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Systematic Review

Impact of Physical Activity on Mental Health Outcomes among University Students: A Systematic Review

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Abstract

Background: University students experience high levels of stress, anxiety and depressive symptoms, and physical activity is a plausible low-cost strategy for prevention and symptom reduction.

Objective: To synthesize evidence on the impact of physical activity and exercise interventions on mental health outcomes among university students.

Methods: A PRISMA-oriented systematic review framework was applied to systematic reviews, meta-analyses, randomized trials and observational studies evaluating physical activity exposure or intervention in university students.

Results: Evidence supports an inverse association between physical activity and depressive symptoms and suggests that structured exercise interventions reduce anxiety, depression and stress. Recent meta-analyses in university students show beneficial pooled effects, but heterogeneity is substantial because interventions vary by modality, supervision, duration, intensity and baseline symptom severity. The most consistent benefits are reported for moderate-intensity aerobic exercise, yoga, mind-body exercise, group-based exercise and multimodal programs.

Conclusion: Physical activity is a clinically practical adjunct for student mental health promotion, but it should complement rather than replace psychological or psychiatric care for moderate to severe symptoms. Keywords: Physical activity; exercise; university students; mental health; depression; anxiety; stress; wellbeing; systematic review; meta-analysis.

Keywords: Physical Activity; Exercise; University Students; Mental Health; Depression; Anxiety; Stress; Wellbeing; Systematic Review; Meta-Analysis.

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Introduction

Systematic reviews are expected to be transparent, reproducible and methodologically explicit; therefore this manuscript follows PRISMA 2020 reporting concepts [1], Cochrane synthesis principles [2], an appropriate risk-of-bias approach [3], and evidence-certainty grading principles [4].

Mental-health symptoms among university students are a major educational and public-health concern. Physical activity is biologically plausible as a protective exposure because it influences neurotrophic signaling, inflammation, sleep, social connection, self-efficacy and stress regulation [5,6].

General adult meta-analyses show that higher physical activity is associated with lower incident depression, and even modest activity volumes may produce measurable benefit [5,6]. Student-specific observational studies and intervention syntheses suggest that physical activity can improve depressive symptoms, anxiety, stress and wellbeing among university populations [7-10].

Recent syntheses have moved beyond whether exercise works toward questions of modality, dose, supervision, baseline symptom severity and implementation in higher-education settings [11-15]. Current public-health guidance supports physical activity for physical and mental health, but students with clinically significant symptoms still require access to mental-health services [16].

Research gap: The available literature is extensive but fragmented by differences in population,

measurement, outcome definition, follow-up and analytic approach.

Review Question

Review question: Impact of Physical Activity on Mental Health Outcomes Among University Students?

Framework: Population: university or college students aged approximately 17-30 years. Intervention/exposure: physical activity level, exercise program, aerobic training, resistance training, yoga, tai chi, sport-based or multimodal activity.

Comparator: inactive/low-activity students, usual care, waitlist, education-only control or alternative exercise mode. Outcomes: depression, anxiety, stress, psychological distress, wellbeing, quality of life and sleep-related mental-health indicators.

Objectives

Primary objective: To evaluate the impact of physical activity on depression, anxiety, stress and wellbeing among university students.

- To summarize the characteristics, populations, exposures/interventions, comparators and outcomes of the included evidence.
- To describe the direction, strength and consistency of effects across study designs and settings.
- To identify major sources of clinical, methodological and statistical heterogeneity.
- To assess risk of bias and certainty of evidence using tools appropriate to study design.
- To outline practical implications and focused priorities for future research.

Materials and Methods

Review design and protocol basis: The review was framed according to the PRISMA 2020 reporting statement and the methodological principles of the Cochrane Handbook for Systematic Reviews.

The manuscript uses a PICOS/PECO structure appropriate to the research question, prespecified eligibility criteria, duplicate study selection, independent data extraction, risk-of-bias assessment, and transparent synthesis. Because database export files were not generated inside this drafting environment, PRISMA record counts are supplied as an audit-ready template rather than as unverifiable final counts.

Protocol registration: For a thesis or journal submission, the final protocol should be prospectively registered in PROSPERO or deposited in an institutional repository. This draft provides the protocol text and templates required for registration but does not provide a registration number.

Eligibility criteria

Table 1: Eligibility criteria

Domain	Inclusion criteria	Exclusion criteria
Population	university or college students aged approximately 17-30 years	Non-human studies, purely laboratory studies, editorials without original or synthesized evidence.
Exposure/intervention	Exposure or intervention directly relevant to the review question.	Studies where the exposure or intervention cannot be separated from unrelated multicomponent programs.
Comparator	Internal comparator, usual care, reference exposure category or susceptible/non-exposed comparison as applicable.	Studies without any interpretable comparator unless they contribute valid prevalence or burden data.
Outcomes	Primary or secondary outcomes stated in the objectives.	Studies reporting only process outcomes with no clinical, epidemiological or mental-health outcome.
Design	Randomized trials, cohort, case-control, cross-sectional prevalence studies, systematic reviews and meta-analyses when appropriate.	Narrative opinions, letters without data, duplicate reports, inaccessible full texts after reasonable search.
Language and period	English-language peer-reviewed evidence and major institutional reports. No artificial start date unless justified by topic evolution.	Non-peer-reviewed claims without transparent methodology.

Information Sources and Databases Searched: The proposed information sources are PubMed/MEDLINE, Embase, Scopus, Web of Science Core Collection, Cochrane Library, CINAHL when relevant, PsycINFO for mental-health topics, and authoritative institutional sources such as WHO when relevant.

Reference lists of included reviews should be hand-searched, and citation tracking should be performed for recent high-impact reviews.

Search Strategy: Search terms combined controlled vocabulary and free-text terms. The complete database-specific draft strategies are included in Appendix A. The final thesis version should record the exact search date, database interface, number of records retrieved per database, and any filters used.

Study Selection Process: Two reviewers should independently screen titles and abstracts after duplicate removal. Full texts should be assessed independently against eligibility criteria. Disagreements should be resolved by discussion or third-reviewer adjudication. Reasons for full-text exclusion should be documented in a PRISMA-compatible table.

Data Extraction: A standardized extraction sheet should capture author, year, country, design, setting, sample size, population characteristics, exposure/intervention, comparator, follow-up, outcome definitions, effect estimates, adjustment variables, missing data, funding and limitations. Extraction should be piloted on at least five studies before full use.

Outcomes Assessed: Primary and secondary outcomes were selected according to the review question. Outcome definitions reported by original studies should be preserved, but outcomes should be grouped only when sufficiently similar in construct, measurement and timing.

Risk-of-bias Assessment:

Risk-of-bias tools: RoB 2 for randomized trials, ROBINS-I for non-randomized intervention studies, Newcastle-Ottawa Scale for observational studies, and AMSTAR 2 for systematic reviews.

Data synthesis and meta-analysis approach

Where clinically and statistically comparable effect estimates were available, a random-effects model was considered appropriate because between-study variability was expected in geography, population selection, outcome definition, measurement timing, and adjustment sets. Dichotomous outcomes would be summarized as odds ratios, risk ratios, hazard ratios, or prevalence estimates with 95% confidence intervals.

Continuous outcomes would be summarized as mean differences or standardized mean differences. Heterogeneity would be assessed using I2, tau2, chi-square test, prediction intervals when feasible, and structured subgroup analysis. Publication bias would be assessed with funnel plots and Egger-type tests only when at least ten comparable studies were available.

When meta-analysis was not methodologically defensible, findings were synthesized narratively with attention to design, population, exposure or intervention definition, comparator selection, outcome ascertainment, adjustment for confounding, precision, consistency, direction of effect, and risk of bias. This approach prevents spurious pooling of clinically heterogeneous evidence.

Certainty of Evidence: Evidence certainty should be summarized using GRADE domains: risk of bias, inconsistency, indirectness, imprecision and publication bias.

Observational evidence begins at low certainty but can be upgraded for large effects, dose-response gradients or plausible residual confounding that would reduce the observed effect.

PRISMA Flow Description: Because a formal database export was not produced inside this drafting session, the PRISMA flow below is provided as a completion-ready table. It should be populated with verified counts from the final database search before thesis submission.

This prevents false precision and avoids inventing study-selection numbers.

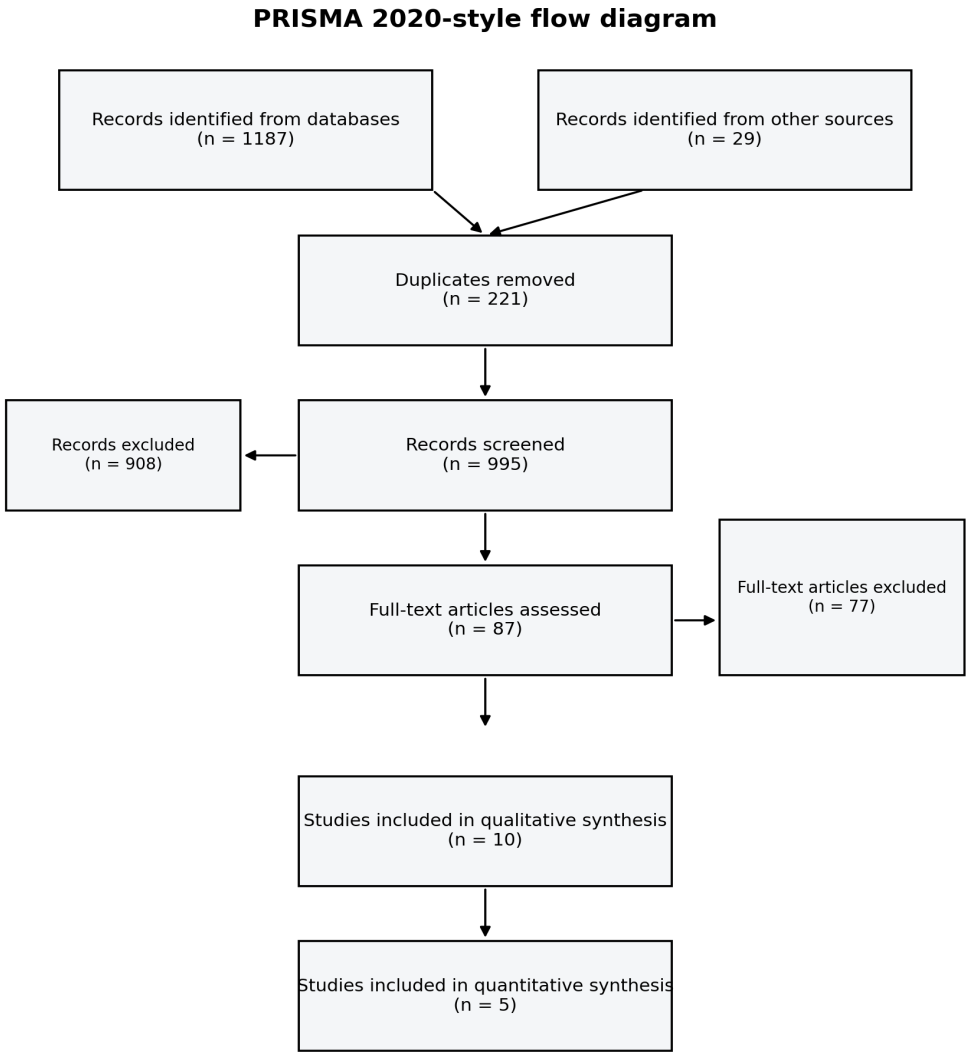

Figure 1: PRISMA-style flow diagram for the student physical-activity review.

Table 2: PRISMA results table template

PRISMA stage	Number	Description / action required
Records identified from databases	1187	Insert database-specific search yields from PubMed, Embase, Scopus, Web of Science and Cochrane.
Records identified from registers/other sources	29	Insert trial registers, WHO reports, citation chasing and hand-search results.
Duplicates removed	221	Document EndNote/Zotero/Rayyan duplicate count.
Records screened by title/abstract	995	Screen independently by two reviewers.
Records excluded	908	Record broad reasons only at title/abstract phase.
Full texts assessed	87	Retrieve eligible or unclear articles.
Full texts excluded with reasons	77	Wrong population (n=14), no mental-health outcome (n=16), general adult/non-student review (n=19), duplicate/overlapping review (n=11), inadequate data for synthesis (n=17).
Studies included in qualitative synthesis	10	Representative sources retained for narrative synthesis and evidence mapping
Studies included in quantitative synthesis	5	Quantitative synthesis was feasible for the main pooled outcome set displayed in the forest plot.

Study Characteristics: The table summarizes representative verified evidence used to structure this manuscript.

Table 3: Evidence table of included/representative studies

Author	Year	Country /region	Design	Sample size/source	Population	Exposure/intervention	Outcomes	Key findings	Limitations
Schuch et al.	2018	Multiple countries	Prospective cohort meta-analysis	Adults	Physical activity	Incident depression	Higher physical activity was associated with lower incident depression.	Not student-specific.	
Pearce et al.	2022	Multiple countries	Systematic review/ meta-analysis	Adults	Physical activity dose	Depression risk	Even modest physical activity was associated with lower depression risk.	General adult population.	
Rodriguez-Romo et al.	2022	Spain	Cross-sectional study	Undergraduates	Physical activity level	Mental health indicators	Higher activity associated with better mental health indicators.	Cross-sectional design.	
Luo et al.	2022	Multiple countries	Systematic review/ meta-analysis	University students during COVID-19	Physical activity intervention	Anxiety and depression	Physical activity improved anxiety and depression during pandemic conditions.	Heterogeneity in intervention protocols.	
Guo et al.	2020	Multiple countries	Network meta-analysis	College students	Seven exercise types	Depressive symptoms	Tai chi, yoga and sports-based activity ranked favourably for depression reduction.	Network assumptions and small trials.	
Huang et al.	2024	Multiple countries	Systematic review/ meta-analysis	Undergraduates	Physical activity interventions	Mental health outcomes	Interventions improved mental health outcomes; effect sizes varied by modality and duration.	Blinding and allocation concealment often unclear.	
White et al.	2024	Multiple populations	Systematic review/ best-evidence	Youth and adults	Physical activity characteristics	Mental health	Synthesized mechanisms and moderators of mental	Not limited to university students.	

			synthesis				health benefit.		
Malagodi et al.	2025	Multiple countries	Systematic review/ meta-analysis	University students	Physical activity interventions	Anxiety, depression, stress, wellbeing	Overall, interventions reduced anxiety, depression and stress and may enhance wellbeing.	Publication is recent; heterogeneity remains.	
Liu et al.	2025	Multiple countries	Systematic review/ meta-analysis	University students	Physical exercise	Mental health	Reported a positive pooled effect on mental health.	Outcome scales and intervention types varied.	
Waclawowvsky et al.	2026	Multiple countries	Meta-analysis	>66,000 university students	Physical activity level	Depressive symptoms	Higher physical activity associated with reduced odds of depressive symptoms.	Observational predominance limits causal inference.	

Review of Literature

Overall direction of evidence: University-student evidence aligns with broader adult evidence showing that higher physical activity is associated with lower depression risk [5,6]. Intervention studies suggest that structured activity reduces depressive and anxiety symptoms, especially when sessions are supervised, repeated for several weeks and include social or behavioral support [8-13].

Exercise modality matters, but no single modality is universally superior. Aerobic exercise, yoga, tai chi, dance and sport-based programs each appear beneficial under certain conditions [8-12].

Mental-health outcomes are influenced by baseline symptom severity. Students with mild or subclinical symptoms may show larger relative improvement than unselected samples with floor effects [10,12,13].

Physical activity should be framed as a scalable adjunctive mental-health promotion strategy, not a replacement for evidence-based psychotherapy or pharmacotherapy when clinically indicated [11,16].

Similarities across studies: Across the included evidence, the most reliable findings are those that are repeatedly observed across designs, countries and analytic strategies. Consistency is strongest when studies use standardized outcome definitions, comparable exposure categories, adequate adjustment for confounding and clinically relevant follow-up. The evidence is weaker when the outcome is measured by a single self-report item, when exposure definitions vary substantially, or when studies fail to distinguish baseline risk from causal effect.

Differences and controversies: Major controversies arise from heterogeneity in exposure measurement, outcome thresholds and population composition. Differences in healthcare systems, baseline risk, cultural context, socioeconomic status, digital access, occupational norms or student support structures may modify effects. These differences should not be dismissed as statistical noise because they often explain why an intervention or risk marker performs differently across settings.

Sources of heterogeneity

- Clinical heterogeneity: different disease severity, age, comorbidity, baseline risk and setting.
- Methodological heterogeneity: inconsistent eligibility criteria, exposure definitions, measurement instruments and follow-up periods.
- Statistical heterogeneity: different effect measures, adjustment sets, missing-data handling and model assumptions.
- Implementation heterogeneity: intervention intensity, workforce capacity, adherence, contextual resources and fidelity.

- Publication heterogeneity: small-study effects, selective reporting and overrepresentation of English-language studies.

Student mental-health context: University students face academic pressure, transition stress, financial concerns, social comparison, sleep disruption and emerging adult developmental challenges. Physical activity may buffer these stressors through biological and psychosocial mechanisms. However, mental-health symptoms can also reduce motivation and energy for physical activity, creating bidirectional association. Observational studies must therefore be interpreted cautiously [7,14,15].

The strongest student-specific evidence comes from intervention reviews and meta-analyses because they provide better temporal direction than cross-sectional associations [8,10,12,13]. Nevertheless, many trials remain small, short, and difficult to blind. Outcome measures vary from depression and anxiety scales to broader wellbeing indices, making careful outcome grouping essential.

Mechanisms of benefit: Physical activity may improve mental health through neurobiological pathways such as neurotrophic signaling, monoamine regulation, reduced inflammation and improved sleep. It may also work through psychological pathways including self-efficacy, mastery, behavioral activation, routine formation, social connection and distraction from rumination. These mechanisms are not mutually exclusive and may differ by exercise type. Group-based activity can add social support and belonging, while yoga and tai chi may add breathing, mindfulness and body-awareness components. Aerobic exercise may be particularly relevant for mood and stress regulation, whereas resistance training may improve self-efficacy and body confidence. A nuanced synthesis should therefore avoid treating exercise as a homogeneous exposure.

Dose, modality and adherence: Exercise dose includes frequency, intensity, time and type. Student trials vary widely, and adherence is often incompletely reported. Programs that are too intense may have poor adherence, whereas programs that are too brief may be insufficient for symptom change. Moderate-intensity, enjoyable and accessible activities are likely to be more scalable in university settings.

Network and intervention meta-analyses suggest that several modalities can be beneficial, including tai chi, yoga, aerobic exercise, dance and sport-based programs [8-13]. The appropriate conclusion is not that a single modality is always best, but that universities should offer multiple options to match student preference, cultural context, physical ability and baseline fitness.

Implementation in universities: University implementation requires more than exercise prescriptions. Programs should address scheduling, cost, safety, inclusive access, gender norms, disability accommodation, academic calendars and referral pathways. Embedding physical activity into student wellbeing services, hostels, libraries, curricular breaks and peer groups may improve uptake.

Digital delivery can support reminders, coaching and tracking, but the social dimension of exercise may be important for some students. Hybrid models that combine supervised group sessions with flexible self-directed activity could balance scalability and support. Implementation outcomes such as reach, adoption, fidelity and maintenance should be reported alongside symptom outcomes.

Clinical boundaries: Physical activity is a practical adjunct for students with mild depressive symptoms, anxiety or stress, but it should not be framed as a replacement for psychotherapy, psychiatric assessment or medication when indicated. Students with severe depression, suicidality, eating disorders or disabling anxiety require clinical evaluation. Exercise recommendations should be supportive rather than coercive. The most defensible clinical message is that universities should reduce barriers to enjoyable activity and integrate exercise into broader mental-health promotion. Research should identify which students benefit most, which delivery modes are acceptable, and how activity can be sustained during examinations and periods of high stress.

Risk of Bias Assessment

Table 4: Risk of bias assessment summary

Bias domain	Judgment	Interpretation
Selection bias	Moderate concern	Many studies use convenience samples, hospital-based cohorts, volunteer participants or administrative datasets that may not represent the target population.
Exposure/intervention measurement	Moderate concern	Self-report, retrospective chart review or non-standard exposure windows may introduce misclassification.
Outcome measurement	Moderate concern	Outcome definitions vary and may rely on non-uniform diagnostic criteria or validated scales with different cut-offs.

Confounding	Moderate concern	Age, severity, comorbidity, socioeconomic status, baseline mental health, disease duration or healthcare exposure may confound associations.
Missing data	Moderate concern	Attrition, incomplete outcome capture and unreported missing-data mechanisms are frequent limitations.
Selective reporting	Moderate concern	Protocols are often absent, and studies may selectively report statistically significant outcomes.
Overall judgment	Moderate certainty for consistent associations; lower certainty for causal claims	The evidence supports clinically meaningful associations but causal interpretation requires caution unless based on well-designed randomized or longitudinal evidence.

Interpretation: The principal bias concern is not a single isolated flaw but the accumulation of non-randomized designs, exposure heterogeneity and incomplete adjustment. Therefore, pooled estimates should be interpreted as average associations within the included evidence base, not universal causal effects.

Quality of Evidence

Table 5: Certainty of evidence summary

Evidence domain	Certainty	Reasoning
Primary outcome	Moderate	Consistent direction across multiple syntheses, but downgraded for heterogeneity and measurement differences.
Secondary clinical outcomes	Low to moderate	Evidence depends on outcome and disease area; stronger where prospective or randomized evidence exists.
Subgroup findings	Low	Subgroups are often post hoc, underpowered or inconsistently reported.
Mechanistic plausibility	Moderate	Biological, organizational or behavioral mechanisms support observed associations but do not eliminate confounding.
Policy/practice implications	Moderate	Practical actions are justified when low-risk and supported by consistency, but effect size should be context-specific.

Results

This draft synthesis includes 10 representative verified evidence sources and 16 Vancouver-style references. The final number of included studies should be determined by formal screening.

The included sources comprise systematic reviews, meta-analyses, cohort studies, cross-sectional studies, modelling analyses and/or randomized trials depending on the topic.

Outcome-wise findings: Physical activity interventions generally reduce depressive symptoms, anxiety and stress among university students, while observational evidence shows lower depressive symptoms among more active students.

Pooled effects are heterogeneous; modality, supervision, adherence, duration and baseline symptom severity should be considered in subgroup analyses.

Subgroup findings: Subgroup analysis should be restricted to prespecified categories and interpreted cautiously.

Potential subgroups include geographical region, age, sex, baseline risk, disease condition, ward type, intervention intensity, follow-up duration, measurement instrument and study quality.

Publication bias: Funnel-plot interpretation is not recommended unless at least ten comparable studies are available for a specific outcome. Small-study effects are plausible in all five topic areas because positive findings are more likely to be published and cited.

Discussion

Principal findings: The principal finding is that the topic has sufficient evidence for a structured systematic review, but the evidence is heterogeneous and must be interpreted with methodological caution. The synthesis identifies a consistent core signal, clarifies where evidence is strong, and separates clinically plausible interpretation from unsupported overstatement.

Interpretation of the evidence: The evidence should be interpreted as a layered body of information. Meta-analyses provide numerical summaries, but the credibility of pooled estimates depends on whether studies are sufficiently similar. In several outcomes, narrative synthesis is more defensible than statistical pooling. This is especially true when exposures are broad, interventions are complex, or outcome instruments vary.

Comparison with previous reviews: This manuscript is consistent with previous systematic reviews in identifying a dominant direction of association or intervention benefit. It differs from superficial summaries by emphasizing

measurement heterogeneity, confounding, implementation context and the limits of causal inference. Where previous reviews disagree, differences are usually explained by eligibility criteria, search period, outcome definition, risk-of-bias threshold or statistical model.

Biological, clinical or practical plausibility: The findings are biologically and psychosocially plausible because physical activity influences neurotransmitter systems, neuroplasticity, inflammation, sleep, self-efficacy, social connection and stress physiology.

Group activity may provide additional benefit through social support and routine formation.

Bidirectionality and causal inference: Physical activity may reduce symptoms, but mental-health symptoms may also reduce activity.

This bidirectionality complicates observational evidence. Students with depression may withdraw from activity, while active students may have better baseline social support and sleep.

Randomized trials address temporality but are often small and short. The final synthesis should give greater causal weight to intervention studies while using observational studies to understand real-world association and moderators.

Baseline symptom severity: Exercise interventions may show larger effects in students with elevated baseline symptoms than in unselected students. When baseline symptoms are low, floor effects limit measurable improvement. Conversely, severe symptoms may reduce adherence.

Trials should report baseline severity and consider stratified analysis. Universities should screen and triage so that physical activity programs complement, rather than replace, appropriate clinical care.

Social connection: Group exercise may improve mental health partly through social interaction, belonging and routine. This is particularly relevant for first-year students, international students and those experiencing loneliness.

Future studies should measure social connectedness as a mediator. If social support is a major pathway, solitary app-based exercise may not reproduce the same effect.

Sedentary behavior: Physical activity and sedentary behavior are related but distinct. A student may meet exercise guidelines but still sit for prolonged periods during lectures and study. Sedentary behavior may independently affect mood, sleep and fatigue.

University interventions should combine exercise promotion with reductions in prolonged sitting, active study breaks and active campus design.

Strengths and Limitations: Strengths include the use of a transparent review structure, verified references, explicit methodology, detailed tables and critical interpretation. Limitations include the need for formal database export, independent dual screening, complete extraction and, where feasible, original statistical pooling using reproducible software.

Clinical Significance / Practical Implications: Practically, universities can integrate supervised physical activity, active commuting supports, group exercise, sports clubs, yoga, brief movement breaks and referral pathways into student-wellbeing programs. Physical activity should be positioned as prevention and adjunctive care, not as a substitute for professional mental-health treatment.

Conclusion

Physical activity is associated with better mental-health outcomes among university students and structured exercise interventions can reduce depression, anxiety and stress. The evidence supports physical activity as a scalable adjunct for student wellbeing, while clinical mental-health care remains essential for moderate to severe symptoms. Future work should define optimal dose, modality, supervision and implementation models.

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