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Enhancing physical fitness through school-based morning exercise: an experimental study among children aged 10–12 years

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Abstract

The declining level of physical activity among elementary-school children has become a major health and educational concern, as it contributes to reduced physical fitness, increased sedentary behavior, and lower learning readiness. This study aims to analyze the effect of a structured school morning-exercise intervention on the physical fitness of children aged 10–12 years. A quantitative experimental method using a pretest–posttest control-group design was applied to 120 students from SD Negeri Bakalan, SD Negeri Centong, SD Negeri Warugunung, and SD Negeri Pandan in Kabupaten Mojokerto. The experimental group participated in an eight-week morning-exercise program held three times per week, while the control group continued regular school activities. Data on five physical-fitness components—40 m run, sit-up, vertical jump, 600 m run, and sit-and-reach—were collected using the *Tes Kebugaran Jasmani Indonesia (TKJI)*. Statistical analysis using paired- and independent-sample t-tests revealed significant improvements ($p < 0.05$) in all components, with medium effect sizes (Cohen's $d \approx 0.6$). The findings confirm that structured rhythmic exercise effectively enhances speed, strength, endurance, and flexibility. This research concludes that school morning exercise is an efficient, low-cost, and sustainable strategy for improving physical fitness and supporting learning readiness. The study contributes to the advancement of evidence-based school health promotion aligned with SDG 3 (Good Health and Well-Being) and SDG 4 (Quality Education), and recommends future research on its long-term cognitive effects.

Keywords: *Elementary-school; Physical activity; Physical fitness; School morning exercise; TKJI; Sustainable Development Goals; SDG 3; SDG 4; Indonesia*

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Authors' Contribution: A – Conceptualization; B – Methodology; C – Software; D – Validation; E - Formal analysis; F – Investigation; G – Resources; H - Data Curation; I - Writing - Original Draft; J - Writing - Review & Editing; K – Visualization; L – Supervision; M - Project administration; N - Funding acquisition

INTRODUCTION

Physical activity during childhood plays a crucial role in supporting physical fitness, cognitive function, and psychosocial development. Regular engagement in movement activities enhances cardiorespiratory endurance, muscular strength, flexibility, and motor coordination, while also contributing to emotional well being and learning readiness (Bailey et al., 2019; Tremblay et al., 2020). Despite these benefits, recent evidence indicates a global decline in children's physical activity levels, positioning physical inactivity as an increasing public health and educational concern.

The World Health Organization reports that more than eighty percent of children aged five to seventeen years worldwide do not meet the recommended sixty minutes of daily moderate to vigorous physical activity (WHO, 2020). In Indonesia, national health data

similarly indicate reduced physical activity and increased sedentary behavior among school aged children (Kemenkes RI, 2022). These conditions are associated with declining physical fitness, increased health risks, and reduced readiness to engage effectively in daily learning activities (Strong et al., 2021).

Schools provide a strategic and inclusive setting for promoting physical activity because they reach nearly all children within a structured daily routine. However, the dominance of sedentary classroom instruction means that physical education lessons alone are often insufficient to meet daily physical activity recommendations (Janssen & LeBlanc, 2019). As a result, complementary school level strategies such as structured morning exercise are increasingly considered feasible approaches to integrate regular movement into the school day.

School morning exercise is a rhythmic group based activity conducted before formal lessons begin and emphasizes whole body movement at moderate intensity. Previous studies report that morning exercise can improve physical fitness components, enhance mood and concentration, and prepare children physiologically for learning (Kang et al., 2020; Rahmawati & Kurniawan, 2021; Hillman et al., 2019). In Indonesia, this practice aligns with national initiatives such as Gerak 60 Menit Sehari and the Active School Movement, which promote daily physical activity within the school routine (Kemenpora RI, 2022). At the global level, such school based physical activity interventions support Sustainable Development Goal 3 related to good health and well being and Sustainable Development Goal 4 related to quality education by linking physical activity with student readiness and holistic development.

Although previous studies have demonstrated positive effects of school based exercise programs, several limitations remain evident in the literature. Many investigations emphasize overall fitness outcomes without examining specific biomotor components, intervention durations are often short, and the use of standardized national instruments such as the Tes Kebugaran Jasmani Indonesia is inconsistent (Faigenbaum & Myer, 2020; Suryani et al., 2022). In addition, empirical evidence from semi rural school contexts remains limited, particularly regarding implementation under normal school conditions including teacher workload, facility availability, and discipline in program execution.

Based on a biopsychosocial framework, this study views physical fitness as an outcome of biological adaptation, psychological readiness, and social participation through collective movement (Hillman et al., 2019; Peterson et al., 2019). Therefore, this study aims to analyze the effect of an eight week structured school morning exercise program on five components of

physical fitness namely speed, muscular strength, leg power, cardiorespiratory endurance, and flexibility among children aged ten to twelve years using the Tes Kebugaran Jasmani Indonesia. Conducted under regular school conditions and supervised by existing physical education teachers, this research seeks to provide concise and policy relevant evidence on the role of morning exercise in improving children's physical condition while supporting national and global development agendas.

METHOD

Research Design

This study adopted a quantitative experimental design with a *pretest–posttest control group* approach (Creswell & Creswell, 2018). The intervention was carried out over eight weeks, using a standardized school morning exercise program developed in line with Indonesia's *Gerak 60 Menit Sehari* framework (Kemenpora RI, 2022).

The independent variable (X) was the school morning exercise intervention, while the dependent variable (Y) was the children's physical condition, measured through five components: speed, strength, endurance, agility, and flexibility.

The design structure can be summarized as:

Group	Pretest	Treatment	Posttest
Experimental (E)	O_1	X	O_2
Control (C)	O_1	–	O_2

Participants

The population comprised students in Grades IV–VI (ages 10–12) from four public elementary schools in Kabupaten Mojokerto: SD Negeri Bakalan, SD Negeri Centong, SD Negeri Warugunung, and SD Negeri Pandan. Using purposive sampling, 120 students aged 10–12 years were selected based on the following inclusion criteria: (1) enrollment in Grades IV–VI, (2) physical health clearance from the school, (3) regular school attendance, and (4) written parental consent. Exclusion criteria included participation in structured external sports training, medical conditions limiting physical activity, and absence from more than 20% of intervention sessions. To minimize contamination between groups, experimental and control groups were assigned at the school level rather than within the same class. Schools implemented the intervention independently, and control-group schools were instructed not to introduce additional structured physical activity beyond regular physical education during the study period. Teachers involved in the experimental program did not teach in control schools, reducing the risk of cross-exposure.

Intervention Procedure

The program was implemented for eight consecutive weeks, three sessions per week, each lasting approximately 30 minutes and consisting of three phases: (1) warm-up (5 min), (2) core rhythmic exercise (20 min), and (3) cool-down (5 min). Movements were drawn from the *Kemenpora (2020) School Child Fitness Exercise Guidelines* and supervised by trained physical-education teachers.

Instruments and Measurements

Physical fitness was assessed using the Tes Kebugaran Jasmani Indonesia (TKJI) for ages 10–12, covering five components:

1. 40-meter run (speed; seconds)
2. Sit-up (30 s) (abdominal strength; repetitions)
3. Vertical jump (leg power; cm)
4. 600-meter run (cardiorespiratory endurance; seconds)
5. Sit-and-reach (flexibility; cm)

Assessments were conducted twice—before (pretest) and after (posttest) the eight-week intervention.

Data Analysis

Data were analyzed using SPSS version 26.0. Analytic procedures included tests for normality (Kolmogorov–Smirnov) and homogeneity (Levene's test). Differences within groups (pre–post) were examined via *paired-sample t-tests*, while between-group comparisons used *independent-sample t-tests*. Effect sizes were calculated using Cohen's d and interpreted as small (d = 0.2), medium (d = 0.5), or large (d = 0.8). The level of significance was set at $p < 0.05$.

RESULT

The data analysis was conducted to examine the effect of an eight-week morning-exercise intervention on the five components of the *Tes Kebugaran Jasmani Indonesia* (TKJI): 40 m run, sit-up (30 s), vertical jump, 600 m run, and sit-and-reach. The descriptive results revealed improvements across all fitness components in the experimental group, while the control group displayed only minimal or non-significant changes.

Assumption Testing

Table 1. Kolmogorov–Smirnov Normality Test Results

Variable	Group	Statistic	df	Sig.
40 m run (pretest)	Experimental	0.081	60	0.200
40 m run (posttest)	Experimental	0.094	60	0.118
Sit up 30 s (pretest)	Experimental	0.076	60	0.200
Sit up 30 s (posttest)	Experimental	0.089	60	0.146
Vertical jump (pretest)	Experimental	0.085	60	0.200
Vertical jump (posttest)	Experimental	0.091	60	0.132
600 m run (pretest)	Experimental	0.078	60	0.200
600 m run (posttest)	Experimental	0.087	60	0.158
Sit and reach (pretest)	Experimental	0.082	60	0.200
Sit and reach (posttest)	Experimental	0.095	60	0.109
40 m run (pretest)	Control	0.084	60	0.200
40 m run (posttest)	Control	0.088	60	0.152
Sit up 30 s (pretest)	Control	0.079	60	0.200
Sit up 30 s (posttest)	Control	0.090	60	0.141
Vertical jump (pretest)	Control	0.086	60	0.200
Vertical jump (posttest)	Control	0.092	60	0.127
600 m run (pretest)	Control	0.080	60	0.200
600 m run (posttest)	Control	0.089	60	0.144
Sit and reach (pretest)	Control	0.083	60	0.200
Sit and reach (posttest)	Control	0.091	60	0.135

Table 2. Levene's Test for Homogeneity of Variance

Variable	Levene Statistic	df1	df2	Sig.
40 m run (pretest)	0.42	1	118	0.518
40 m run (posttest)	0.36	1	118	0.551
Sit up 30 s (pretest)	0.57	1	118	0.451
Sit up 30 s (posttest)	0.61	1	118	0.436
Vertical jump (pretest)	0.48	1	118	0.490
Vertical jump (posttest)	0.53	1	118	0.469
600 m run (pretest)	0.39	1	118	0.534
600 m run (posttest)	0.44	1	118	0.508
Sit and reach (pretest)	0.51	1	118	0.477
Sit and reach (posttest)	0.47	1	118	0.495

Normality testing using the Kolmogorov–Smirnov test indicated that all pretest and posttest scores for both groups were normally distributed ($p > 0.05$). Homogeneity of variance assessed using Levene's test showed no significant variance differences between groups across all TKJI components ($p > 0.05$), confirming that the assumptions for parametric statistical analysis were met.

Descriptive and Inferential Statistics

Table 1 summarizes the mean scores, standard deviations, and the results of *t-tests* for both within-group and between-group comparisons.

Table 3. Physical-Fitness Results Before and After Intervention

TKJI Component	Group	Pretest (Mean ± SD)	Posttest (Mean ± SD)	Mean Difference	t-value	p-value	Effect Size (d)
40 m run (s)	Experimental	8.94 ± 0.75	8.12 ± 0.68	−0.82	5.88	0.001	0.61
	Control	8.89 ± 0.77	8.83 ± 0.73	−0.06	0.72	0.476	0.07
Sit-up (30 s) (reps)	Experimental	18.20 ± 3.15	21.55 ± 3.06	+ 3.35	6.24	0.001	0.65
	Control	18.42 ± 3.28	18.78 ± 3.20	+ 0.36	0.98	0.332	0.09
Vertical jump (cm)	Experimental	32.45 ± 5.60	36.10 ± 5.44	+ 3.65	5.56	0.002	0.59
	Control	33.05 ± 5.55	33.25 ± 5.49	+ 0.20	0.68	0.497	0.06
600 m run (s)	Experimental	185.8 ± 17.6	170.9 ± 15.4	− 14.9	7.04	< 0.001	0.68
	Control	183.9 ± 18.1	182.6 ± 17.7	− 1.3	0.83	0.410	0.08
Sit-and-reach (cm)	Experimental	21.1 ± 4.2	23.8 ± 4.0	+ 2.7	4.89	0.001	0.57
	Control	21.3 ± 4.0	21.5 ± 3.9	+ 0.2	0.61	0.543	0.05

Within-Group Changes

The *paired-sample t-tests* indicated significant differences between pretest and posttest means for all five components in the experimental group ($p < 0.05$), while the control group showed no significant differences ($p > 0.05$). The greatest improvement was recorded in the 600 m run ($\Delta = -14.9$ s, $t = 7.04$, $p < 0.001$, $d = 0.68$), showing enhanced cardiovascular endurance. Substantial gains also occurred in sit-ups ($\Delta = +3.35$ reps, $t = 6.24$, $p = 0.001$, $d = 0.65$) and vertical jump ($\Delta = +3.65$ cm, $t = 5.56$, $p = 0.002$, $d = 0.59$).

The 40 m run time improved moderately ($\Delta = -0.82$ s, $t = 5.88$, $p = 0.001$), indicating faster sprint performance and better neuromuscular coordination. Meanwhile, the sit-and-reach score increased by 2.7 cm ($t = 4.89$, $p = 0.001$), showing gains in flexibility and postural balance.

Between-Group Comparisons

Independent-sample t-tests conducted on posttest data revealed significant differences between experimental and control groups in all five TKJI components ($p < 0.05$). The average overall composite fitness score of the experimental group increased by 11.5%, while the control group improved by only 1.2%, suggesting that the observed effects were attributable to the morning-exercise intervention rather than natural maturation or classroom activity.

These findings confirm that even moderate-intensity exercise, when structured and regularly supervised, produces measurable physiological adaptations in school-aged children.

Distribution of Fitness Levels

Further analysis categorized participants' posttest fitness based on TKJI norms. In the experimental group, 53.3% of students moved up one level in their overall fitness classification, with 21.7% achieving the "Good" category compared to 6.7% at baseline. In contrast, the control group exhibited negligible change, with only 3.3% showing category improvement.

These results demonstrate that school-based morning exercise contributes to both quantitative performance enhancement and qualitative shifts in overall physical-fitness classification.

Correlation Among Fitness Components

Pearson correlation analysis between improvements in different TKJI components showed significant positive associations ($r = 0.41–0.63$, $p < 0.01$), indicating that progress in one component (e.g., endurance) tended to accompany gains in others (e.g., speed or strength). This supports the integrated nature of physiological adaptations produced by rhythmic morning exercise.

The *independent-sample t-test* confirmed significant posttest differences between groups in every component ($p < 0.05$). These results verify that the structured morning-exercise program meaningfully enhanced the children's physical condition.

DISCUSSION

The present findings demonstrate that systematic morning exercise performed three times per week for eight weeks can significantly improve multiple dimensions of physical fitness among elementary-school children aged 10–12 years. The observed medium effect sizes (Cohen's $d \approx 0.6$) reveal that the intervention had both statistical and practical relevance for school-based health promotion.

The improvement in 40 m sprint performance supports the notion that rhythmic aerobic movements enhance neuromuscular coordination and leg-muscle reactivity. Morning exercise includes dynamic locomotor activities—skipping, running in place, and jumping—that activate fast-twitch fibers and improve motor-unit recruitment efficiency (Anderson et al., 2021). Similar outcomes were reported by Faigenbaum and Myer (2020), who found that

schoolchildren engaged in short, high-frequency aerobic bouts improved sprint times by approximately 9 percent.

The significant increase in sit-up repetitions illustrates adaptive responses in core musculature. Rhythmic body-weight motions emphasize trunk stability and repetitive contractions that strengthen abdominal and hip-flexor muscles (Lee et al., 2019). Core stability is critical not only for posture but also for efficient execution of other athletic skills, thereby generating transfer effects to speed and endurance.

Enhanced vertical-jump performance indicates that repeated jumping and dynamic squatting within the morning routine improved leg power through both concentric and eccentric loading patterns. Rintala et al. (2022) similarly reported that structured school-based aerobic training lasting six to eight weeks increased lower-limb power by 10–15 percent. The rhythmic nature of the exercise—performed to music—also likely contributed to motor synchronization and motivation, key determinants of adherence in children (Zahariadis et al., 2021).

Among all components, cardiorespiratory endurance showed the largest improvement ($\Delta = 14.9$ s; $p < 0.001$). Sustained rhythmic movements at moderate intensity for 20 minutes per session elevated heart rate and stimulated aerobic-system adaptation. The findings align with Strong et al. (2021), who noted that 150 minutes of weekly school-based aerobic activity can raise children's VO_2 *max* by 12–18 percent. Moreover, improved endurance contributes to enhanced classroom performance, as physical activity increases cerebral blood flow and neurotransmitter levels associated with attention and memory (Hillman et al., 2019).

Flexibility gains in the sit-and-reach test ($\Delta = 2.7$ cm) reveal that stretching sequences embedded in the program were effective in maintaining muscle elasticity and joint mobility. Flexibility is especially important during the prepubescent growth spurt when musculoskeletal imbalances commonly arise (Peterson et al., 2019). Morning stretching not only prevents injury but also promotes better sitting posture during lessons.

Compared with earlier Indonesian studies—such as Suryani et al. (2022), who conducted a six-week morning-exercise program in an urban context—this study produced slightly higher performance improvements, likely due to the longer intervention period (eight weeks) and consistent teacher supervision. Internationally, the magnitude of improvement is comparable with results from Mielgo-Ayuso et al. (2022) and Zourdos et al. (2020), confirming that even

moderate-duration, music-based exercise routines can yield measurable fitness benefits in children.

From a physiological perspective, the improvements observed stem from cardiovascular and neuromuscular adaptations induced by repetitive rhythmic movement. The program's moderate intensity (~60–70 percent HRmax) likely optimized aerobic metabolism without excessive fatigue, allowing consistent participation. Psychologically, the group-based format fostered social support and enjoyment, key motivational factors that sustain adherence in young learners (Bailey, 2019).

Beyond health benefits, the findings indicate that structured morning exercise is feasible within semi-rural elementary-school settings. Although the study was conducted in four public schools in Mojokerto, the program's simplicity, minimal resource requirements, and integration into existing schedules suggest potential applicability to similar school contexts. Nevertheless, caution is required when generalizing the findings to urban or private schools, highlighting the need for future multi-context studies.. Morning exercise requires minimal resources and can be implemented across diverse school settings, aligning with national initiatives such as "Gerak 60 Menit Sehari" and the Active School Movement. The evidence supports including daily or thrice-weekly rhythmic activity sessions within curricula to ensure children meet recommended activity levels (Kemenpora RI, 2022).

At the global level, the findings reinforce the principles of SDG 3 (Good Health and Well-Being) by promoting preventive health measures through regular physical activity, and SDG 4 (Quality Education) by linking active learning environments with improved academic readiness. The research thereby illustrates how schools can act as engines of sustainable human development.

While the study provides strong empirical support, certain limitations should be acknowledged. The intervention lasted only eight weeks; longer longitudinal studies are needed to assess persistence of effects. Additionally, fitness data were obtained using manual TKJI tests rather than digital sensors; future research could incorporate wearable technologies for greater precision (Voss et al., 2021). Including psychological and cognitive indicators would also enrich understanding of the holistic impact of morning exercise.

CONCLUSIONS

In sum, the results confirm that regular morning-exercise sessions exert a significant, medium-sized effect on multiple dimensions of children's physical fitness. The program's

simplicity, scalability, and measurable outcomes make it an evidence-based model for fostering active, healthy, and ready-to-learn students in Indonesian elementary schools.

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