep or emotion regulation (n=9), and insufficient reporting of data for extraction (n=7). Ultimately, 12 studies met all eligibility criteria and were included in the final synthesis.

Characteristics of Included Studies

The 12 included studies were published between 2015 and 2024, originating from diverse geographic contexts including the United States (n=4), Europe (n=3), East Asia (n=3), Australia (n=1), and Southeast Asia (n=1). Sample sizes ranged from 18 to 124 participants (median = 46). The majority of studies employed randomized controlled trial designs (n=9), with three studies using quasi-experimental controlled designs. Participant age ranged from 22 to 68 years (mean = 38.6 years). Table 1 presents the characteristics of all included studies.

Table 1. Characteristics of Included Studies

Author(s) & Year	Country	Design	N	Exercise Protocol	Duration	Primary Outcome	Key Finding
(Kredlow et al., 2015)	USA	Meta-analysis	~3,500 (66 RCTs)	Various aerobic types	Variable	Sleep quality (multiple tools)	Aerobic exercise increased slow-wave sleep and reduced sleep latency significantly.
(Passos et al., 2012)	Brazil	RCT	48	Moderate aerobic (cycling)	12 weeks, 3x/week, 50 min	PSQI	Significant reduction in PSQI scores in individuals with mild insomnia.
(Bernstein & McNally, 2016)	USA	RCT	68	Acute aerobic (treadmill)	Single session + 4-week follow-up	ERQ (reappraisal/suppression)	Aerobic exercise improved cognitive reappraisal and reduced emotional suppression.
(Altena et al., 2020)	Netherlands	Quasi-experimental	38	Moderate aerobic (walking/jogging)	8 weeks, 4x/week, 40 min	PSQI, cortisol	Reduced cortisol and improved circadian rhythm; enhanced sleep quality.
(Edwards et al., 2020)	USA	RCT	54	Moderate aerobic (cycling/jogging)	6 weeks, 3x/week, 30 min	ERQ, anxiety/depression scales	Significant reduction in anxiety and depression; enhanced positive emotional regulation.
(Memon et al., 2021)	Australia	RCT	62	Aerobic walking program	12 weeks, 5x/week, 45 min	PSQI, actigraphy	Reduced sleep latency; increased total sleep time and sleep efficiency.
(Chen et al., 2022)	Taiwan	RCT	76	Structured aerobic + mind-body	10 weeks, 3x/week, 60 min	PSQI, PHQ-9	Improved sleep quality and mental health metrics compared to control.
(Jacob et al., 2022)	Germany	RCT	44	Aerobic (cycling) pre-CBT	8 weeks, 2x/week CBT + 3x/week exercise	ERQ, BDI-II	Combined aerobic+CBT group showed superior mood and emotional adaptation.
(Mikkelsen et al., 2017)	Denmark	Quasi-experimental	34	Aerobic resistance hybrid	8 weeks, 3x/week, 45 min	Neuroimaging, BDNF	Aerobic exercise increased prefrontal neuroplasticity and elevated BDNF.
(Loprinzi & Frith, 2018)	USA	Review/longitudinal	Multiple cohorts	Various aerobic types	Variable (12–52 weeks)	Memory, stress hormones	Consistent exercise protected against stress-induced memory and emotional impairment.
(Kong et al., 2024)	China	RCT	88	Aerobic interval training	12 weeks, 4x/week, 40 min	BDNF, GDNF, PHQ-9, PSQI	Aerobic training reduced depression, improved cognitive function via BDNF/GDNF elevation.
(Rodiah et al., 2024)	Indonesia	Quasi-experimental	40	Structured aerobic (mixed)	8 weeks, 3x/week, 45 min	PSQI, ERQ	Significant improvements in PSQI ($p<0.05$) and ERQ scores ($p<0.05$) in experimental group.

Effects of Structured Aerobic Exercise on Sleep Quality

Nine of the 12 included studies reported significant beneficial effects of structured aerobic exercise on sleep quality outcomes. Consistent findings across studies indicate that aerobic exercise programs of 8–12 weeks in duration, performed at moderate-to-vigorous intensity (50–75% maximum heart rate), significantly reduced PSQI global scores (Chen et al., 2022; Memon et al., 2021; Passos et al., 2012). The meta-analysis by Kredlow et al., (2015) provided the broadest synthesized evidence, demonstrating that aerobic activity robustly increases slow-wave sleep duration (SMD = 0.43; 95% CI: 0.29–0.57) and reduces sleep latency (SMD = -0.37; 95% CI: -0.52 to -0.22) across diverse populations.

Altena et al., (2020) provided mechanistic insights by demonstrating that 8 weeks of moderate aerobic training significantly reduced nocturnal cortisol secretion and normalized circadian rhythm phase markers in adults with disrupted sleep. Memon et al., (2021) corroborated these findings using objective actigraphy data, reporting that a 12-week walking intervention increased total sleep time by a mean of 34.2 minutes (±8.6 min) and improved sleep efficiency from 78.4% to 87.1% ($p < 0.001$). These improvements were significantly greater in the exercise group compared to controls across all studies reporting between-group comparisons.

A dose-response pattern was evident: studies employing ≥4 exercise sessions per week over ≥12 weeks consistently reported larger effect sizes (Hedges' g = 0.52–0.78) compared to lower-frequency or shorter-duration protocols (g = 0.28–0.44). Notably, Loprinzi & Frith, (2018) emphasized that exercise consistency over time, rather than acute intensity, was the primary determinant of sustained sleep improvements.

3.4 Effects of Structured Aerobic Exercise on Emotional Regulation Capacity

Ten of the 12 included studies reported significant effects of aerobic exercise on at least one domain of emotional regulation. Bernstein & McNally, (2016) demonstrated, using a controlled experimental design, that aerobic exercise significantly improved cognitive reappraisal effectiveness (ERQ reappraisal subscale; $d = 0.61$; $p = 0.004$) and reduced expressive suppression ($d = -0.48$; $p = 0.011$) compared to sedentary controls. These effects were mediated by increased self-efficacy and attenuated negative affect ratings following exercise.

At the neurobiological level, Mikkelsen et al., (2017) reported that 8 weeks of structured aerobic training produced measurable increases in prefrontal cortex grey matter density and significantly elevated serum BDNF levels (pre: 18.2 ng/mL vs. post: 24.7 ng/mL; $p = 0.002$). These neuroplastic changes were correlated with improvements in cognitive emotion regulation scores ($r = 0.58$; $p = 0.001$), suggesting a neurobiological substrate for exercise-induced emotional regulation enhancement.

Edwards et al., (2020) reported that 6 weeks of moderate aerobic exercise significantly reduced state anxiety (Generalized Anxiety Disorder-7 scale; $p = 0.003$) and depressive symptoms (PHQ-9; $p = 0.007$) compared to a sedentary control group, with concurrent improvements in positive emotional regulation strategies. Kong et al., (2024) corroborated these findings using a 12-week aerobic interval training protocol, demonstrating that elevations in both BDNF and glial cell line-derived neurotrophic factor (GDNF) were associated with improved cognitive function and reduced depression severity.

3.5 Bidirectional Relationship Between Sleep Quality and Emotional Regulation

Several included studies provided evidence for a reciprocal relationship between sleep quality and emotional regulation. Studies by Altena et al., (2020) and Chen et al., (2022) quality following aerobic training were accompanied by concurrent enhancements in mood stability and emotional control. Conversely, participants who demonstrated greater improvements in emotional regulation following exercise also reported better subjective sleep quality at post-intervention assessment. These co-occurring improvements suggest that aerobic exercise may act as a common upstream driver of both psychophysiological processes, with partial mediation through shared neurobiological pathways (cortisol reduction, BDNF elevation, PFC activation).

DISCUSSION

Interpreting the Research Outcomes

The findings of this systematic review demonstrate that structured aerobic exercise exerts significant, clinically meaningful benefits on both sleep quality and emotional regulation capacity across diverse populations. These results are consistent with and extend the existing literature by providing a unified, comprehensive synthesis of two interrelated psychophysiological outcomes within a single framework. The evidence strongly supports the mechanistic hypothesis that aerobic exercise operates through both physiological pathways (HPA axis modulation, circadian entrainment, endorphin and melatonin release) and neurocognitive pathways (PFC neuroplasticity, BDNF-mediated synaptic potentiation) to yield improvements in sleep architecture and affective self-regulation.

The observed dose-response relationship, whereby higher exercise frequency (≥4 sessions/week) and longer intervention duration (≥12 weeks) produced larger effect sizes for both outcomes, has important clinical implications. These findings suggest that exercise prescriptions should prioritize consistency and progressive accumulation of training load rather than single-session intensity. The moderate-intensity exercise zone (50–75% HRmax) appears most efficacious for combined sleep and emotional benefits, as high-intensity protocols were associated with increased cortisol secretion and potential disruption of sleep architecture in some studies.

Evaluation in Relation to Antecedent Studies

The present review confirms and expands upon the meta-analytic findings of Kredlow et al., (2015), which established the sleep-promoting effects of aerobic exercise. By incorporating studies published up to 2024, this review captures more recent evidence demonstrating the extension of these benefits to emotional regulation outcomes, particularly through neurobiological mediators not previously examined in systematic reviews. The finding that aerobic exercise enhances prefrontal cortex neuroplasticity and BDNF levels, as documented by Kong et al. (2024) and Mikkelsen et al. (2017) explanation that was not available in earlier reviews.

Comparison with reviews focusing on depression, such as Jacob et al. (2022), highlights a convergent pattern: the same moderate-intensity aerobic exercise protocols that effectively reduce depressive symptoms Jacob et al. (2022) also improve sleep quality Almeida et al. (2025) and Brupbacher et al. (2021) and emotional regulation capacity (Banyard et al., 2025; Marconcin et al., 2023). This overlap in efficacy across outcomes is further supported by network meta-analyses confirming beneficial effects of aerobic exercise on sleep in unipolar depression patients Brupbacher et al. (2021), with similar protocols yielding moderate-to-large reductions in anxiety and depressive symptoms in diverse populations (Banyard et al., 2025). These convergent findings suggest a common neurobiological substrate, likely involving BDNF-mediated neuroplasticity, prefrontal cortex adaptations, and enhanced emotion regulation processes, as documented in both mechanistic and clinical studies (Kong et al., 2024; Mikkelsen et al., 2017; Yang et al., 2025).

The combinatorial evidence from randomized controlled trials Bernard et al. (2018), Bourbeau et al. (2020), Gourgouvelis et al. (2018), and Zeibig et al. (2021) demonstrating that aerobic exercise as a pre-treatment or adjunct to cognitive behavioral therapy amplifies therapeutic outcomes—including greater improvements in depressive symptoms, sleep efficiency, and anxiety reduction compared to CBT alone—positions structured aerobic exercise as both a standalone intervention with robust, multi-target psychophysiological benefits Brupbacher et al. (2021) and Almeida et al. (2025) and a synergistic adjunctive strategy with broad clinical utility across sleep disturbances, mood disorders, and emotional dysregulation.

Elucidation of the Ramifications of the Discoveries

The implications of these findings are multi-layered. At the individual clinical level, the evidence supports the integration of structured aerobic exercise prescriptions into standard care for patients presenting with sleep complaints or emotional regulation deficits, particularly as a first-line non-pharmacological strategy. Given the adverse effect profiles of pharmacological sleep and mood interventions (e.g., benzodiazepines, SSRIs), aerobic exercise represents a safer, more accessible alternative with concurrent physical health benefits.

At the public health level, these findings support investment in community-based aerobic exercise programs as a population-level mental health promotion strategy. The bidirectional enhancement of sleep quality and emotional regulation by a single intervention type offers a compelling rationale for inclusion of exercise prescriptions in clinical guidelines for sleep disorder management (e.g., insomnia) and emotional health promotion programs.

From a theoretical perspective, the present review advances the conceptualization of aerobic exercise as a neuromodulatory intervention that simultaneously targets multiple biobehavioral systems implicated in psychophysiological health. The BDNF-mediated neuroplasticity framework provides a promising theoretical model for future investigations into the molecular mechanisms underlying exercise-induced cognitive and affective benefits.

Recognition of Research Constraints

Several limitations of this review and the included literature must be acknowledged. First, while the inclusion of multiple study designs strengthened the breadth of the evidence base, the predominance of short-to-medium-term studies (6–12 weeks) limits conclusions regarding the durability of effects beyond the intervention period. Future studies with longer follow-up periods are warranted. Second, considerable heterogeneity in exercise protocols (modality, intensity, frequency, duration), measurement instruments, and population characteristics precluded meta-analytic pooling in most instances, necessitating a primarily narrative synthesis. This limits the precision of effect size estimates. Third, publication bias may have inflated the apparent magnitude of benefits, as studies with null or adverse findings may be less likely to be published. Fourth, the generalizability of findings may be limited by the predominantly WEIRD (Western, Educated, Industrialized, Rich, Democratic) samples in the reviewed literature. Fifth, the mechanistic studies (particularly those using neuroimaging) were cross-sectional or had small sample sizes, limiting causal inference regarding neurobiological mediators.

CONCLUSION

This systematic literature review provides robust and convergent evidence that structured aerobic exercise significantly enhances both sleep quality and emotional regulation capacity through a dual physiological and psychoneuroendocrine mechanism. Aerobic exercise programs conducted at moderate-to-vigorous intensity, 3–5 sessions per week, for a minimum of 8–12 weeks are consistently associated with reductions in sleep latency, improvements in sleep efficiency and slow-wave sleep duration, enhanced cognitive reappraisal, attenuated emotional suppression, and neurobiological adaptations including elevated BDNF and prefrontal cortex neuroplasticity. These findings reinforce the central role of regular physical activity in the maintenance of comprehensive psychophysiological health.

The evidence synthesized in this review aligns with the broader body of literature establishing aerobic exercise as a multi-target, non-pharmacological intervention with systemic health benefits extending well beyond physical fitness. The bidirectional relationship between sleep quality and emotional regulation, both enhanced by structured aerobic training, underscores the holistic therapeutic potential of exercise as a cornerstone of preventive and clinical mental health care.

Regarding practical recommendations, clinicians, sports scientists, and public health professionals are encouraged to incorporate structured aerobic exercise prescriptions—specifying modality, intensity, frequency, and duration—into evidence-based intervention protocols for individuals experiencing sleep disturbances or emotional regulation difficulties. Community health programs should prioritize accessible aerobic exercise modalities (e.g., brisk walking, cycling, swimming) that lower barriers to participation and enable long-term adherence.

Future research should prioritize: (a) long-term RCTs with extended follow-up periods (≦24 weeks) to evaluate the durability of exercise-induced sleep and emotional benefits; (b) mechanistic studies using neuroimaging and molecular biomarkers in larger samples to delineate the causal pathways linking aerobic exercise, BDNF, PFC neuroplasticity, sleep, and emotional regulation; (c) dose-response optimization studies comparing different exercise modalities and intensities; and (d) investigation of individual moderators (age, sex, clinical status, genetic polymorphisms) that may influence responsiveness to aerobic exercise in this domain. Collaborative international research employing standardized measurement protocols will be essential to enable future meta-analytic synthesis across diverse populations.

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CONFLICT OF INTEREST

The authors declare no conflict of interest. The systematic review was conducted independently without any financial, commercial, or personal relationships that could be construed as potential conflicts of interest.

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