Multidisciplinary Reviews

CONFERENCE PAPER
Published Online: December 29, 2025
https://doi.org/10.31893/multirev.2025ss0422

Social Entrepreneurship: Innovations for Sustainable Development

Linking physical activity and mental health: Meta analysis of school-based interventions in children

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Abstract Significant issues with low stages of physical activity, sedentary behavior, and mental health illnesses have been identified throughout the past decade. The objective of this meta-analysis and systematic review is to assess the impact of treatments on the mental health of children and teens that target inactive or physically inactive behavior at school. Studies focusing on the broad demographics of children and teens between the ages of 5 and 20 years were eligible for inclusion as long as they addressed a variety of school-related initiatives to encourage exercise or discourage sedentary behavior. A total of 5,122 distinct studies were found in the literature search, and 13 publications reporting 13 treatments were eventually included in the review. The results showed that programs for physical exercise at school had a substantial favorable impact on resilience. Treatments that encourage physical exercise at school reduce anxiety, increase resilience, promote health, and enhance psychological well-being. The variability of the research necessitates caution. For better comprehension, future studies should offer specific operational data.

Keywords: psychological well-being, exercise programs, sedentary behavior, physical exercise

1. Introduction

Physical exercise is extremely important for supporting the general health of people, particularly school-aged children. Concerns regarding the diminishing mental health of children and adolescents and the increasing frequency of mental well-being illnesses, including depressive disorders and anxiety, have increased in recent years (Rodriguez-Ayllon et al., 2019). Researchers and instructors have focused on educational programs that encourage physical activity and enhance mental health outcomes for children, leading to the realization that physical exercise has a major positive influence on mental health. School-age children frequently have mental health issues (Van den Berg et al., 2017). Among the most prevalent mental health issues affecting children and teens are anxiety and depression. These ailments can harm a person's capacity to learn, engage with others, and generally lead to a productive life (Creswell et al., 2020). With a focus on school-aged children, this meta-analysis analyzes the data from prior research on the efficiency of such treatments. Physical exercise and mental health are complicated and diverse (Brignell et al., 2021). By easing signs of anxiety and depression, recovering self-esteem, strengthening cognitive performance, and fostering general psychological wellness, exercising has been found to benefit mental health directly. Furthermore, it has been demonstrated that participating in physical exercise as a young person has lasting benefits for mental wellness in adults.

Exercise has long been known to have many positive effects on physical well-being, but its influence on mental health is also becoming more widely accepted (Soga et al., 2017). Activity on a regular basis has been shown to produce endorphins, which are inherent mood-enhancing substances in the brain. Along with increasing possibilities for social engagement, confidence in oneself, and sleep quality, exercise also benefits mental health (Deady et al., 2017). A meta-detection must be used to summarize and evaluate the general effectiveness of these therapies. The main important results will be measurements of anxiety, sadness, confidence, and cognitive performance; interaction with others, academic success, and general well-being are some examples of additional results (Savulich et al., 2017). Finding the best physical activity treatments can help design and execute focused initiatives that support psychological wellness in educational settings (Williams et al., 2017). This meta-analysis also highlights gaps in the literature and recommends topics for further research.

To date, no systematic evaluation has specifically focused on school-related treatments that increase activity levels or decrease sedentary behavior to enhance mental health or lower psychological disorders in broad communities of students. The most recent information on the efficiency of educational exercise treatments for mental health must be organized, the most

successful therapeutic modalities must be described, and the procedures involved must be made clear. Authorities and educational institutions can act on the basis of this understanding to support good mental health and avoid mental illness in students in school. This systematic review has the following objectives:

- To assess the impact of sedentary behavior or educational physical motion programmes on psychological indicators, such as the internalization of psychological issues and excellent mental health, in children aged 5--20 years.
- Elements that could moderate these impacts, such as age, sex, socioeconomic status, relationships within families, location, the goal of assistance, the make-up of the control group, the stage of operation, and the caliber of the research, should be considered.

Andermo et al. (2020) investigated the characteristics of successful programs as well as the impact of educational exercise or sedentary behavioral changes on children's and teenagers' mental health. In the overall population of children and teens, Wu et al. (2017) assessed the relationships between exercise, sedentary lifestyles, and health-related aspects of life. Calestine et al. (2017) examined the connections between students' exercise routines and academic aspects, such as their grade point average, research habits, and course load. They also examined the relationships between fitness metrics (muscular endurance, mobility, and body shape), physical exercise, and academic results. Scholastic variables were used to analyze differences in fitness and behavioral results between groups via t tests, whereas correlations between health, exercise, and academic results were assessed. Smith et al. (2017) determined which environmental enhancements had the greatest local-level impact on residents' levels of physical activity, and they added to the body of research by considering intervention costs and the differing impacts of treatments on individuals on the basis of their ethnicity and socioeconomic status.

The effects of the pandemic on health habits, stress levels, financial stability, and food availability among young families have been documented by Carroll et al. (2020). Parents from different households participated in an online survey with open-ended and closed-ended inquiries. The subjective replies were evaluated via theme analysis, and statistical techniques were used to describe the numeric data. Bruni et al. (2017) provided an empirical evaluation of educational behavior reduction initiatives and a few supporting factors that could affect the effectiveness of such interventions. Tau-U, and the cause size value for single-case models that consider the baseline and pattern were derived across trials, enabling the investigation of several moderator factors, including the practical behavior evaluation method utilized. Odgers et al. (2020) examined the effectiveness and force modifiers of mindfulness-based interventions (MBIs) on anxiety in children, teens, and MBIs of individuals 18 years of age or younger. They used a recognized anxiety scale to look at the results. The organization of this research is as follows: Methodology is explored in phase 2. The results are provided in phase 3. The conclusions are described in phase 4.

2. Methodology

The search yielded 7,418 results, and 5,122 distinct titles were left when duplicates were eliminated. Through the use of the endnote reference organizer program, duplicates were eliminated. The research included 14 publications, all of which were published in English and represented 13 separate intervention trials. In most research, the socioeconomic category was either mixed or poor. Figure 1 depicts the PRISMA guidelines.

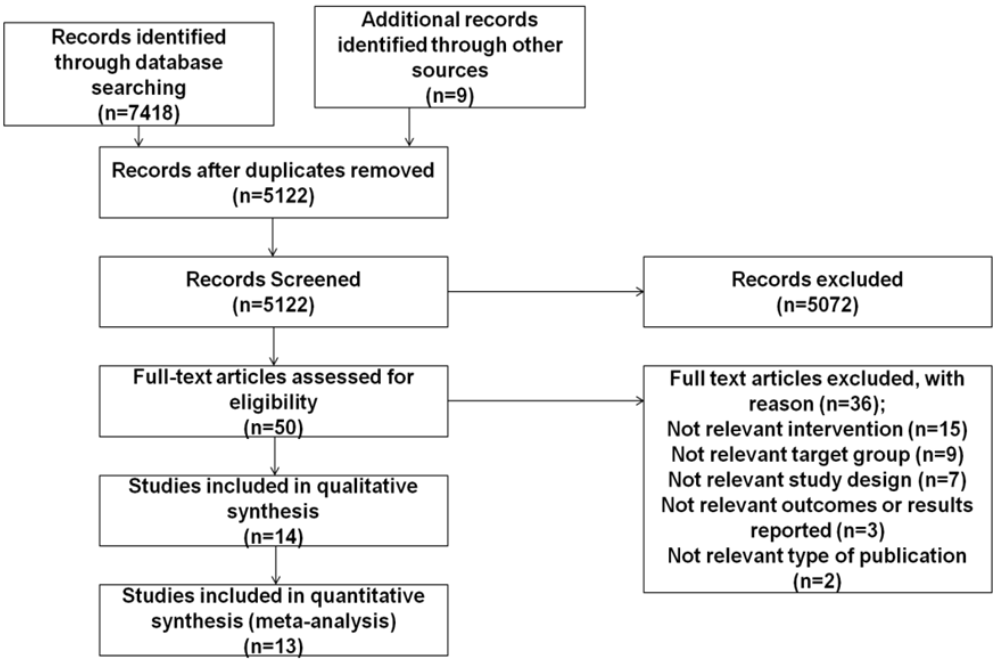

Figure 1 PRISMA.

This review provides PRISMA suggestions for the performance of meta-analyses and systematic reviews. The following databases were used for a research search: other nonindexed and in-process citations and Epub Ahead of Print exemplary resources, including MEDLINE, ERIC (ProQuest), etc. Search keywords describing the population and intervention were used. Table 1 presents the inclusion and exclusion criteria.

Table 1 Inclusion and exclusion process.

Inclusion	Exclusion
Research Features: innovative, peer-reviewed empirical research the period from February 2009 to September 2019	Applied only to clinical populations
Population: The general population sample of preschool-aged, primary-aged, and secondary aged children Aged 5 to 20 years	Intervention is not connected to education.
Intervention: All forms of interventions that are connected to or launched by schools. Interventions using a single or more components	Do not try to enhance your exercise or decrease your inactive habits.
Conducted in- or outside school: Aspect designed to promote physical exercise or reduce inactivity. Possibilities include making changes to the rules or surroundings to promote physical activity during active periods throughout the instructional day.	Treatments that do not need extra effort, like mindfulness
Research Designs: Models for longitudinal observational studies, almost experimental studies, and RCT.	Self-realization
Control or comparison group: A group for comparison that is drawn from the same sample or pairs up on important variables. The waiting control group, the nonexposed classification, and the physical education as usual group, or alternative treatment without exercising category	Functionality
Results: Measurements of the main and secondary results at the baseline and postintervention. Positive psychological outcomes are happiness, wellness, medical quality of life, self-confidence, compassion for oneself, and a sense of adaptation, success, and coping. Internalizing mental health issues, including emotional issues, concerns, worry, adverse consequences, and depression signs. The results were assessed using a reliable and valid scoring system appropriate for use with kids and teenagers.	Self-destructive conduct Unhealthy eating habits Psychosomatic illnesses such as chronic pain, restless nights, or stress

2.1. Meta-analysis

A random-effects meta-analysis was carried out to consider the anticipated differences across trials. For both the treatment groups and the control groups at the beginning and beginning of each trial, uncorrected mean scores and standard deviations were provided. Modified mean scores, average modifications, and standard errors (SEs) were used when there were no unmodified mean ratings. When there were several follow-ups, the initial follow-up (posttreatment) was chosen for comparison with the initial score. Although the within-group correlation was not stated, it was 0.7. Using the pooled standard deviations and the average distinction (posttest–pretest) among both groups of participants, the effect value for each trial was determined. The overall disparity in mean scores among the treatment and control groups throughout all trials was reflected by the pooled standardized mean difference (SMD). The adjusted SMD (Hedges' g), confidence intervals (CIs) of 95%, and p values were included to address bias resulting from small sample sizes. A positive Hedges' g value suggested an effective solution, whereas a negative value suggested the reverse.

2.2. Moderator analysis

The moderating evaluation was performed. The studies were divided into 3 groups for narrative evaluation: those with a statistically significant blank operation, those that had a statistically significant adverse impact, and those that experienced statistically significant positive pressure. The various degrees of the putative moderators were subsequently contrasted to these categories.

2.3. Evaluation of research quality

Choice bias, investigative design, confounding variables, structure, data set techniques, withdrawal, and dropout rates were all evaluated for quality. Selection bias was graded on the basis of the percentage of people who agreed to participate and the population's representativeness. Although cluster randomized controlled trials (RCTs) are commonly used, a strong rating for this research design was assigned. The effectiveness of the blinding procedure was measured by the extent to which the responders and evaluators were unaware of the research question. The gathering of data was evaluated according to the evidence offered to support the reliability and validity of the quantity tools used. Finally, dropout and withdrawal rates were calculated from the proportion of individuals who finished the trial. The scores for the above structures were combined to provide a global score. The reliability of the support and suitability of the evaluation for the research topic were also assessed. However, the ranking of these constructions did not impact the overall rating.

Finally, failure and withdrawal rates were calculated from the proportion of individuals who finished the trial. The asymmetric sharing of investigations within the mean effect size in the resulting components was examined via funnel plots to assess the possibility of publishing prejudice throughout the research process. A relationship between the quantity of data and the impact sizes that were built into the meta-detection of each result was examined, followed by Egger's evaluation. The effect of possible bias in publications on meta-analytic aggregated impacts was calculated via the filling technique. This approach calculates the overall impact after accounting for any source bias.

2.4. Preparation of the data

Various considerations had to be made concerning the best way to integrate the scales and measures for every result before the meta-analysis could be carried out. Before the impact values were calculated, the aggregate mean and variance of the intervention groups were ascertained when several treatment groups were compared to a control group. Since the scales' measurements were equal, a total mean and standard deviation (SD) for the results were produced when two pertinent measures were utilized concurrently in the research sample to capture distinct aspects of the same outcome. Instead, one of the measures was chosen to replace the many dependent effect sizes found in research, which would have given more weight to research conclusions with more outcomes.

3. Results and Discussion

3.1. Data collection

Article names and summaries were first assessed independently. Potentially appropriate articles were imported into Endnote Reference Manager for a full-text evaluation. The complete texts were evaluated separately on the basis of predetermined standards. An Excel spreadsheet was created by extracting pertinent data from the included studies, including the author, release year, methodology, demographic and intervention details, control group type, results related to mental wellness, measurement methods, and key findings. The data extraction process addresses any conflicts. To perform a meta-analysis, the information obtained was then sent to sophisticated meta-analysis software. P 0.05 was used as the cutoff for statistical significance. Data on the implementation of the intervention, including its faithfulness, dosage, value, adaptability, and reach, were also collected.

3.2. Performance assessment

The analysis also considered the target group's gender distribution, age range, socioeconomic condition, extent of execution, and research caliber. Internalizing psychological issues was a trend revealed by 2 elements. One factor was age, where treatments had no effect or had a large detrimental effect on younger children while having a large favorable impact on older children. According to previous research (Resaland et al., 2019), physical education courses taught by specialists resulted in significantly greater levels of depression than did the control group. Table 2 shows the results of the publication bias investigation.

Research value was poor, moderate, or well built (Table 3). Two studies were strong quality (Moore et al., 2019; Resaland et al., 2019), 5 were moderate quality (Adab et al., 2018; Resaland et al., 2019; Ruiz-Ariza et al., 2019; Resaland et al., 2019; Ruiz-Ariza et al., 2019), and 5 were low quality (Altunkurek & Bebis, 2019; Breslin et al., 2019; Luna et al., 2019; Moore et al., 2019; Yook et al., 2017). The key flaws were selection bias and the absence of blinding to respondents and evaluators.

Meta-analysis findings: Table 4 displays the outcomes of the 11 meta-analyses. Four of the 11 outcomes assessed—anxiety, resilience, well-being, and the mixed result of good mental health—were significantly impacted by physical exercise. The meta-analysis could not uncover any evidence of a significant combined effect of the treatments compared with the other factors' controls. Those with a limited application level had no effect or favorable influence on the resolution of mental health disorders. High acceptability reaches trials that had a substantial detrimental or no impact. There was no connection between moderator traits and assurance, health, or positive psychological state. The studies set out to reduce sedentary behavior as their main objective. The 4 kinds of therapies we classified as having a "body" emphasis (n = 2) (Resaland et al., 2019; Ruiz-Ariza et al., 2019) are ‘body-education’ (n = 4) (Adab et al., 2018; Breslin et al., 2019; Luna et al., 2019; Resaland et al., 2019; Shannon et al., 2018) and ‘body-mind’ (n = 1) (Yook et al., 2017) and ‘body-education mind’ (n = 5) (Adab et al., 2018, Altunkurek & Bebis, 2019, Moore et al., 2019). By "body," strategies for enhancing physical activity and bodily strength are referred to. To define "education" as learning-focused treatment and "mind" as actions to enhance thought processes.

Table 2 Publication bias analysis.

Results	Number of studies	Experiment of Egger				Trim and fill of Duval Tweedie's				
		β	SE	95% CI	p	Studies trimmed	Effect size as seen		changed the impact size	
							Hedges' g	95% (CI)	Hedges' g	95% (CI)
Depression signs	7	1.832	0.539	0.489; 3.876	0.02	3	-0.008	-0.205;0.212	-0133	-0.320;0.071
nervousness	6	1.951	0.883	-0.088;4.231	0.048	-	0.258	0.042;0.623	0.346	0.062;0.614
Mental challenges	5	-0.582	3.395	-10.657;9.467	0.78	-	-0.047	-0.287;0.155	-0.137	-0.227;0.122
Well-being	10	8.918	3.876	0.582;17.142	0.03	-	0.768	0.345;1.388	0.876	0.346;1.398
The standard of life about health	12	2.852	1.249	0.357;4.275	0.03	-	0.181	-0.021;0.192	0.075	-0.1;0.182
Self-worth and self-esteem	11	0.828	1.128	-2.543;4.285	0.65	-	0.128	-0.088;0.352	0.206	-0.088;0.313
Flexibility	4	-1.08	3.317	-13.750;12.852	0.75	-	0.629	-1.325;0.672	0.642	0.322;1.157
Positive result	5	-1.311	0.91	-3.571;1.869	0.26	-	0.126	-0.323;1.166	0.047	-0.1;0.232
Negative result	5	-2.289	4.562	-21.210;16.93	0.67	3	-0.235	-0.1;0.233	0.133	-2.15;0.317
Internalizing trouble	16	1.165	0.823	0.890;3.087	0.25	3	0.216	-0.110;0.12	-0.022	-0.157;0.166
Positive mental well-being	27	3.813	1.734	0.506;7.332	0.03	-	0.107	0.228;0.404	0.307	0.318;0.401

Table 3 Meta-analysis.

Result	No. studies	Length (INT)	Mean age	Female (%)	Heterogeneity				Impact of the Summary			
					Q	Hedges' g	SE	95% CI	p	df (Q)	p	I2 (%)
Signs of depression	8	9-54	12.11	50	12.396	-0.008	0.102	-0.204;0.19	0.95	6	0.03	60
Stress	7	7-15	14.76	53	13.756	0.349	0.141	0.072;0.62	0.01	7	0.01	65
Emotional problems	6	8-55	9.47	62	17.464	-0.039	0.092	-0.217;0.14	0.67	5	0.00	79
Well-being	12	4-54	11.16	54	53.332	0.875	0.267	0.356;1.39	0.00	8	<0.01	95
Health quality of life	14	4-50	10.47	68	33.981	0.087	0.049	-0.010;0.17	0.07	11	<0.01	73
Self-esteem, self-worth	12	8-56	12.76	69	76.415	0.109	0.102	-0.092;0.30	0.29	10	<0.01	89
Resilience	6	8-14	14.18	50	10.479	0.786	0.217	0.326;1.17	0.01	4	0.015	74
Positive effect	7	4-19	11.12	52	4.085	0.057	0.077	-0.100;0.21	0.48	5	0.39	4
Negative effect	8	4-20	11.13	52	53.26	-0.320	0.500	-1.298;0.66	0.52	4	<0.01	93
Internalizing Problem	16	4-52	10.21	55	52.289	0.015	0.062	-0.107;0.13	0.81	16	<0.01	73
Positive mental health	26	4-52	10.77	61	637.615	0.405	0.101	0.208;0.60	<0.01	27	<0.01	98

The treatments ranged in length from four weeks to four years. In one investigation, the extent of implementation reach was modest (Adab et al., 2018) and high in five studies (Altunkurek & Bebis, 2019; Christiansen et al., 2018; Halliwell et al., 2018; Luna et al., 2019; Moore et al., 2019; Resaland et al., 2019; Resaland et al., 2019; Ruiz-Ariza et al., 2019; Shannon et al., 2018), whereas it was unknown in four studies (Ardic & Erdogan, 2017; Breslin et al., 2019; Shannon et al., 2018; Yook et al., 2017). The control groups received PE usual (Adab et al., 2018; Altunkurek & Bebis, 2019, Breslin et al., 2019; Christiansen et al., 2018; Halliwell et al., 2018; Moore et al., 2019; Resaland et al., 2019; Resaland et al., 2019; Ruiz-Ariza et al., 2019), attention control programs without physical activity (Ardic & Erdogan, 2017), other physical activity (Luna et al., 2019) or waiting list control (Breslin et al., 2019), whereas the control group activity was not provided in one study (Yook et al., 2017). The research designs included RCTs (Halliwell et al., 2018; Moore et al., 2019; Ruiz-Ariza et al., 2019; Yook et al., 2017), RCTs (Adab et al., 2018; Altunkurek & Bebis, 2019; Ardic & Erdogan, 2017; Breslin et al., 2019; Christiansen et al., 2018; Luna et al., 2019; Resaland et al., 2019), and quasiexperiments (Ardic & Erdogan, 2017; Shannon et al., 2018). Internalizing mental health issues and good mental health were also characterized as composite results. Table 4 lists the features of the listed studies.

Table 4 Features of the included studies.

Study (Author, Year)	Design	Intervention Overview	Control Group	Mental Health Outcome	Remark
Adab et al. (2018).	RCT	School-based PA and healthy lifestyle education over 1 year	Standard PE	No significant effect on health-related quality of life	Subgroup analyses showed no treatment variability
Altunkurek and Bebis (2019)	RCT	12-week health tutoring program (interviews, group sessions, PA)	No intervention	Significant improvement in mental health	No data used from health education org
Ardic and Erdogan (2017).	Q-exp	15-week T-COPE CBT program with PA and diaries	Health guidelines without PA	Reduced anxiety, no effect on depression	-
Breslin et al. (2019).	cRCT	12-week PA and healthy eating program (1 session/week)	Standard PE with waitlist	No significant difference in mental health	Used KIDSCREEN measure
Christiansen et al. (2018)	cRCT	Year-long PE, mindfulness, and theme days	Standard PE	No observable effect on self-worth	Delivered by teachers
Halliwell et al. (2018).	RCT	4-week yoga replacing one PE session	Standard PE	No significant differences between groups	-
Luna et al. (2019).	cRCT	6-week Ringo-based sports instruction	Team sports	Significant reduction in negative affect	No effect on positive affect or social anxiety
Moore et al. (2019)	RCT	10-week martial arts and mental training (1x/week)	Late intervention group	Improved resilience and self-confidence	No effect on behavior problems
Olive et al. (2019).	cRCT	4-year specialist-led mobility and movement program	Standard PE	No significant effect on depression	Comparison lasted 12 months
Resaland et al. (2019)	cRCT	7-month ASK program (added PA to PE)	Standard PE	No significant mental health effect	HRQOL data provided
Ruiz-Ariza et al. (2019)	RCT	16-week cooperative high-intensity training	Regular exercise	Increased happiness	Health data collected by researchers
Shannon et al. (2018)	Q-exp	10-week "Healthy Decisions" with daily walk and weekly PA	Standard PE	No significant effect on HRQOL	Used KIDSCREEN score
Yook et al. (2017).	RCT	8-week yoga, running, and Kimball (1x/week)	Article not reported	No group differences in self-worth or enjoyment	Meta-analysis showed significant combined effects

Moderator analysis: Several possible facilitators, including internalizing mental health issues, good mental health, self-esteem, mental health, and HRQOL, were examined and narrated for their impact on the results. Every research result was listed as either a substantial adverse effect, no effect, or an important beneficial effect (not indicated). Body, body-mind, and body-education-mind were the 4 categories into which the interventions fell. One might split the control groups into 3 categories: regular PE, waiting list control, additional physical exercise, and other activities.

Consequences of publication bias in various studies: The results of the meta-analyses for anxiety, joy, elements of life that are associated with health, and positive mental health showed that there might be publication bias. However, publication bias did not affect the contribution of exercise instruction to these 5 outcomes. The so-called randomized trim-and-fill approach was used to alter the adjusted standardized variances in averages for anxiety, health, and the standard of life associated with

happiness and high levels of psychological well-being. Even after applying the random effect cut-and-fill approach and accounting for depressive disorders, the correlation remained negligible, which changed the adjusted standardized variance in values from 0.007 to 0.0132. Importantly, the statistical analyses, especially Egger's test, were much less effective because of the small amount of included research and the broad ranges of confidence.

Restructuring causal inferences through the employment of correlation analyses in the research, introducing bias using self-reported data, and the lack of longitudinal follow-up, controlling for confounding variables, and measuring physical activity in depth diminishes generalizability and research depth (Calestine et al., 2017). The research has no longitudinal follow-up or controlled trials, which restricts causal interpretations. The lack of a clear distinction between clinical youth and nonclinical youth minimizes their applicability. Not investigating anxiety maintenance processes decreases the theoretical depth. Indeterminate school-based mindfulness-based interventions (MBIs) raise doubts as to their effectiveness in reducing youth anxiety (Odgers et al., 2020). The generalizability of the research is restricted because of the largely Caucasian and high-income sample. Self-reported data raise the possibility of bias, since parent reports might not necessarily translate into actual changes in behavior. The lack of direct measures of health outcomes hinders the understanding of the long-term effects of stressors and behavior changes. Research also fails to include the full scope of difficulties encountered by lower-income and racial minority families (Carroll et al., 2020). In contrast, longitudinal follow-up studies and controlled trials involving these methods are lacking. Causal implications are therefore minimized. Self-reports introduce subject bias, weakening the validity of the results. Generalizability is limited by the lack of demographic diversity included in studies. Standardized outcomes are not in place to compromise long-term measures of mental health.

4. Conclusion

This methodical examination suggests that curricular activities promoting physical activity can increase children's and teenagers' anxiety levels, resilience, happiness, and positive mental health. These results should support school-based programs to improve fitness levels, given the benefits of exercise on general wellness. Future studies should include an in-depth account of the workouts of the control group and specify if they are added to or take the place of regular exercise programs to make it simpler to interpret the outcomes. The results also demonstrate the necessity for more thorough fitness programs and consistent monitoring of effectiveness in the setting of schools. To further understand how these measurements work and how they can be used in reality, attention must be given to their mechanisms of action and evaluation.

Ethical Considerations

Not applicable.

Conflict of Interest

The authors declare no conflicts of interest.

Funding

This research did not receive any financial support.

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