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The Impact of Traditional Game Belempongan on Elementary Students' Physical Fitness: A Quasi-Experimental Study

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Abstract

The decline in physical activity among children, exacerbated by the COVID-19 pandemic, necessitates innovative and engaging interventions in school settings. Culturally relevant physical education methods, particularly those grounded in local traditions, may offer viable solutions to improve children's physical health, motivation, and sense of belonging. This study aimed to examine the impact of the traditional game Belempongan on elementary students' physical fitness, measured using the Indonesian Physical Fitness Test (TKJI). A quasi-experimental pretest-posttest design was employed involving 30 students. Participants engaged in Belempongan sessions integrated into physical education over several weeks. Physical fitness components: 30-meter sprint, bent-arm hang, sit-ups, vertical jump, and 600-meter run; were measured before and after the intervention. Data were analyzed using paired sample t-tests with JASP 0.19.3, assuming normal distribution. All physical fitness indicators showed statistically significant improvements ($p < .001$), with very large effect sizes across components: sprint speed ($d = 2.180$), bent-arm hang ($d = 8.050$), sit-ups ($d = 5.623$), vertical jump ($d = 3.161$), and 600-meter run ($d = 1.985$). The overall TKJI score also improved significantly ($d = 7.938$). These results affirm that Belempongan not only improves measurable physical health indicators but also offers a sustainable, low-cost, and contextually meaningful alternative to conventional physical education. Traditional game-based physical education offers a culturally resonant, enjoyable, and effective method for improving child fitness and should be considered for wider implementation within school curricula. Future studies should explore longitudinal outcomes, cross-regional comparisons, and additional psychosocial indicators to broaden the empirical foundation for culturally integrated PE programs.

Keywords: Traditional Games; Physical Fitness; Elementary Education; Culturally Responsive Pedagogy; Belempongan

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INTRODUCTION

Physical fitness plays a vital role in the holistic development of elementary school-aged children, contributing to their physical health, cognitive functioning, emotional regulation, and academic performance. Despite its importance, the current generation of children faces a steep decline in physical activity levels, exacerbated by lifestyle shifts and the digital environment. The COVID-19 pandemic has intensified this issue, limiting opportunities for structured movement and reinforcing sedentary

behavior through online learning. Studies have confirmed that reduced physical activity among children is linked to an array of long-term health problems, including obesity, cardiovascular risks, and increased psychological stress (Vilchez et al., 2021; Lee et al., 2022; Luo et al., 2022; Mahmood et al., 2024; Bu et al., 2021; Arsić et al., 2023).

These physical consequences are accompanied by equally serious psychosocial risks. This decline has resulted not only in physical deconditioning but also in increased reports of mental health issues among students, such as anxiety, stress, and low self-esteem. Children who engage less frequently in physical activity are more likely to experience somatic complaints such as headaches and abdominal pain, which subsequently interfere with their academic and social development (Arsić et al., 2023; Lynch et al., 2022). Given these intertwined physical and psychological challenges, there is a critical need for interventions that combine health promotion with culturally meaningful engagement. These findings underline the urgency for physical education programs that are both engaging and inclusive, capable of restoring children's physical activity levels through culturally relevant and motivating approaches.

One promising strategy involves the integration of culturally-based physical education. These approaches not only resonate with students' cultural identities but also foster a sense of belonging and pride, thereby enhancing motivation and participation (Dutrisac et al., 2023). Research shows that students are more likely to engage in physical activity when it reflects their lived experiences and cultural backgrounds, leading to improved attitudes toward fitness and higher participation rates (Poudevigne et al., 2019; Watson et al., 2019). By embracing cultural relevance, educators can transform physical education from a standardized routine into a contextually meaningful and emotionally enriching experience (Hodges et al., 2022). Moreover, international studies affirm that game-centered pedagogies are particularly effective for improving not only physical skills but also cognitive engagement and affective outcomes such as motivation and self-perception (Breed et al., 2024).

Such culturally responsive pedagogies bridge the gap between physical activity and personal identity. For example, integrating local traditional games into physical education not only enhances physical skills but also strengthens cultural connections. When students recognize and value their cultural practices within the curriculum, their intrinsic motivation for physical activity increases, which can lead to sustained behavioral change (Hatten & Hannon, 2020; Marciano et al., 2020; Rakhman et al., 2024). Furthermore, participatory educational frameworks that involve students in planning and decision-making enhance ownership and motivation, especially when rooted in local traditions (Marciano et al., 2020; Giese et al., 2022; Wang, 2023).

The integration of traditional games into educational settings has received growing attention for its effectiveness in promoting physical fitness. Traditional games, by nature, are movement-rich and socially engaging, often requiring teamwork, agility, and endurance. Empirical evidence indicates that these games significantly improve various components of physical fitness, including cardiovascular endurance, flexibility, and coordination (Kusuma et al., 2021; Rakhman et al., 2024). Furthermore, their familiar and playful format makes them more accessible and enjoyable for children, reducing the resistance often found in conventional fitness regimens. At the same time, traditional games carry embedded cultural narratives that help students make sense of movement not merely as exercise but as a form of cultural expression.

Globally, the incorporation of culturally-rooted activities into curricula has shown success across educational levels. From integrating folk sports in early childhood education to applying indigenous dance in primary schools, these interventions enhance physical literacy, social cohesion, and cultural identity (Jing, 2023; Liu et al., 2024; Xiuyang & Luen, 2024). In Indonesia, the use of local wisdom in educational frameworks has been linked to positive outcomes in environmental awareness and moral character development (Nadhiroh, 2022; Sakti et al., 2024). These findings collectively underscore the multifaceted value of integrating traditional games, not only as a medium for physical training but also as a tool for cultural affirmation and social development.

Despite this growing body of evidence, region-specific traditional games in Indonesia remain underexplored, particularly in formal educational settings. While games such as *Engklek* and *Congklak* have received attention, others like *Belempongan*, native to Lombok, have been sparsely documented and poorly understood in terms of their pedagogical applications. Existing studies often fail to detail the gameplay, cultural context, or its potential impacts on various domains of child development (Festiawan, 2020; Triansyah et al., 2023). There is a notable absence of systematic frameworks for adapting these games into classroom settings, leaving educators with minimal guidance on implementation (Khalidah, 2022). This gap reflects a larger disconnect between local cultural resources and formal curriculum design, preventing potentially impactful games from being meaningfully embedded into school programs.

Additionally, there is limited comparative research evaluating the physical and cognitive benefits of *Belempongan* relative to other traditional games. Unlike more individualized games, *Belempongan* emphasizes collective play, teamwork, and synchronized strategy. This distinctive nature suggests it may excel not only in physical fitness outcomes but also in enhancing social skills and collaborative learning (Raharjo & Kurniawan, 2022). However, the lack of empirical studies makes it difficult to validate these assumptions or to develop best-practice guidelines for its integration into physical education curricula (Festiawan, 2020; Alvisari et al., 2024; Sudarwo et al., 2023). In response, this study aims to provide a structured pedagogical model based on empirical testing of *Belempongan* within the school environment.

In light of these gaps, this study focuses specifically on the integration of *Belempongan* as a culturally significant intervention in elementary physical education. The novelty of this research lies in its targeted evaluation of *Belempongan* using a quantitative quasi-experimental design that isolates its effects on specific physical fitness components: sprint speed, muscular strength, core endurance, explosive leg power, and cardiovascular stamina—as measured by the standardized Indonesian Physical Fitness Test (TKJI). Unlike previous research that generally explores traditional games in aggregated formats, this study provides a focused analysis of a single traditional game and its direct impact on multiple physical domains.

The objective of this study is to examine the effectiveness of integrating the Sasak traditional game *Belempongan* into physical education classes to enhance the physical fitness of elementary school students. The research seeks to determine whether this culturally rooted game can serve as a viable pedagogical tool for improving health outcomes, fostering social engagement, and promoting cultural identity in a school setting.

The scope of this research is limited to a single school with a four-week intervention period, using TKJI as the outcome measure across five physical fitness indicators. The novelty of this study lies in its use of a specific, under-researched traditional game (*Belempongan*), analyzed through a multi-dimensional fitness lens using validated instruments, and grounded in a culturally responsive pedagogical framework. By offering empirical data on the physiological and psychosocial benefits of *Belempongan*, the study aims to bridge the gap between cultural preservation and modern physical education demands, thereby informing both academic discourse and educational practice.

METHOD

Research Design

This study employed a quasi-experimental design using a one-group pretest-posttest format to assess the effectiveness of integrating the Sasak traditional game *Belempongan* into physical education for improving students' physical fitness. This design enables the measurement of differences in outcomes before and after an intervention within the same group, offering insight into its efficacy without randomization. Such an approach is deemed effective for educational settings where full control conditions are difficult to implement (Kairgozhin et al., 2023; Jiménez-Parra et al., 2022). A visual summary of the study flow is provided in Table 1 to clarify the procedural structure. To maintain internal validity, consistent implementation procedures and systematic documentation were adopted throughout the study.

Participants and Sampling

The sample consisted of 30 fifth-grade students (aged 10–11) from SDN 10 Mataram, selected using purposive sampling. The selection was based on accessibility, school readiness to collaborate, and parental consent. The class included 15 boys and 15 girls, ensuring equal gender representation. Prior to data collection, a briefing was conducted involving teachers and guardians to inform them of the objectives, benefits, and ethical considerations of the research.

Intervention Procedure

The intervention consisted of *Belempongan* sessions conducted over four weeks, with a frequency of three sessions per week, and a duration of 60 minutes per session. Each session was structured into three phases: warm-up (10 minutes), core game activity (40 minutes), and cool-down (10 minutes). The students were divided into two opposing teams, each trying to roll a ball on the ground with the objective of reaching a designated target or "hit" area, as demonstrated in **Figure 1**. This gameplay tested students' motor control, reaction speed, coordination, and strategic interaction.

Table 1. Timeline of Study Procedure

Week	Activity	Description
1	Pre-test	TKJI assessment across five fitness domains
1–4	Intervention sessions	*Belempongan* game-based PE, 3x/week, 60 min
5	Post-test	TKJI reassessment

Figure 1. *Belempongan* game procedure

Belempongan involves physical demands that target multiple fitness components: (1) Sprint bursts and evasion movements, which stimulate speed and agility; (2) Crouching, throwing, and dodging, which develop upper body strength and flexibility; (3) Sustained engagement, which enhances cardiovascular endurance and motor coordination; and (4) Strategic targeting and balance control, which train accuracy and postural stability. The rules of the game were adapted into an educational format emphasizing inclusive participation, teamwork, and safety. Sessions were supervised by the researchers and physical education instructors trained for consistency and safety. All sessions were monitored for fidelity by a PE teacher and the lead researcher using a structured observation checklist to ensure consistency and adherence to protocol.

Measurement Instruments

The physical fitness of students was assessed using the *Tes Kesegaran Jasmani Indonesia* (TKJI), a standardized and nationally recognized tool recommended for school-aged children by the Indonesian Ministry of Education. The TKJI comprises five core physical fitness indicators designed to reflect multidimensional aspects of student health and motor performance: (1) 30-meter sprint – assessing speed, (2) Bent-arm hang – measuring upper-body muscular strength; (3) 60-second sit-up – evaluating abdominal endurance, (4) Vertical jump – testing explosive leg power, and (5) 600-meter run – measuring cardiovascular endurance.

To standardize interpretation and ensure comparability across students, all raw scores from each test component were converted into a 1-to-5 scale using the TKJI scoring rubric as developed by the Indonesian Ministry of Education and Culture (Depdikbud, 2010). The conversion is presented Table 2.

Table 2. Conversion Table for Indonesian Physical Fitness Test (TKJI) – Depdikbud 2010

30m Sprint (sec)	Bent-Arm Hang (sec)	Sit-up 30s (count)	Vertical Jump (cm)	600m Run (min:sec)	Score
≤ 6.3	> 51	> 23	> 46	≤ 2:09	5
6.4 – 6.9	31 – 50	18 – 22	18 – 22	2:10 – 2:30	4
7.0 – 7.7	15 – 30	12 – 17	12 – 17	2:31 – 2:45	3
7.8 – 8.8	5 – 14	4 – 11	4 – 11	2:46 – 3:44	2
≥ 8.9	0 – 4	0 – 3	0 – 3	≥ 3:45	1

This conversion system enables a comprehensive and equitable assessment of fitness development by allowing educators to quantify performance across various physical domains. The final score for each student was derived by summing the converted scores from all five components, yielding a maximum total of 25 points.

The TKJI has been extensively validated and is recognized for its high construct validity ($r = 0.92$) and internal consistency reliability ($\alpha = 0.89$) in assessing children aged 10–12 years (Hidayat et al., 2023; Duhe et al., 2022). Furthermore, its adaptability for diverse educational environments makes it suitable for use in both urban and rural school contexts.

Data Analysis

Pretest and posttest data for each component of the *Tes Kesegaran Jasmani Indonesia* (TKJI) were collected and processed to evaluate the effectiveness of the *Belempongan* intervention. Prior to conducting inferential statistical analysis, data normality was assessed using the Shapiro-Wilk test, which confirmed that the dataset met assumptions of normal distribution across all physical fitness variables (Hidayat et al., 2023; Apriyano et al., 2022).

Accordingly, statistical analysis was carried out using paired-sample t-tests, which are appropriate for normally distributed data within a repeated-measures or within-subjects design. This method enables researchers to detect significant mean differences between two related conditions—in this case, the participants' physical fitness levels before and after the *Belempongan* intervention. Specifically, the paired-sample t-test was applied to evaluate changes in the overall TKJI total score as well as each of the five individual physical fitness components, namely: 30-meter sprint (to assess speed), bent-arm hang (for upper body strength), 60-second sit-up (for abdominal endurance), vertical jump (for explosive leg power), and 600-meter run (for cardiovascular endurance). This approach aligns with widely accepted statistical practices in quasi-experimental physical education research (Kairgozhin et al., 2023; Rashid et al., 2019), where the aim is to determine the effectiveness of an intervention by comparing pretest and posttest scores within the same group.

All statistical analyses were performed using JASP version 0.19.3, a validated and transparent open-source software frequently used in behavioral and educational research (Kolovelonis et al., 2022). A significance level of $p < 0.05$ was established for hypothesis testing. Additionally, Cohen's d was computed to assess the magnitude of intervention effects, with thresholds interpreted as small (0.2), medium (0.5), or large (0.8) according to conventional benchmarks.

To enrich the interpretation of quantitative results, a range of visual representations was utilized to effectively communicate the impact of the intervention. Bar charts were created to illustrate the differences in mean scores between pretest and posttest measurements, offering a clear visual comparison of overall improvements across all physical fitness components. Boxplots were employed to depict the distribution, variance, and presence of outliers within the data, enhancing understanding of the spread and consistency of student performance both before and after the intervention. Furthermore, documentary photographs taken during the implementation of *Belempongan* sessions (as presented in Figures 1) provided contextual insight into the physical environment, gameplay structure, and

student engagement, supporting the interpretation of outcomes by situating them within the real-life instructional setting.

In order to contextualize raw TKJI outcomes, each score was converted using the official TKJI scoring rubric (Depdikbud, 2010), allowing classification into performance categories ranging from "Very Poor" to "Excellent." This conversion enhanced interpretability and facilitated comparison across individuals and fitness dimensions.

To ensure intervention fidelity, sessions were monitored using structured observation protocols. Facilitators were trained in advance, and a checklist-based monitoring system was used to document procedural adherence. Fidelity checks were co-conducted by the lead researcher and a certified physical education teacher, following a standardized protocol aligned with national safety and instructional guidelines. This is in accordance with best practices in physical education intervention research, which emphasize fidelity monitoring and contextual responsiveness (Masangcay et al., 2024; Oktadinata et al., 2023; Basterfield et al., 2023).

Ethical Considerations

The study was approved by the school administration, and written parental consent was obtained for all participating students. Procedures, benefits, and safeguards were explained to teachers and guardians beforehand. Student confidentiality was protected through anonymous data handling, and the Belempongan game was adapted to ensure safety, inclusivity, and age-appropriateness. All sessions were supervised by trained instructors and a certified PE teacher in accordance with national safety guidelines.

RESULTS AND DISCUSSION

Improvement in Physical Fitness (Total TKJI Scores)

The integration of the traditional Sasak game *Belempongan* into physical education sessions resulted in a statistically significant overall improvement in students' physical fitness levels, as measured by the *Tes Kesegaran Jasmani Indonesia* (TKJI). A comparative analysis of the total TKJI scores before and after the four-week intervention revealed notable gains in performance across all components of physical fitness.

Table 3. Data Normality test results

Test	Pre-test					Post-test				
	V1	V2	V3	V4	V5	V1	V2	V3	V4	V5
Valid	30	30	30	30	30	30	30	30	30	30
Missing	0	0	0	0	0	0	0	0	0	0
Mean	7.453	28.667	13.000	15.933	2.384	6.607	52.333	24.400	43.533	2.196
SD	0.254	2.987	1.800	2.406	0.063	0.184	0.959	1.102	8.220	0.070
Shapiro-Wilk	0.901	0.957	0.924	0.829	0.839	0.940	0.878	0.877	0.471	0.814
P-value	0.009	0.258	0.034	< .001	< .001	0.090	0.003	0.002	< .001	< .001
Min	7.100	22.000	10.000	11.000	2.230	6.300	51.000	23.000	22.000	2.110
Max	7.900	33.000	16.000	21.000	2.450	6.900	54.000	27.000	48.000	2.330

Note. V1 (30 Meter Sprint); V2 (Bent-Arm Hang); V3 (Sit-Up 60 Seconds); V4 (Vertical jump); V5 (600 Meter Run)

Pre-intervention TKJI scores showed a relatively narrow distribution, with a mean overall score of 14.27 (SD = 0.868). Following the intervention, the posttest scores increased substantially, with the mean rising to 23.63 (SD = 2.341), indicating an average improvement of 9.36 points across the cohort (see Table 3). This substantial change is visually illustrated in Figure 2, which compares the distribution of overall scores before and after the intervention using a violin plot and mean difference graph. The posttest scores were not only higher but also more varied, reflecting differentiated individual responses to the intervention.

The normality of the dataset was confirmed using the Shapiro-Wilk test in JASP 0.19.3. While some individual variables approached thresholds for non-normality in the pretest phase (e.g., V1: $p = 0.009$; V4: $p < 0.001$), the overall composite scores and posttest data largely conformed to normal distribution assumptions. Therefore, paired-sample t-tests were applied, yielding statistically significant differences across all indicators ($p < 0.001$). The t-value for the total score was -43.481 (df = 29), with a Cohen's d of -7.938, denoting an extremely large effect size and confirming the effectiveness of the intervention (Table 4).

Table 4. Paired-sample t-test results

Pretest	Post-test	t	df	p	Cohen's d	SE Cohen's d
Overall Score	Overall Score	-43.481	29	< .001	-7.938	1.587
V1	V1	11.940			2.180	0.593
V2	V2	-44.091			-8.050	1.327
V3	V3	-30.798			-5.623	1.012
V4	V4	-17.312			-3.161	0.655
V5	V5	10.874			1.985	0.448

Note. V1 (30 Meter Sprint); V2 (Bent-Arm Hang); V3 (Sit-Up 60 Seconds); V4 (Vertical jump); V5 (600 Meter Run)

These results substantiate prior findings that traditional games can significantly improve multiple domains of physical fitness in elementary school children. Traditional games, such as *Belempongan*, promote dynamic full-body engagement, blending aerobic and anaerobic exertion with social interaction. As emphasized by Sudarwo et al. (2023), traditional games in Lombok effectively enhance physical literacy, helping students develop motor skills, coordination, and sustained interest in physical activity. The improved posttest scores in this study further validate the effectiveness of culturally rooted interventions in producing quantifiable fitness gains.

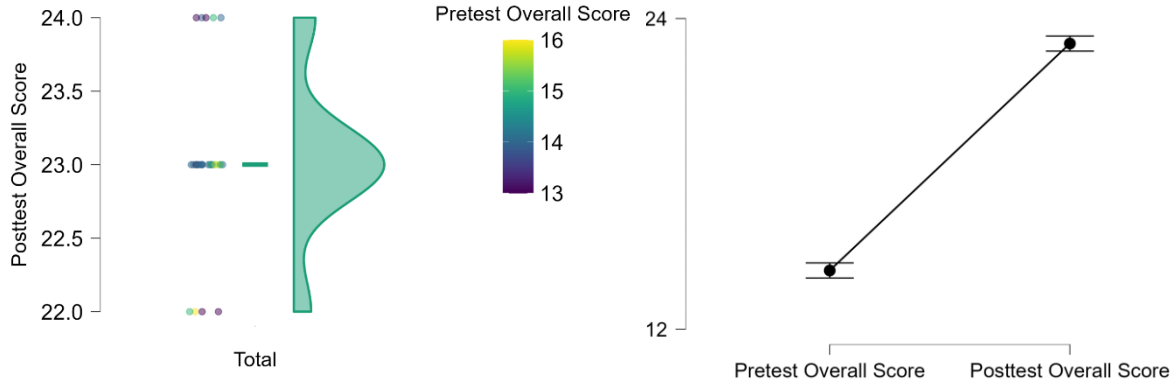

Figure 2. Comparative analysis of overall scores

Additionally, Anwar et al. (2019) note that modified traditional games can positively influence not just physical fitness but also students' nutritional and behavioral health outcomes. The structured yet playful nature of *Belempongan* allowed students to move continuously, foster teamwork, and build resilience—all of which contribute to improved physical and emotional well-being.

From a theoretical perspective, the observed improvement aligns with experiential and culturally responsive learning frameworks. According to Rustan and Rachmat (2024), culturally relevant PE interventions enhance engagement by integrating students' identities into learning, thereby motivating active participation and reinforcing positive behavior change. Moreover, game-based activities such as *Belempongan* provide a setting that is psychologically safe, cooperative, and emotionally stimulating—conditions which promote holistic development.

When compared to conventional, highly structured exercise programs, traditional games are more inclusive and adaptable, making them better suited for school contexts where student motivation varies widely. Studies such as Joyner et al. (2019) and Lambe et al. (2022) have shown that gamified and culturally grounded interventions increase adherence, enjoyment, and physical activity frequency. In line with this, students in the current study demonstrated not only fitness improvement but also greater enthusiasm and attendance consistency during the intervention.

The findings indicate that *Belempongan* serves as a highly effective medium for enhancing the overall physical fitness of elementary students. The implementation of this culturally embedded game contributed to significant physical performance improvements, substantiating its use as an alternative or complementary strategy in physical education. These results highlight the broader potential of traditional games to fulfill academic, physical, and socio-emotional objectives simultaneously, reinforcing the rationale for incorporating such culturally contextual interventions in school curricula.

Sprint Speed (30m Run)

The 30-meter sprint test, which serves as a standard measure of short-distance speed and lower-limb neuromuscular coordination, demonstrated significant improvement following the *Belempongan* intervention. As shown in Figure 3, students' posttest sprint times decreased considerably compared to their pretest performance. The mean sprint time improved from 7.45 seconds (SD = 0.254) pre-intervention to **6**.61 seconds (SD = 0.184) post-intervention, reflecting a mean time reduction of approximately 0.84 seconds (Table 2). This change was not only statistically significant but also practically meaningful in the context of elementary school physical development.

The paired-sample t-test yielded a t-value of 11.940, degrees of freedom (df) = 29, and a p-value < .001, indicating a highly significant difference in sprint speed before and after the intervention. The associated Cohen's d effect size was 2.180, which is classified as a very large effect (Table 4), suggesting a strong impact of the traditional game intervention on students' sprinting performance.

These results underscore the effectiveness of *Belempongan* in developing speed-related motor skills among children. The game's structure—requiring frequent bursts of acceleration, directional changes, and evasive maneuvers—provides rich and varied stimuli for improving sprint capabilities. Compared to traditional sprint drills

that typically emphasize straight-line speed and repetitive motions, *Belempongan* offers a more holistic training environment that fosters both linear and multidirectional acceleration.

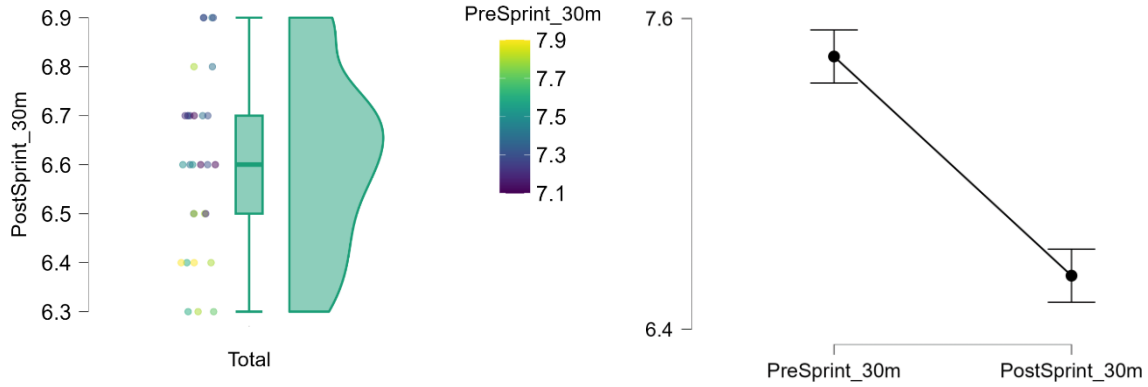

Figure 3. Comparison of pre- and post-intervention mean times for the 30-meter sprint

Research supports the assertion that traditional games positively influence sprint performance by enhancing neuromuscular control, agility, and reactive movement patterns (Karahan, 2020; Tang et al., 2024). As children engage in culturally grounded games like *Belempongan*, they experience natural, unpredictable movement demands that closely mimic real-life sport and play scenarios. These demands may include accelerating to avoid an opponent, sprinting to a target, or rapidly changing direction—actions that recruit fast-twitch muscle fibers and improve speed through experiential learning (Clemente et al., 2019).

Furthermore, studies have shown that traditional games often produce higher sprint frequencies than linear training sessions, as they embed short bursts of movement within a competitive and social context (Mandorino et al., 2024). This dynamic interplay of motivation, variability, and spontaneous exertion facilitates the development of sprint speed and agility in a more integrated and engaging way than static conditioning drills (Nicholson et al., 2021). The present study's findings align with these observations, reinforcing the value of traditional games as an effective pedagogical tool for physical education.

The use of the TKJI scoring rubric further confirmed this improvement. According to the TKJI conversion scale (Depdikbud, 2010), several students advanced from the lower categories (scores of 2 or 3) to higher categories (scores of 4 or 5), indicating a clear progression in their sprint performance levels. This advancement demonstrates not only numerical gains but also improved health-related fitness classifications among participants.

Upper Arm Strength (Bent-Arm Hang)

The bent-arm hang test, which evaluates upper body muscular endurance and strength, showed a substantial increase in performance following the *Belempongan* intervention. The average duration of the bent-arm hang increased from 28.67 seconds (SD = 2.987) in the pretest to 52.33 seconds (SD = 0.959) in the posttest, indicating a marked enhancement in the participants' ability to sustain body weight using arm and shoulder musculature (Table 3). This progression is clearly depicted in Figure 4, where

post-intervention data demonstrates both a substantial increase in mean performance and a reduction in performance variability.

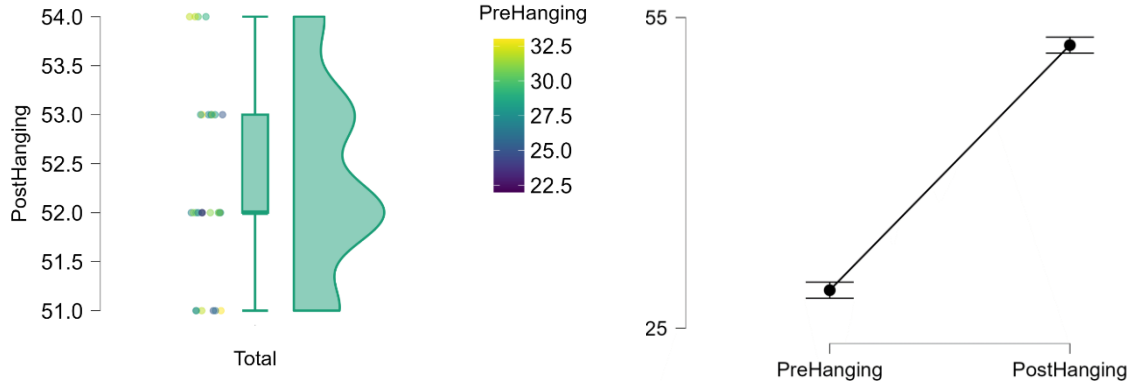

Figure 4. Comparison of pre- and post-intervention mean times for the Bent-Arm Hang

Statistical analysis using a paired-sample t-test revealed a t-value of -44.091 with 29 degrees of freedom, and a p-value < .001, indicating that the improvement was highly significant. The corresponding Cohen's d value of -8.050 signifies an extremely large effect size (Table 4), providing robust evidence of the intervention's effectiveness in enhancing upper body strength and endurance.

The traditional game *Belempongan* likely contributed to these improvements through its structured yet dynamic gameplay that demands frequent arm movements, stabilization, and reactive coordination. During the game, participants perform activities that require sustained arm engagement—such as throwing, catching, and bracing—especially when maintaining body posture in rapid movement scenarios or when preparing to dodge or redirect the ball. These actions stimulate the deltoids, biceps, and stabilizing muscles of the upper back, replicating resistance-type exertion in a playful and natural context.

Research by Gadžić and Vučković (2023) and Mandal et al. (2020) supports the idea that traditional physical activities enhance upper-body muscular endurance through frequent and sustained arm usage. Activities such as tug-of-war, relay challenges, or folk movement patterns all involve isometric and isotonic contractions of arm and shoulder muscles, which are directly transferable to tasks like the bent-arm hang. Similarly, Ha et al. (2021) and Fu et al. (2019) emphasized that traditional games stimulate repeated upper body muscle activation, enhancing the muscle endurance capacity required to maintain prolonged hangs.

Moreover, traditional games often integrate movement diversity and moderate resistance, which aligns with effective endurance training principles. Rather than isolating muscle groups in repetitive sets, traditional activities engage multiple muscle groups in dynamic and meaningful contexts. This multi-joint engagement promotes functional strength and endurance, especially when executed with high frequency but moderate intensity, as is common in children's game-based play (Iglesias-Soler et al., 2021).

In addition, the game-based structure of *Belempongan* may reduce psychological resistance often associated with traditional training routines, making it easier for students to participate fully and repeatedly. This accessibility, combined with the physiological demands of gameplay, supports the development of upper arm strength

without the need for formalized resistance equipment or external loads (Guseman et al., 2020).

According to the TKJI scoring rubric, students who initially performed in the lower scoring brackets (1–2) for the bent-arm hang moved to higher categories (4–5) after the intervention. This not only highlights absolute improvements in performance time but also indicates a categorical shift in fitness classification for many participants, emphasizing the practical educational and health benefits of the *Belempongan*-based program.

Abdominal Endurance (Sit-Up 60 Seconds)

The abdominal endurance of students, as measured by the number of sit-ups performed in 60 seconds, exhibited a notable and statistically significant improvement following the *Belempongan* intervention. The average pretest score was 13.00 repetitions (SD = 1.800), which increased to 24.40 repetitions (SD = 1.102) in the posttest (Table 3). This represents an average gain of over 11 repetitions, reflecting a considerable improvement in core muscular endurance. The performance distribution and score increase is presented in Figure 5, which shows a clear upward shift in the frequency of sit-up repetitions, along with decreased score variability.

Paired-sample t-test analysis yielded a t-value of -30.798, 29 degrees of freedom, and a p-value < .001, indicating a statistically significant improvement. The effect size, measured by Cohen's d, was -5.623, which qualifies as a very large effect (Table 4), confirming the strong impact of the traditional game-based intervention on abdominal strength.

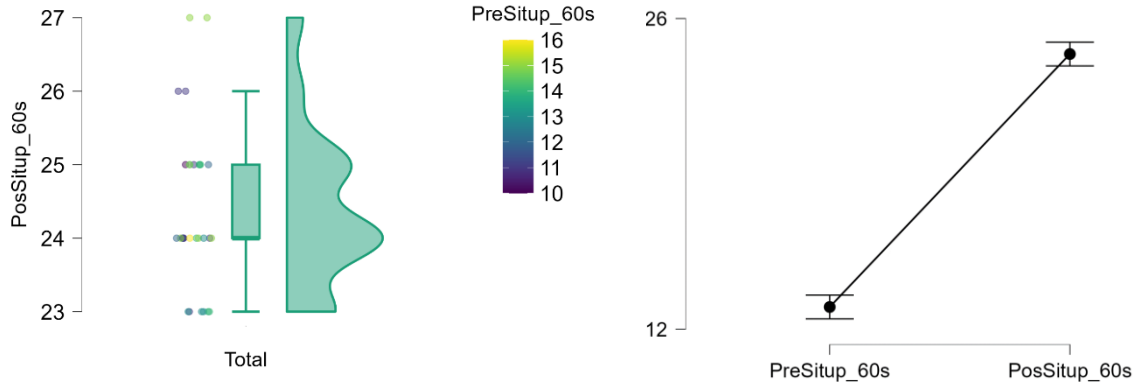

Figure 5. Comparison of pre- and post-intervention mean frequencies for sit-up 60 seconds

The game *Belempongan*, while not targeting core musculature directly in a traditional fitness sense, incorporates frequent and varied dynamic movements such as bending, reaching, crouching, dodging, and quick transitions—all of which engage the abdominal and stabilizing muscles. These spontaneous and body-weight driven motions require consistent activation of the core to maintain balance, stability, and control, particularly during rapid changes in movement or direction.

Research supports the effectiveness of traditional games in improving core endurance. Studies by Dimyati et al. (2022) and Ningrum et al. (2022) emphasize that traditional, movement-based games foster the natural engagement of abdominal muscles through repetitive, playful physical activities such as hopping, jumping, crawling, or turning. These movements demand active stabilization from the core,

which over time leads to improved muscular endurance without the mental fatigue often associated with formal exercise routines.

Moreover, traditional games often simulate functional resistance training by using the body's own weight in varied movement patterns. Unlike fixed-position conditioning (e.g., sit-up drills), traditional play encourages fluid transitions between standing, crouching, and jumping—each of which recruits core musculature in an integrated and dynamic fashion. As highlighted by Ningrum et al. (2022), the continuous nature of such gameplay also promotes prolonged core activation, which is more effective for endurance development than short, isolated efforts.

In addition to physical engagement, the social and motivational aspects of traditional games contribute to improved outcomes. Children are often more engaged and persistent in game-based activities, which increases the volume and frequency of movement, leading to cumulative muscular development. This sustained participation, driven by competition and enjoyment, is essential for developing physical habits and endurance in school-age children.

In terms of classification based on the TKJI rubric, the majority of participants progressed from categories 2–3 (moderate core endurance) to levels 4–5 (good to excellent). This categorical improvement suggests that the intervention had not only a measurable statistical effect but also meaningful educational and developmental implications.

Leg Explosive Power (Vertical Jump)

The vertical jump test, which measures explosive power in the lower limbs, showed a statistically significant and meaningful improvement after the implementation of the *Belempongan* intervention. Students' mean jump height increased from 15.93 cm (SD = 2.406) in the pretest to 43.53 cm (SD = 8.220) in the posttest (Table 3). This remarkable increase is clearly illustrated in **Figure 6**, where the shift in data distribution reflects a substantial enhancement in lower-body power.

The paired-sample t-test yielded a t-value of -17.312, df = 29, and a p-value < .001, confirming the statistical significance of the improvement. The corresponding Cohen's d value of -3.161 indicates a very large effect size (Table 4), suggesting that the traditional game-based intervention had a robust impact on students' leg explosive capacity.

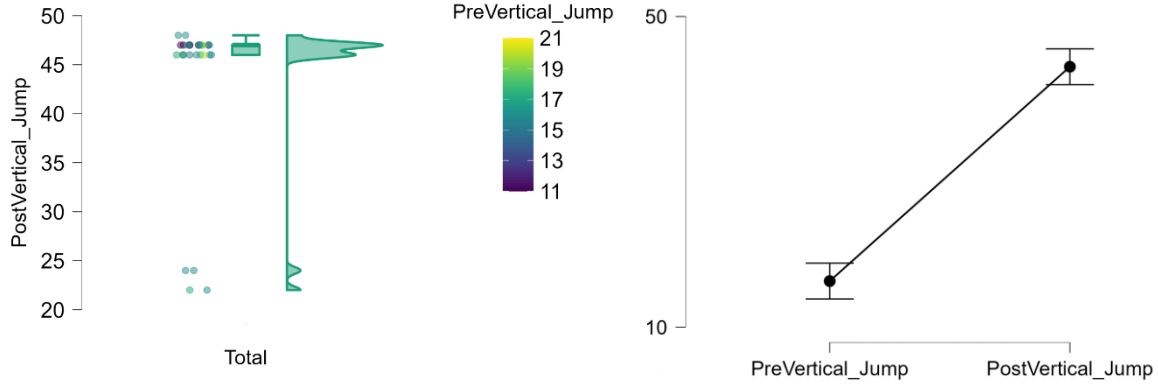

Figure 6. Comparison of pre- and post-intervention mean height for the vertical jump

The observed improvement can be attributed to the dynamic nature of the *Belempongan* game, which involves rapid direction changes, dodging, lunging, and

jumping movements—elements that naturally recruit and strengthen the quadriceps, hamstrings, calves, and glutes. Such gameplay mimics biomechanical conditions required in vertical jumping by activating the stretch-shortening cycle and encouraging forceful ground reaction.

According to Li et al. (2024) and Shu-qing et al. (2023), traditional games involving hopping, sprinting, and jumping over obstacles foster the development of leg power by simulating plyometric conditions in a less structured and more engaging manner. Unlike formal plyometric drills, which can be monotonous or overly technical for children, traditional games offer spontaneous, multidirectional, and varied jumping patterns embedded within playful competition. These movements encourage neuromuscular adaptation and explosive force generation while minimizing psychological fatigue.

Moreover, traditional jumping games offer unique biomechanical advantages due to their inherent unpredictability and varied stimulus. Children are required to jump in response to moving targets, dodge objects, or change trajectory mid-air—actions that enhance muscular responsiveness, joint coordination, and postural control. Dobrijević et al. (2020) emphasize that enjoyment and self-directed play in these contexts contribute to increased intensity and longer engagement time, allowing children to accumulate a greater volume of explosive training without perceiving it as a formal workout.

In the context of *Belempongan*, the need to respond quickly to an opponent's throw or to reposition one's body rapidly to avoid contact encourages repeated and instinctive use of jumping mechanics. These high-repetition, bodyweight-resisted movements not only stimulate muscle fiber recruitment but also promote motor unit synchronization, essential for vertical propulsion. Additionally, TKJI score conversions showed categorical improvements, with many students moving from the "Fair" or "Poor" jump performance categories (scores of 2–3) into the "Good" or "Excellent" ranges (scores 4–5). This upward shift in classification affirms that the intervention produced not only statistically significant improvements but also educationally meaningful gains in student fitness status.

Cardiovascular Endurance (600 Meter Run)

The performance on the 600-meter run—a standard indicator of cardiovascular endurance in the TKJI—showed a significant improvement following the implementation of the *Belempongan* intervention. Prior to the intervention, participants had a mean completion time of 2 minutes and 23.84 seconds (SD = 0.063), which improved to 2 minutes and 19.60 seconds (SD = 0.070) after the intervention. This indicates an average reduction of over four seconds in run time, reflecting meaningful gains in aerobic capacity. Figure 7 presents a comparative view of these changes, demonstrating a marked downward shift in completion time post-intervention, along with tighter data clustering around the improved mean.

The paired-sample t-test for this variable resulted in a t-value of 10.874 with 29 degrees of freedom, and a p-value < .001, confirming the statistical significance of the observed difference. The Cohen's d value of 1.985 reflects a very large effect size, suggesting a highly substantial improvement in cardiovascular endurance due to the intervention.

This enhancement can be attributed to the nature of *Belempongan*, which includes repetitive running, chasing, and strategic movement—components that require continuous engagement of large muscle groups and sustain elevated heart rates. These demands effectively simulate the physiological conditions of middle-distance running, thereby supporting cardiovascular adaptation.

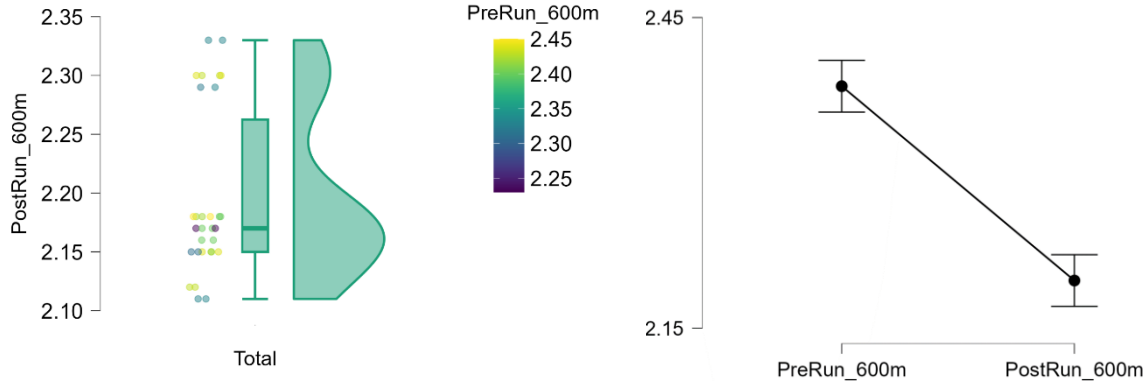

Figure 7. Comparison of pre- and post-intervention mean times for the 600 Meter Run

Consistent with the findings of Dube et al. (2025) and Obaid et al. (2022), traditional games can act as effective cardiovascular training tools by fostering sustained moderate-to-vigorous physical activity in enjoyable contexts. The repeated bursts of activity followed by short recovery intervals inherent in these games closely mirror the interval patterns found in structured aerobic training and competitive middle-distance running. These patterns develop both the aerobic and anaerobic energy systems critical to endurance performance.

Moreover, the integration of culturally relevant elements into physical activity enhances both participation and physiological outcomes. As noted by Tauro et al. (2024), students are more likely to engage consistently and enthusiastically in games that reflect their cultural heritage and collective identity. This cultural relevance adds an emotional and social dimension to physical activity, which encourages sustained effort, motivation, and adherence—key factors in long-term fitness development.

The enjoyable, inclusive format of traditional games also reduces the psychological fatigue often associated with repetitive running drills, allowing children to maintain higher levels of activity for longer durations. This translates into more frequent and effective cardiovascular stimulation, improving heart-lung efficiency, blood circulation, and muscular oxygenation capacity.

Finally, in terms of TKJI score conversions, a majority of participants moved from moderate or fair categories (score 2–3) into higher performance tiers (score 4–5), confirming that the gains were not only statistically significant but also pedagogically meaningful. These results underscore the potential of traditional games as an accessible, enjoyable, and culturally embedded strategy for improving cardiovascular endurance in school-aged children.

Discussion

The present study aimed to evaluate the impact of a culturally grounded traditional game—*Belempongan*—on the physical fitness components of elementary school students, as measured using the Indonesian Physical Fitness Test (TKJI). The

findings demonstrated substantial and statistically significant improvements across all five fitness indicators: sprint speed (30-meter run), upper arm strength (bent-arm hang), abdominal endurance (sit-up 60 seconds), leg explosive power (vertical jump), and cardiovascular endurance (600-meter run). These results offer compelling evidence for the utility of integrating culturally embedded physical activities into elementary physical education programs.

The improvement in overall physical fitness, as indicated by the total TKJI score, reflects the effectiveness of traditional game-based interventions in fostering comprehensive motor development. This outcome supports earlier findings that culturally relevant games not only increase physical engagement but also elevate motivation and enjoyment among children (Sudarwo et al., 2023; Rustan & Rachmat, 2024). Compared to structured physical training, traditional games offer a more inclusive and stimulating environment that naturally encourages varied physical movements and sustained effort (Anwar et al., 2019).

In the domain of sprint speed, the 30-meter run showed significant enhancement post-intervention, with a large effect size (Cohen's d = 2.180). This suggests that the multidirectional and unpredictable movements inherent in *Belempongan* contribute to neuromuscular coordination and acceleration capacity (Tang et al., 2024; Karahan, 2020). Unlike linear sprint drills, traditional games introduce spontaneous speed changes and varied locomotor tasks that foster agility and sprinting performance in more naturalistic contexts (Clemente et al., 2019).

Upper arm muscular endurance, assessed through the bent-arm hang, also improved dramatically (Cohen's d = 8.050). This finding is consistent with prior literature indicating that traditional games often involve upper-body activation through pulling, holding, or lifting actions that simulate resistance training (Gadžić & Vučković, 2023; Ha et al., 2021). Importantly, these tasks are performed within a playful framework, which reduces perceived exertion and facilitates higher engagement (Mandal et al., 2020). This contributes to better outcomes in upper-limb muscle endurance without requiring formal resistance equipment or techniques.

Abdominal endurance, measured via sit-up frequency in 60 seconds, improved significantly (Cohen's d = 5.623). This supports the notion that dynamic traditional games offer repeated core stabilization demands due to actions such as crouching, sudden turns, and changes in posture (Dimyati et al., 2022; Ningrum et al., 2022). These games mimic functional core engagement in real-life movement situations, rendering them especially effective for building trunk strength and postural control.

Vertical jump height, indicative of lower limb explosive power, saw a notable increase post-intervention (Cohen's d = 3.161). This aligns with previous findings asserting that activities involving repetitive jumping or bounding motions embedded in traditional games offer plyometric-like benefits without the monotony or technical rigor of formal drills (Li et al., 2024; Shu-qing et al., 2023). The engaging nature of these games leads to higher movement frequency and intensity, optimizing neuromuscular adaptations in the legs.

Cardiovascular endurance, as indicated by the 600-meter run, improved significantly (Cohen's d = 1.985). The sustained bursts of activity required during *Belempongan* sessions likely contributed to elevated heart rate and oxygen demand, thereby training both aerobic and anaerobic energy systems (Dube et al., 2025; Obaid et al., 2022). Traditional games offer a unique combination of moderate-to-vigorous

intensity activity, social interaction, and cultural resonance, all of which are critical to promoting consistent participation and aerobic conditioning in school settings (Tauro et al., 2024).

The broader implication of these findings lies in the capacity of culturally rooted interventions to promote inclusive, enjoyable, and effective physical education. The integration of traditional games like *Belempongan* into formal curricula addresses both the physical development and cultural affirmation of children, particularly in post-pandemic contexts where physical activity levels have declined (Lee et al., 2022; Vilchez et al., 2021). Additionally, these games can support emotional well-being by fostering cooperation, self-efficacy, and group belonging (Watson et al., 2019; Hodges et al., 2022).

From an educational policy perspective, the results advocate for the systematic incorporation of traditional games into school-based physical education programs. This approach supports holistic child development by nurturing motor skills, cardiovascular health, muscular strength, and cultural identity in an integrated manner. Furthermore, traditional game-based interventions are scalable, low-cost, and adaptable to various local contexts, making them viable strategies for improving youth physical fitness on a national scale. These findings align with the Indonesian Ministry of Education's 2020 PE policy, which emphasizes culturally rooted approaches to physical fitness.

Nevertheless, the study has certain limitations. The sample size was limited to a single school and age group, restricting generalizability. Future research should explore the comparative effectiveness of various traditional games across diverse regions and student demographics, and investigate the longitudinal effects of sustained implementation over academic semesters.

CONCLUSION

This study provides empirical evidence that integrating *Belempongan,* a traditional Sasak game into elementary physical education significantly enhances students' physical fitness across five domains. The intervention led to statistically significant and pedagogically meaningful enhancements in sprint speed, upper arm strength, abdominal endurance, leg explosive power, and cardiovascular endurance as measured by TKJI. These gains highlight the unique value of culturally relevant, game-based physical activities that not only promote physical development but also engage students in enjoyable and meaningful ways. The high effect sizes across fitness components suggest that *Belempongan* offers a potent, low-cost, and culturally resonant alternative to conventional physical education drills.

Importantly, the results support the broader application of local traditional games as pedagogical tools that address both physical and psychosocial dimensions of health in children. By fostering collaborative play and cultural recognition, *Belempongan* also aligns with holistic educational goals that emphasize identity formation and emotional well-being. Educators and policymakers are encouraged to adopt and scale these approaches within national curricula to foster holistic student development, cultural pride, and sustained physical engagement. To enhance generalizability, future research should conduct longitudinal studies and multi-site implementations that examine not only fitness outcomes but also behavioral, cognitive, and social-emotional development over time.

RECOMMENDATIONS

Based on the findings, several recommendations can be made to maximize the educational and developmental potential of traditional games in school settings. First, education authorities should integrate traditional games like *Belempongan* into the official elementary school physical education curriculum as standardized instructional components. This integration would ensure that culturally grounded activities are not only preserved but also systematically leveraged to promote health and physical fitness. Second, it is crucial to provide teachers with professional development and training on how to adapt and facilitate traditional games effectively. Such training would equip educators with the necessary pedagogical skills to deliver culturally sensitive instruction that enhances student outcomes while maintaining the traditional integrity of the games.

Third, collaboration with community stakeholders—including cultural leaders, parents, and local organizations—should be prioritized in the planning and implementation of traditional game programs. Community involvement enhances the cultural authenticity of these activities and fosters greater student engagement through the inclusion of familiar social practices. Fourth, schools should conduct longitudinal monitoring of student fitness using validated instruments such as the Indonesian Physical Fitness Test (TKJI). Regular assessments will help track progress, identify areas for improvement, and evaluate the long-term sustainability of game-based interventions. Lastly, further research is recommended to examine the applicability and effectiveness of similar traditional games in diverse cultural settings and among different age groups. Cross-cultural replication studies would broaden the evidence base, promote inclusive pedagogical practices, and support the global recognition of traditional games as effective educational tools for holistic child development.

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Conflict of interests
The authors declare no conflict of interest.

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