

EFFECTS OF THE FITKIDS PROGRAM ON PHYSICAL ACTIVITY LEVELS AND CARDIOVASCULAR FITNESS AMONG ELEMENTARY SCHOOL STUDENTS

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Abstract Elementary school students in urban areas are experiencing low physical activity and declining cardiovascular fitness, threatening their long-term health. This study examined the effectiveness of the 12-week FitKids Program in improving physical activity and cardiovascular fitness among 9–10-year-old students in Tasikmalaya City. A cluster-allocated (school-based) quasi-experimental design was conducted in six urban schools (three FitKids (EXP); three regular PE (CON), with non-random allocation based on feasibility and scheduling. The final sample comprised 150 students (experimental n75, control n75). Physical activity was assessed with the Indonesian-adapted Physical Activity Questionnaire for Children (PAQ-C), and cardiovascular fitness

via average Multistage Fitness Test (MFT) scores. The FitKids Program showed strong content validity (mean Aiken's $V=0.90$) and acceptable reliability ($\alpha=0.612$). Descriptively, EXP PAQ-C scores increased from 2.15 to 5.21, compared with 2.26 to 4.40 in CON, while MFT improved from 31.74 to 41.75 (EXP) versus declining from 28.41 to 27.17 (CON). After school clustering adjustment (ICC PAQ-C=0.129; ICC MFT=0.045) and baseline covariate control, mixed-effects modelling revealed no significant intervention effect on physical activity ($\beta=0.88$, $p=0.478$, $d=0.33$) but strong effects on cardiovascular fitness ($p<0.001$, $d=0.74$). These findings demonstrate FitKids effectively enhances cardiovascular fitness through structured interval and circuit training within regular PE sessions, though broader physical activity changes require longer duration or complementary strategies. The cluster-adjusted approach underscores the importance of accounting for school-level dependencies in educational interventions.

Key words: physical activity, cardiovascular fitness, physical education, elementary school students

Introduction

Physical and sports education (PE) as a teaching subject provides an environment conducive to the development of life skills through the practice of individual and collective physical activities (Ouaddou, et al., 2025). As simple as it may sound, being physically active might be the very thing most people from across the world need to significantly change their lives for better (Bujdoš, et al., 2025). Physical activity and cardiovascular fitness represent two fundamental indicators supporting the health of elementary school children. Adequate physical activity plays an important role in physiological function and cognitive development. Numerous studies demonstrate that participation in physical activity improves cardiac health, aerobic capacity, and energy metabolism (Cumillaf et al., 2020; Cumillaf et al., 2021). Cumillaf et al. affirmed that physical activity is directly associated with reduced obesity risk and improved cardiovascular fitness, which may contribute to disease prevention in adulthood (Cumillaf et al., 2019). Furthermore, active engagement in sports positively impacts children's learning readiness (Fonseca del Pozo et al., 2017). Another study by Nqweniso et al. demonstrated that good cardiovascular fitness can help prevent overweight and reduce future hypertension risk (Nqweniso et al., 2020). These findings underscore the necessity for school-based interventions focusing on enhancing physical activity and cardiovascular fitness.

Modern lifestyle transformation significantly impacts children's physical activity behavior. Increased screen time, changing play patterns, and limited access to child-friendly public spaces contribute to rising sedentary behavior (Jones et al., 2021; Engberg et al., 2020). In urban areas, this phenomenon is increasingly concerning, as children tend to have low physical activity levels and high sedentary time, particularly due to limited facilities and open spaces supporting physical activity (Kim & Yoo, 2019). Kärmeniemi et al. (2018) highlighted that many elementary school children in urban areas fail to meet aerobic fitness standards due to insufficient opportunities for regular physical activity participation, while their play patterns are increasingly dominated by screen time such as watching television or playing video games.

A similar situation occurs in Indonesia, where urban children exhibit high sedentary levels due to minimal safe and adequate open spaces for play (Sridhar & Gumpeny, 2024). Additionally, low student physical activity is concerning, as most engage in physical exercise only during physical education lessons without independent physical activity outside school (Mulya et al., 2025). This finding aligns with Mendes et al. (2024), who affirmed that increasing sedentary behavior is closely linked to low physical activity, negatively impacting children's physical development and cardiovascular fitness. School curricula have not fully integrated daily physical activity learning

with comprehensive health education, necessitating structured and sustained intervention strategies. Responding to these conditions, interventions such as reducing screen time, increasing outdoor play opportunities, and educating about balanced nutrition become critically important (Hassinger et al., 2023; Pandya & Lodha, 2021).

School-based interventions represent the most effective and economical approach to promoting healthy behaviors in children. Therefore, the FitKids Program was developed as a physical activity-based intervention model that not only increases aerobic capacity through structured physical activity training but also integrates healthy lifestyle education including nutritious food consumption, adequate sleep, and regular movement habits. This program adopts behavior change concepts, physical literacy, and school-based health promotion aligned with WHO-recommended whole-school approaches. The Health Promoting School (HPS) model emphasizes shifting school culture through curricula, policies, and environments supporting active lifestyles (Busch et al., 2023).

This approach has demonstrated consistent effectiveness. Langford et al. (2015) found that HPS-based interventions successfully improved student health and academic achievement through integrating health promotion activities into learning processes. This finding is reinforced by Brandes et al. (2020) who reported that HPS implementation effectively reduced obesity prevalence and improved student cardiovascular fitness. Consistent with these findings, Ngatman et al. (2025) demonstrated that nutrition education combined with active physical education successfully improved both gross motor skills and nutritional literacy simultaneously, affirming the importance of integrative approaches in school health programs.

The FitKids Program is designed to enhance cardiovascular fitness and physical activity through light-to-moderate intensity aerobic training, basic movement-based games, and reflection on healthy living habits. Integration of cognitive aspects (health knowledge), affective aspects (motivation), and psychomotor aspects (physical activity) makes it a comprehensive intervention. However, scientific evidence regarding the effectiveness of integrative interventions like FitKids in Indonesia remains limited. Many programs focus solely on physical activity without balancing nutrition education, sleep management, or daily movement habit formation. Research demonstrates that interventions targeting only physical activity without educational components do not produce significant impacts on children's overall health (Bull et al., 2020).

Furthermore, Lahti et al. (2020) affirmed the importance of an integrated approach combining physical activity with nutrition education and sleep management. The "Creating Active Schools" program in Bradford demonstrated that increased physical activity becomes more effective when accompanied by nutrition education and healthy sleep practices (Morris et al., 2023). Carson et al. (2016) added that interventions not including comprehensive educational components tend to be ineffective in improving children's cardiovascular health. Integration of physical activity, nutrition, and sleep patterns is also considered important for establishing healthy habits sustained into adulthood (Muthuri et al., 2014; Pereira et al., 2018).

To date, no comprehensive scientific publication has evaluated the effectiveness of an integrative program combining physical activity, healthy lifestyle education, and active behavior habit formation among elementary school students in Indonesia, particularly in urban areas. Furthermore, few studies employ cluster-based quasi-experimental designs, despite this design being more suitable for school intervention contexts. The novelty of this research lies in developing and implementing the FitKids Program a school-based intervention integrating interval cardio training, simple circuit exercises, and healthy lifestyle education ("Eat Smart, Sleep Well, Move More"). This approach not only enhances structured physical activity but also instills healthy living habits relevant to children in urban environments.

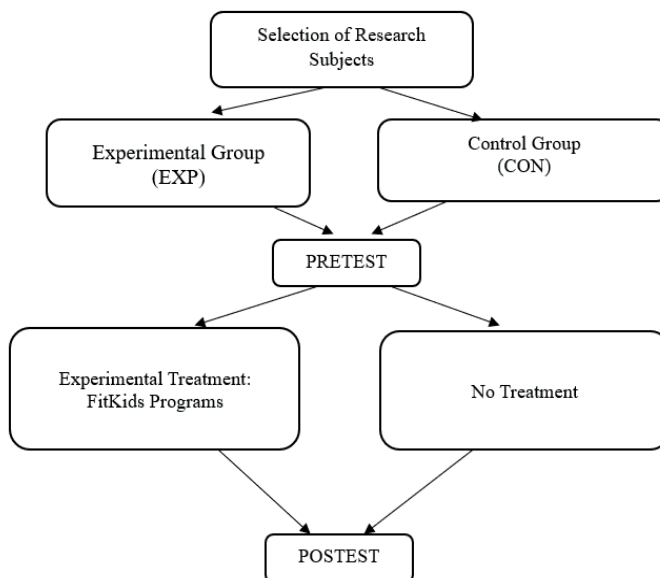
Therefore, this study aimed to analyze the impact of the FitKids Program on physical activity and cardiovascular fitness among elementary school students through a cluster-based quasi-experimental design. The findings are expected to provide empirical contributions to developing school-based health interventions in Indonesia, enrich international literature on integrative interventions in middle-income countries, and serve as reference for policymakers and educators in designing effective, applicable, and sustainable child health promotion programs.

Material and Methods

Research Design

This research employed a cluster-based quasi-experimental pretest–posttest non-equivalent control group design, with elementary schools in the urban area of Tasikmalaya City serving as cluster units. Six schools were involved: three designated as the experimental group receiving the FitKids Program and three as the control group following regular physical education instruction without additional intervention. School allocation was non-random and was determined by the principal investigator in consultation with the school principals, primarily based on implementation feasibility and scheduling considerations; therefore, no random sequence generation or allocation concealment procedures were applied. The intervention lasted 12 weeks, conducted at a frequency of one session per week with a duration of 70 minutes during scheduled physical education lessons.

Figure 1. Research flow



Participants

The study population comprised all students aged 9–10 years in elementary schools in Tasikmalaya City during the academic year of the study. The sample was obtained using a cluster sampling technique, selecting

six elementary schools with similar characteristics in terms of school status and urban environmental context. All students in the target grades meeting inclusion criteria were enrolled in the study. The six schools served as the cluster units and were allocated a priori to study conditions based on feasibility and scheduling considerations (non-random allocation), with three schools assigned to the FitKids condition (EXP) and three schools assigned to regular physical education (CON). Each school contributed 25 students to the final analysis (equal cluster sizes), yielding 75 participants in EXP and 75 participants in CON.

Of the total 180 students across six schools, 150 met inclusion criteria and comprised the final sample. Participants were divided into an experimental group ($n=75$; 42 boys and 33 girls) and a control group ($n=75$; 41 boys and 34 girls) based on their school's pre-determined cluster allocation. Inclusion criteria encompassed: (1) absence of medical conditions limiting moderate-intensity physical activity, (2) participation in the complete pretest and posttest assessments, and (3) parental or guardian written consent. Baseline characteristics and baseline outcomes are reported by group in Table 1. Because allocation occurred at the school (cluster) level without randomization, baseline equivalence between groups could not be assumed, and these baseline differences should be considered when interpreting intervention effects. The study received formal approval from the university via letter number 139/UN58.10/KM/2025, which was communicated to schools and parents. Student participation proceeded following parental or guardian signature on informed consent forms.

Table 1. Baseline Characteristics

Variable	Experimental ($n=75$)	Control ($n=75$)
Age (years), mean $\pm$ SD	9.55 $\pm$ 0.503	9.55 $\pm$ 0.501
Boys, n (%)	57.3%	54.7%
Girls, n (%)	42.7%	45.3%
PAQ-C baseline, mean $\pm$ SD	2.1479 $\pm$ 0.4314	2.2641 $\pm$ 0.3906
MFT baseline, mean $\pm$ SD	31.7387 $\pm$ 6.390004	28.4053 $\pm$ 6.44249

Table 2. Distribution of Participants Across Schools

School	Group	n
1	EXP	25
2	EXP	25
3	EXP	25
4	CON	25
5	CON	25
6	CON	25

Procedures

Experimental Group (EXP)

The FitKids Program comprised 12 structured sessions combining moderate-intensity physical activity with lifestyle education based on habit formation. Each session was conducted during regular physical education class time and divided into three phases: warm-up (10–15 minutes), core activity (± 30 –35 minutes), and cool-down (10–15 minutes). Exercise intensity was monitored using the Borg Rating of Perceived Exertion (RPE) Scale with a target range of 11–13, whereby activity was perceived as “somewhat hard” yet remained safely manageable for

students (Williams et al., 1991). Teachers regularly asked students to report their RPE values and adjusted pace, duration, or movement complexity if readings fell below 11 (too light) or exceeded 13 (too hard).

The primary physical activity components were delivered through Cardio Interval Training (CIT) and Mini Circuit Training (MCT). CIT sessions included activities such as follow-the-line run, shadow running, relay run, skipping, high-knees, jumping jacks, and structured tag games with brief work–rest interval patterns (e.g., 20–60 seconds work interspersed with 1-minute rest) to maintain moderate intensity. MCT was conducted at 4–5 stations focusing on fundamental movement skills including squat, sit-to-stand, step-up/step-on box, cone weaving/zig-zag, side shuffle, mini-hurdle, plank, and balance exercises, with 40–50 seconds per station, 60 seconds rest between stations, and 90 seconds between circuits, completed twice per session. Healthy Habit Breaks (Eat Smart, Sleep Well, Move More) were interspersed between or following physical activity blocks to reinforce understanding of balanced nutrition, healthy sleep, and daily physical activity.

Table 3. FitKids Program: 12-Week Protocol Structure

Week	Cardio Interval Training (CIT)	Mini Circuit Training (MCT)	Healthy Habit Break (HHB)
1	Follow-the-line run (5 min); skipping (1 min×2)	4 stations: basic squat, wall push-ups, step-on box, balance stand	Eat Smart: Introduction to healthy food concepts
2	Jumping jacks (30 sec×3); high-knees (20 sec×2)	Stations: squat, sit-to-stand, cone weaving, plank (10 sec)	Eat Smart: Portion sizes & “plate model”
3	Combined skipping + shadow running	Stations: step-on box, wall push-ups, jump rope, balance line walk	Eat Smart: Choosing healthy snacks
4	High-knees (30 sec×3); jumping jacks (30 sec×3)	Stations: squat, mini-hurdle step, side shuffle, plank	Eat Smart: Hydration and low-sugar beverages
5	Relay run: 1 min work – 1 min rest	Stations: sit-to-stand, cone zig-zag, skipping, wall push-ups	Sleep Well: Importance of 9–11 hours of sleep
6	Jumping jacks (30 sec×4); skipping (1 min×2)	Stations: mini step-up, balance, squat, plank	Sleep Well: Sleep routines
7	High-knees (30 sec×4); structured tag game (5 min)	Stations: cone weaving, sit-to-stand, wall push-ups, mini-hurdle	Sleep Well: Reducing screen time before bed
8	Skipping (1 min×3); jumping jacks (45 sec)	Stations: step-up, side shuffle, squat, balance stand	Sleep Well: Optimal sleep environment
9	Shadow running intervals (2 min work – 1 min rest)	Stations: skipping, plank (15 sec), cone zig-zag, sit-to-stand	Move More: Benefits of daily activity
10	High-knees (40 sec); jumping jacks (45 sec)	Stations: wall push-ups, step-up, balance, mini-hurdle	Move More: Limiting prolonged sitting
11	Skipping (1 min×3); follow-the-line run (5 min)	Stations: squat, cone weaving, side shuffle, plank	Move More: Physical activity at home/in the city
12	Combined relay run + high-knees	5 integrated stations based on previous weeks’ progression	Move More: Review of 12-week active habits

Note: Each 70-minute session comprised warm-up (10–15 min), core activity (30–35 min) including CIT and MCT components, and cool-down (10–15 min). Healthy Habit Breaks were interspersed between activity blocks. Exercise intensity was maintained at RPE 11–13 (moderate intensity) throughout all sessions

Facilitators, Training, and Fidelity Monitoring

All activities in the experimental group were facilitated by physical education teachers with a minimum qualification of a bachelor’s degree in Physical Education and adequate teaching experience at the elementary school level. Prior to intervention implementation, teachers in the experimental schools received intensive training

on the program objectives, session structure, safety procedures, use of the Borg Rating of Perceived Exertion (RPE) scale, and the FitKids fidelity monitoring procedures.

The study procedures were conducted sequentially as follows: (1) training of physical education teachers regarding FitKids implementation; (2) baseline (pretest) measurements of physical activity and cardiovascular fitness for all participants in both the experimental and control groups; (3) 12-week implementation of the FitKids Program in experimental schools, while control schools continued regular physical education instruction without additional modification; and (4) post-intervention (posttest) measurements using identical instruments, followed by data analysis to examine between-group differences and estimate intervention effect sizes.

Intervention fidelity was monitored weekly using a structured observation checklist to assess adherence to session duration, activity sequence, and delivery of the CIT, MCT, and Healthy Habit Break components. Checklist completion was performed by the physical education teacher delivering the session and assisted by the classroom teacher to support recording and cross-checking of implementation details. Fidelity indicators recorded included student attendance per session and overall attendance rate, the proportion of planned sessions successfully delivered (delivered/planned $\times 100\%$), adherence to intended session duration (minutes delivered versus minutes planned), adherence to intended exercise intensity using Borg RPE (target RPE 11–13), documentation of protocol deviations and reasons (e.g., shortened sessions, skipped components, facility/equipment constraints, or scheduling disruptions), and a brief safety log of adverse events/incidents and actions taken.

Control Group (CON)

Students in the control group participated in regular physical education (PE) instruction according to the school curriculum without any additional FitKids Program components. During PE lessons (± 60 –70 minutes per week), teachers implemented conventional activities including practice of basic locomotor and manipulative movement skills, simple games or small-ball games, and light stretching and fitness exercises, following the standard warm-up–core activity–cool-down format used in daily school practice. This group did not receive Cardio Interval Training, Mini Circuit Training, or structured Healthy Habit Break sessions, and no specific exercise intensity targets were set. As a matter of fairness and ethical consideration, after completion of all post-intervention measurements, control group students were offered the opportunity to participate in the FitKids Program and receive the same educational materials provided to the experimental group.

Measurement Instruments

Physical Activity Assessment (PAQ-C Indonesian-adapted version)

Physical activity was measured using the Indonesian-adapted version of the Physical Activity Questionnaire for Children (PAQ-C) (Sari et al., 2024). The PAQ-C is a self-administered, 7-day recall questionnaire comprising nine items that assess children's physical activity patterns across various domains including school, leisure, and sports participation. Items are scored on a 5-point Likert scale (1=minimally active to 5=very active), with an overall activity score calculated as the mean of all items, ranging from 1 to 5. The Indonesian version of PAQ-C demonstrated good convergent validity (Average Variance Extracted=0.659; Construct Reliability=0.892) and acceptable internal consistency (Cronbach's α =0.705–0.712), suitable for measuring physical activity in Indonesian children aged 9–11 years across diverse environmental contexts (Sari et al., 2024). The instrument's validity and reliability have been confirmed through Confirmatory Factor Analysis, supporting its use in school-based research.

Cardiovascular Fitness Assessment (MFT)

Cardiovascular fitness was assessed using the Multistage Fitness Test (MFT), also known as the “beep test” or progressive shuttle run test. The MFT is a maximal aerobic fitness test wherein participants perform continuous 20-meter shuttles between two lines at an incrementally increasing pace controlled by audio signals from a pre-recorded audio file. Participants continue running until they are unable to keep pace with the audio signals, at which point volitional exhaustion is typically achieved. Test performance was quantified as the average MFT score (composite performance metric across completed levels/shuttles), with higher scores indicating better cardiovascular endurance. The MFT has demonstrated excellent test-retest reliability ($r=0.94$) and validity in assessing aerobic fitness in children, making it an appropriate field-based measure of cardiovascular fitness in school settings (Mayorga-Vega et al., 2015).

Validity content of FitKids Program

The FitKids program materials were content-validated through expert review to evaluate their alignment with learning objectives, curriculum relevance, developmental appropriateness, and coverage of the targeted healthy-lifestyle behavior domains (Table 2). Analysis of the 10 items showed that all aspects exceeded the Aiken's V threshold of ≥ 0.80 , indicating adequate content validity based on expert judgment and supporting the program's suitability for implementation. The average validity coefficient across all program items was 0.90, suggesting that the healthy lifestyle habit formation program is content-valid and acceptable for application in school settings.

Table 4. Validation of the FitKids Program

No	Rated Aspect	Σs	V	Description
1	Alignment of FitKids program with physical education learning objectives and Merdeka Curriculum for upper elementary students (ages 9–10 years)	20	1	Accepted
2	Integration of physical activity, nutrition, and healthy sleep content with Merdeka Curriculum competency achievement	16	0.8	Accepted
3	Program inclusion of important aspects of children's healthy lifestyle (personal hygiene, balanced nutrition, physical activity, healthy sleep) appropriate to developmental stage.	19	0.95	Accepted
4	Appropriateness of personal hygiene content (hand washing, body cleansing, toilet etiquette, personal equipment care) with basic health learning standards for school-age children.	20	1	Accepted
5	Program incorporation of balanced nutrition concepts (Eat Smart) appropriate for ages 9–10, including healthy food selection, portion sizes, and drinking patterns	16	0.8	Accepted
6	Alignment of nutrition content with balanced nutrition guidelines for school-age children (food types, portions, healthy snack selection)	16	0.8	Accepted
7	Comprehensive physical activity components (Cardio Interval Training and Mini Circuit Training) including safe movement introduction and practice with appropriate intensity and duration	19	0.95	Accepted
8	Mini circuit training station design consistency with principles of children's physical development (progressive load, movement variety, emphasis on fundamental movement skills)	17	0.85	Accepted
9	FitKids session content relevance (CIT, MCT, Healthy Habit Break) to daily life contexts of 9–10 year-old children in school, home, and surrounding environments	18	0.9	Accepted

No	Rated Aspect	Σs	V	Description
10	Program integration of diverse topics and subtopics (personal hygiene, balanced nutrition, physical activity, healthy sleep habits) within a coherent 12-week sequence	18	0.9	Accepted
	Average	18	0.9	Accepted

Analysis of the 10 items revealed that all items successfully exceeded the Aiken's V validity coefficient threshold of ≥ 0.80 , indicating that the FitKids Program demonstrated adequate validity and is suitable for implementation. This finding demonstrates that all tested items met content validity criteria. The average validity coefficient across all program items was 0.90, indicating that the healthy lifestyle habit formation program is valid and acceptable for application in school settings.

Table 5. Reliability Reliability of the 10-item expert evaluation

Cronbach's Alpha	N of Items
0.612	10

Table 5 reports the internal consistency of the 10-item expert evaluation form used to appraise the FitKids Program content. The Cronbach's alpha coefficient was $\alpha=0.612$ (10 items), indicating moderate internal consistency of the evaluation form. This coefficient reflects the internal consistency of the expert-rating instrument and does not represent the reliability of FitKids intervention delivery itself.

Statistical Analysis

Data analysis included FitKids program validity testing using Aiken's V formula and reliability testing using Cronbach's Alpha coefficient. Intraclass correlation coefficients (ICC) and design effects (DE) were calculated to assess school-level clustering. Descriptive statistics (mean, SD, Δ mean), assumption testing (normality, homogeneity), and linear mixed-effects models (LMM) with random intercepts for schools were conducted to examine post-intervention differences while controlling for baseline scores and clustering. Fixed effects included group (experimental vs. control) and baseline scores; random effects included school variance (τ^2) and residual variance (σ^2). Cluster-adjusted effect sizes were calculated using Cohen's d ($\beta_{\text{group}}/\text{SD}_{\text{residual}}$), and normalized gains (N-gain) were computed for interpretive purposes. The significance level was set at $\alpha=0.05$.

Results

This study generated data analyzed sequentially through intervention fidelity assessment, baseline clustering analysis (ICC and design effect), descriptive statistics, assumption testing (normality and homogeneity), normalized gain (N-gain) calculations, and primary analysis using linear mixed-effects models (LMM) with school-level random intercepts on physical activity (PAQ-C) and cardiovascular fitness (MFT) variables. Results are presented systematically: intervention fidelity, clustering statistics, descriptive statistics by group/time, LMM results with cluster-adjusted estimates, and effect sizes/normalized gains. Findings are as follows.

Intervention implementation/fidelity (FitKids group)

Intervention fidelity monitoring was conducted during FitKids Program implementation (12 weeks; 12 sessions per school) using a structured weekly observation checklist. Observations and recording were performed by PE teachers facilitating sessions, assisted by homeroom teachers for documentation and verification. All experimental students ($n=75$) attended every session, achieving 900/900 student-sessions (100%). All 36 planned sessions across three schools were conducted (100%). Mean session duration was 70 minutes, with mean Borg RPE of 12 (target 11–13). No protocol deviations or safety incidents occurred.

Table 6. Summary of FitKids Intervention Implementation and Fidelity (Experimental Group)

Implementation/Fidelity Indicator	Target/Planned	Actual
Number of experimental schools (clusters)	3	3
Intervention duration	12 weeks	12 weeks
Planned sessions per school	12	12
Total planned sessions (3 schools)	36	36
Total sessions conducted	36	36
Proportion of sessions conducted (conducted/planned $\times$ 100%)	100%	100%
Number of students (experimental group)	75	75
Planned student-sessions (75 $\times$ 12)	900	900
Student-sessions attended	—	900
Overall attendance percentage	—	100%
Session duration (minutes)	70	Mean 70
Intensity (Borg RPE)	11–13	Mean 12
Protocol deviations	0	0
Safety incidents/events	0	0

Baseline Clustering Statistics

Table 7. Baseline Clustering Statistics (Intraclass Correlation & Design Effect)

Outcome	σ^2 (Within-school variance)	τ^2 (Between-school variance)	ICC	Design Effect (DE)	Effective Sample Size
PAQ-C baseline	6.893256	46.9332	0.129	4.096	36.62
MFT baseline	1.983230	42.0254	0.045	2.08	72.12

*Note: $DE=1 + (25-1)\times ICC$; Effective $N=150/DE$

Table 7 confirms school-level clustering. PAQ-C ICC (0.129) indicates 12.9% activity variation explained by between-school differences ($DE=4.096$), reducing effective sample to 36.62. Unadjusted analyses risk biased estimates. MFT shows smaller clustering ($ICC=0.045$, $DE=2.08$) but still requires mixed-effects adjustment.

Descriptive Statistics

Table 8. Descriptive Statistics by Group and Time Point

Outcome	Group	Pretest Mean±SD	Posttest Mean±SD	Δ Mean
PAQ-C	Experimental	2.1479±0.4314	5.2123±0.8140	+3.06
PAQ-C	Control	2.2641±0.3906	4.4000±0.6869	+2.14
MFT	Experimental	31.7387±6.39004	41.7453±9.04948	+10.0066
MFT	Control	28.4053±6.44249	27.1733±8.70101	-1.232

Descriptively, PAQ-C increased modestly in both groups (EXP +3.06 vs CON +2.14), showing no striking group difference. Conversely, MFT showed substantial EXP gains (+10.01) versus CON decline (−1.23), indicating clearer intervention impact on cardiovascular fitness.

Linear Mixed Model Results

Table 9. Linear Mixed Model Results for Physical Activity (PAQ-C)

Fixed Effects	Estimate (β)	SE	95% CI	t	p
Intercept	4.7242	0.9380	2.89, 6.56	5.036	0.000
Group (EXP vs CON)	0.8769	1.232380	−1.54, 3.29	0.712	0.478
PAQ-C baseline	−0.0834	0.0902	−0.26, 0.09	−0.924	0.357

Random Effects (Variance Components)

Component	Variance
School (τ^2)	46.9332
Residual (σ^2)	6.893256

LMM results show no significant group effect on PAQ-C posttest ($\beta=0.88$, $p=0.478$) after controlling for baseline scores and school variation. PAQ-C baseline also showed no significant association with posttest scores. After cluster and baseline adjustment, the intervention had no significant effect on students' physical activity.

Table 10. Linear Mixed Model Results for Cardiovascular Fitness (MFT)

Dependent variable: MFT posttest

Random effect: School (random intercept)

Fixed Effects	Estimate (β)	SE	95% CI	t	p
Intercept	0.6200	2.521357	−4.37, 5.62	0.246	0.806
Group (EXP vs CON)	0.456004	1.211639	0.28, 0.63	9.455	<0.001
MFT baseline	0.9347	0.083771	0.77, 1.10	11.159	<0.001

Random Effects (Variance Components)

Component	Variance
School (τ^2)	42.71
Residual (σ^2)	0.38

In contrast, LMM results for MFT demonstrate a significant and strong group effect ($p<0.001$), with higher average MFT posttest scores in the experimental group compared to control. Baseline MFT scores were a highly significant predictor, indicating individual fitness performance stability. The intervention produced significant cardiovascular fitness improvements, even after controlling for baseline scores and school clustering structure.

Cluster-Adjusted Effect Sizes

Table 11. Cluster-Adjusted Effect Sizes and Normalized Gain

Outcome	Cohen's d (adjusted)	95% CI	Effect Magnitude	N-gain EXP	N-gain CON	Gain Category
PAQ-C	0.33	-0.59, 1.25	Small to moderate effect	1.63	0.46	Medium, Low
MFT	0.74	-3.13, 4.61	Moderate to large effect	0.315	0.043	Medium, Low

* Note: $d = \beta_{\text{group}} / SD_{\text{residual}}$; $N\text{-gain} = (\text{Post-Pre}) / (\text{Max-Pre})$

PAQ-C shows small-moderate effect (CI crosses zero, aligns with nonsignificant LMM). MFT demonstrates moderate-large effect with higher EXP N-gain, confirming intervention effectiveness for cardiovascular fitness. PAQ-C N-gain interpreted cautiously due to scale limitations.

Discussion

This study examined the effectiveness of the FitKids Program on physical activity levels and cardiovascular fitness among elementary school students. The program was designed as a school-based intervention integrating interval training, circuit training, and healthy lifestyle education (Eat Smart, Sleep Well, Move More) within a single sequence of regular PE sessions, with content aligned to the Merdeka Curriculum and validated by local experts. The sequential CIT–MCT–HHB structure within each session, utilization of Borg RPE Scale for intensity control, and application of contextually relevant visual media (images of local foods, color symbols, nutrition category cards) represent unique design features distinguishing FitKids from traditional PE models that typically focus on isolated games or single skill training.

Mixed-effects modelling results revealed differential effects across outcomes. After adjusting for school clustering (ICC PAQ-C=0.129; ICC MFT=0.045) and baseline values, the intervention did not significantly improve PAQ-C scores ($\beta=0.88$, $p=0.478$; $d=0.33$), despite descriptive gains in both groups. This finding aligns with evidence that school-based physical activity programs may face challenges in substantially enhancing self-reported activity levels within short durations (Cornett et al., 2023; Brusseau, 2015).

However, cardiovascular fitness (MFT) showed strong intervention effects ($p < 0.001$, $d = 0.74$), with experimental gains (+10.01) contrasting control declines (-1.23). This demonstrates that structured interval and circuit training effectively enhance aerobic capacity even within regular PE time constraints, consistent with Gu et al. (2020) and Seljebotn et al. (2019), who reported that systematically designed interventions improve cardiorespiratory fitness in children. FitKids not only increases activity volume but also regulates intensity through RPE control, providing measured aerobic stimulus.

The intervention's success on MFT is consistent with Meyer et al. (2014), who demonstrated that planned physical activity programs yield significant improvements in aerobic fitness, and with Zhou et al. (2019), who emphasized the importance of intensive school-based programs. Compared to single-component approaches, FitKids offers an integrative framework that combines interval training, fundamental movement circuit training, and healthy habit education into a single, implementable package.

Covariance analysis revealed that baseline ability significantly influenced both outcomes (MFT: $\beta = 0.93$, $p < 0.001$; PAQ-C: $\beta = -0.08$, $p = 0.357$). Nevertheless, the strong group effect for MFT indicates improvements were primarily attributable to the intervention (Wilhite et al., 2022; Masini et al., 2022). Emphasis on fundamental movement circuit training permitted students with lower baseline abilities to remain engaged and experience success.

Theoretically, these findings align with experiential learning and social interaction frameworks, in which integrating nutrition education into active physical activity provides opportunities for students to construct knowledge through movement experiences, observational learning, and peer/teacher interactions (Gall et al., 2020; Aceves-Martins et al., 2021). FitKids addresses the limitations of traditional models by offering an integrated approach that targets both physical and cognitive domains simultaneously.

In elementary school physical education, enhanced cardiovascular fitness has important implications for student autonomy and self-confidence, while nutrition literacy provides a foundation for long-term, healthy decision-making (Masini et al., 2022). With adaptive design, contextual visual media, and clear session structure, FitKids has the potential to reduce health participation gaps and can be adapted across diverse school contexts.

Several limitations warrant consideration. This research used a quasi-experimental design with school clustering that limits absolute causal inference, although mixed-effects modelling adequately controlled intra-cluster dependence. This research was conducted in urban elementary school contexts with relatively brief intervention duration (12 weeks), necessitating further investigation of generalization to rural contexts, resource-limited areas, or different curriculum systems. Additionally, physical activity was measured via self-report (PAQ-C), which carries potential memory and social desirability bias. Future research should incorporate objective measures such as accelerometers or pedometers, expand school and student characteristic variability, and explore integration of digital technology or game-based learning to support student engagement. Despite these limitations, this study contributes important evidence to physical education and child health literature by demonstrating that brief integrated intervention models implemented within regular class time, combining interval training, circuit exercises, and healthy habit education produce meaningful improvements in cardiovascular fitness.

The global relevance of these findings is that schools across diverse nations, particularly in regions with high sedentary lifestyle prevalence and facility limitations, may adapt the FitKids Program framework as a practical, relatively low-cost strategy supporting international physical activity recommendations for children and long-term public health goals. Future investigations should examine long-term sustainability, explore adaptations for diverse cultural contexts, and investigate potential mechanisms linking integrated PA-nutrition interventions to additional

outcomes including academic performance, mental health, and metabolic health markers in larger and more diverse populations.

Conclusion

This study's findings confirm that the FitKids Program, integrated into physical education lessons, effectively increases cardiovascular fitness, but did not significantly improve overall physical activity levels after school clustering and baseline adjustment. Meaningful cardiovascular fitness increases in the experimental group demonstrate that the combination of interval training, moderate-intensity circuit training, and healthy habit education produces tangible aerobic fitness changes.

This learning framework combining movement and knowledge within a single session provides meaningful learning experiences, supporting physical competence development alongside healthy lifestyle awareness. Based on these results, FitKids has potential for global adaptation as a flexible, relatively low-cost school intervention model, with cultural and curriculum content adjustments. Future cross-national research is needed to test effect replication, utilize more objective physical activity measurements, and explore digital technology support to enable widespread program implementation and contribute to long-term public health goals.

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