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Systematic Review

Effects of High-Intensity Interval Training on Mental Health Outcomes in Adolescents and Young Adults: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: Given rising physical inactivity and mental health challenges, time-efficient interventions like High-Intensity Interval Training (HIIT) require rigorous evaluation. This systematic review and meta-analysis synthesized the evidence for HIIT's effects on mental health in adolescents and young adults. **Method:** Six electronic databases were systematically searched for Randomized Controlled Trials (RCTs) up to September 2025, comparing HIIT (defined as ≥85% HRmax) against a passive control group in non-clinical populations aged 11-29 years. **Results:** 11 RCTs comprising 1,401 participants were included. The random-effects meta-analysis showed a modest reduction in perceived stress associated with HIIT (SMD = −0.29, 95% CI −0.59 to 0.004, *p* = .053), although the effect did not reach conventional statistical significance and substantial uncertainty remained. No statistically significant effects were observed for depressive symptoms, anxiety, or psychological wellbeing. **Conclusions:** HIIT may be associated with modest reductions in perceived stress; however, the certainty of the evidence was low to very low across all outcomes. These findings should be interpreted with caution, and further high-quality research is needed to clarify the effects of HIIT on mental health outcomes.

Efectos del Entrenamiento Interválico de Alta Intensidad en la Salud Mental de Adolescentes y Adultos Jóvenes: una Revisión Sistemática y Metaanálisis

Palabras clave:
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RESUMEN

Antecedentes: Ante la creciente inactividad física y los problemas de salud mental, las intervenciones eficientes en tiempo, como el entrenamiento interválico de alta intensidad (HIIT), requieren una evaluación rigurosa. Esta revisión sistemática y metaanálisis sintetizó la evidencia sobre los efectos del HIIT en la salud mental de adolescentes y adultos jóvenes. **Método:** Se realizaron búsquedas sistemáticas en seis bases de datos electrónicas hasta septiembre de 2025 para identificar ensayos controlados aleatorizados que compararon HIIT (≥85% de la frecuencia cardíaca máxima) con un grupo control pasivo en poblaciones no clínicas de entre 11 y 29 años. **Resultados:** Se incluyeron 11 estudios con 1,401 participantes. El metaanálisis con modelos de efectos aleatorios mostró una reducción modesta del estrés percibido a favor del HIIT (DME = −0.29; IC del 95%: −0.59 a 0.004; *p* = .053), sin alcanzar la significación estadística convencional y con elevada incertidumbre. No se observaron efectos significativos sobre síntomas depresivos, ansiedad ni bienestar psicológico. **Conclusiones:** HIIT podría asociarse con reducciones modestas del estrés percibido; sin embargo, la certeza de la evidencia fue baja a muy baja. Se requieren estudios de mayor calidad para clarificar sus efectos sobre la salud mental.

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Depression and anxiety are the most prevalent mental health challenges among youth, affecting up to 30% of adolescents and young adults (Silva et al., 2020). These developmental periods are marked by increased vulnerability to mental health difficulties, driven by academic stress, social pressures, and developmental challenges (Patton et al., 2016; Twenge et al., 2019). This burden has intensified following the COVID-19 pandemic, with documented increases in psychological distress (Madigan et al., 2023; Racine et al., 2021). While antidepressants are effective, concerns regarding side effects in minors (Cipriani et al., 2016) underscore the need for accessible non-pharmacological alternatives such as exercise (Howlett et al., 2021). Studies have reported an inverse relationship between physical activity levels and symptoms of anxiety and depression (Bélair et al., 2018; Carter et al., 2021), reinforcing the potential of exercise as a complementary intervention. However, adherence to global physical activity guidelines remains low (Guthold et al., 2020), notwithstanding the benefits of exercise, largely due to barriers such as lack of time (Hoare et al., 2017).

Addressing these issues is essential, as individuals with elevated anxiety sensitivity may benefit significantly from physical activity (Mason & Asmundson, 2018; Schmidt et al., 2010). Although moderate-intensity exercise is widely recommended for managing depression (Pilling et al., 2009) and anxiety (Paluska & Schwenk, 2000), evidence in youth remains less conclusive than in adults (Carter et al., 2021; Schuch et al., 2016). The variability in these findings suggests that specific exercise parameters may play a crucial role in therapeutic efficacy. In this regard, Noetel et al. (2024) suggest that exercise intensity is a key determinant of mental health outcomes, with vigorous-intensity exercise potentially producing larger and more clinically meaningful effects than moderate-intensity activity. High-Intensity Interval Training (HIIT) appears to engage key neurobiological mechanisms more robustly, contributing to improved stress regulation (Heijnen et al., 2016; Miller & Raison, 2016). These adaptations may be particularly relevant for youth, whose brains are highly responsive to neuroplasticity enhancements promoted by vigorous exercise (Lubans et al., 2016a). Unlike moderate continuous training, HIIT imposes a rapidly fluctuating physiological demand that may trigger distinct neurobiological adaptations. Specifically, vigorous exercise bouts have been linked to greater acute increases in brain-derived neurotrophic factor (BDNF), catecholamines, and cortisol, which collectively mediate stress regulation and hippocampal plasticity (Heijnen et al., 2016; Miller & Raison, 2016). Furthermore, HIIT has shown superior efficacy in improving cardiorespiratory fitness compared to moderate exercise (Costigan et al., 2015). Given that low cardiorespiratory fitness is a strong predictor of depressive symptoms and psychological distress (Ruggero et al., 2015), the robust physiological stimulus provided by HIIT may offer a potent pathway for mental health promotion.

Despite this theoretical promise, the specific application of HIIT for mental health in young populations requires clarification. While HIIT acts as a time-efficient strategy addressing common barriers (Guthold et al., 2020), existing research remains fragmented. Previous reviews have been limited by substantial heterogeneity regarding intervention protocols, ranging from cycle ergometers to bodyweight circuits, and the frequent mixing of clinical and non-clinical samples (Leahy et al., 2020; Rodriguez-Ayllon et al., 2019). Consequently, it remains unclear whether the benefits observed in clinical settings translate to the prevention of symptoms in healthy youth, or if the variability in protocols (e.g., work-rest ratios, duration) dilutes the potential efficacy. Based on evidence linking higher exercise intensity to greater benefits, it is expected that HIIT may be associated with improvements in mental health outcomes, although substantial heterogeneity across studies is acknowledged.

This systematic review aims to evaluate the effects of HIIT on mental health outcomes in adolescents and young adults from a preventive perspective. Distinct from clinical trials focusing on symptom remission, this study targets non-clinical populations to determine whether HIIT can serve as a proactive strategy to manage subclinical symptomatology and buffer against stress. By addressing methodological limitations of previous research, this review offers new insights into the potential of HIIT as a time-efficient intervention for youth mental health.

Method

This systematic review and meta-analysis were conducted in accordance with the recommendations of the Cochrane Handbook for Systematic Reviews of Interventions (Higgins et al., 2024) and was reported following the guidelines established by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021). The study protocol was pre-registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the registration number CRD42024567984.

Eligibility Criteria

The formulation of the research question, the process of evidence searching, and the definition of eligibility criteria were based on the components of the patient, intervention, comparator, outcomes and type of study (PICOS strategy) (Methley et al., 2014; Schardt et al., 2007). The titles and abstracts of all identified studies were screened, followed by a full-text review of relevant articles to assess their eligibility. Eligibility was determined by two independent researchers (MH and HO) according to the following predefined criteria: (1/P) healthy adolescents and young adults with no physical disease nor severe mental illness or mental disorder and aged between 11 and 29 years. The selection of this age range was guided by a public health and prevention-oriented perspective. Inclusion was restricted to passive control groups to specifically isolate the effects of HIIT relative to no structured exercise; (2/I) studies that follow a HIIT protocol at or above 85% of maximum heart rate (HR_{max}), which corresponds to over 75% of maximum oxygen uptake (VO_2max) (American College of Sports Medicine, 2018), being eligible any form of exercise of any duration and frequency. The HIIT intervention group may not perform any other interventions; (3/C) HIIT intervention compared to a passive control group that does not perform any intervention; (4/O) measurement of any mental health outcome; (5/S) studies should be RCTs.

Search and Study Selection

EMBASE, PsycInfo, PubMed, Scopus, SportDiscus and Web of Science were searched by two authors (MH and HO) from inception up to September 2025 for RCTs investigating HIIT in healthy adolescents and young adults.

In addition to the database search, a manual search was conducted by reviewing the reference lists of recent meta-analyses and all included studies to identify potentially relevant articles not captured by the initial search. Studies identified through this manual process were subjected to the same independent screening procedures and were required to meet the same predefined inclusion and exclusion criteria as studies retrieved from the database search.

MH and HO independently conducted the screening and selection stages of the studies. Any divergence between investigators was solved in a consensus meeting with a third investigator (MF). The search terms used are available on the Open Science Framework (OSF): https://osf.io/vrs4u/files/bhfu6

Data Extraction

Data coding from each selected study was conducted by HO and independently cross-checked for accuracy by MH. Data extracted included: first author's last name and publication year, sample characteristics (baseline physical activity levels, sample size, mean age and standard deviation (or range if not available) and gender proportion), mental health assessments (outcome, instrument), intervention details (duration, frequency, time and type). Outcome data were reported as mean and standard deviation.

Assessment of Risk of Bias

The risk of bias in the included studies was assessed using the Cochrane Risk of Bias Tool for Randomized Clinical Trials (RoB 2.0), across its five standard domains. Two researchers (MQ and HO) independently applied the assessment tool to each included study. The risk of bias for each outcome was categorized as "high," "low," or "some concerns." and visualized using the robvis tool (McGuinness & Higgins, 2021). Any divergence between investigators was solved in a consensus meeting with a third investigator (MH). Formal inter-rater agreement statistics (e.g., kappa coefficients) were not calculated.

Assessment of Evidence Certainty

The Grading of Recommendations Assessment Development and Evaluation (GRADE) was used to evaluate the certainty of the evidence. Two researchers (MQ and HO) independently rated each meta-analysis, following GRADE guidelines which initially address RCTs to be rated high quality, and could be downgraded to moderate, low or very low based on the following domains: risk of bias, imprecision of results and inconsistency (Guyatt et al., 2011; Higgins, 2003). Any divergence between investigators was solved in a consensus meeting with a third investigator (MH).

Data Analysis

All analyses were conducted using R (The R Foundation for Statistical Computing), employing the *meta* and *metafor* packages (Schwarzer, 2025; Viechtbauer, 2010). Meta-analyses were performed when at least three studies were available for a given outcome (perceived stress, depressive symptoms, anxiety, wellbeing, and positive and negative affect).

Effect sizes for between-group comparisons accounting for change over time were calculated as standardized mean changes between groups using the escalc function in *metafor*, following the procedures described by Skvarc and Fuller-Tyszkiewicz (2024). This approach is consistent with the standardized mean change originally proposed by Becker (1988). When pre–post correlation coefficients were not reported, a conservative correlation of $r = 0.5$ was assumed for variance estimation, in accordance with recommendations from the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins et al., 2024).

Effect sizes were expressed as Cohen's *d*. To further improve interpretability, pooled effect sizes were additionally transformed into the percentage of superiority, representing the probability that a randomly selected participant from the intervention group shows a better outcome than a randomly selected participant from the control group. Effect size magnitude was interpreted as a continuous measure, without relying on conventional categorical benchmarks.

Pooled estimates were obtained using random-effects models with inverse-variance weighting, reflecting expected heterogeneity in exercise protocols, follow-up durations, and study populations across trials. Statistical heterogeneity was assessed using the I^2 statistic, with values above 50% and 75% indicating moderate and high heterogeneity, respectively.

Meta-analytic results were presented using forest plots. No moderator analyses were pre-specified in the PROSPERO protocol, as fewer than ten effect sizes were anticipated per outcome. Similarly, formal assessments of small-study effects or publication bias were not conducted due to the limited number of available studies. Statistical significance was set at $p < .05$.

Assessment of Reporting Biases

Assessment of publication bias using funnel plot inspection and Egger's regression test was planned for any meta-analysis that included at least 10 studies. However, as no meta-analysis met this minimum number of studies, these analyses could not be formally conducted. According to the Cochrane Handbook for Systematic Reviews of Interventions, tests for funnel plot asymmetry are underpowered and unreliable with fewer than 10 studies, making their results potentially misleading (Higgins et al., 2024).

Results

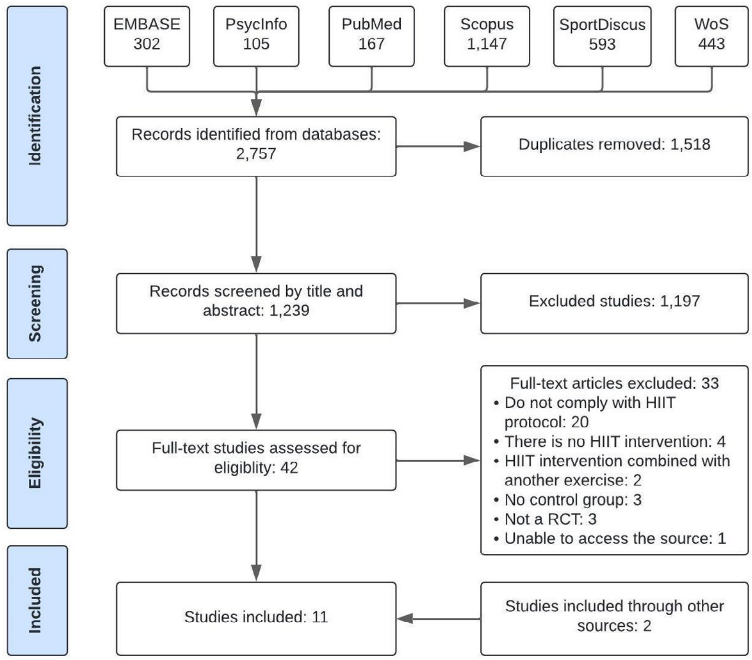
Search Results

The literature searches identified a total of 2,757 studies. Once 1,518 duplicates were removed, 1,239 titles and abstracts were examined. At full text review stage, 42 studies were reviewed to evaluate eligibility, of which nine met the inclusion criteria. Two studies were added from other sources for the final 11 studies included in this systematic review (Figure 1).

Study Characteristics

A total of 1,401 participants who completed treatments were included in the review: 709 in HIIT intervention groups and 692 in control groups. The duration of the interventions ranged from 2 to 16 weeks, except for one study that lasted 12 months (Lubans et al., 2020). Eight studies performed 3 sessions per week (Costigan et al., 2016; Eather et al., 2019; Leahy et al., 2018; Liu et al., 2022; Lubans et al., 2020; Lucibello et al., 2020; May et al., 2018; Shandu et al., 2023), one study 2 sessions per week (Harris et al., 2022), one study 1 session per week (Allen et al., 2018) and one study 10 sessions in 11 days (Ormsbee et al., 2013). Five studies used progressively longer sessions (Costigan et al., 2016; Eather et al., 2019; Leahy et

Figure 1
Prisma Flow Diagram



Note: Flowchart illustrating the study selection process, including number of records identified, screened, assessed for eligibility and finally included in the systematic review.

al., 2018; Lubans et al., 2020; Ormsbee et al., 2013), with session durations ranging from 8 to 40 minutes. One study included only male participants (Shandu et al., 2023); the remaining ten studies have female representation ranging from 31% to 82%, with a mean of 59%. The mean age of the participants was not reported in one study (Shandu et al., 2023), while in the remaining studies, ranged from 12 to 31 years. Mental health outcomes assessed across studies included salivary and hair cortisol, depressive symptoms, perceived stress, positive and negative affect, wellbeing and anxiety. Detailed study characteristics are presented in Table 1.

Risk of Bias

Risk of bias was independently assessed by two reviewers (MQ and HO) using the Cochrane Risk of Bias Tool (RoB 2.0). Based on this assessment, six studies were rated as low risk of bias, two were rated as having some concerns and three were rated as high risk of bias (Figure 2).

Meta-Analysis

Forest plots for all mental health outcomes derived from the meta-analyses are presented in Figure 3.

Figure 2
Risk of Bias Using Cochrane Risk of Bias 2.0 Tool

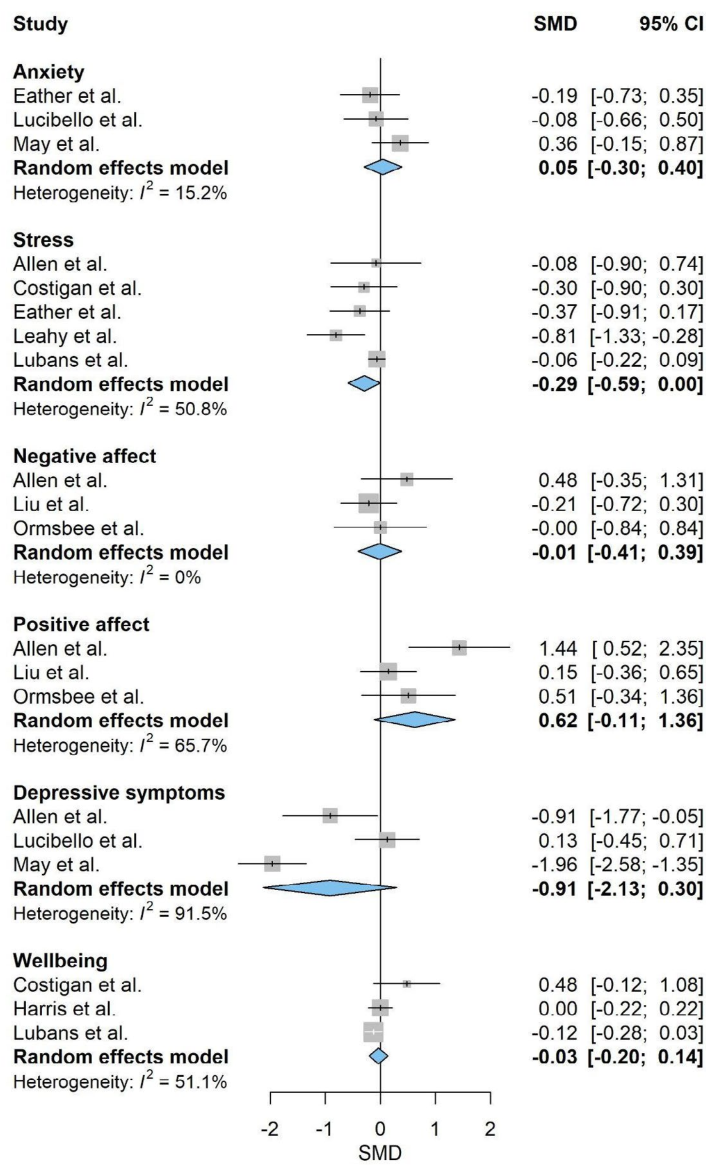
Table 1
Characteristics of the Studies Included in the Study.

Study	Participants	Measures	HIIT intervention	Results
Allen et al. (2018)	PA levels: moderate Smokers IG: *n* = 12, 30,4 ± 0,5 years, 33% women; CG: *n* = 11, 31 ± 2 years, 82% women	CES-D - baseline, week 4, week 8 and post intervention PANAS - baseline, week 4, week 8 and post intervention PSS - baseline, week 4, week 8 and post intervention	Stationary bike 12 weeks 1 session/week 20 minutes/session	Significant improvements at week 8 ($p < .015$) and week 12 ($p < .019$) in positive affect between groups Rest of mental health outcomes: no significant changes
Costigan et al. (2016)	PA levels: NR England high school students (15,8 ± 0,6 years) 31% women IG1: *n* = 21, IG2: *n* = 22; CG: *n* = 21	K10 - baseline and post intervention Flourishing Scale - baseline and post intervention Feelings State - pre and post every session	IG1: gross motor cardiorespiratory exercises; IG2: combination of cardiorespiratory and body weight resistance training exercises (PE classes) 8 weeks 3 session/week Progressive (from 8 to 10 min/session)	Feelings State: significant differences ($p < .001$) between pre and post for IG1; improvements for IG2 ($p < .06$) Well-being (Flourishing Scale): small intervention effect for both IG1 and IG2 K10: No intervention effect
Eather et al. (2019)	PA levels: NR Australia university students (20,38 ± 1,88 years) IG: *n* = 22, 64% women; CG: *n* = 31, 68% women	STAI - baseline and post intervention PSS - baseline and post intervention Feelings State - pre and post every session	Combination of aerobic and core resistance using body weight or basic equipment 8 weeks 3 session/week Progressive (from 8 to 10 min/session)	No significant changes
Harris et al. (2022)	PA levels: NR New Zealand students IG: *n* = 160, 12,1 ± 0,6 years, 55% women; CG: *n* = 163, 12,2 ± 0,6 years, 45% women	SDQ - baseline and post intervention Warwick-Edinburgh Mental Wellbeing Scale - baseline and post intervention	Major muscle groups (PE classes) 16 weeks (2 of rest) 2 session/week 15 minutes/session	No intervention effect
Leahy et al. (2018)	PA levels: NR Australia high school students (16,2 ± 0,4 years), 54% women IG: *n* = 38; CG: *n* = 30	SDQ - baseline and post intervention PSS - baseline and post intervention	Aerobic-based and resistance-based exercises 14 weeks 3 session/week From 12 to 20 minutes/session	Moderate improvement for IG for total difficulties ($p = .02$) and reduction in subscales emotional problems ($p = .02$) and peer problems ($p = .02$)
Liu et al. (2022)	PA levels: low University students (26,26 ± 2,21 years) IG: *n* = 33, 56% women; CG: *n* = 28, 57% women	SPANE - baseline and post intervention	Treadmill 12 weeks 3 session/week 40 minutes/session	Small differences in favour of the IG: trends upward for satisfaction, positive affect and well-being; trend downward for negative affect
Lubans et al. (2020)	PA levels: NR Australia high school students IG: *n* = 337, 16 ± 0,4 years, 50% women; CG: *n* = 333, 16 ± 0,5 years, 39% women	PSS - baseline, middle and post intervention SDQ - baseline, middle and post intervention Warwick-Edinburgh Mental Wellbeing Scale - baseline, middle and post intervention Hair cortisol (baseline-6 months) - baseline and middle intervention	Aerobic and body weight resistance exercises 12 months 3 session/week From 8 to 20 minutes/session	Hair cortisol: small difference in favour of the IG; moderation effects for mental health status: stronger effects on poor mental health at baseline Other mental health outcomes: no differences between groups
Lucibello et al. (2020)	PA levels: low University students (19,8 ± 2,2 years) 63% women IG: *n* = 25; CG: *n* = 21	BAI - baseline and post intervention BDI-II - baseline and post intervention	Cycle ergometer 9 weeks 3 session/week 20 minutes/session	No intervention effect
May et al. (2018)	PA levels: low USA university students (18,55 ± 0,99 years) 82% women IG: *n* = 30; CG: *n* = 30	SBI - baseline and post intervention CES-D - baseline and post intervention STAI - baseline and post intervention	Cyclo ergometer 4 weeks 3 session/week 20 minutes/session	No intervention effect

Study	Participants	Measures	HIIT intervention	Results
Ormsbee et al. (2013)	PA levels: moderate-high Active university students IG: *n* = 12, 19,3 ± 0,4 years, 58% women; CG: *n* = 10, 19,5 ± 0,4, 80% women	PANAS - baseline and post intervention Salivary cortisol - baseline, pre and post intervention	Cycle ergometer 10 sessions (within 2 weeks); 1 session/day Progressive (from 7,5 to 20 min/session)	No significant changes
Shandu et al. (2023)	PA levels: low Male smoker students (18-30 years) IG: *n* = 18; CG: *n* = 14	WHOQOL-BREF - baseline and post intervention	Cycle ergometer 8 weeks 3 session/week 33 minutes/session	Significant improvements ($p < .05$) for IG

Note: BAI, Beck Anxiety Inventory; BDI-II, Beck Depression Inventory II; CES-D, Center for Epidemiological Studies - Depression; CG, Control Group; IG, Intervention Group; K10, Kessler Psychological Distress Scale; NR, Not Reported; PANAS, Positive And Negative Affect Scale; PA, Physical Activity; PSS, Perceived Stress Scale; SBI, School Burnout Inventory; SDQ, Strength and Difficulties Questionnaire; SPANE, Scale of Positive And Negative Experience; STAI, State-Trait Anxiety Scale; WHOQOL-BREF, World Health Organization Quality of Life.

Figure 3
Forest Plot



Note: CI, Confidence Intervals; SMD, Standardized Mean Difference.

Depressive Symptoms

The quantitative synthesis showed a non-significant effect of HIIT on depressive symptoms compared to no intervention (SMD = −0.91, 95% CI −2.13 to 0.30, p = .14), with substantial heterogeneity (I^2 = 91.5%; quality of evidence: very low). The pooled effect corresponded to a percentage of superiority of 74%. The prediction interval ranged from -6.03 to 4.20.

Anxiety

There was no statistically significant effect in favour of the control group for anxiety compared to the HIIT group (SMD = 0.05, 95% CI −0.30 to 0.40, p = .79), with low heterogeneity (I^2 = 15.2%; quality of evidence: very low). The pooled effect corresponded to a percentage of superiority of 51.4%. The prediction interval ranged from −0.91 to 1.00.

Wellbeing

There was no significant effect of HIIT on psychological wellbeing compared to no intervention (SMD = −0.03, 95% CI −0.20 to 0.14, p = .71), with moderate heterogeneity (I^2 = 51.1%; quality of evidence: low). The pooled effect corresponded to a percentage of superiority of 49.1%. The prediction interval ranged from -0.56 to 0.50.

Stress

The inclusion of HIIT protocols was associated with a modest reduction in perceived stress compared to no intervention; however, this effect did not reach conventional statistical significance (SMD = −0.29, 95% CI −0.59 to 0.005, p = .053), with moderate heterogeneity (I^2 = 50.8%; quality of evidence: very low). The pooled effect corresponded to a percentage of superiority of 58.2%. The prediction interval ranged from −1.06 to 0.47, indicating substantial uncertainty in the expected effects across future studies.

Positive and Negative Affect

There was no statistically significant effect of HIIT on positive affect compared to no intervention (SMD = 0.63, 95% CI −0.11 to 1.36, p = .09), with substantial heterogeneity (I^2 = 65.7%; quality of evidence: very low). The pooled effect corresponded to a percentage of superiority of 67.2%. The prediction interval ranged from −2.17 to 3.42. Conversely, there was no statistically significant effect of HIIT on negative affect compared to the control group (SMD = −0.01, 95% CI −0.41 to 0.39, p = .96), with no observed heterogeneity (I^2 = 0.0%; quality of evidence: very low). The pooled effect corresponded to a percentage of superiority of 49.7%. The prediction interval ranged from −0.94 to 0.92.

Discussion

This systematic review and meta-analysis examined the effects of HIIT on mental health outcomes in adolescents and young adults. The findings suggest a potential modest reduction in perceived stress following HIIT. Although this effect did not reach conventional statistical significance and the certainty of evidence was low, the direction of the effect is noteworthy. Regarding depressive symptoms and positive affect, while non-significant effects were observed, the estimates were generally directionally favourable to HIIT. No significant effects were found for anxiety, psychological well-being or negative affect, indicating variability in the impact of HIIT across different mental health domains. The certainty of the evidence for all analysed outcomes ranged from low to very low, underscoring the need for more rigorous, high-quality studies in this area.

To aid interpretation of the pooled effects, SMDs were complemented with prediction intervals and the percentage of superiority. Prediction intervals were wide for most outcomes and frequently crossed the null value, highlighting the substantial variability in expected effects across future studies. The percentage of superiority provided a clinically interpretable estimate of the probability that an individual receiving HIIT would show better outcomes than one in the control group; however, these values should be interpreted cautiously given the low certainty of evidence and the wide prediction intervals observed.

We did not observe a statistically significant effect of HIIT on depressive symptoms, although the estimated effects tended to favour HIIT. This pattern is broadly consistent with previous research suggesting that exercise, including HIIT, may influence mood and emotional regulation. Notably, some interventions included participants with baseline symptoms of depression or anxiety, and HIIT may have yielded greater mental health benefits in those individuals with poorer mental health status (Lubans et al., 2020). However, the interpretation of these findings is limited by the small number and low quality of the included RCTs (Schuch et al., 2016; Stubbs et al., 2017).

Consistent with these findings, the pooled analysis of depressive symptoms was marked by substantial heterogeneity (I^2 = 91.5%). This high level of statistical inconsistency is likely a direct reflection of the considerable clinical and methodological diversity across the included trials, as detailed in Table 1. For instance, intervention durations varied dramatically, from a short-term 2-week protocol by Ormsbee et al. (2013) to a 12-month intervention by Lubans et al. (2020). Similarly, the HIIT dose was inconsistent, with frequencies ranging from a single weekly session (Allen et al., 2018) to 3 sessions per week in the majority of studies. Furthermore, the nature of the HIIT protocols themselves was diverse, including cycle ergometer-based sessions (e.g., Lucibello et al., 2020) and bodyweight-based resistance exercises (e.g., Costigan et al., 2016). Such profound variations in intervention design, duration, and modality prevent a clear conclusion and underscore the difficulty in determining an optimal HIIT prescription for mental health outcomes based on the current evidence.

Perceived stress was the only outcome showing a consistent tendency towards improvement, representing a medium effect size with potential clinical relevance as a complementary management strategy. These results align with previous findings (Borrega-Mouquinho et al., 2021); however, the high heterogeneity suggests that physiological adaptations alone (e.g., anti-inflammatory pathways) do not guarantee benefits. Crucially, recent evidence indicates that individual traits, such as emotional impulsivity, may blunt the psychoneuroendocrine response to stress despite fitness gains (Javelle et al., 2024). Consequently, while HIIT shows promise, it should be prescribed cautiously, accounting for baseline psychological characteristics rather than as a uniform solution.

The lack of significant effects on anxiety and psychological well-being observed in this review may be partially explained by the short duration of many interventions and their emphasis on more transient affective states (Biddle et al., 2019; Harris et al., 2022; Schuch et al., 2016). Longer intervention periods may be necessary to detect measurable changes in these outcomes, particularly in individuals with more severe baseline symptoms (Eather et al., 2019). However, the current evidence on HIIT remains inconclusive, as studies vary widely in their methods, including differences in intervention duration, intensity, and outcome assessment (Hood et al., 2011; Little et al., 2010). Furthermore, some studies suggest that factors such as intensity, duration, and frequency of HIIT sessions may not significantly influence mental health outcomes (Gaia et al., 2024; Lucibello et al., 2020).

The low heterogeneity observed for anxiety (I^2 = 15.2%) and the moderate heterogeneity for psychological well-being (I^2 = 51.1%) indicate relatively consistent findings across studies, particularly for anxiety. However, the absence of statistically significant effects and prediction intervals centred around the null value suggest that HIIT may have limited or variable influence on anxiety and psychological well-being across different populations and intervention contexts.

It is possible that acute features of HIIT, such as high exercise intensity, may temporarily divert attention from negative thoughts or stressors, while the structured and goal-oriented nature of HIIT could contribute to feelings of accomplishment or self-efficacy. Nevertheless, these potential psychological responses may be transient and insufficient to produce sustained changes in more stable mental health constructs such as anxiety or psychological well-being.

No statistically significant effects were observed for either positive or negative affect following HIIT interventions. For positive affect, the pooled effect was non-significant and characterized by substantial heterogeneity (I^2 = 65.7%), suggesting considerable variability in responses across studies. In contrast, findings for negative affect were highly consistent (I^2 = 0%), with effect estimates centred around the null value, indicating no systematic effect of HIIT on this outcome.

The lack of significant effects on positive affect and the high heterogeneity (I^2 = 65.7%) align with the notion that emotional responses to HIIT are highly individualized. Lubans et al. (2016a; 2016b) suggest that these responses depend on baseline fitness and psychological mediators like self-esteem. Consequently, individuals with lower fitness may not experience the immediate physiological adaptations required to elicit emotional improvements, reinforcing the need to account for personal characteristics when prescribing HIIT.

Despite mixed findings, HIIT may be considered a time-efficient exercise modality with potential relevance for mental health outcomes, although current evidence remains limited. School-based programs show potential given the rising stress trends among youth (Patalay & Gage, 2019). However, outcomes vary considerably, possibly due to short intervention durations and implementation challenges common in educational settings (Naylor et al., 2015). Evidence suggests that interventions exceeding three months may be necessary to yield consistent mental health improvements (Brown et al., 2013), contrasting with the shorter protocols typical of experimental HIIT research.

From a clinical perspective, the observed reduction in perceived stress represents a medium effect size. While this suggests that HIIT can be a valuable component of stress management strategies for young people, the substantial heterogeneity indicates that individual responses vary significantly. Consequently, HIIT should be viewed as a complementary tool rather than a standalone first-line treatment for mental health difficulties in this population.

Despite the directionally favourable estimates of some findings, several methodological limitations of the included studies contribute to the low to very low certainty of the evidence. Due to the small number of studies included in each meta-analysis (N < 10), standard methods to assess small-study effects, such as funnel plots and Egger's test, lacked sufficient statistical power and were therefore not performed. Furthermore, sensitivity analyses excluding studies rated as high risk of bias were not performed due to the limited number of studies, preventing a formal assessment of how study quality influenced the pooled estimates. As a result, the observed reduction in perceived stress, characterized by marginal statistical significance and wide confidence and prediction intervals, may represent an imprecise estimate of the true effect and should be interpreted with caution until supported by a larger and more robust body of evidence. Second, substantial variability in study designs, participant characteristics, and intervention protocols limits the generalizability of the findings. We acknowledge that the broad age range (11–29 years) encompasses distinct developmental stages, but, age-related subgroup analyses were not feasible due to the limited number of studies. Differences in session duration, intensity prescription, frequency, and adherence rates likely contributed to the observed heterogeneity across mental health outcomes. Moreover, the predominant reliance on self-reported measures introduces the potential for reporting bias, influenced by factors such as social desirability and transient mood states. In addition, the use of diverse validated instruments raises concerns regarding measurement equivalence. Differences in developmental stage, symptom expression, and interpretation of self-report measures across the broad age range may limit comparability and contribute to heterogeneity.

It is important to note that, as this review focused on non-clinical populations, the initial burden of depressive and anxiety symptoms was generally low. This likely created a 'floor effect,' making it statistically difficult to detect large magnitude reductions in these specific outcomes compared to therapeutic interventions in clinical samples. Some studies also assessed physiological stress markers; however, these could not be included in the meta-analyses due to the limited number of available studies and were therefore considered only in the narrative synthesis, further highlighting challenges in outcome comparability. Additionally, the restriction of our search to peer-reviewed literature constitutes a limitation that may have introduced publication bias. However, this decision was made to prioritize the inclusion of studies with a verified standard of methodological reporting, given the high variability in protocols typically found in non-peer-reviewed sources. Finally, many interventions were of relatively short duration, which may be insufficient to detect changes in more stable mental health constructs such as anxiety or depressive symptoms. Future research should prioritize larger, well-powered randomized controlled trials with standardized HIIT protocols, comprehensive reporting of participant characteristics, longer intervention and follow-up periods, and the inclusion of age-appropriate subjective and objective mental health outcomes to strengthen the quality and interpretability of the evidence.

In conclusion, HIIT may be associated with modest reductions in perceived stress, although substantial uncertainty remains.

No statistically significant effects were observed for depressive symptoms, anxiety, or psychological wellbeing. Overall, the certainty of the evidence ranged from low to very low, and the findings should be interpreted with caution.

Author Contributions

Miguel Heres: Writing – Review & Editing, Writing – Original Draft, Validation, Methodology, Investigation, Formal Analysis, Data Curation, Conceptualization. **Susana Pulgar:** Writing – Review & Editing, Validation, Methodology. **Marcos Quintana-Cepedal:** Writing – Review & Editing, Validation, Methodology, Conceptualization, Formal Analysis. **Maria Fernandez-del-Valle:** Writing – Review & Editing, Supervision, Conceptualization. **Hugo Olmedillas:** Writing – Review & Editing, Writing – Original Draft, Validation, Methodology, Investigation, Formal Analysis, Data Curation, Conceptualization, Supervision.

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Conflict of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability Statement

All data generated or analyzed during this study are available from the corresponding author upon request.

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