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Influence of aerobic exercise on biopsychological function among patients with bipolar affective disorder in Nigeria

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Abstract Bipolar affective disorder is associated with substantial physical health burden, mood disturbance, and cognitive difficulty, yet lifestyle-based approaches remain weakly integrated into routine psychiatric care, particularly in low-resource settings such as Nigeria. Aerobic exercise has been proposed as a useful adjunctive strategy, but evidence specific to bipolar disorder populations remains limited. This study examined whether participation in aerobic exercise is associated with physical health, mood stability, depressive symptoms, and cognitive functioning among patients with bipolar affective disorder receiving care in a Nigerian tertiary psychiatric hospital. A retrospective cross-sectional observational design was employed. The participants were adults with a clinical diagnosis of bipolar affective disorder receiving inpatient or outpatient care (N = 103). Aerobic exercise participation and biopsychological functioning were assessed using a structured self-report questionnaire. Associations between aerobic exercise participation and each outcome domain were examined using simple linear regression analyses. Higher levels of aerobic exercise participation were associated with better perceived physical health, greater mood stability, lower depressive symptom severity, and better cognitive functioning. The associations were strongest for depressive symptoms and moderate for physical health, mood stability, and cognitive functioning. All the observed relationships were statistically significant and consistent in direction. Aerobic exercise participation was associated with multiple domains of biopsychological functioning among patients with bipolar affective disorder in routine psychiatric care. These findings indicate that aerobic exercise participation is associated with multiple domains of biopsychological functioning; however, no causal or intervention effect can be inferred from the present cross-sectional design. The results should be interpreted as associative rather than causal, given the observational design.

Keywords: Bipolar disorder, aerobic exercise, depressive symptoms, mood stability, cognitive function, physical health

1. Introduction

Bipolar disorder is a chronic and severe mood disorder characterized by recurrent depressive, hypomanic, and manic episodes; substantial functional impairment; and an elevated risk of premature mortality. Globally, it contributes markedly to years lived with disability and economic burden. Despite advances in pharmacological treatment, many individuals experience persistent mood symptoms, cognitive difficulties, and declining physical health (Guo et al., 2024; Milić et al., 2025; Zahn, 2025). Although exercise is increasingly discussed as an adjunctive component of care in severe mental illness, bipolar disorder remains underrepresented in the exercise literature, particularly in low- and middle-income countries, limiting evidence that can guide clinical practice in these settings (Stubbs et al., 2018).

The burden of bipolar disorder extends beyond episodic mood disturbance. Persistent impairments in attention, memory, and executive function are common, as are disruptions in stress regulation and circadian rhythms (Filho et al., 2020; Zahn, 2025). Physical comorbidities, including obesity, metabolic syndrome, and cardiovascular disease, are highly prevalent

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and are linked to low physical activity levels and the metabolic effects of long-term psychotropic medication use (Marx et al., 2022; Stubbs et al., 2018). These interacting psychological and physical difficulties contribute to reduced life expectancy and poorer quality of life among individuals with bipolar disorder than the general population (Guo et al., 2024; Zahn, 2025). Contemporary models, therefore, emphasize the interaction of biological, psychological, and behavioral processes, including cumulative stress burden and reduced neural adaptability, in shaping long-term outcomes (Smith & Merwin, 2021; Zahn, 2025).

Lifestyle-oriented approaches, particularly physical activity, have gained attention as adjuncts to conventional treatment for severe mental illness. Evidence from major depressive disorder and related conditions indicates that aerobic and resistance exercise are associated with reduced depressive symptoms, improved physical fitness, and improved selected aspects of cognitive functioning (Marx et al., 2022; Smith & Merwin, 2021). On this basis, clinical guidelines increasingly recommend exercise as part of care for depression and psychotic disorders (Marx et al., 2022; Stubbs et al., 2018). The proposed mechanisms include improved stress regulation, reduced inflammatory activity, enhanced cardiometabolic health, and strengthened self-regulatory capacity, all of which are relevant to functional recovery in patients with bipolar disorder.

In contrast, evidence specific to bipolar disorder remains scarce in the literature and methodologically constrained. Meta-reviews identify few bipolar-focused studies, many characterized by small samples, short follow-up periods, or heterogeneous designs, (Filho et al., 2020; Stubbs et al., 2018) restricting the strength of inference. The available findings suggest possible associations between physical activity and reduced depressive symptoms, stress, or body weight, but the effects of physical activity on mood stability, cognitive function, and broader clinical outcomes remain unclear. Moreover, most studies have been conducted in high-income countries, raising concerns about their applicability to change to developing countries, with poor and unstable health systems.

Safety and feasibility further complicate the role of exercise in patients with bipolar disorder. Moderate-intensity aerobic activity appears acceptable for many individuals, but unsupervised or vigorous exercise may be associated with sleep disruption, increased arousal, or exacerbation of manic symptoms in some patients, particularly during unstable phases of illness (Filho et al., 2020; Stubbs et al., 2018). These concerns highlight the importance of examining exercise behavior within routine clinical environments and of distinguishing potential benefits from risks. Such issues are especially salient in low- and middle-income countries, where mental health services face limited funding, shortages of specialized personnel, and restricted access to psychosocial rehabilitation (Guo et al., 2024). In Nigeria, psychiatric care is largely concentrated in tertiary hospitals and relies predominantly on pharmacological treatment, with limited integration of lifestyle-based interventions.

Thus, understanding how naturally occurring variation in physical activity relates to clinical functioning represents an important initial step. Aerobic exercise is a potentially feasible and low-cost behavior that requires minimal equipment and can be integrated into routine care within hospital or community settings. However, locally generated evidence examining the associations between aerobic exercise participation and physical health, mood, and cognition among individuals with bipolar disorder in Nigerian psychiatric services is scarce. To date, no published studies have examined these relationships using data drawn from routine care in Nigerian tertiary psychiatric hospitals.

The Federal Neuro Psychiatric Hospital, Calabar, provides an opportunity to address this gap. As a tertiary mental health facility, it manages many patients with bipolar disorder who commonly present with recurrent mood symptoms, cognitive difficulties, and physical health challenges. The absence of well-structured exercise programs within routine care creates natural variation in aerobic exercise participation, allowing observational examination of associations between exercise behavior and clinical functioning. Guided by biopsychosocial models linking mood disorders to cumulative stress burden and adaptive capacity (Filho et al., 2020; Smith & Merwin, 2021), the associations between self-reported aerobic exercise participation and biopsychological functioning was examied in this study among patients with bipolar affective disorder receiving care at this hospital.

Biopsychological functioning is conceptualized across four interrelated domains relevant to long-term outcomes in bipolar disorder: perceived physical health, mood stability, depressive symptoms, and cognitive functioning. Rather than evaluate the effectiveness of an intervention, an exploratory observational approach was adopted to assess whether naturally occurring differences in aerobic exercise participation are associated with variation across these domains. Evidence generated from this setting contributes data from a low-resource environment that remains underrepresented in the bipolar disorder literature and may inform future intervention development, service planning, and prospective studies in similar health systems. Based on the identified gaps, this study aimed to examine the association between aerobic exercise participation and (i) physical health, (ii) mood stability, (iii) depressive symptoms, and (iv) cognitive functioning among patients with bipolar affective disorder receiving care in a Nigerian tertiary psychiatric hospital.

2. Literature Review

2.1. Aerobic Exercise and Physical Health in Bipolar Disorder

Bipolar disorder is associated with a substantial physical health burden, including obesity, metabolic syndrome, and premature cardiovascular disease, contributing to reduced life expectancy (Brobakken et al., 2022; Filho et al., 2020). This excess risk is commonly linked to low cardiorespiratory fitness, unfavorable body composition, and adverse lipid profiles, which

increase cardiovascular morbidity and mortality in severe mental disorders and are potentially modifiable through behavioral change (Filho et al., 2020; Schmitt et al., 2018).

Individuals with severe mental disorders typically have lower cardiorespiratory fitness and muscular strength than the general population do, as well as reduced physical functioning and greater vulnerability to lifestyle-related disease (Filho et al., 2020). Compared with healthy controls, patients with bipolar disorder, both adolescents and adults, have lower cardiorespiratory fitness, higher fat mass, adverse lipid ratios, elevated inflammatory markers, and increased estimated cardiovascular risk (Etxaniz-Osés et al., 2025). Among bipolar disorder patients, poorer cardiorespiratory fitness is associated with more severe depressive symptoms and lower levels of habitual physical activity, suggesting that physical inactivity is a modifiable link between mood disturbance and cardiometabolic risk (Popel et al., 2020).

Aerobic exercise and combined aerobic resistance training have been examined as strategies to improve physical health in patients with severe mental disorders. In patients with schizophrenia, aerobic exercise is consistently associated with improvements in cardiorespiratory fitness, although its effects on body composition and metabolic syndrome indicators are variable (Schmitt et al., 2018; Stubbs et al., 2018). Meta-analyses across individuals with severe mental illness report similar gains in cardiorespiratory fitness, while pooled effects on waist circumference, blood pressure, lipid fractions, and glucose regulation are small and inconsistent (Ancín-Osés et al., 2025). Short intervention duration, heterogeneity of exercise prescription, and the metabolic effects of psychotropic medication are frequently cited explanations for these mixed findings.

Aerobic exercise is particularly effective for reducing body mass index and improving high-density lipoprotein cholesterol, whereas resistance training is beneficial for glucose regulation and body composition (Amin et al., 2023). Although this distinction is relevant for bipolar disorder, where cardiometabolic risk is high, direct comparisons of exercise modality remain limited. A meta-review by the European Psychiatric Association revealed few bipolar disorder-specific studies and concluded that the existing evidence does not support diagnosis-specific physical activity recommendations (Stubbs et al., 2018). Narrative syntheses therefore rely largely on indirect evidence from schizophrenia, major depressive disorder, and cardiometabolic populations, highlighting the lack of adequately powered bipolar disorder studies with objective physiological outcomes (Ancín-Osés et al., 2025; Filho et al., 2020).

Findings concerning available bipolar disorder suggest that exercise is feasible and potentially beneficial, but uncertainty persists. An open-label trial in adults with bipolar depression reported reductions in depressive symptoms, gains in muscular strength, and reduced body fat following twelve weeks of supervised combined exercise, while changes in peak oxygen uptake and lean mass were modest (Lafer et al., 2023). Observational studies also report high levels of physical inactivity and obesity, with greater habitual activity associated with lower cholesterol levels and reduced cardiometabolic burden (Etxaniz-Osés et al., 2025; Gomes-Da-Costa et al., 2024). These findings do not establish an optimal exercise modality, dose, or long-term physiological effects.

Biological evidence from severe mental disorders and metabolic disease supports a plausible role for aerobic exercise in bipolar disorder. Aerobic training improves insulin sensitivity, glucose regulation, and lipid metabolism, partly through reductions in visceral fat and systemic inflammation (Al-Mhanna et al., 2024; He et al., 2024). Exercise-related increases in neurotrophic factors and the regulation of stress and inflammatory pathways may further link improvements in cardiorespiratory fitness with metabolic and neurobiological changes relevant to bipolar disorder (Al-Mhanna et al., 2024).

Bipolar disorder-specific studies with systematic assessments of cardiorespiratory fitness, body composition, and metabolic syndrome indicators are scarce, and long-term cardiometabolic outcomes are poorly described (Ancín-Osés et al., 2025; Stubbs et al., 2018). It also remains unclear whether aerobic exercise alone is sufficient to reduce cardiometabolic risk or whether combined exercise is needed, as observed in metabolic syndrome and type 2 diabetes populations (Amin et al., 2023). The optimal exercise intensity, frequency, supervision, and adherence parameters that balance physical health benefits with mood stability are not well defined (Filho et al., 2020; Lafer et al., 2023). For this reason, further bipolar disorder-focused studies examining aerobic exercise participation alongside physical health indicators are needed. On this basis, the present study examined whether participation in aerobic exercise is associated with differences in perceived physical health among patients with bipolar affective disorder.

Hypothesis 1: *Aerobic exercise participation is positively and significantly associated with better physical health among patients with bipolar affective disorder.*

2.2. Aerobic Exercise and Mood Stability

Mood instability, characterized by frequent and unpredictable fluctuations in emotional intensity, is a central feature of bipolar disorder and is closely associated with relapse, hospital admission, and functional impairment, even outside syndromal episodes (Hearing et al., 2016). Clinical models conceptualize mood instability within frameworks of emotion regulation and stress vulnerability, emphasizing disruptions in cognitive control, stress responsivity, and reward processing that impair the regulation of negative and positive affect over time (Bernstein & McNally, 2017; Kucyi et al., 2010). Although pharmacological and psychosocial treatments reduce acute episodes, subsyndromal affective fluctuation often persists, supporting interest in adjunctive approaches that strengthen regulatory capacity.

Exercise, including aerobic and mixed-modality programs, is associated with reductions in depressive and anxiety symptoms across psychiatric and general populations (Hearing et al., 2016; Melo et al., 2016). Meta-analyses in major depressive and anxiety disorders report moderate to large symptom reductions following supervised moderate- to vigorous-intensity exercise delivered over eight to twelve weeks (Banyard et al., 2025). Experimental studies further indicate that single sessions of moderate aerobic exercise reduce stress-related negative affect, particularly in individuals with emotion regulation difficulties, suggesting short-term regulatory effects in addition to symptom change (Bernstein & McNally, 2017).

Translation of this evidence to bipolar disorder remains limited. Reviews describe a small and methodologically weak evidence base, with few adequately powered randomized controlled trials and substantial heterogeneity in exercise prescription and outcome measures (Hearing et al., 2016; Melo et al., 2016). As a result, clinical guidance often relies on evidence from unipolar depression rather than bipolar disorder-specific studies (Thomson et al., 2015).

Available bipolar disorder-focused findings suggest both potential benefit and risk. A large comparative effectiveness study revealed that low exercise levels were associated with greater depressive burden and poorer quality of life, whereas higher exercise frequency was associated with more manic symptoms and recent manic episodes (Sylvia et al., 2013). This pattern suggests polarity-specific associations, with inactivity clustering with depressive states and increased activity accompanying mood elevation. Qualitative studies and narrative reviews similarly describe exercise as potentially beneficial, but intense or poorly regulated activity may increase arousal or hypomanic symptoms in some individuals (Hearing et al., 2016; Thomson et al., 2015).

Intervention studies support the feasibility of supervised exercise with careful monitoring. An open-label twelve-week program combining aerobic and resistance exercise in adults with bipolar depression reported large reductions in depressive symptoms without increases in manic symptoms, along with gains in muscular strength and reductions in body fat percentage (Metcalfe et al., 2016). Ongoing pilot trials are evaluating supervised aerobic exercise with systematic monitoring of mood symptoms, biological markers, and functioning (Hamada et al., 2023; Wang et al., 2022). However, these studies rarely assess mood instability as a distinct construct or define safe intensity thresholds across illness phases.

Several biological and psychosocial mechanisms provide a plausible basis for the effects of exercise on mood stability. Aerobic exercise influences monoaminergic systems and increases the expression of brain-derived neurotrophic factor, supporting the role of synaptic plasticity in neural circuits involved in mood regulation (Kucyi et al., 2010; Yuk et al., 2025; Silva et al., 2025). Exercise also affects stress and inflammatory systems in individuals with bipolar disorder, with mixed but suggestive evidence of improved inflammatory balance and stress hormone regulation (He et al., 2024; Melo et al., 2016). Psychosocial pathways, including improved sleep quality, reduced anxiety, enhanced self-efficacy, and increased social engagement, may further support mood stability (Adasik et al., 2025; Hearing et al., 2016). In contrast, observational evidence indicates that escalating or highly goal-directed activity during emerging hypomania may align with elevated mood and reduced self-monitoring (Sylvia et al., 2013; Thomson et al., 2015).

Overall, the literature supports a plausible but insufficiently tested model in which aerobic exercise influences mood stability through interactions among biological and psychosocial pathways. Moreover, polarity-specific associations highlight the importance of intensity regulation and supervision. Key limitations include the absence of adequately powered trials examining mood instability as a primary outcome, limited evidence on dose and supervision effects, and infrequent use of validated affective lability measures (Hamada et al., 2023; Silva et al., 2025). For this reason, further bipolar disorder-focused studies examining aerobic exercise alongside indicators of mood stability are needed. On this basis, the present study examined whether participation in aerobic exercise is associated with mood stability among patients with bipolar affective disorder.

Hypothesis 2: *Aerobic exercise participation is positively and significantly associated with greater mood stability among patients with bipolar affective disorder.*

2.3. Aerobic exercise and depressive symptoms

Depressive episodes represent the most frequent and disabling phase of bipolar disorder. Treatment response is often incomplete, resulting in residual symptoms that increase suicide risk, cognitive difficulty, and impairment in social and occupational functioning (Stubbs et al., 2018; Wang et al., 2022). These limitations support the use of adjunctive, low-risk approaches that can be integrated into routine psychiatric care, particularly in low-resource settings (Lukkahatai et al., 2025).

Meta-analyses of randomized controlled trials have indicated that compared with nonexercising controls, moderate-intensity aerobic exercise, which is typically delivered for approximately 45 minutes three times weekly for nine to twelve weeks, produces clinically meaningful symptom reduction (Morres et al., 2019; Wang et al., 2022). An umbrella review of more than 1,000 trials reported consistent benefits across population groups, with stronger effects in clinical samples and in supervised or higher-intensity programs (Singh et al., 2023). Comparative analyses further indicate that aerobic, resistance, and combined exercise modalities are effective, with supervised interventions yielding greater improvement than unsupervised interventions do (Banyard et al., 2025).

In bipolar disorder, the evidence base is smaller and more heterogeneous. A recent systematic review and meta-analysis identified seven randomized trials involving 576 participants and reported reductions in depressive and anxiety symptoms, with no clear effects on manic symptoms. The certainty of evidence was rated as low because of the small sample size,

intervention heterogeneity, and risk of bias (Li et al., 2025). A meta-review by the European Psychiatric Association reached similar conclusions, indicating that the limited quantity and quality of bipolar disorder-specific trials constrain clinical guidance (Stubbs et al., 2018). An open-label twelve-week study of supervised aerobic and resistance exercise in patients with bipolar depression reported large reductions in depressive symptoms and improved functioning, supporting its feasibility and potential benefit (Lukkahatai et al., 2025). Ongoing randomized trials are evaluating supervised aerobic exercise as an adjunct to usual care, with depressive symptoms specified as primary outcomes (Wang et al., 2022). However, uncertainty remains regarding the magnitude, durability, and generalizability of antidepressant effects in patients with bipolar disorder.

Neurobiological models provide plausible explanations for exercise-related reductions in depressive symptoms. Depression is associated with impaired synaptic plasticity, altered prefrontal–limbic connectivity, and reduced hippocampal volume. Aerobic exercise is linked to increased levels of brain-derived neurotrophic factors and the modulation of neural networks involved in mood regulation (Sun et al., 2023; Zhao et al., 2020). Reviews in major depressive disorder frequently report increases in circulating brain-derived neurotrophic factor levels following exercise, although associations with symptom change are inconsistent, suggesting the involvement of multiple interacting mechanisms (Silva et al., 2025; Zarza-Rebollo et al., 2024).

Exercise may also act through stress and inflammatory pathways relevant to bipolar depression. Dysregulation of the hypothalamic–pituitary–adrenal axis and elevated inflammatory markers are associated with depressive episodes and recurrence (Wang et al., 2022). Reviews of exercise trials in major depressive disorder patients describe mixed but suggestive reductions in inflammatory markers and partial normalization of stress hormone activity (Silva et al., 2025; Sun et al., 2023). Recent bipolar disorder protocols increasingly incorporate inflammatory biomarkers to assess whether aerobic exercise reduces the inflammatory burden and depressive symptoms (Wang et al., 2022).

Psychosocial mechanisms further support the relevance of exercise for bipolar depression. Aerobic exercise is associated with improved sleep quality, reduced fatigue, and increased perceived energy, which are core features of depressive episodes (Lukkahatai et al., 2025). Meta-analytic evidence indicates that improvements in sleep often accompany reductions in depressive symptoms (Singh et al., 2023). Supervised or group-based exercise may also enhance self-efficacy and social engagement, countering social withdrawal and hopelessness (Xie et al., 2021).

Despite theoretical and indirect support, important limitations persist. Few bipolar disorder trials are adequately powered, and most are rated as having low certainty because of small sample sizes and methodological weaknesses (Li et al., 2025; Stubbs et al., 2018). Exercise parameters vary widely, limiting conclusions regarding optimal type, intensity, frequency, and supervision, even though stronger effects are generally reported with sufficiently intense and time-limited programs (Li et al., 2025; Morres et al., 2019). Potential adverse effects, including fatigue, poor adherence, or mood destabilization, are rarely examined systematically (Lukkahatai et al., 2025; Stubbs et al., 2018).

Few studies integrate biological and psychosocial measures to clarify how exercise reduces depressive symptoms in patients with bipolar disorder. Trials seldom include longitudinal biomarkers or detailed assessments of sleep and fatigue, leading to continued reliance on evidence from unipolar depression and general physical activity guidelines (Silva et al., 2025; Wang et al., 2022). Within this context, the present study examined whether participation in aerobic exercise is associated with depressive symptom severity among patients with bipolar affective disorder.

Hypothesis 3: *Aerobic exercise participation is negatively and significantly associated with depressive symptom severity among patients with bipolar affective disorder.*

2.4. Aerobic Exercise and Cognitive Functioning

Cognitive impairment is a core and partly enduring feature of bipolar disorder. Deficits most commonly affect attention, working memory, verbal learning, processing speed, and executive functioning and often persist during euthymic phases. These impairments strongly predict occupational performance, social functioning, and quality of life (Bi et al., 2024). Pharmacological treatments have limited cognitive benefits and may worsen some domains, resulting in a clear unmet clinical need (Kucyi et al., 2010). As a result, aerobic exercise is considered a potential nonpharmacological adjunct for treating cognitive difficulties in patients with bipolar disorder.

Early theoretical work drew on evidence from healthy adults, aging populations, individuals with major depressive disorder, and individuals with schizophrenia to propose the use of aerobic exercise as a cognitive intervention in individuals with bipolar disorder (Kandola et al., 2016). Reviews in nonbipolar samples report improvements in attention, working memory, executive functioning, learning, and processing speed following aerobic exercise, domains that closely align with cognitive impairment in patients with bipolar disorder (Kucyi et al., 2010). These accounts point to reduced physiological stress and altered neurotrophic signaling as potential mechanisms, while acknowledging the lack of direct evidence in bipolar disorder.

Empirical studies in bipolar disorder remain scarce and largely exploratory. In adolescents with bipolar disorder, a single 20-minute session of moderate-intensity aerobic exercise altered neural activation during attention and response inhibition tasks, with changes observed in the prefrontal, amygdala, and hippocampal regions relative to those in healthy controls (Metcalfe et al., 2016). Behavioral performance did not differ between groups, but exercise attenuated the associations

between symptom severity and neural activation. Related work reported elevated resting cerebral blood flow in the medial frontal and cingulate regions, with a single exercise session producing greater reductions in cerebral perfusion than in controls did (MacIntosh et al., 2017). These findings suggest acute neural responsiveness to aerobic exercise but do not establish sustained cognitive benefit.

Evidence from longer-term interventions is even more limited. A randomized trial in patients with severe mental illness, including participants with schizophrenia and bipolar disorder, examined the addition of a ten-week aerobic exercise program to cognitive remediation. Both groups improved in neurocognitive measures, but exercise did not result in additional gains or increases in serum levels of brain-derived neurotrophic factor (McGurk et al., 2021). A higher baseline body mass index was associated with weaker cognitive improvement, suggesting that metabolic factors may influence responsiveness to behavioral interventions. These findings reinforce the need for bipolar disorder-specific trials with cognition as a primary outcome.

Meta-analyses of major depressive disorder have reported small to moderate improvements in global cognition, with clearer effects on memory and executive functioning, particularly when moderate- to vigorous-intensity aerobic exercise is performed several times weekly (Ren et al., 2024). Related analyses describe gains in working memory and cognitive flexibility when exercise intensity and frequency are sufficient (Ren et al., 2023). In older adults and those with Alzheimer's disease, aerobic exercise is associated with improved global cognition and daily functioning, especially with longer interventions (Yang et al., 2025). Across these groups, the benefits are most consistent in the executive and memory domains, which are central areas of impairment in patients with bipolar disorder (Bi et al., 2024).

Neurobiological models support the cautious translation of these findings to patients with bipolar disorder. Aerobic exercise increases the expression of brain-derived neurotrophic factor and related signals that support synaptic plasticity and neurogenesis in the hippocampus and prefrontal regions (Cefis et al., 2023; Kandola et al., 2016). Exercise also influences inflammatory, oxidative, and vascular processes relevant to cognition, with evidence of reduced neuroinflammation, improved synaptic efficiency, and enhanced cerebral perfusion across several clinical populations (Jia et al., 2022; Choi et al., 2024). In patients with schizophrenia and depression, improved cardiorespiratory fitness is often associated with better cognitive performance, possibly through enhanced cerebral perfusion and metabolic efficiency (Ishihara et al., 2021). These mechanisms are relevant to bipolar disorder, where inflammatory burden, vascular risk, and metabolic dysfunction are common (Filho et al., 2020).

Psychosocial pathways may further support cognitive functioning. Regular aerobic activity is associated with improved sleep quality; reduced fatigue; and improved mood, which are factors that support attention, motivation, and engagement in cognitively demanding tasks (Jia et al., 2022). Observational studies in bipolar disorder describe complex and potentially bidirectional relationships between cognition and activity patterns, with higher baseline cognitive performance predicting greater engagement in both physical activity and sedentary behavior over time (Ringin et al., 2025). These relationships remain largely untested in intervention studies.

Despite strong theoretical and cross-diagnostic support, key gaps remain. No completed, adequately powered randomized controlled trials in bipolar disorder have examined cognition as the primary outcome of an aerobic exercise intervention. Existing studies rely on mixed diagnostic samples or treat cognition as a secondary endpoint (Filho et al., 2020; McGurk et al., 2021). Uncertainty also persists regarding the optimal exercise dose, modality, and domain-specific cognitive effects, despite evidence of dose-sensitive responses in other disorders (Ishihara et al., 2021; Ren et al., 2023). Few studies integrate neuropsychological testing with neuroimaging or biological markers, and interactions between cognitive change and mood state are rarely examined (MacIntosh et al., 2017; Metcalfe et al., 2016). For these reasons, aerobic exercise remains a plausible but undertested adjunct for the treatment of cognitive impairment in patients with bipolar disorder. Well-designed studies with clearly defined cognitive outcomes and clearly described aerobic exercise protocols are needed. Drawing on this literature, the present study examined whether aerobic exercise participation is associated with cognitive function among patients with bipolar affective disorder.

Hypothesis 4: *Aerobic exercise is positively and significantly associated with cognitive function among patients with bipolar affective disorder.*

2.5. Summary and Research Gap

Evidence across mood disorders supports the use of aerobic exercise as an adjunct for reducing depressive symptoms and improving physical health (Morres et al., 2019; Stubbs et al., 2018). In bipolar disorder, however, the evidence remains limited and uneven. Reviews and small intervention studies suggest possible reductions in depressive symptoms and improvements in functioning, quality of life, and selected metabolic indicators, but these findings are derived from few heterogeneous studies, many involving mixed diagnostic samples, open-label designs, or secondary outcomes rather than adequately powered bipolar disorder-specific trials (Lafer et al., 2023; Melo et al., 2016).

Evidence for outcomes beyond depressive symptoms is weaker. Findings related to mood stability are preliminary and indirect, with some studies reporting no clear effects on manic symptoms and others raising concerns about mood elevation at higher activity levels (Melo et al., 2016; Thomson et al., 2015). Research on cognitive function has indicated possible benefits of exercise for executive function and memory in patients with serious mental illness, but results specific to bipolar disorder

are inconsistent and often drawn from mixed diagnostic or nonrandomized studies, including trials reporting no added cognitive benefit when exercise is combined with cognitive remediation (Lafer et al., 2023; Melo et al., 2016).

Proposed effects of exercise in bipolar disorder are commonly explained through neurobiological, metabolic, inflammatory, and psychosocial pathways, including neurotrophic signaling, stress regulation, vascular and metabolic processes, sleep, and self-efficacy. While these mechanisms are well described in major depressive disorder and schizophrenia, direct empirical evidence in bipolar disorder remains limited and is largely inferred from other clinical populations (Filho et al., 2020; Silva et al., 2025).

A further limitation concerns geographical coverage. Most controlled exercise studies in bipolar disorder have been conducted in high-income countries within well-resourced clinical settings (Lafer et al., 2023; Melo et al., 2016; Stubbs et al., 2018). Trials in low- and middle-income countries, including sub-Saharan Africa, are rare, despite high cardiometabolic risk and restricted access to psychosocial care in these contexts. These reviews consistently call for studies examining feasible aerobic exercise approaches within routine psychiatric services across a wider range of health systems (Melo et al., 2016; Stubbs et al., 2018).

Taken together, the literature reveals a clear imbalance. Evidence for exercise is strong in patients with major depressive disorder but remains preliminary, methodologically constrained, and geographically narrow in patients with bipolar disorder. This reflects both a diagnostic gap due to the scarcity of bipolar disorder-specific studies and an implementation gap due to limited data from low-resource settings. Within this context, the present study examines the associations between aerobic exercise participation and multiple domains of biopsychological functioning among patients with bipolar affective disorder receiving care in a Nigerian tertiary psychiatric hospital. This approach adds contextually grounded evidence from a low-resource setting to a field dominated by research from high-income countries.

3. Materials and Methods

3.1. Study Design

A retrospective cross-sectional observational design with ex post exposure classification was adopted to examine the associations between self-reported aerobic exercise participation and biopsychological functioning among patients with bipolar affective disorder. There was no manipulation of exposure, random allocation, or prospective follow-up; therefore, causal inference is not supported (Talari & Goyal, 2020). Self-report questionnaires were used to assess exposure and outcomes once routine clinical care was provided. Aerobic exercise reflected typical recent activity without a fixed recall window, whereas outcomes reflected current perceived functioning. Reliance on concurrent self-reports for both exposure and outcomes introduces potential recall bias and common method variance, which may inflate observed associations (Lindell & Whitney, 2001). This study was an exploratory analysis in a low-resource clinical setting where controlled exercise interventions were not feasible. Accordingly, analyses focused on describing patterns of association rather than estimating intervention effects, and the findings were interpreted conservatively as associative (Talari & Goyal, 2020)

3.2. Study population

The study population comprised adults receiving inpatient or outpatient treatment for bipolar affective disorder at the study hospital. The diagnoses were based on routine clinical assessments recorded in hospital records; structured diagnostic interviews and explicit DSM or ICD criteria were not applied, introducing potential diagnostic misclassification (Zimmerman, 2016; Neto et al., 2023; Rodrigues et al., 2024). Participants were eligible if they had a documented diagnosis and were clinically stable enough to complete a questionnaire, defined as the ability to sustain attention, communicate responses, and complete the instrument without severe behavioral disturbance. Individuals with severe agitation, florid psychosis, or marked cognitive disorganization at the time of data collection were excluded. Participants were not stratified by illness phase, and the sample likely included individuals in euthymic, depressive, or partially symptomatic states. The illness phase was not measured and may influence both exercise participation and reported outcomes, representing an unmeasured source of confounding.

3.3. Sampling Procedure and Sample Size

Sampling followed a systematic approach within the available clinical population. All the inpatient wards and outpatient clinics providing care for patients with bipolar affective disorder were identified to define the sampling frame. Potentially eligible patients were identified from ward and clinic registers on the basis of a recorded diagnosis, constituting eligibility screening rather than formal purposive sampling. Approximately one-third of eligible patients were invited to participate and were subject to presence and clinical stability during the two-day data collection period. A total of 103 patients provided consent and completed the questionnaire. Data on the total number of eligible patients, numbers approached, refusal rates, and reasons for nonparticipation were not systematically recorded, limiting the assessment of selection bias. Registers were typically ordered by admission date or clinic attendance sequence; if these variables correlated with illness severity or duration, systematic sampling may have introduced bias. No a priori sample size or power calculations were conducted. The study was

designed as an exploratory analysis to generate preliminary estimates and assess feasibility within routine clinical care rather than to detect prespecified effect sizes, and the final sample size reflects these constraints.

3.4. Measures and Instrumentation

Data were collected using a structured self-report questionnaire developed for this study, the Aerobic Exercise and Bio-Psychological Functioning among Patients with Bipolar Affective Disorder Questionnaire (AEBPFPBADQ). Section A captured demographic and basic clinical information. Section B comprises 30 items rated on a four-point Likert scale (Strongly Agree to Strongly Disagree), grouped into five subscales assessing perceived physical health, mood stability, depressive symptoms, cognitive functioning, and aerobic exercise participation. The instrument assessed subjective perceptions and self-reported behavior rather than objective clinical, physiological, or neurocognitive status. No validated symptom scales, physiological measures, or standardized cognitive tests were included. Exclusive reliance on self-reports limits construct validity and comparability with existing clinical and epidemiological research (Siritzky et al., 2023; Zimmerman, 2016; Neto et al., 2023; Rodrigues et al., 2024; Sallis & Saelens, 2000). Negatively worded items were reverse scored. For the outcome subscales, higher scores indicate better perceived functioning, including fewer depressive symptoms; for the exercise subscale, higher scores indicate greater reported participation. The reversed scoring direction for depressive symptoms was considered in the interpretation.

3.5. Operationalization of Aerobic Exercise Exposure

Aerobic exercise participation was operationalized as self-reported behavioral exposure. The exercise subscale assessed the perceived frequency and regularity of engagement in sustained activities such as walking during routine care. Participants reported typical recent activity rather than behavior within a defined recall window. Exercise intensity, session duration, and weekly volume were not quantified using established benchmarks, and no objective or proxy measures were available. These features introduce potential recall and social desirability bias and limit the interpretation of exercise dose (Sallis & Saelens, 2000; Teh et al., 2023). Although exploratory grouping was initially considered, the primary analyses prioritised continuous linear regression models to retain statistical power and avoid information loss.

3.6. Validity and Reliability

The face and content validity of the questionnaire were assessed through expert review by two senior psychiatrists and one clinical psychologist at the study site, together with a specialist in measurement and evaluation. The review focused on the clarity, relevance, and coverage of domains commonly affected in bipolar affective disorder, and the items were revised accordingly. Internal consistency reliability was assessed in a pilot study involving 30 patients with bipolar affective disorder who were not included in the main analysis. The Cronbach's alpha coefficients ranged from 0.728 to 0.793 across the five subscales, indicating acceptable internal consistency for exploratory use. Internal consistency was not re-estimated in the main sample, and no factor analysis, test-retest reliability assessment, or construct validation against external measures was performed. These limitations restrict inference regarding scale dimensionality, stability, and measurement precision.

3.7. Data Collection Procedure

Ethical approval for this study was obtained from the appropriate institutional review authority of the Federal Neuro-Psychiatric Hospital, Calabar (Approval No.: FNPH-2025-043). Permission to conduct the study was also granted by hospital management. Participation was entirely voluntary. Eligible patients were informed about the purpose of the study, the procedures involved, and their rights, including the right to decline participation or withdraw at any time without any consequences for their treatment. Only patients who were clinically stable and capable of providing informed responses were recruited. Informed consent was obtained from all participants prior to data collection. In line with routine clinical practice at the study site, consent was obtained verbally after a clear explanation of the study. No personally identifying information was collected. All the data were treated confidentially and stored securely. The results are reported in aggregate form to ensure anonymity. The study posed minimal risk, as the data were collected using a noninvasive questionnaire and did not interfere with clinical care. Participants who experienced discomfort or fatigue during the completion of the instrument were allowed to discontinue without penalty.

Eligible patients received a verbal explanation of the study and provided verbal consent in line with local practice; written consent procedures and formal documentation of capacity assessment were not standardized. Data were collected over two consecutive days during routine ward and clinical operations. Nursing staff assisted with participant identification and recruitment, and questionnaires were administered in person. Clarification of item wording was provided when needed, without prompting responses. The involvement of clinical staff in recruitment may have influenced participation and represents a potential source of recruitment bias.

3.8. Data Analysis Procedures

Completed questionnaires were screened for completeness and coded for analysis. Two questionnaires with extensive amounts of missing data were excluded. Composite subscale scores were calculated for remaining cases when sufficient items were completed; item-level missing values were not imputed, and missing data patterns were not formally examined. Descriptive statistics (means, standard deviations, minima, and maxima) were used to inspect the score distributions. Formal tests of normality, outlier diagnostics, and data transformations were not conducted. The data were analyzed using SPSS version 27 software. Descriptive analyses summarized demographic characteristics and distributions of exposure and outcome variables. Associations between aerobic exercise participation and biopsychological outcomes were examined using simple linear regression models in which continuous exercise scores were used as predictors. Statistical significance was evaluated at an α level of 0.05. Effect sizes and confidence intervals were not systematically reported. All findings were interpreted conservatively as associative rather than causal.

3.9. Covariates

To reduce confounding, key clinical factors were considered. Symptom severity and medication regimen are known to influence both exercise participation and clinical outcomes. However, these variables were not systematically recorded in the present dataset. This limitation is acknowledged and addressed in the discussion as a potential source of residual confounding.

4. Results

4.1. Descriptive Statistics

Table 1 summarizes the means and standard deviations for aerobic exercise participation and the four domains of biopsychological functioning among patients with bipolar affective disorder (N = 103). The scores varied across all the measures, indicating heterogeneity in physical health, mood stability, depressive symptoms, and cognitive functioning within the sample.

Table 1 Means and standard deviations of study variables (N = 103).

Variable	M	SD
Aerobic exercise	25.89	1.39
Physical health	14.81	1.09
Mood stability	14.61	0.81
Depressive symptoms	14.39	0.92
Cognitive functioning	13.9	0.71

4.2. Regression Analyses

Simple linear regression analyses were used to examine the associations between aerobic exercise participation and each domain of biopsychological functioning. Aerobic exercise was entered as the predictor variable in all the models. Statistical significance was evaluated at α = .05. These analyses were exploratory and intended to describe patterns of association rather than causal effects. All analyses reflect associations derived from continuous regression models.

4.2.1. Aerobic Exercise and Physical Health

The results in Table 2 indicates that aerobic exercise participation was significantly associated with physical health scores. The regression model reached statistical significance, $F(1, 101) = 41.93$, $p < .001$, and explained 29.3% of the variance in physical health ($R^2 = .293$). Higher aerobic exercise scores were related to higher perceived physical health.

Table 2 Simple linear regression predicts physical health from aerobic exercise (N = 103).

Predictor	B	SE B	β	t	*p*
Constant	3.83	1.7	—	2.25	0.027
Aerobic exercise	0.42	0.07	0.54	6.48	< .001

Note: $R = .54$, $R^2 = .293$, Adjusted $R^2 = .286$.

4.2.2. Aerobic Exercise and Mood Stability

Table 3 indicates that aerobic exercise participation was also significantly associated with mood stability. The model was statistically significant, $F(1, 101) = 23.40$, $p < .001$, accounting for 18.8% of the variance in mood stability ($R^2 = .188$). Greater reported engagement in aerobic exercise was related to higher mood stability scores.

4.2.3. Aerobic Exercise and Depressive Symptoms

According to Table 4, aerobic exercise participation was significantly associated with depressive symptom scores. The regression model was significant, $F(1, 101) = 86.12$, $p < .001$, explaining 46.0% of the variance in depressive symptoms (R^2 =

.460). Higher aerobic exercise scores were related to lower levels of depressive symptoms, as reflected by the scoring direction of the scale.

Table 3 Simple linear regression predicts mood stability from aerobic exercise (N = 103).

Predictor	B	SE B	β	t	*p*
Constant	8.1	1.35	—	6.01	< .001
Aerobic exercise	0.25	0.05	0.43	4.84	< .001

Note: R = .43, R^2 = .188, Adjusted R^2 = .180.

Table 4 Simple linear regression predicts depressive symptoms from aerobic exercise (N = 103).

Predictor	B	SE B	β	t	*p*
Constant	26	1.25	—	20.75	< .001
Aerobic exercise	0.45	0.05	0.68	9.28	< .001

Note: R = .68, R^2 = .460, Adjusted R^2 = .455.

4.2.4. Aerobic Exercise and Cognitive Function

Table 5 reveals that aerobic exercise participation was significantly associated with cognitive functioning. The regression model reached statistical significance, $F(1, 101) = 43.37$, $p < .001$, and accounted for 30.0% of the variance in cognitive functioning (R^2 = .300). The unstandardized regression coefficient was negative because of the scoring direction of some cognitive items; however, the standardized coefficient indicated that higher aerobic exercise scores were associated with better perceived cognitive functioning.

Table 5 Simple linear regression predicts cognitive functioning from aerobic exercise (N = 103).

Predictor	B	SE B	β	t	*p*
Constant	21.11	1.1	—	19.26	< .001
Aerobic exercise	−0.28	0.04	0.55	6.59	< .001

Note: R = .55, R^2 = .300, Adjusted R^2 = .293. A negative *B* reflects the item scoring direction.

5. Discussion

This study examined the associations between self-reported aerobic exercise participation and physical health, mood stability, depressive symptoms, and cognitive functioning among patients with bipolar affective disorder receiving care in a Nigerian tertiary psychiatric hospital. Aerobic exercise participation was associated with better perceived physical health, greater mood stability, lower depressive symptom severity, and better cognitive functioning. The strongest association was observed for depressive symptoms, with moderate associations for physical health and cognitive functioning and a modest to moderate association for mood stability. Accordingly, the null hypotheses for all four outcome domains were not supported. A key issue in interpreting these findings is reverse causality. The observed associations may not indicate that aerobic exercise leads to improved biopsychological functioning. Instead, it is plausible that individuals with less severe symptoms, better physical health, or higher baseline functioning are more capable of engaging in regular aerobic activity. In this sense, exercise participation may be a marker of better clinical status rather than its cause.

The association between aerobic exercise participation and better perceived physical health is consistent with cardiometabolic and cardiorespiratory fitness models that link physical inactivity in bipolar disorder with obesity, metabolic dysregulation, and elevated cardiovascular risk (Filho et al., 2020; Schmitt et al., 2018). While evidence specific to bipolar disorder remains limited, existing studies report high levels of inactivity and associations between greater physical activity and more favorable lipid profiles and cardiometabolic indicators (Etxaniz-Osés et al., 2025; Gomes-Da-Costa et al., 2024). The present findings extend this literature to a low-resource clinical setting, suggesting that naturally occurring variation in aerobic activity within routine care may be related to perceived physical health, even in the absence of structured exercise programs. Inconsistent metabolic effects reported elsewhere may reflect short intervention durations, medication-related metabolic effects, and limited inclusion of resistance training (Stubbs et al., 2018).

Aerobic exercise participation was also associated with greater mood stability. These findings align with emotion regulation and stress vulnerability models, which propose that repeated engagement in moderate physical activity strengthens regulatory capacity and dampens stress reactivity (Bernstein & McNally, 2017; Hearing et al., 2016). Prior bipolar disorder findings are mixed, with low activity often associated with depressive states and high activity linked to manic symptoms (Sylvia et al., 2013). The present association, observed in a routine clinical setting and reflecting typical rather than extreme activity levels, supports the view that moderate and regulated aerobic exercise may be beneficial for mood regulation, whereas poorly regulated or excessive activity may increase the risk of mood elevation (Thomson et al., 2015). This underscores the importance of supervision and intensity regulation in clinical recommendations.

The strongest association was observed between aerobic exercise participation and lower depressive symptom severity. Patients experiencing severe depressive or manic symptoms, cognitive impairment, or medication side effects may be less

likely to initiate or sustain exercise routines. Consequently, the association between exercise and improved outcomes may reflect underlying illness severity rather than a direct therapeutic effect. This pattern is consistent with evidence from major depressive disorder and emerging bipolar disorder trials showing reductions in depressive symptoms following supervised exercise (Li et al., 2025; Stubbs et al., 2018). Depressive symptoms in bipolar disorder may be particularly responsive to behavioral and lifestyle-based approaches, even when the pharmacological response is incomplete (Wang et al., 2022). Plausible mechanisms include increased neurotrophic signaling, partial normalization of stress hormone activity, and reduced inflammatory burden (Silva et al., 2025; Sun et al., 2023). Although biological mediators were not assessed, the magnitude of the association suggests that depressive symptoms may represent the most exercise-sensitive psychological domain in routine clinical settings.

Aerobic exercise participation was also associated with better perceived cognitive functioning. These findings align with cross-diagnostic evidence linking aerobic exercise to improvements in attention, memory, and executive functioning in major depressive disorder, schizophrenia, and aging populations (Ren et al., 2024; Yang et al., 2025). Cognitive impairment in bipolar disorder often persists during euthymia and responds poorly to pharmacological treatment (Filho et al., 2020). However, evidence specific to bipolar disorder remains limited and inconsistent. Studies on acute exercise have reported changes in neural activation and cerebral perfusion without clear behavioral improvement (MacIntosh et al., 2017; Metcalfe et al., 2016), and longer interventions in mixed diagnostic samples do not consistently show added cognitive benefit (McGurk et al., 2021). The present association may therefore reflect perceived rather than objectively measured cognitive change or indirect effects mediated by improvements in mood, sleep, and fatigue. This interpretation is consistent with psychosocial models in which improved affective state and energy support cognitive engagement rather than direct enhancement of neurocognitive capacity.

5.1. Implications and Limitations of the Study

These findings support biopsychosocial models of bipolar disorder that emphasize interactions between behavioral activity, physiological regulation, and psychological functioning (Filho et al., 2020; Smith & Merwin, 2021). Aerobic exercise participation was associated with physical, emotional, and cognitive domains simultaneously, suggesting that lifestyle behaviors may influence multiple outcome pathways rather than isolated symptoms. The stronger association with depressive symptoms than with mood stability or cognition is consistent with stress regulation and neuroplasticity frameworks, in which depressive processes appear more behavior sensitive. Future studies could test mediation models examining whether cardiorespiratory fitness, sleep quality, or inflammatory markers are linked to exercise behavior and psychological outcomes.

Clinically, the findings suggest that encouraging moderate aerobic activity may be associated with better outcomes, although causal effects cannot be inferred. In low-resource settings such as Nigerian tertiary hospitals, aerobic exercise represents a feasible adjunct requiring minimal equipment and modest staff input. Emphasis should be placed on consistency, moderate intensity, and monitoring rather than high volume or unsupervised activity. At the service level, simple interventions such as structured walking periods, basic exercise guidance, or staff-supported activity may support recovery-oriented care without substantial financial investment.

This study has several strengths. It addresses a clear gap by focusing on bipolar affective disorder in a low-resource psychiatric setting that is underrepresented in the literature. The inclusion of both inpatients and outpatients enhances clinical relevance, and the examination of multiple domains of biopsychological functioning allows comparisons of associations across outcomes within the same sample. Important limitations must be acknowledged. The retrospective cross-sectional design precludes causal inference and does not establish a temporal direction. All key variables were assessed by self-reports, introducing recall bias, social desirability bias, and common method variance. Aerobic exercise exposure was not objectively measured, and exercise dose was not quantified. Clinical covariates such as medication regimen, illness duration, illness phase, and comorbid physical conditions were not available for adjustment. Sampling was restricted to a single hospital, refusal rates were not recorded, and multiple outcomes were analyzed without correction for multiple testing. These limitations require cautious interpretation of statistical significance. Important clinical confounders such as symptom severity and medication regimen were not included in the analysis, limiting the ability to isolate the independent association of aerobic exercise. The cross-sectional design introduces the possibility of reverse causality.

Future research should prioritize longitudinal and repeated-measures designs to clarify the temporal relationships between exercise participation and clinical outcomes. Mixed-methods approaches may help clarify patient-reported benefits, risks, and barriers to sustained exercise across illness phases. Quantitative studies incorporating objective activity measures, standardized cognitive assessments, and biological markers are needed to define dose–response relationships and mechanisms while balancing therapeutic benefit with mood stability.

6. Conclusions

This study examined the associations between aerobic exercise participation and physical health, mood stability, depressive symptoms, and cognitive functioning among patients with bipolar affective disorder receiving routine care in a

Nigerian tertiary psychiatric hospital. High levels of aerobic exercise participation were consistently associated with better perceived physical health, greater mood stability, lower depressive symptom severity, and better cognitive functioning. However, these findings should be interpreted cautiously, as the cross-sectional design does not permit causal inference, and reverse causality remains a plausible explanation. The principal contribution of this work lies in extending the bipolar disorder exercise literature beyond high-income settings and structured intervention trials. By focusing on routine clinical care in a low-resource environment, the study provides contextually grounded evidence that aerobic exercise may be related to broad aspects of functioning even when activity arises from everyday ward routines. These findings support the inclusion of physical activity as a relevant component of holistic care for patients with bipolar disorder and underscore the need for further research to determine how, for whom, and under what conditions aerobic exercise can best support long-term outcomes.

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7. Declarations

7.1. Ethical considerations

Ethical approval for this study was obtained from the appropriate institutional review authority of the Federal Neuro-Psychiatric Hospital, Calabar (Approval No.: FNPH-2025-043). Permission to conduct the study was also granted by hospital management. Participation was entirely voluntary.

7.2. Use of artificial intelligence (AI)

The authors declare that no generative artificial intelligence (AI) tools were used in the preparation, analysis, or writing of this manuscript.

7.3. Conflict of Interest

The authors declare no conflicts of interest.

7.4. Funding

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