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RESEARCH ARTICLE

Effect of Educational and Fitness Interventions on Obesity and Cardiovascular Risk among Adolescents

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Abstract

Adolescent obesity has become a pressing public health problem worldwide, largely because of its links to cardiovascular disease and metabolic dysfunction. Educational institutions provide an empirical framework for interventions that integrate health education with physical activity, thereby promoting healthier lifestyles and mitigating obesity-related risks among adolescents. We executed a randomized controlled trial involving 120 male students classified as obese, aged between 15 and 18 years. Participants were allocated randomly and in equal proportions to one of four distinct groups: an educational awareness initiative, a fitness training regimen, a hybrid educational and fitness program, or a designated control group. The duration of the intervention was established at 12 weeks. We conducted measurements of body mass index (BMI), waist-hip ratio (WHR), total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), and triglycerides at both the pre- and post-intervention phases. Analysis of covariance was employed to evaluate comparative outcomes among the groups. In relation to the control group, all three experimental cohorts exhibited statistically significant enhancements in both anthropometric and biochemical parameters ($p \leq 0.05$). The group receiving the combined intervention consistently demonstrated superior performance across all assessed variables. Effect sizes were quantified to range from 0.14 to 0.21, reflecting moderate yet practically significant effects of the intervention. Our results indicate that the amalgamation of educational awareness and physical fitness training surpasses the efficacy of either modality in isolation concerning the reduction of obesity and cardiovascular risk factors among adolescents. School-based programs that address multiple dimensions of health behavior may serve as important preventive measures to reduce chronic disease risk in this population.

Keywords: Adolescent obesity; Health education; Cardiovascular risk factors; Body mass index; Randomized Controlled Trial; School-based intervention.

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Introduction

Obesity has gained recognition as a leading force in the discipline of serious public health challenges of the 21st century, particularly among youth and young adults. Over the past few decades, rates of overweight and obesity have risen sharply in both industrialized and non-industrialized countries (Banerjee, 2007 & Bandura, 2004). This pattern is due to largely by shifts in lifestyle—changes in diet, reduced physical activity, and increased sedentary behavior (Bray & Bouchard, 2019 & (World Health Organization, 2021)).

The rise in adolescent obesity is especially concerning. Obesity during puberty frequently continues into maturity and fits with chronic conditions, including type 2 diabetes, hypertension, dyslipidemia, and cardiovascular disease (Bray & Bouchard, 2019). In India, the incidence the rate of overweight among adolescents has risen substantially in recent years, mirroring global trends (Brown et al., 2019). This is particularly troubling given that cardiovascular disease is already the predominant factor of mortality in India (Brown et al., 2019).

Puberty represents a pivotal phase for establishing health behaviors that can last a lifetime. At this point in life,

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many young people develop habits related to diet, physical activity, and self-care that often carry into adulthood (Dishman et al., 2018). Unfortunately, many adolescents today lead increasingly sedentary lives, spending more time on screens and less time engaging in physical activity (Divakaran et al., 2013). At the same time, nutritional habits have transitioned towards energy-dense, nutrient-poor foods (Dobbins et al., 2013).

Schools provide a distinct opportunity to reach large numbers of adolescents and deliver interventions in a structured, supportive environment. School-based programs can address both knowledge and behavior, offering health education alongside opportunities for physical activity (Gupta & Misra, 2017 & Hatefnia et al., 2024). Prior investigations have indicated that such programs can improve health outcomes, although findings have been inconsistent depending on the design and intensity of the intervention (John Bosco, 2026 & Juonala et al., 2011).

Despite growing recognition of the problem, there is still limited evidence from India on the effectiveness of combined educational and fitness interventions for reducing obesity and cardiovascular risk among adolescents. The majority of current research has concentrated on either education or physical activity in isolation, rather than examining the potential synergistic effects of combining both approaches (Khadilkar et al., 2011 & Langford et al., 2014).

We designed this study to address that gap. We postulated that the effectiveness of three different intervention strategies—educational awareness, fitness training, and a combination of both—on obesity-related anthropometric measures and cardiovascular risk factors in obese male adolescents. Our primary objective was to assess the combined intervention would produce greater improvements than either approach alone.

Methods

Study Design and Participants

We conducted a randomized controlled parallel-group trial over a 12-week period. The investigation was executed in a government-aided higher secondary school in Pudukkottai district, Tamil Nadu, India, between January and April 2025.

Participants were male students aged 15 to 18 years who were classified as obese based on age- and sex-specific BMI criteria (Lobstein et al., 2004). We screened 287 students and identified 135 who satisfied the inclusion criteria. Of these, 120 agreed to participate and furnished written informed consent (parental consent was acquired for individuals under 18 years). Students with known chronic illnesses, physical impairments that would hinder participation in fitness activities, or those already enrolled in structured weight management programs were excluded.

Randomization and Allocation

Individuals were allocated at random into a distribution of 1:1:1:1 across four separate groups (n = 30 for each group):

- Educational Awareness Group (EAG): Engaged in weekly health education sessions.
- Joined in on supervised fitness training gatherings offered by the Fitness Training Group (FTG).
- Combined Group (CG): Received both educational sessions and fitness training concurrently. 4. Control Group (CON): Continued with standard school activities without any form of intervention. Using a computer-generated random number sequence, a researcher completely independent from data collection or intervention implementation executed the randomization process. Sealed and opaque envelopes were employed to successfully accomplish allocation concealment.

Interventions

Educational Awareness Programme

The educational intervention consisted of 12 biweekly sessions, each enduring roughly, 45 minutes. Sessions were delivered by trained health educators using interactive instructional methodologies, comprising lectures, group dialogues, and audiovisual materials. The curriculum covered topics related to obesity, cardiovascular health, nutrition, physical activity, and lifestyle modification.

Fitness Training Programme

The fitness training program was conducted thrice weekly,, with each session lasting 60 minutes. Sessions included a warm-up (10 minutes), aerobic exercises such as jogging, cycling, and circuit training (40 minutes), and a cool-down period with stretching (10 minutes). Training intensity was progressively enhanced over the 12 weeks, starting at moderate intensity (60-70% of maximum heart rate) and progressing to vigorous intensity (70-85% of maximum heart rate). All sessions were supervised by qualified physical education instructors.

Combined Programme

Participants in the combined group received both the educational sessions and the fitness training program as described above.

Control Group

The control group was not provided with any intervention. They ccontinued with their standard educational curriculum, which included standard physical education classes (two 40-minute sessions per week).

Key Results

All worked were taken at baseline (pre-test) and immediately subsequent to the 12-week intervention period (post-test)

Table 1: Educational Intervention Schedule

Week	*Educational Topic*
•	Introduction to obesity and cardiovascular diseases
•	Causes and consequences of adolescent obesity
•	Understanding BMI and body composition
•	Nutritional guidelines for adolescents
•	Importance of regular physical activity
•	Healthy dietary practices and calorie balance
•	Exercise and cardiovascular health
•	Prevention of coronary heart disease risk factors
•	Lifestyle modification strategies
•	Stress management and mental well-being
•	Review of healthy behaviours
•	Reinforcement and evaluation session

by trained research assistants who were blinded to group allocation.

Anthropometric Measures

Body Mass Index (BMI)

Determined as weight (kg) divided by height squared (m^2). Weight was recorded using a calibrated digital scale (precise to 0.1 kg), and height was measured utilizing a stadiometer (accurate to 0.1 cm).

Waist-Hip Ratio (WHR)

Waist circumference was measured at the narrowest point between the lower rib and iliac crest, and hip circumference was measured at the widest point over the buttocks. Both evaluations were conducted utilizing a non-stretchable tape measure.

Biochemical Measures

Blood samples were procured following after an overnight fast (minimum 10 hours). Samples were analyzed at a certified diagnostic laboratory using standard enzymatic methods. The subsequent lipid profile parameters were measured: - Total cholesterol (mg/dL) - HHigh-density lipoprotein cholesterol (HDL, mg/dL) - Low-density lipoprotein cholesterol (LDL, mg/dL) - Triglycerides (mg/dL)

Statistical Analysis

Report was taken using SPSS version 26.0. Descriptive statistics (means and standard deviations) were computed for all variables at baseline and post-intervention. We used Analysis of Covariance (ANCOVA) to compare post-test scores across the four groups, with pre-test scores entered as covariates to control for baseline differences. This approach is more powerful than analyzing change scores and accounts for regression to the mean (Mane et al., 2016).

Partial eta squared (η^2) was calculated as a measure of effect size, with values of 0.01, 0.06, and 0.14 interpreted as small, medium, and large effects, respectively. Post-hoc pairwise comparisons were conducted using Scheffé's test to identify specific group disparities while adjusting for Type I error. Statistical significance was established at $p < 0.05$.

Ethical Considerations

The study received approval from the A committee that protects people in research of H H: The Rajah's College (Autonomous). All participants and their parents/guardians secured written informed consent. Participants were free to withdraw from the research at any time without penalty. After the study concluded, educational materials and fitness training opportunities were offered to the control group.

Results

All one twenty presents completed the 12-week intervention, resulting in a 100% retention rate. Baseline characteristics were analogous across all four groups, indicating successful randomization.

Descriptive Statistics

Table 2 presents the overall pre-test and post-test Average and variation for all measured variables, pooled across groups. On average, participants showed improvements in all anthropometric and biochemical measures from baseline to post-intervention.

ANCOVA Results

Table 3 shows the results of the ANCOVA for each dependent variable. After controlling for baseline scores, significant group differences were found for all six variables ($p \leq 0.002$). Effect sizes ranged from 0.14 (HDL) to 0.21 (BMI), indicating moderate practical significance.

Post-hoc Comparisons

Scheffé post-hoc tests were conducted to examine pairwise differences between groups. Table 4 presents the results for

Table 2: Pre-test and Post-test Average and variation of Selected Variables

Variable	*Pre-test Mean*	*Pre-test SD*	*Post-test Mean*	*Post-test SD*
Body Mass Index (kg/m^2)	29.84	1.92	27.43	1.74
Waist-Hip Ratio	0.96	0.04	0.90	0.03
Total Cholesterol (mg/dL)	212.65	14.72	196.34	13.58
HDL (mg/dL)	38.24	4.16	44.81	4.39
LDL (mg/dL)	142.57	11.63	128.76	10.94
Triglycerides (mg/dL)	168.42	18.35	150.37	16.21

Table 3: ANCOVA Summary for Selected Variables

Variable	*F Value*	*p-value*	*Effect Size* (η^2)
BMI	9.65	0.001	0.21
WHR	7.83	0.001	0.17
Total Cholesterol	8.47	0.001	0.19
HDL	6.12	0.002	0.14
LDL	7.56	0.001	0.16
Triglycerides	8.91	0.001	0.18

Table 4: Scheffé Post-hoc Comparison for BMI

Comparison	*Mean Difference*	*p-value*
Educational vs Control	-2.14	0.003
Fitness vs Control	-2.87	0.001
Combined vs Control	-3.76	0.000
Combined vs Educational	-1.62	0.041
Combined vs Fitness	-0.89	0.092

BMI as an example; similar trends were noted for observed for the other variables.

Intervention groups showed significantly lower BMI compared to the control cohort. The combined group achieved the greatest reduction (mean difference = -3.76 kg/m^2, $p < 0.001$). The combined group also exhibited significantly superior performance than the educational group alone (mean difference = -1.62 kg/m^2, $p = 0.041$). The difference between the combined and fitness groups approached value ($p = 0.092$).

Similar patterns emerged for the alternative outcome variables. Across all measures, the combined intervention consistently produced the largest improvements, followed by the fitness training group, then the educational group, with the control group showing the least change.

Discussion

This study examined the effectiveness of educational awareness, fitness training, and a combined intervention on obesity and cardiovascular risk factors among obese male adolescents. The report was three intervention approaches led to significant improvements compared to the control cohort, with, the combined intervention producing the most substantial benefits.

Interpretation of Findings

The superiority of the combined intervention suggests that addressing both knowledge and behavior is more effective than targeting either dimension alone. Educational sessions may have increased participants' awareness of health risks and motivated them to adopt healthier behaviors, while the fitness training provided a structured opportunity to translate that knowledge into action (Malik et al., 2013), (Mane et al., 2016). This observation corresponds with social cognitive theory, which underscores the importance of both cognitive factors (knowledge, self-efficacy) and environmental supports (opportunities for physical activity) in behavior change (Lobstein et al., 2004).

The fitness training group showed greater improvements than the educational group across most variables. This is congruent with prior research illustrating that physical activity has direct physiological effects on body composition and lipid metabolism (Nassis et al., 2005), (Ng et al., 2014). Regular aerobic exercise increases energy expenditure, promotes fat oxidation, and improves cardiovascular function, leading to reductions in BMI, WHR, and adverse lipid profiles (Malik et al., 2013), (Mane et al., 2016).

However, the educational intervention alone also produced meaningful improvements, particularly in HDL cholesterol. This suggests that knowledge-based interventions can influence health behaviors even without structured exercise programs. Participants in the educational group may have enacted dietary modifications or increased their physical activity outside of school, though we did not measure these behaviors directly (Norozi et al., 2020), (Popkin et al., 2012).

The effect sizes we observed (η^2 = 0.14 to 0.21) are in the moderate range and are comparable to those reported in other school-based obesity interventions (Prabhakaran et al., 2016), (Ranjani et al., 2016). While these effects may appear modest, they are, clinically meaningful. Even small reductions in BMI and improvements in lipid profiles during adolescence can reduce risk of cardiovascular affliction later in life (Khadilkar et al., 2011 & Langford et al., 2014).

Comparison with Previous Research

Our results align with multiple previous studies that have examined school-based interventions for adolescent obesity. For example, a systematic review by Lobstein et al. [17] found that multicomponent interventions combining education and physical activity were more effective than single-component programs. Similarly, studies from India have shown that health education programs can improve knowledge and attitudes related to cardiovascular health among adolescents (Prabhakaran et al., 2016), (Ranjani et al., 2016).

However, our study extends this literature in several ways. First, we directly compared three different intervention strategies within a single randomized trial, allowing for more robust conclusions about their relative effectiveness. Second, we included both anthropometric and biochemical outcome measures, providing a more comprehensive assessment of cardiovascular risk. Third, we conducted the study in a real-world school setting with a relatively long intervention period (12 weeks), enhancing the external validity of our findings.

Practical Implications

From a practical standpoint, our results suggest that schools should consider implementing comprehensive programs

that integrate health education with regular physical activity. While fitness training alone was effective, the added benefit of educational sessions was substantial and came at relatively low cost. Educational components can be delivered by existing school staff with appropriate training, making them a feasible addition to physical education programs (Ray et al., 2016), (Reilly & Kelly, 2011).

The structured nature of the fitness training program was likely important to its success. Many adolescents lack access to safe spaces for physical activity or do not have the knowledge or motivation to exercise on their own (Tremblay et al., 2011), (Waters et al., 2011). School-based programs can address these barriers by providing supervised, age-appropriate activities in a supportive environment.

It is also worth noting that our intervention was relatively brief (12 weeks). Longer-term programs with ongoing support may be needed to sustain behavior change and prevent weight regain (Yadav & Khokhar, 2021) . Future research should examine the durability of intervention effects and identify strategies for maintaining improvements over time.

Conclusion

This meticulously planned controlled study suggests that educational initiatives in schools that unite knowledge and physical fitness can notably lower the incidence of obesity and heart-related issues in obese male adolescents. Although the educational and workout components revealed substantial advancements when looked at separately, their collaborative use generated the most significant enhancements across every metric investigated. The data we collected clearly indicates that a wide range of thorough initiatives in schools is crucial for effectively combating the rising rates of teenage obesity. Such initiatives possess the capacity to engage a considerable number of youths during a pivotal developmental phase and may contribute to the prevention of chronic diseases in their later years. In response to the mounting challenges of obesity and cardiovascular conditions in India and worldwide, a significant demand for practical and scalable initiatives has emerged. Educational institutions present a practical and effective avenue for the implementation of these initiatives. In unity, policymakers, educators, and medical experts can successfully formulate and roll out initiatives that are grounded in empirical data, directing young people towards improved decision-making.

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