

The Effect of the Traditional Sack Race Game on the Lower Limb Muscle Strength of Fifth-Grade Elementary School Students

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Submitted: 02/04/2026

Revised: 20/04/2026

Accepted: 11/05/2026

Published: 12/06/2026

Abstract

This study aims to examine the impact of physical activity based on local wisdom, specifically through the traditional sack race, on lower-limb muscle strength in Physical Education, Sports, and Health (PJOK) classes for fifth-grade elementary school students. The intervention was designed in a structured manner, following the principle of progressive overload, and implemented over six sessions. A quantitative approach using a True Experimental Design via a Pretest-Posttest Control Group Design was applied in this study. The entire population of 28 fifth-grade students at SDN Cicariu was included as participants using total sampling, who were then randomly assigned to an experimental group ($n = 14$) and a control group ($n = 14$). The experimental group received a learning program based on the traditional sack race game, while the control group followed conventional Physical Education (PJOK) instruction. Data on lower-body muscle strength were collected via the vertical jump test, which was subsequently analyzed using descriptive statistics and the non-parametric Mann-Whitney U test at a significance level of 0.05. The research results showed an upward trend in the average scores for both groups; however, the experimental group recorded a significantly higher percentage increase of 16.66% compared to the control group, which increased by only 5.36%. Through the Mann-Whitney U test, an Asymp. Sig. A value of 0.089 ($p > 0.05$) was obtained. This study concludes that physical activity through sack races is descriptively effective in stimulating lower limb muscle strength in elementary school-aged children. Implicitly, traditional games packaged systematically can be adopted by physical education teachers as a recreational yet educational alternative for physical activity to optimize students' physical capacity without relying on expensive facilities.

Keywords

True Experimental Design, Pretest-Posttest Control Group Design, Total Sampling, Sack Race, Lower-Body Muscle Strength.



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INTRODUCTION

Within the framework of elementary education, the subject of Physical Education, Sports, and Health (PJOK) plays a strategic role in promoting physical fitness while instilling character values in students through physical activities. The PJOK instruction is not merely focused on mastering gross motor skills but also aims to foster an active lifestyle and maintain an ideal level of fitness to support students' long-term learning productivity and health. One of the pillars of physical fitness that significantly contributes to the effectiveness of children's movement is lower-body muscle strength, defined as the capacity of the lower body to generate explosive power for basic movements such as walking, running, and jumping (Hendryanto, 2025). This lower-body muscle strength serves as a crucial foundation for physical mobility, as it directly correlates with students' locomotor performance and postural stability (Nevada, 2017). In a school setting, a lack of lower-body muscle strength can create obstacles to active participation in physical education activities, as students tend to experience early fatigue and are unable to demonstrate movement techniques to their full potential (Sholihah & Hasanah, 2024).

Physical Education should ideally be conceptualized as a structured pedagogical process through the implementation of varied, planned, and meaning-oriented physical activities. In essence, physical education is a movement-based educational tool designed to comprehensively stimulate students' physical, cognitive, and affective domains (Fajar Siddik et al., 2024). Nevertheless, empirical observations in school settings often reveal a gap, where students' physical fitness levels remain below the ideal standard. Based on initial observational data at SDN Cicariu, a decline in physical performance is evident among the majority of fifth-grade students, particularly in lower-body muscle strength. This phenomenon is characterized by low explosive power utilization during fundamental movements such as jumping and running, accompanied by early fatigue during physical activity. These physical limitations are exacerbated by the Physical Education (PJOK) teaching methods, which have so far been delivered conventionally and have not integrated specialized training programs targeting specific fitness components, particularly lower-body muscle strength.

The primary focus of this experiment is on two key variables: physical activity based on traditional games as the independent variable, and lower-body muscle strength as the dependent variable. In principle, physical activity is conceptualized as any form of physical movement stimulated by skeletal muscle work that consumes energy, where such activity directly contributes

to improving physical fitness levels (Rut et al., 2020). To optimize its implementation at the elementary school level, the physical activity program need not be confined to rigid conventional exercise models but can be innovated into educational game formats to encourage students to engage in active movement voluntarily. The integration of these traditional games aligns with the psychological development phase of elementary school-aged children, who exhibit high enthusiasm for play activities, particularly those involving social interaction and competitive yet recreational elements. Furthermore, the mechanics of traditional games, which are dominated by repetitive jumping and running movements, provide positive stimulation for the development of lower body muscle networks through intense and sustained muscle contractions (Mustafa, 2022).

Stimulation of lower-body muscle strength development can be effectively achieved through the integration of traditional games, given that these activities involve repetitive movement patterns such as pushing off, running, and jumping, which compel the lower-body musculoskeletal system to function optimally (Handoko & Gumantan, 2021). Game patterns conducted at moderate to high intensity levels have been shown to trigger sustained muscle contraction mechanisms, which in turn induce physiological adaptations in the form of enhanced capacity and functional explosive power of students' lower-body muscles (Siswanto et al., 2025). Based on this mechanism, the essence of this traditional game is not merely to highlight the entertainment aspect, but also to play a strategic role as a form of functional physical exercise intervention to boost physical fitness, particularly in enhancing lower-body muscle strength (Ilahi, 2023).

In the context of this experiment, traditional games are conceptualized as a form of sociocultural recreational activity that has developed within the community and is passed down from generation to generation, integrating local wisdom, physical movement, and the stimulation of social interaction. In addition to providing recreational entertainment, children's participation in these games helps internalize foundational character traits such as collectivity, sportsmanship, discipline, and teamwork (Suhartini, 2025). From a sports pedagogy perspective, the integration of these local wisdom-based activities is considered highly adaptive because their structure emphasizes dynamic movement manipulation—including running acceleration, jumping, balance, and evasive movements—which intensively activates the lower body muscles. In the contemporary era, where the trend of a sedentary lifestyle due to smartphone addiction is increasingly widespread among children, the utilization of traditional games serves as a strategic option in Physical Education (PJOK) instruction capable of stimulating students to engage in active movement while

simultaneously enhancing their anthropometric and physical capacities (Laksono & Mandalawati, 2022).

The distinguishing feature of this study compared to previous literature lies in the specific use of the traditional sack race as the primary intervention, rather than employing a variety of games. Its unique nature requires students to perform repetitive jumps by placing the full force of propulsion on both feet as the fundamental support. This kinematic movement mechanism simultaneously activates the leg muscle groups, particularly the femoral (thigh) and gastrocnemius (calf) muscle compartments, to generate both vertical and horizontal forces that propel the body forward. The repetitive, programmed jumping activities in this traditional game are projected to enhance the functional capacity of the lower body muscles, as they integrate components of explosive power, dynamic balance stability, and the synchronization of children's motor coordination (Jalilah, 2022).

In this experiment, lower-body muscle strength was set as the dependent variable, representing the functional capacity of the lower-limb muscle tissue to generate propulsive force for the optimal execution of basic physical activities—such as standing stability, walking acceleration, running, and jumping (Ardilla et al., 2023). Specifically in Physical Education (PJOK) instruction, this lower-body muscle strength is a crucial component because it is linearly correlated with students' fundamental motor performance and physical endurance throughout the duration of physical education activities. In principle, the stimulation of lower limb muscle strength and mass can be achieved through structured training programs that utilize repetitive contractions and bodyweight exercises, which, in turn, condition the body to undergo physiological adaptations, such as increased muscle fiber efficiency in generating maximum mechanical force (Irma et al., 2024).

A body of scientific literature has confirmed that physical activity combined with traditional games improves students' physical fitness, particularly strength and motor skills. Periodic, systematic physical activities can enhance muscle mechanical capacity through the body's physiological adaptation process (Ezar, 2025), a finding supported by the argument that dynamic movement manipulation—such as running acceleration and jumping push-offs—effectively stimulates lower-body muscle strength (Sulistiono, 2014). Furthermore, learning models integrated with game elements have proven far more effective in fostering active student engagement while enhancing their physical capabilities (Mulyana et al., 2024) and in optimizing muscle performance through repetitive contractions at specific intensity levels (Handoko & Gumantan, 2021).

Nevertheless, the majority of previous research remains limited to the macro/general scope of physical fitness and has not been specifically focused on analyzing the correlation between traditional games and lower-body muscle strength. Based on this research gap, this experiment was specifically designed to test the actual impact of the local wisdom game of sack racing on the increase in lower limb muscle strength in elementary school-aged children (Putranto & Efendi, 2024).

In previous research, the focus of physical fitness assessments has typically remained at a macro level and has not yet been specifically tailored to map lower-body muscle strength using objective, practical instruments suitable for the school setting. A similar gap was observed at SDN Cicariu through a series of in-depth observations and initial discussions, indicating that the implementation of Physical Education (PJOK) instruction has so far relied on conventional exercise models such as rhythmic gymnastics, short-distance running, and other basic physical activities. According to accounts from PE teachers in the field, a group of students showed deficits in lower-body muscle strength, reflected in suboptimal propulsive power during jumping and running movements, and reduced physical endurance, leading to early fatigue during the learning process. Furthermore, the current assessment system remains rudimentary and does not use valid measurement tools to precisely assess lower-body muscle strength, such as the vertical jump test. Consequently, the accumulated evaluation results have not accurately represented the students' true physical capabilities.

The existence of this problem is underscored by students' learning outcomes in physical fitness, where the majority of fifth-grade students were classified as having low levels of lower-body muscle strength. This reality indicates a clear discrepancy between on-the-ground results and the theoretical goals of Physical Education (PJOK) instruction, which is actually intended to simultaneously improve students' overall fitness levels. From another perspective, recordings of student dialogues confirm that their enthusiasm for learning increases significantly when the physical education curriculum is structured around group-based games, social interaction, and a recreational atmosphere. Although previous literature has confirmed the significance of traditional games for children's physical fitness, the focus of most studies remains on macro-fitness aspects or general motor skills. Research evaluating the specific impact of traditional games on lower-body muscle strength is still very scarce; therefore, conducting more specific and targeted experiments is absolutely necessary to comprehensively explore this correlation.

Building on these dynamics, this experiment examined the impact of physical activity

through traditional games specifically sack races on the lower-body muscle strength of elementary school students. The rationale for selecting the sack race is its kinematic characteristics, which are dominated by repetitive jumps; this pattern simultaneously forces the lower limb muscles to contract intensively and continuously, triggering muscle hypertrophy and strengthening (Daya, 2025). The implementation of a structured approach in this research is supported by the use of an accommodative evaluation instrument, a vertical jump test, to precisely and objectively map the accumulation of data on students' lower limb muscle strength. Through this framework, the research outcomes are projected to contribute to the theoretical body of knowledge regarding the development of sports pedagogy, particularly concerning the efficiency of local wisdom games as instructional media, while also offering practical guidance for physical education practitioners or teachers in formulating more innovative, recreational, and effective physical learning designs to enhance children's motor performance (Mudzakir, 2020).

METHOD

The operationalization of research methods is understood as a systematic sequence of steps devised by the researcher to collect and analyze data in order to draw conclusions aligned with the research objectives (Subandi, 2025). This experiment used a quantitative approach based on the true-experimental method. The scheme applied is a pretest-posttest control group design, a design involving two comparison groups namely the intervention group and the control group—where the determination of members is based on the principle of random assignment (Creswell, 2023). A pretest was administered to both groups to assess the students' baseline lower-body muscle strength. Subsequently, the experimental group was oriented to receive an intervention in the form of a traditional sack race game program, while the control group was conditioned to follow conventional physical education learning routines. After the intervention period ended, a final evaluation (posttest) was conducted on both groups to assess the significance of the resulting physical changes.

The participants in this study comprised all fifth-grade students at SDN Cicariu, totaling 28 children. Given the relatively small population, this experiment employed a total sampling technique, meaning that all members of the population were included in the research sample. Furthermore, the total sample was divided into two balanced comparison groups: 14 students assigned to the experimental group and the remaining 14 to the control group. The experiment was

conducted throughout the even semester of the 2025/2026 academic year at SDN Cicariu, with meetings scheduled for April 8, 10, 13, 15, 16, 20, 22, and 23, 2026.

The intervention for the experimental group was implemented over six sessions, with the duration of each session aligned with the time allocation regulations of the school's physical education curriculum. The sequence of instructional activities was systematically organized to include an introductory phase, a warm-up phase, core activities, and a cool-down phase. The integrated traditional game model took the form of sack races, which were conducted periodically and repetitively in accordance with the Training Implementation Plan (RPL), where the intensity of the movements was gradually increased (progressive overload). In the other control group, participants were directed to follow the conventional Physical Education (PJOK) learning routine as on regular days, without exposure to a structured traditional game program (Ibrahim, 2022).

Data collection in this study was conducted through a combination of standardized tests, direct observation, interviews, and documentation. The observation activities were designed to periodically monitor the implementation of physical activities based on traditional games while recording the dynamics of the participants' physical development in the field. Additionally, data collection through informal interviews was employed to reinforce the observation findings and compile a comprehensive picture of the reality of learning implementation in schools. The specific instrument used to evaluate lower limb muscle strength parameters is the vertical jump test, a standardized instrument designed to measure the explosive power capacity of lower extremity muscles based on the jump height achieved (Permana, 2024). The final score is derived from the difference in vertical jump distances and is then classified according to the standardized assessment guidelines for students' physical capacity. As a concluding step, documentation activities—including photographs of the activities, field notes, and test score summary sheets—serve as valid supporting data.

The accuracy of measurements in this experiment was supported by the use of the vertical jump test, an instrument with standardized validity and widely recognized for assessing lower-body explosive strength. To ensure measurement consistency, the researchers assessed the instrument's reliability using a simple reliability index. The method applied was the test-retest procedure, which involved administering an initial measurement to the participants, then repeating the vertical jump test after a 30-minute interval to a small sample group (ranging from 1 to 3 students).

Data computation and analysis in this study were performed using SPSS version 29. To

determine whether the distribution of the sample data reflected a population with equal variance, the researchers conducted a homogeneity test. Meanwhile, confirmation of the fulfillment of the data distribution assumption was performed through a normality test using the Shapiro–Wilk method. Since empirical calculations indicated that the collected data were not normally distributed, the hypothesis comparison was shifted to a nonparametric statistical approach. In this context, the Mann–Whitney U test was applied as a tool to analyze the significance of the difference in posttest scores between the intervention group and the control group, given that the characteristics of the two comparison groups were independent of one another.

FINDINGS AND DISCUSSION

Findings

Classical Assumption Test

Verification of the prerequisites for data analysis was conducted to ensure that all collected data met the fundamental criteria for statistical modeling, so that the final conclusions drawn would have scientifically sound credibility (Wulandari & Widiyono, 2025). In this experiment, the scope of the prerequisite testing focused on the normality of the data distribution and the homogeneity of population variances.

Normality Test

An exploration of the normality of the data distribution was conducted to determine whether the experimental data followed a normal distribution pattern or not. The normality test in this study was conducted using the Shapiro-Wilk test, an approach considered the most accurate and relevant given that the sample size in each comparison group was below the threshold of 50 participants. All stages of data computation were performed using SPSS version 29 software, and the results of the normality calculations are presented in detail in the table below:

Table 1. Shapiro–Wilk Normality Test Results

	Test of Normality			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest_Eksperimen	.278	14	.004	.878	14	.055
Posttest_Eksperimen	.214	14	.081	.861	14	.032
Pretest_Kontrol	.205	14	.007	.912	14	.029
Posttest_Kontrol	.134	14	.200	.923	14	.053

Source: Output SPSS 29

Referring to the calculations presented in Table 1, the p-value of the Shapiro–Wilk test for the pretest data was 0.055 ($p > 0.05$). This result confirms that the data distribution in the pretest phase meets the assumption of a normal distribution. Conversely, in the posttest phase, the significance value obtained was 0.032 ($p < 0.05$), indicating that the posttest data were not normally distributed. Based on the finding that one component of the data did not meet the criteria for a normal distribution, it was decided to shift the hypothesis testing to measure the intervention in this experiment by utilizing a nonparametric statistical approach.

Homogeneity Test

A test of homogeneity of variances was conducted to determine whether the variability characteristics of the data were comparable between the experimental group—which received a physical activity intervention based on the traditional sack race—and the control group, which followed a conventional learning model. This homogeneity parameter was computed using SPSS version 29 software via an estimation based on Levene’s Test. The criteria for drawing conclusions in this test stipulate that if the significance value (Sig.) obtained exceeds the threshold of 0.05, the variance distribution of the data is classified as homogeneous. Conversely, if the significance value (Sig.) is below 0.05, the data variance is concluded to be heterogeneous. A summary of the test results is presented in detail in the table below:

Table 2. Homogeneity Test Results

		Test of Homogeneity of Variance			
		Levene Statistic	df1	df2	Sig.
Pretest	Based on Mean	.650	1	26	.427
Eksperimen_Kontrol	Based on Median	.642	1	26	.430
	Based on Median and with adjusted df	.642	1	17.795	.434
Posttest	Based on trimmed mean	.839	1	26	.368
	Based on Mean	.858	1	26	.363
Eksperimen_Kontrol	Based on Median	.553	1	26	.464
	Based on Median and with adjusted df	.553	1	25.953	.464
	Based on trimmed mean	1.077	1	26	.309

Source: Output SPSS 29

Based on the description of the statistical results summarized in Table 2, it is evident that the mean-based significance estimate for the pretest data in the experimental and control groups is 0.363. Since this coefficient exceeds the critical threshold ($\text{Sig. } 0.363 > 0.05$), it is concluded that the variability of the pretest data on lower limb muscle strength in both groups is homogeneous.

Consistent with this finding, calculations during the posttest phase yielded a significance value based on the mean of 0.427. This functional value is also above the required significance index (Sig. $0.427 > 0.05$), indicating that the variance characteristics of the posttest data between the intervention and control groups are equivalent (homogeneous). Based on these findings, the accumulated pretest and posttest data for both groups were determined to have met the prerequisite assumption of homogeneity of variance, thereby validating the data comparison procedure for the subsequent stage.

Hypothesis Test

Confirmation from the normality test provided exploratory evidence that the data on lower limb muscle strength were not normally distributed. Based on these empirical findings, the operationalization of hypothesis verification in this study was shifted to a linear approach using nonparametric statistical methods. Given that the primary focus of this research is on mapping the comparison of lower limb muscle strength between two independent comparison groups (the experimental group and the control group), the Mann–Whitney U test was selected as the most valid and appropriate analytical tool for implementation.

The hypothesis proposed in this study asserts that “there is a significant effect of the traditional sack race intervention on the increase in lower limb muscle strength among fifth-grade students at Cicariu Public Elementary School.” The operationalization of this hypothesis was conducted by examining the difference in posttest scores between the experimental group and the control group. The rules for drawing conclusions are based on the significance level: if the significance value obtained is < 0.05 , then the conclusion is that H_0 is rejected and H_a is accepted. Conversely, if the significance coefficient is > 0.05 , then H_0 is accepted and H_a is automatically rejected. A summary of the results of the nonparametric Mann–Whitney U test using SPSS is presented comprehensively in the table below:

Table 3. Mann-Whitney U Test Results

Test Statistics	
	Posttest_Eksperimen - Pretest_Eksperimen
Mann-Whitney U	65.000
Wilcoxon W	170.000
Z	-1.699
Asymp. Sig (2-tailed)	.089

Source: Output SPSS 29

Based on the description of the Mann-Whitney U test results in Table 6, which was used to compare the posttest scores between the experimental and control classes, an empirical Mann-Whitney U value of 65.000 was obtained, along with a Wilcoxon W value of 170.000. This calculation also yielded a Z-value of -1.699 with an Asymp. Sig. (2-tailed) of 0.089. Given that this significance coefficient exceeds the predetermined error level ($0.089 > 0.05$), the null hypothesis (H_0) is accepted and the alternative hypothesis (H_a) is rejected according to statistical conventions. These empirical findings indicate that there is no statistically significant difference in the posttest results for lower limb muscle strength between the experimental and control groups at a 95% confidence level.

In this study, percentage increases were calculated to determine the effectiveness of a traditional game-based physical activity intervention on the lower-body muscle strength of fifth-grade students at Cicariu Public Elementary School. This calculation was designed to map the improvement in the lower-body muscle strength of students following the implementation of the exercise program in the experimental group. To calculate the percentage increase in physical strength, the following mathematical formula was applied:

$$\text{Percentage Increase: } \frac{\text{Posttest Average Score} - \text{Pretest Average Score}}{\text{Average Pretest Score}} \times 100\%$$

Table 4. Results of Calculation of Percentage of Pretest and Posttest Improvement of Control Class and Experimental Class

Class	Variable	Average	percentage increase
Eksperimen	Pretest	15,25	16,66%
	Posttest	17,79	
Kontrol	Pretest	15,29	5,36%
	Posttest	16,11	

Based on the data presented in Table 4, calculations of the percentage increase in lower-body muscle strength indicate a statistically significant difference in performance gains between the experimental group and the control group. The intervention group recorded a 16.66% increase in performance, while the control group recorded only a 5.36% increase. These figures confirm that stimulation through the traditional activity of sack racing contributes significantly more to students' average achievements compared to conventional teaching methods. Although there is a 11.3% difference in improvement between the two groups, the results of the nonparametric statistical hypothesis test (Mann-Whitney U test) with a p-value of 0.089 indicate that this difference has not reached the threshold of statistical significance at the $\alpha = 0.05$ level. Nevertheless, within the context of physical education, the 16.66% improvement in the experimental group indicates a highly

significant practical impact in supporting the development of explosive power in the lower extremity muscles of the students.

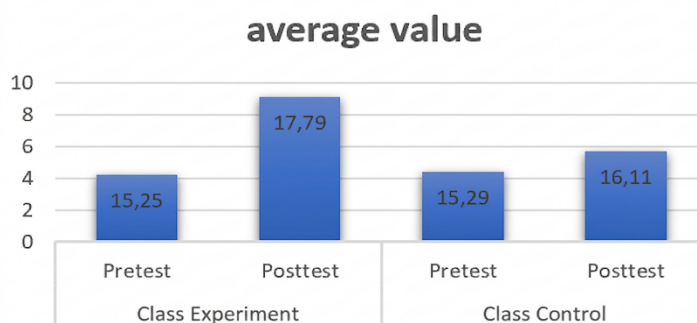


Figure 1. Average Increase in Cardiovascular Endurance Experimental and Control Classes

The data visualization presented in the graph above illustrates a gap in the trend of average lower-body muscle strength scores between the experimental group and the control group. In the intervention group, the average leg muscle strength scores of the students increased positively, from a baseline of 15.25 at the initial measurement (pretest) to 17.79 at the final evaluation (posttest). Based on the mathematical calculations performed, this change represents a 16.66% increase in performance. This finding confirms that physical activity stimulation integrated through the traditional sack race game makes a tangible contribution to the acceleration of students' lower limb muscle strength.

In another comparison, the control group also showed an upward trend in average scores for lower-body muscle strength, but the rate of improvement was relatively lower. The average score in the control group increased from a baseline of 15.29 at the initial measurement (pretest) to 16.11 at the final evaluation (posttest), which, when converted, equates to a percentage increase of 5.36%. This percentage gap in the increase between the intervention group and the control group explicitly confirms that the experimental group achieved a significantly higher level of lower-body muscle strength accumulation compared to the group that received only conventional treatment.

Through the accumulation of this data, the synthesis presented in Table 4 and the visualization in Figure 1 linearly confirm the urgency of the research findings that physical activities based on the traditional sack race game provide a more significant stimulus for accelerating the lower-body muscle strength of students. The implementation of physical activities based on the traditional sack race has proven to be more effective in increasing the lower-body muscle strength of fifth-grade students at Cicariu Public Elementary School, compared to conventional learning models that do not incorporate similar interventions.

Discussion

Based on the conclusions drawn from the data analysis, the findings of this study demonstrate that the implementation of physical activities based on the traditional sack race game has a positive effect on stimulating lower-body muscle strength in fifth-grade students at Cicariu Public Elementary School. This phenomenon is empirically reflected in the difference in final achievement scores between the experimental and control groups following the rolling intervention. The average posttest score in the experimental group increased from a baseline of 15.25 to 17.79, representing a percentage increase of 16.66%. On the other hand, the control group only recorded a shift from 15.29 to 16.11, with a cumulative percentage increase of 5.36%. This significant difference clearly demonstrates that the sack race program in the intervention group produced a far more substantial physical enhancement effect than conventional learning methods.

The more optimal improvement in lower-limb muscle strength performance in the intervention group was driven by the kinematic characteristics of movement in the sack race, which predominantly involves explosive jumping. From a sports biomechanics perspective, this motor activity triggers massive workloads on the thigh muscle compartment (quadriceps femoris) and the calf muscle (gastrocnemius) to execute strong concentric contractions to generate propulsion force in both vertical and horizontal directions. Although the results of the nonparametric Mann-Whitney U test showed a significance coefficient of 0.089—which means it is above the linear threshold of $p < 0.05$ —mathematically, the threefold increase in the percentage of successful participants in the experimental group compared to the control group clearly indicates that this traditional game possesses functional effectiveness as a tool for physical motor stimulation in an elementary school setting.

The non-normal distribution of the data and the research focus on comparing two independent groups formed the basis for the decision to use a nonparametric statistical approach. In this context, the Mann-Whitney U test was applied to analyze the differences in posttest lower-body muscle strength scores between the experimental and control groups. The computational results yielded an Asymp. Sig. (2-tailed) coefficient of 0.089 with a Z-value of -1.699. Since this significance value is above the 0.05 error threshold, the null hypothesis (H_0) is mathematically accepted, confirming the absence of a statistically significant difference between the experimental and control groups at a 95% confidence level. Nevertheless, a descriptive review shows that the mean leg muscle strength score in the intervention group (17.79) is higher than that of the control

group (16.11). This empirical indication provides strong evidence that physical stimulation based on the traditional sack race game demonstrates a positive trend that tends to be more effective in enhancing students' lower limb muscle strength compared to conventional physical education instruction, even though this improvement has not yet reached the threshold of statistical significance within the scope of this study.

The findings of this examination do not merely present descriptive mathematical differences in improvement, but can also be conceptually analyzed based on relevant theoretical frameworks. When correlated with the Motor Learning Theory proposed by Richard Schmidt (1975), the increase in lower limb muscle strength in the intervention group can be traced through the mechanisms of motor schema formation and consolidation. The acquisition of movement skills is stimulated through the development and reinforcement of motor schemas obtained from repetitive practice and diverse movement experiences. Within the context of this study, jumping activities embedded in the traditional sack race game provided dynamic movement stimulation; students were continuously required to adapt their motor responses in order to maintain postural stability while simultaneously generating optimal explosive leg power within a movement space constrained by the sack. This constant adaptive mechanism triggered the formation of increasingly structured and efficient movement synergies. This theoretical premise is consistent with the scientific findings of Chua et al. (2019), which demonstrated that variability in training programs stimulates superior motor skill learning compared to constant (monotonous) training schemes. The intensive movement variability inherent in sack racing assists students in refining their motor schemas and neuromuscular coordination synchronization, which subsequently exerts a positive effect on enhancing the functional capacity of their lower limb muscle strength.

Through the traditional sack race activity, students were intensively engaged in repetitive yet varied jumping movement patterns, a condition that required optimal synchronization between lower-extremity explosive power and postural stability within a constrained movement space. Every movement articulation executed provided sensory and motor feedback that was systematically stored in the students' motor memory. Through consistently programmed repetition throughout the experimental intervention period, the jumping mechanics structure, which was initially fluctuating and unstable, gradually transformed into a more structured, efficient, and directed pattern. The implications of this motor efficiency were not merely limited to more economical energy utilization management, but also contributed to optimizing the recruitment mechanisms of motor units and

muscle fibers in the lower limbs. As a result, students developed the capacity to generate explosive power more massively and consistently without triggering the premature onset of muscle fatigue.

From a different perspective, the empirical phenomenon identified in this study can be conceptually justified through the General Adaptation Syndrome (GAS) theory introduced by Hans Selye, which was later specifically formulated within the doctrine of training periodization by Tudor Bompa and Carlo Buzzichelli (2019) concerning the regulation of the body's biological adaptation to training load. The progressively and consistently regulated increase in workload throughout the sack race intervention represented the implementation of the progressive overload principle. During the initial introduction phase, the students' physiological systems responded to the training stressor through the alarm reaction stage, identified by the emergence of fatigue in the lower-extremity muscles as a direct consequence of explosive jumping movements. Nevertheless, because the physical stimulus was administered in a structured manner and increased gradually, the body avoided entering the exhaustion stage or acute fatigue phase, and instead successfully transitioned into the resistance or adaptation stage. This biological adaptation mechanism triggered improvements in the functional capacity of the leg muscles, including more efficient synchronization of motor unit recruitment as well as enhanced muscular contraction tension in generating explosive power. These adaptive outcomes were validly reflected through the significant increase in Vertical Jump test performance scores during the final evaluation (posttest) of the experimental group. From a motor learning perspective, students strengthened their movement schemas through systematically programmed repetition; meanwhile, physiologically, their bodies successfully developed adaptations to the progressive workload generated by the sack race jumping activities, which ultimately resulted in a more optimal improvement in lower limb muscle strength compared to the control group.

In the context of literature comparison, the findings of this examination strengthen the thesis proposed by Fauzi et al. (2023) regarding the effectiveness of utilizing traditional games to improve the physical fitness of elementary school students. The fundamental distinction lies in the focus of this study, which specifically isolated the parameter of lower limb muscle strength through the application of the vertical jump test instrument, rather than evaluating physical fitness in a broader sense. In line with this, the findings are also consistent with the explanation of Surur et al. (2024), which confirmed the existence of differences in fitness improvement following traditional activity interventions, although in this study the statistical significance test result reached $p = 0.089$,

presumably due to the limitation in the number of field samples. Nevertheless, this study provides novelty by exclusively focusing the intervention on the traditional sack race game, which naturally integrates plyometric movement characteristics (natural plyometric) through the implementation of a true-experimental design in the form of a pretest-posttest control group design. Validation from previous researchers regarding the capability of traditional activities to stimulate lower-extremity strength further reinforces the argumentative framework of this study, particularly in the dimension of developing muscular explosive power. However, the primary distinction of this research lies in proving that a single game modality such as sack racing is capable of providing structured high-intensity stimulation through the adoption of the progressive overload principle. This linear focus on one type of activity, implemented continuously with gradually increasing workloads, proved effective in maintaining students' motivational attention while simultaneously triggering neuromuscular adaptation in the leg muscles throughout the learning process.

The active involvement of students in physical activities through the traditional sack race game modality provided a functional space for them to construct real and repetitive movement experiences. Throughout the implementation of the sack race game, students did not merely adopt passive instructions; rather, they directly internalized the process of explosive jumping, controlled postural stability within the sack, and regulated both the rhythm and magnitude of leg propulsion in accordance with the target trajectory of the game. This motor exploration was implemented directly in the field and conducted continuously throughout the six intervention sessions. The positive implications of this training consistency were reflected in the increase in posttest achievement scores, which exceeded the baseline pretest phase in the experimental group, rising from 15.25 to 17.79. This performance acceleration of 16.66% serves as empirical evidence of the transformation in students' lower limb muscle strength capacity after receiving structured and repetitive loading stimuli based on the movement mechanics of traditional games.

In addition to the physiological dimension, the acceleration of lower-extremity muscle strength was also closely correlated with the contextual and recreational (enjoyable) characteristics of the game model. Students did not conceptualize the activity as a monotonous form of physical exercise; rather, they became immersed in an atmosphere of competitive as well as cooperative interaction through the medium of sack racing. This psychological stimulation generated a positive impact on the enhancement of motivation and the degree of participation throughout the implementation of physical education learning activities. In line with this, observational data

records confirmed that students in the experimental group demonstrated a tendency toward greater enthusiasm, were more active in executing explosive jumps, and were capable of maintaining activity intensity within a denser frequency rhythm compared to the phase prior to the intervention. This condition contrasted with the profile of the control group, which was only exposed to conventional learning models; although an increase in performance was still recorded, the magnitude was not as progressive as that of the experimental group. This occurred because the physical activity design in the control group was not formulated using a scheme of increasing intensity and specific overload aimed at optimizing lower limb explosive power to its fullest extent.

Comprehensively, the implementation of physical activities through the traditional sack race game modality confirmed a positive impact on the acceleration of lower limb muscle strength among fifth-grade students at SDN Cicariu. This indication was clearly reflected through the margin of difference between the mean pretest and posttest scores in the intervention group (an increase of 16.66%), which significantly exceeded the achievement of the control group (an increase of 5.36%). Although the results of the nonparametric Mann-Whitney U statistical test produced a significance coefficient of 0.089 (slightly above the critical threshold of 0.05), this contrasting descriptive improvement trend demonstrates that the traditional sack race game—when formulated based on the principle of progressive overload—not only functions as a recreational instrument, but is also capable of transforming into an accommodative learning strategy for enhancing the explosive power of lower limb muscles in elementary school students. These empirical findings emphasize the urgency of assimilating local wisdom into the structure of the physical education curriculum in order to stimulate the achievement of physical fitness objectives through a more engaging and systematically programmed approach.

The successful implementation of physical activities based on the traditional sack race game in this examination emphasizes that a learning orientation which is active, participatory, and grounded in the exploration of real experiences is far more relevant to the developmental characteristics of elementary school children. At this developmental stage, children possess a linear tendency to construct knowledge through movement activities and play; therefore, the integration of physical components with cultural competition is capable of stimulating a more dynamic learning atmosphere. Through the medium of the sack race game, students not only developed the functional strength and explosive power capacity of their lower limb muscles, but also internalized essential character values such as collaboration, sportsmanship, and the regulation of postural stability and

concentration amidst fluctuating game situations.

On the other hand, implementing the traditional game of sack racing within the PE curriculum serves as a viable alternative to conventional teaching methods, which often rely on monotonous, repetitive drills. By positioning students as active agents, this recreational activity offers a richer and more meaningful motor experience through tangible physical challenges. Students are continuously exposed to situational demands that require explosive lower-limb power, postural coordination, and sustained muscular force modulation while jumping inside the sack. This dynamic process implicitly enhances functional lower-body strength while simultaneously fostering physical readiness to adapt to high-intensity training loads.

Beyond its physiological ramifications, the traditional sack race (*balap karung*) profoundly affects the psychosocial attributes and character development of fifth-grade students at SDN Cicariu. The organic interactions manifested during the competition—encompassing peer-to-peer encouragement and constructive rivalry—naturally cultivate interpersonal communication skills, social cohesion, and mutual respect. Within this competitive atmosphere, students learn to manage their emotions, celebrate victories with humility, and graciously accept defeat as an integral part of the pedagogical process. In the context of Physical Education (PE), such an environment facilitates a more holistic and meaningful learning experience, in which the development of lower-limb muscular strength occurs concurrently with character building and social intelligence. Furthermore, this study underscores that the efficacy of using traditional games as physical conditioning tools hinges on systematic, structured planning, particularly in modulating training volume and intensity. The incremental escalation of jumping volume and repetition thresholds across the six-session intervention represents a concrete manifestation of the progressive overload principle. Without meticulously pre-determined parameters concerning duration, track distance, and jump frequency, the sack race risks devolving into a merely sporadic, purely recreational activity. Through this targeted intervention design, this activity is empirically proven to deliver an optimal stimulus for neuromuscular adaptation in the lower-limb muscles, as substantiated by a substantially higher mean progression trend in the experimental group (16.66%) relative to the control group (5.36%). Consequently, incorporating structured physical training principles into folklore games constitutes a highly potent strategy to achieve physical fitness competencies without diminishing the intrinsic joy of children's movement.

Ultimately, the findings of this study illuminate that physical activities rooted in the traditional sack race are not merely relevant from a cultural preservation perspective, but also possess a robust scientific foundation for enhancing lower-limb muscular strength. The prominent advancement observed in the experimental group compared to the control group demonstrates that a structured, progressive approach tailored to children's developmental characteristics can yield tangible physiological transformations. Consequently, the traditional game of sack racing can be strategically positioned within the PE curriculum as a pedagogical method that is not only intrinsically engaging, but also highly effective in driving measurable improvements in physical fitness.

CONCLUSION

Based on the comprehensive research findings, it can be concluded that physical activity utilizing the traditional sack race (balap karung) significantly contributes to enhancing the lower-limb muscular strength of fifth-grade students at SDN Cicariu. The implementation of this traditional game, systematically structured with a gradual escalation of training intensity, successfully fosters an active and meaningful learning experience aligned with the motor development characteristics of elementary school children. Furthermore, the empirical evidence demonstrates that integrating the sack race into the PE curriculum effectively supports the students' neuromuscular adaptation processes, thereby optimizing their lower-limb explosive power during vertical jumping mechanics.

This study underscores that traditional games possess highly relevant pedagogical and physiological values within physical education, extending far beyond mere recreational purposes or cultural preservation. Implementing progressive training principles within an engaging play environment offers a viable alternative solution to address the deficit in elementary school students' lower-limb muscular strength. Nevertheless, this research is constrained by a limited sample size and a relatively brief intervention duration spanning only six sessions, which mathematically influenced the statistical significance output ($p = 0.089$). External factors, such as the open-field setting and unpredictable weather conditions, also introduced confounding variables that could not be fully controlled. Consequently, future research incorporating extended durations, larger sample cohorts, and more strictly controlled environments is highly recommended to substantiate and expand upon these findings regarding the efficacy of traditional games across other physical fitness

components.

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