Effect of structured physical activity programs on physical fitness and body compotition among junior high school: a randomized controlled trial

Efecto de los programas de actividad física estructurada sobre la aptitud física y la composición corporal en estudiantes de secundaria: un ensayo controlado aleatorizado

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Abstract

Introduction: Students in their teens must gain physical fitness and be able to manage their body composition.
Objective: A structured physical activity program affects body composition and physical fitness.
Methodology: The research employed an experimental method. The sample consisted of 60 junior high school students. Stratified random sampling was used, considering gender, BMI, and initial physical fitness levels. The structured physical activity intervention program was implemented thrice weekly for 60 minutes per session.
Results: Independent t-test showed significant push-up, sit-up, and VO2 max increases among post-test students ($p < 0.05$). Paired t-test results between pretest and posttest assessments revealed t-values exceeding p-values. Significant differences emerged between the experimental and control groups ($p = 0.033$). The experimental group demonstrated lower BMI with a difference of 1.04, showing a moderate effect size ($d = 0.563$). Body fat percentage was significantly lower in the experimental group ($p = 0.017$) with a difference of 0.36% and a moderate effect size ($d = 0.634$). Visceral fat showed highly significant differences ($p = 0.003$), with the experimental group achieving greater reduction (difference of 1.00) and large effect size ($d = 0.806$). All variable pairs exhibited significant relationships, with correlation strengths ranging from strong (0.884-0.937) to very strong.
Discussion: The findings demonstrate that a structured physical activity program incorporating fundamental movement skills development, circuit training, and sport-based activities provides multiple benefits for students.
Conclusion: The intervention effectively improved physical fitness parameters and positively altered body composition metrics, suggesting valuable applications for school-based physical education programs.

Keywords

Structured physical activity (PA), physical fitness, and body composition.

Resumen

Introducción: Los estudiantes adolescentes deben mejorar su condición física y ser capaces de controlar su composición corporal.
Objetivo: Un programa estructurado de actividad física influye en la composición corporal y la condición física.
Metodología: La investigación empleó un método experimental. La muestra consistió en 60 estudiantes de secundaria. Se utilizó un muestreo aleatorio estratificado, considerando género, IMC y nivel inicial de condición física. El programa estructurado de intervención de actividad física se implementó tres veces por semana durante 60 minutos por sesión.
Resultados: Las pruebas t independientes mostraron aumentos significativos en flexiones, abdominales y VO2máx entre los estudiantes de la prueba posterior ($p < 0,05$). Los resultados de la prueba t pareada entre las evaluaciones pretest y postest revelaron valores t superiores a los valores p. Se observaron diferencias significativas entre los grupos experimental y control ($p = 0,033$). El grupo experimental presentó un IMC más bajo, con una diferencia de 1,04, mostrando un tamaño del efecto moderado ($d = 0,563$). El porcentaje de grasa corporal fue significativamente menor en el grupo experimental ($p = 0,017$), con una diferencia del 0,36 % y un tamaño del efecto moderado ($d = 0,634$). La grasa visceral mostró diferencias altamente significativas ($p = 0,003$), y el grupo experimental logró una mayor reducción (diferencia de 1,00) y un tamaño del efecto amplio ($d = 0,806$). Todos los pares de variables mostraron relaciones significativas, con niveles de correlación que variaron de fuertes (0,884-0,937) a muy fuertes. Discusión: Los hallazgos demuestran que un programa estructurado de actividad física que incorpora el desarrollo de habilidades motoras fundamentales, entrenamiento en circuito y actividades deportivas proporciona múltiples beneficios a los estudiantes.
Conclusión: La intervención mejoró eficazmente los parámetros de aptitud física y modificó positivamente las métricas de composición corporal, lo que sugiere valiosas aplicaciones para los programas de educación física escolar.

Palabras clave

Actividad física estructurada (AF), aptitud física, composición corporal.

Introduction

Adolescent body composition, including Body Mass Index (BMI), body fat percentage, and aerobic capacity (VO2 Max), are important indicators in assessing health and physical fitness. In the school context, these factors can be influenced by various interventions and social environments. A school-based high-intensity interval training (HIIT) program reduced body weight, BMI, and body fat percentage after eight weeks (Bogataj et al., 2021). School environments with more physical activity resources may predict lower BMI in adolescence (Niu et al., 2019). This difference between men and women also affects body balance, women show better balance (Rusek et al., 2021) (Čech et al., 2023). Women tend to experience increased adiposity, while men experience increased muscle mass (Toselli et al., 2021). Adolescent body composition is influenced by various factors including physical and nutritional interventions, socioeconomic status, and school and social environment.

Physical activity and academic achievement among adolescents have become serious concerns in global education. Recent studies have shown a significant decline in physical activity levels among students. Globally, fewer than 30% of children and adolescents meet the recommended 60 minutes of MVPA per day (Neil-Sztramko et al., 2021). In Germany and China, compliance rates are similarly low, with only about 13-30% of children meeting the guidelines (Fan & Cao, 2017) (Jekauc et al., 2012). In Qatar, only 38% of high school children met the MVPA guidelines, with boys being more active than girls (Ahmed et al., 2023). This behavioral trend continues as academic pressure increases and screen time increases, potentially affecting physical fitness and academic performance. Recommendations include incorporating activity and ensuring that physical activity is fun and developmentally appropriate.

Educational research has focused a lot of attention on the connection between structured physical activity and cognitive function. Boys tend to be more physically active than girls, achieving higher moderate-to-vigorous physical activity values (Tanaka, Abe, et al., 2021). Physical education should fulfill physical activity guidelines and be linked to academic achievement and better school-life experiences. Research has shown that in China, adolescents who met the PA guidelines had better scores in mathematics, Chinese, and English, and reported better school-life experiences (Yang et al., 2023). Physical activity programs have positive effects on academic achievement in language and reading, but results are inconsistent (Loturco et al., 2022). However, despite this evidence, many educational institutions are reducing physical education programs in favor of increasing academic learning time. Schools are trying to create a paradoxical situation in an attempt to improve academic performance which can be counterproductive.

Even though other studies have examined the connection between academic success and physical activity, most studies have been observational or short-term. There is a significant gap in the literature regarding randomized controlled trials that specifically examine the impact of structured physical activity programs on academic achievement and physical fitness among junior secondary school students. Good physical fitness can improve cognitive function and academic performance. (Quka & Selenica, 2022). Coordinative training can improve motor and cognitive skills that support academic achievement (Zhou et al., 2019). Mixed findings have been found in studies on how structured physical activity programs affect junior high school student's academic performance and level of physical fitness. This age group is crucial as it represents an important period in physical development and the establishment of an academic foundation.

Students' adherence to physical activity guidelines decreases with age, especially during the transition from primary to secondary school (Tanaka, Kyan, et al., 2021). In Indonesia, this issue is further complicated by the variation in physical education policies between school levels. Some schools reduce physical education class hours to focus on subjects tested in the National Examination, while other schools maintain or even increase their physical activity programs. This non-uniformity creates gaps in students' physical and cognitive development. In addition, existing studies show inconsistent results, possibly due to variations in program structure, intensity, and implementation methods.

Schools in different socioeconomic regions often have varying access to physical activity resources and programs, potentially contributing to educational and health disparities. The student whose object of study is sports faces a series of needs associated with their lifestyle and physical condition (Becerra Patiño et al., 2024). This study sought to address these disparities by conducting a randomized controlled trial to examine the impact of a structured physical activity program on body composition and

physical fitness among junior high school students. Overall, structured physical activity programs in schools may provide benefits for controlling the body composition and physical fitness of junior high school students. However, the effectiveness of these programs is strongly influenced by the intensity of the activities, the qualifications of the teachers, and the duration of the program. Despite some inconsistent results, evidence suggests that regular and structured physical activity can be an effective strategy to improve students' physical fitness.

Method

This study used a randomized controlled trial (RCT) design with two groups, namely the experimental (structured physical activity program) and the control group (regular physical activity). The duration of the study was 16 weeks (1 semester) with a pre-test guideline conducted before the intervention and a post-test after the program ended. The independent variable is a structured physical activity program. Dependent variables are physical fitness (push-ups, Sit-ups, VO2 max) and body composition. External variables are gender, age (13-14 years), initial physical fitness level, health status (physical and mental health), and parental permission.

Participants

The population was 8th-grade junior high school students (aged 13-14 years) with a sample size of 60 students consisting of 37 boys and 23 girls (30 students per group). The sampling technique was Stratified random sampling which took into account gender, Body Mass Index (BMI), initial physical fitness level, and previous academic achievement. The criteria for participants who took part in the study were 8th-grade junior high school students, physically and mentally healthy, and had permission from their parents.

Procedure

Structured physical activity intervention program with a frequency of 3 times a week and a duration of 60 minutes per session. This program is implemented before the first lesson. The components of the physical activity program are as follows: warming up (dynamic stretching 10 minutes), core activities are divided into four (4) weeks, namely weeks 1-4 development of fundamental movement skills, weeks 5-8 circuit training (physical fitness/tag games, strength/bodyweight exercise, agility/obstacle course), weeks 9-12 sport-based activities (modified team sports, small-side games, sport skill challenges), weeks 13-16 combined activities (circuit training and sport-based activities), 10-minute cool down (static stretching).

Development of Fundamental Movement Skills low-moderate intensity with a percentage of 50-65% Maximum Heart Rate (MHR) learning duration 30-55 minutes. Circuit Training medium-high intensity with a percentage of 60-80% MHR, learning duration 40-60 minutes. Sport-based activities medium-high intensity with a percentage of 65-85% MHR, learning duration 55-65 minutes. Combined Activities medium-high intensity with a percentage of 70-90% MHR, learning duration 60-80 minutes. All learning activities also pay attention to the training zone of all participants based on HRmax measurements and increased learning activities every week.

Data analysis

Data collection based on physical fitness tests, namely the Multistage Fitness Test (MFT) is a fitness test that is done by running back and forth as far as 20 meters (Lockie et al., 2021), strength tests are push-ups and sit-ups for 60 seconds. This protocol push-up test has test-retest reliability values of r = 0.93 for both male and female students (Hashim et al., 2018). The push-up test is a measure of upper body muscle strength and endurance (Ajisafe, 2019). The one-minute half sit-up test demonstrated reliability (r = 0.98) (Rifki et al., 2022). Body mass index, waist circumference, and body fat percentage (skinfold measurement) are used to measure body composition. The sites selected were the Biceps, Quadriceps, and Abdomen. The measurement used was a caliper by using a caliper (Grimes & Franzini, 1977) to pinch the skin and pull the fat from the muscle. Measure the thickness of the skin folds with a caliper. Check each point at least twice in the same session. Meanwhile, to measure visceral fat and BMI, Tanita body composition is used (Parker et al., 2022). The first week was dedicated to gathering pretest data,

while the final week was dedicated to administering the posttest. Data analysis is a normality and homogeneity test, an independent t-test to compare groups, a Paired t-test for comparison of the pretest and posttest, and a correlation to determine the relationship between dependent variables.

Results

Physical activity and exercise play an important role in maintaining fitness and healthy body composition, especially at junior high school age. This study aimed to evaluate the effectiveness of structured physical activity programs and sports in looking at students' fitness and body composition. The findings emphasise the importance of structured physical activity programs in supporting students' health and fitness. (Table 1) describes descriptive statistics of physical tests, (Table 2) Descriptive Statistics of Body Composition, (Table 3) tests of normality and homogeneity of data.

Table 1. Descriptive Statistics of Physical Test

Variables	Group	Pretest	Posttest	Min - Max
		Mean (St.Dev)	Mean (St.Dev)	
Push-Up	Control	13,9 (2,3)	16,7 (2,0)	11,0 – 19,0
	Experiment	22,6 (2,1)	29,2 (2,5)	25,0 – 33,0
Sit-Up	Control	20,5 (2,8)	22,3 (2,5)	16,0 – 25,0
	Experiment	38,5 (2,1)	43,0 (1,8)	34,8 – 45,7
VO_2max (ml/kg/min)	Control	14,1 (2,1)	22,6 (2,1)	10,0 – 17,0
	Experiment	38,4 (2,0)	43,0 (1,8)	34,9 – 42,3

Table 2. Descriptive Statistics of Body Composition

Variables	Control Group				Experiment Group			
	Mean	Min	Max	St. Dev	Mean	Min	Max	St. Dev
Height	161,87	145,0	175,0	8,72	160,63	143,0	175,0	10,12
Weight	52,86	37,14	72,41	10,74	51,39	36,59	69,25	11,23
BMI	22,14	19,80	27,70	1,96	21,10	18,70	29,30	2,31
Body Fat	20,0	18,10	22,10	1,28	19,64	17,70	21,7	1,15
Visceral fat	5,77	4,00	7,0	0,97	4,77	3,0	6,0	0,90

Table 3. Normality and Homogeneity of Data

Normality			Homogeneity		
Variables	Group	Shapiro-Wilk	Variables	Levene Statistic	p-value
Push-up	Control	0,962	Push-up	0,178	0,677
	Experiment	0,955	Sit-up	0,532	0,472
Sit-up	Control	0,971	VO_2max	0,233	0,633
	Experiment	0,964			
VO_2max (ml/kg/min)	Control	0,968			
	Experiment	0,960			

Based on the results of the Shapiro-Wilk analysis for data normality p-value > 0.05 so that all data are normally distributed. The homogeneity of variance between the control and experimental groups with Levene's test p-value> 0.05 which means the group variance is homogeneous. Next is the statistical analysis of the independent t-test test to compare post-test differences between the control and experimental groups on each variable. Paired t-test compares the difference between the pretest and post-test in each group for each variable. The Independent t-test Physical test is shown in (Table 4), the independent t-test Body Composition test in (Table 5), and while paired t-test test in (Table 6). The following are the results of the statistical analysis.

Table 4. Independent t-test Physical test

Variables	t-value	df	p-value
Push-up	17,326	58	< 0,001
Sit-up	31,437	58	< 0,001
VO2max (ml/kg/min)	32,829	58	< 0,001

Table 5. Independent t-test Body composition

Variables	Group	Mean Difference	t-value	p-value	Effect Size (d)
BMI	Control Experiment	1,04	2,183	0,033	0,563
Body Fat (%)	Control Experiment	0,36	2,457	0,017	0,634
Visceral fat	Control Experiment	1,00	3,124	0,003	0,806

Table 6. Paired t-test

Variables	Group	t-value	df	p-value
Push-up	Control Experiment	4,264 29.027	29 29	< 0,001 < 0,001
Sit-up	Control Experiment	5,703 35,149	29 29	< 0,001 < 0,001
VO_2max (ml/kg/min)	Control Experiment	14,00 35,149	29 29	< 0,001 < 0,001

Based on the data analysis for all variables, the p-value of the independent t-test <0.05. The post-test measurement shows a substantial difference between the experimental group and the control group. For all variables and both groups, the p-value of the Paired t-test <0.05. The pretest and posttest results for each group differ significantly. The experimental group and the control group differed significantly on post-test assessments for every variable (push-ups, sit-ups, VO2 max), according to the independent t-test results. Paired t-test results show that there are significant differences between the pretest and post-test in each group for all variables. There was a significant difference between the control and experimental groups (p=0.033). The experimental group showed a lower BMI with a difference of 1.04, the effect size showed a moderate effect (d=0.563). There was a significant difference in body fat percentage between the two groups (p=0.017), the experimental group had a lower body fat percentage with a difference of 0.36%. Effect size showed a moderate effect (d=0.634). There was a highly significant difference in visceral fat (p=0.003), the experimental group showed a greater reduction in visceral fat with a difference of 1.00. Effect size showed a large effect (d=0.806). Next is the correlation analysis to test the relationship between variables (push-ups, sit-ups, VO2 max). The following are the results of the correlation analysis in (table 7.)

Table 7. Correlation Analysis Between Dependent Variables

Variables	Push-up	Sit-up	VO_2max
Push-up		0,892	0,884
Sit-up	0,892		0.937
VO_2max (ml/kg/min)	0.884	0.937	

Based on the correlation analysis data, all p-values in the correlation analysis were <0.05. There was a significant relationship between all pairs of variables. The strength of the correlations varied from strong (0.884 - 0.937) to very strong. The findings support that structured physical activity and exercise programs also have a strong relationship with each other.

Discussion

This dynamic warming-up program can help to physically prepare students to prevent injury during the intervention. Research also states that dynamic stretching for 10 minutes can reduce the risk of injury (Emery et al., 2020). The development of basic movement skills in weeks 1 to 4 aims to build the foundation of the student movement for other fitness activities. While the circuit training program aims to improve students' strength and fitness. Sport-based activities are modified team sports that will challenge sports skills. So that students' physical participation and skills will increase. Combined activities are a combination of circuit training and sport-based activities that aim to provide variety and challenge to increase student motivation and fitness. Incorporating revitalization into the athletic curriculum helps guarantee ongoing athletic success and improve students' physical fitness (Landicho & Andal, 2023).

Based on the data analysis, there was a significant increase in repetitions in the push-up variable from 22.6 to 29.2 repetitions. A significant increase in the sit-up variable also increased from an average of 38.5 to 43.0 repetitions. There was a 25% increase in upper body strength after the 12-week program. (Mavilidi et al., 2019). In a youth training program, significant improvements in push-up and sit-up tests after four weeks highlight the effectiveness of structured physical activity. (Cheng et al., 2024). Weeks 5-8 (Circuit Training Programme) impacted bodyweight exercise and increased upper body endurance. Obstacle course training aided functional strength development. This is following research which states that a circuit training program carried out for 8 weeks can significantly increase muscle strength (Milenković, 2022) (Invernizzi et al., 2020). This result was also supported because the structured physical activity program was implemented for 16 meetings, with a frequency of 3 times a week and with a duration of 60 minutes per meeting. The results of this intervention are in contrast to the findings that a 4-week class-based high-intensity training session did not show significant improvement in push-up and sit-up ability (Engel et al., 2019). Although structured programs can increase total physical activity, there are differences in the intensity of activity achieved (West et al., 2021). This could be due to the possibility of students taking daily active breaks, while still engaging in physical activity outside of the program.

The results of this study also showed an effect on students' BMI, Body Fat Percentage, and Visceral Fat. There was a significant effect from the findings of this study as well as the benefits gained by the students during the intervention. Students have an active and healthy life through interests and, developing projects to assess experiences (Martínez et al., 2024). Although the results showed differences in these three variables, other research findings suggest that structured activity programs can improve students' physical fitness. Fundamental Movement Skills-based programs have been shown to increase skill competence and moderate to vigorous physical activity (Lee et al., 2020). In the classroom, a six-week core fitness warm-up regimen markedly increased trunk muscular endurance, mobility, flexibility, and balance (Chang et al., 2020). The multi-component intervention effectively increased physical activity levels and physical fitness (Leung et al., 2019). An individually supervised physical activity program in students with effects persisting for 3 months (Bluechardt & Shephard, 1995). The findings of this study contrasted with the 16-meeting structured physical activity program which had an effect on body composition development.

A structured physical activity program that includes a warm-up, core activities that vary every few weeks, and a cool-down, is effective in improving the physical fitness and body composition of junior high school students. The importance of a holistic and integrated approach in supporting children's physical activity (Sari et al., 2024). The program also helps in the development of basic movement skills, increases participation in physical activity and reduces the risk of injury. One of the main challenges in implementing structured physical activity programs in schools is the limited time in the school curriculum. However, research shows that even short, regular exercise sessions can provide significant benefits (Huhtiniemi et al., 2023). These structured physical activity programs are well focused on improving endurance, strength, and can significantly improve push-up and sit-up abilities in a variety of populations. These improvements are influenced by factors such as age, training intensity, and program structure, with younger and more intensive individuals often experiencing greater benefits.

Conclusions

A structured physical activity programs that includes warm-up, fundamental movement skills development, circuit training, sport-based activities, and cool-down can provide a range of benefits for junior high school students. These benefits include improved BMI, Body Fat Percentage, and Visceral Fat, as well as improved physical fitness and motor skills. The implementation of this programs in the physical education curriculum can help improve the overall physical and mental health of students. Further research could link physical activity outcomes to agility, speed and improved academic performance.

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