Original Article

Age-Based Comparison of Explosive Strength and Strength Endurance in 9- to 11-Year-Old School Boys

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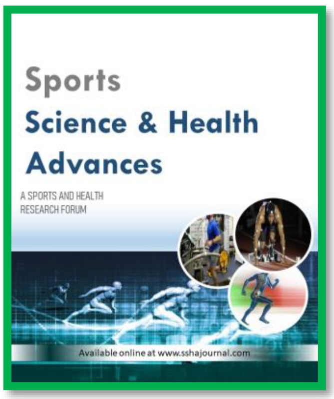

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Abstract

Background: Physical fitness in children is crucial for health, athletic performance, and obesity prevention. Analyzing age-based differences in key fitness components, such as explosive strength and endurance, can guide the development of effective physical education programs. **Study Purpose**: This study examined age-based differences in explosive strength and endurance among schoolboys aged 9 to 11 years. **Material and Methods**: A total of 90 boys, equally distributed across the three age groups, were selected from two schools in Jashore, Bangladesh. The primary criterion measures were explosive strength, assessed through the standing broad jump, and strength endurance, measured by 30 seconds bent knee sit-up test. Data analysis was conducted using IBM SPSS (version 25), with mean and standard deviation, calculated for each age group. One-way ANOVA followed by a post-hoc LSD test was performed to determine significant differences, with a significance level set at 0.05. **Results**: Results revealed a significant age-based effect on both performance measures. In the standing broad jump test, 11-year-olds outperformed both 9- and 10-year-olds, showing a mean difference of 22.80 cm compared to 9-year-olds and 19.17 cm compared to 10-year-olds ($p = 0.00$). Similarly, in the sit-up test, 11-year-olds demonstrated significantly higher endurance than both 9-year-olds (mean difference = 4.07, $p = 0.00$) and 10-year-olds (mean difference = 4.20, $p = 0.00$). These findings suggest that explosive strength and strength endurance improve with age among schoolboys in this age range. **Conclusions**: The study underscores the importance of considering age when assessing physical performance in youth and highlights the potential influence of age-related development on explosive strength and endurance capabilities.

Keywords: Explosive Strength, Strength Endurance, School boys, Age Comparison, Physical Performance

Introduction

Fitness is essential for children's physical and mental health, forming a foundation for lifelong well-being. Fundamental understandings of children develop motor skills and cognitive abilities through biological age, and body composition, with age and healthy weight gain being key factors (Bandyopadhyay & Basu, 2022; Mola & Shaw, 2024a). Lifestyle disorders are becoming more common in school-aged boys, impacting physical health and creating social and economic challenges (Bhavanani, 2017). These economic challenges lead to increased healthcare costs and long-term medical expenses, placing a financial strain on families and healthcare systems. This trend is largely driven by a rise in sedentary activities. Academic demands and frequent technology use have resulted in more time spent sitting or engaging in low-intensity activities, contributing to adverse health effects (University of Jyväskylä, 2024; Zhu, 2021). A sedentary lifestyle during childhood is especially concerning, as it can affect cardiovascular health in adolescence and raise the risk of heart disease later in life (University of Jyväskylä, 2024). Identifying and developing physical talent in young athletes can support their health and contribute to enhanced athletic performance (Mola & Shaw, 2024b). Fortunately, at this early stage, sports practice is generally less competitive, making it more enjoyable and accessible for children than in secondary school (Slater et al., 2010).

Physical fitness in children is a crucial factor influencing overall health and development. Among various fitness components, explosive strength and muscular endurance are key indicators of physical performance, particularly in young boys (Ortega et al., 2008; Reza et al., 2024). Explosive strength, often assessed through tests like the standing broad jump, reflects the ability to exert force rapidly, which is essential for athletic performance and everyday activities (Maffiuletti et al., 2016; Mola & Adane, 2020). Muscular endurance, evaluated using exercises such as the sit-up test, measures the ability of muscles to perform repeated contractions over time, which is vital for maintaining a healthy lifestyle (Bianco et al., 2015). Several studies have highlighted the importance of these physical attributes in children, showing that both explosive strength and endurance can influence sports performance and general fitness levels (Suchomel al., 2016; Ortega et al., 2008). As children grow, physiological changes occur that can impact their strength and endurance capabilities. Research indicates that boys typically experience significant improvements in muscle strength and power between the ages of 10 and 13, during the prepubescent stage (Brown et al., 2017; Manzano-Carrasco et al., 2022). Strength exercises significantly enhance physical performance (Stølen et al., 2005; Ziv & Lidor, 2010), while regular hamstring exercise is essential for maintaining muscle strength and improving overall leg health (Islam et al., 2024).

As children grow and engage in sports and physical activities, the importance of explosive strength becomes increasingly evident. For school boys, developing explosive strength is particularly crucial, as it contributes to overall fitness performance, enhances motor skills, and promotes physical health (Sutapa et al., 2021). Research shows that strong explosive power can improve abilities such as jumping, sprinting, and making quick changes in direction (Suchomel et al., 2016). Furthermore, upper-body strength is linked to enhanced jump force-time performance, highlighting the interconnectedness of different physical attributes (Suchomel et al., 2016; Rahman & Sharma, 2023). Engaging in activities that boost explosive strength not only improves physical capabilities but also helps children develop confidence in their abilities, positively impacting their social interactions and self-esteem (Sutapa et al., 2021). In addition to explosive strength, muscular endurance is another critical aspect of physical fitness involving the movement of the body's limbs (Rahman & Islam, 2021). According to Fenta and Mola (2023), the exercise training program helps improve players' agility, muscular strength, passing accuracy, and dribbling speed. Defined as the capacity of muscles to sustain repeated contractions over an extended period, muscular endurance plays a vital role in overall health and fitness (Beth, 2021). The sit-up test is a widely used method for assessing abdominal muscular endurance, focusing on the endurance of core muscles, including the rectus abdominis, transverse abdominis, and obliques (Bianco et al., 2015; Cronkleton, 2023). By addressing both explosive strength and muscular endurance, physical education programs can help school boys develop a well-rounded fitness foundation.

The present study aims to investigate age-based differences in explosive strength and muscular endurance among school boys aged 9 to 11 years. By comparing these two fitness components, the study seeks to provide insights into the developmental trajectories of young boys in the context of physical education and health. Understanding these differences enables physical education teachers and coaches to design programs that address the unique needs of children at various ages.

Materials and Methods

Participants

The study involved ninety (N = 90) school boys, aged 9 to 11, with an equal number (n=30) from each age group. These participants were selected from two schools in Jashore, Bangladesh, and came from lower- to middle-income families. Informed consent was obtained in writing from each child's parent or legal guardian, along with the school head, and included the child's date of birth.

Variables and Criterion Measures

Explosive strength and strength endurance served as the criterion measures in this study to evaluate leg power and abdominal endurance.

Table 1 Variables and criterion measures

Variables	Test Items	Unit of Measure
Explosive Strength	Standing Broad Jump	Meter (m)
Strength Endurance	30s Sit-up	Second (s)

Test Procedure

The standing broad jump (SBJ) is a widely recognized test for assessing lower limb strength and power. In this test, participants stand with their heels on a marked line and jump horizontally as far as possible, without any specific guidance on arm or leg movements. The jump distance is measured from the starting line to the heel closest to it upon landing with both feet together (Thomas et al., 2020). The bent knee sit-up test was used to assess strength endurance. In this test, participants began in a supine position with knees bent at 90 degrees and hands placed behind the neck. A partner held their feet as they performed as many sit-ups as possible in 30 seconds. Each correctly completed sit-up, where the chest reached the thighs, counted as one point. The total number of sit-ups completed within one minute determined the score (Suman & Sharma, 2023; Singh et al., 2024a).

Statistical Analysis

Data analysis was conducted using IBM SPSS software (version 25). For each group, the mean, standard deviation, standard error of the mean, along with minimum and maximum values, were calculated. A one-way analysis of variance (ANOVA) was conducted, followed by a post hoc least significant difference (LSD) test to identify significant differences, with a significance level of 0.05 applied in the analyses.

Results

Table 2 presents the descriptive statistics (mean, standard deviation, standard error, minimum, and maximum) for the standing broad jump and sit-ups among boys aged 9 to 11 years. Figure 1 illustrates the mean values for each age group.

Table 2. Descriptive statistics

Tests	Groups	N	Mean	Std. Dev.	Std. Err.	Minimum	Maximum
Standing Broad Jump	9 Year	30	140.33	24.79	4.53	86.00	179.00
	10 Year	30	143.97	17.76	3.24	100.00	175.00
	11 Year	30	163.13	24.81	4.53	120.00	220.00
Sit-ups	9 Year	30	13.97	5.43	0.99	2.00	26.00
	10 Year	30	13.83	6.28	1.15	3.00	24.00
	11 Year	30	18.03	3.15	0.57	8.00	23.00

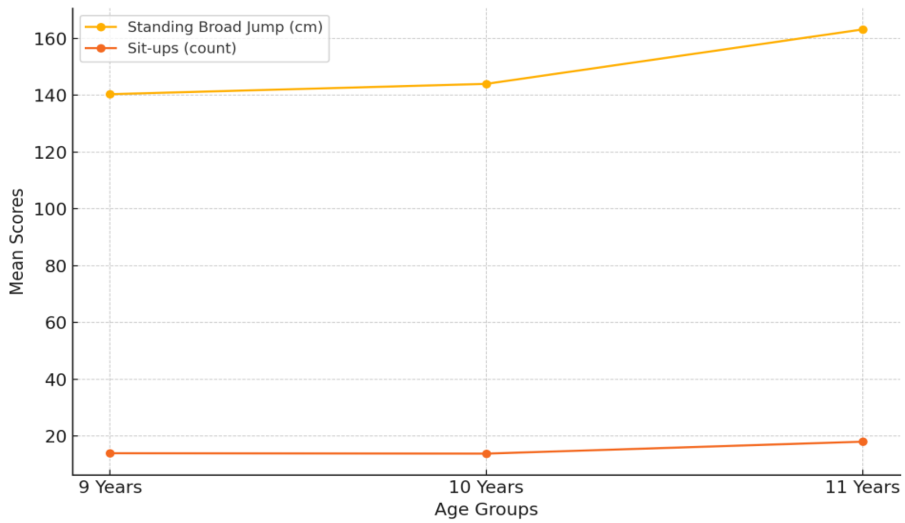

Figure 1. The mean scores of the standing broad jump and sit-ups by age groups

Table 3. One-way ANOVA

Tests	Groups	Sum of Squares	df	Mean Square	F-ratio	p-value
Standing Broad Jump	Between Group	9004.02	2	4502.01	8.74	0.00
	Within Group	44809.10	87	515.05		
Sit-ups	Between Group	341.96	2	170.98	6.51	0.00
	Within Group	2284.10	87	26.25		

*. Significant at 0.05 level

Table 3 one-way ANOVA was conducted to examine differences in performance on the standing broad jump and sit-up tests across groups. For the standing broad jump, there was a statistically significant effect of group on performance, F (2, 87) = 8.74, p = 0.00. Similarly, for the sit-ups test, a significant group effect was observed, F (2, 87) = 6.51, p = 0.00. These results suggest that group membership had a meaningful impact on both the standing broad jump and sit-up test performances.

Table 4. Post-hoc (LSD) Test

Test	Groups	Groups	Mean Diff.	Std. Error	Sig. Level
Standing Broad Jump	9 Year	10 Year	-3.63	5.86	0.54
		11 Year	-22.80*	5.86	0.00
	10 Year	9 Year	3.63	5.86	0.54
		11 Year	-19.17*	5.86	0.00
	11 Year	9 Year	22.80*	5.86	0.00
		10 Year	19.17*	5.86	0.00
Sit-ups	9 Year	10 Year	0.13	1.32	0.92
		11 Year	-4.07*	1.32	0.00
	10 Year	9 Year	-0.13	1.32	0.92
		11 Year	-4.20*	1.32	0.00
	11 Year	9 Year	4.07*	1.32	0.00
		10 Year	4.20*	1.32	0.00

*. The mean difference is significant at the 0.05 level

Table 4 post-hoc (LSD) tests indicated significant differences in both standing broad jump and sit-up performances among age groups. For the standing broad jump, 11-

year-olds showed significantly higher performance than both 9-year-olds (Mean Difference = 22.80, p = .00) and 10-year-olds (Mean Difference = 19.17, p = .00). Similarly, in the sit-ups test, 11-year-olds performed significantly better than both 9-year-olds (Mean Difference = 4.07, p = .00) and 10-year-olds (Mean Difference = 4.20, p = .00). These results suggest that older children outperformed younger peers in both physical tests.

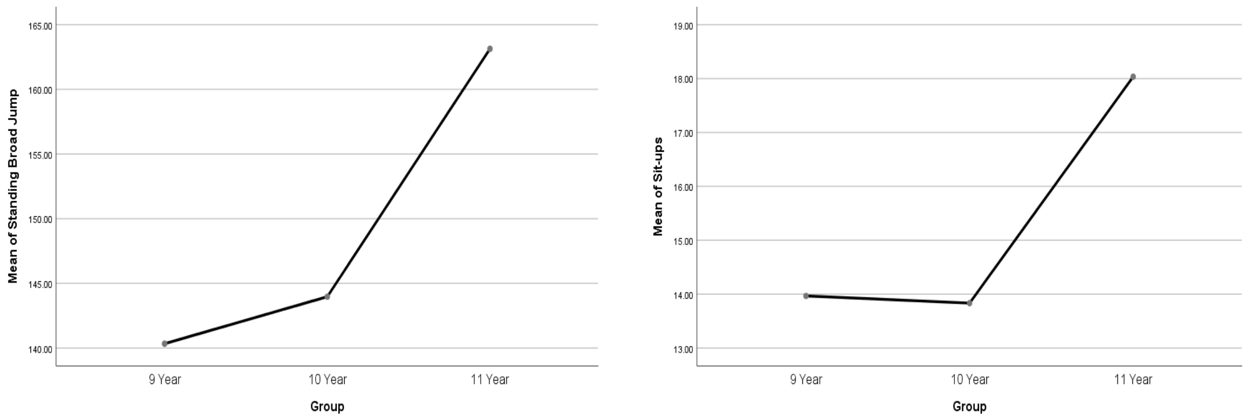

Figure 2. Mean plot of standing broad jump and sit-up across three age groups

Discussion

The present study showed significant group effects on performance in both the standing broad jump and sit-up tests; with older children (11-year-olds) outperforming younger peers (9- and 10-year-olds) in both tests. Post-hoc LSD tests confirmed these differences, indicating meaningful improvements in performance with age. Previous research found that, after the age of 13, boys showed continuous increases in physical fitness, including power, strength, and endurance (Greier et al., 2019). Another study found statistically significant improvements in standing long jump values among the 11 to 13-year-old age group (Jürimäe et al., 2007). Research indicates a gradual, linear increase in muscular explosive strength from ages 6 to around 12 or 13 (Buenen et al., 2020), making the observed improvement in SBJ performance among children anticipated (Thomas et al., 2020). Research consistently demonstrates that regular exercise, particularly resistance and plyometric training, enhances leg strength and explosive power (Singh et al., 2024b). A study found significant differences in standing broad jump performance between children aged 11 and 13 (Bayindir et al., 2015). Similarly, a cross-sectional study of school children aged 8–13 years found no significant difference in sit-up performance among participants (Amenya et al., 2021). Research involving male children and youth from Punjab, aged 8 to 18 years, showed that sit-up scores generally increased, with varying rates between ages 8 and 14 (Dutt, 2005). During puberty, boys experience a rapid increase in steroid hormones, growth hormone, and bone mineral content (Chung et al., 2013), which contribute to improvements in explosive strength and strength endurance. The study found significant differences between 7- to 9-year-old Bangladeshi and Indian primary school boys in lower body explosive strength, as measured by the standing broad jump, with Bangladeshi boys performing better (Mondal, 2015).

Training programs should be tailored to children’s age and developmental stage, with a focus on strength and endurance for those aged 11 and older and early intervention strategies for younger children. Fitness assessments should also account for pubertal changes, as these significantly impact strength and endurance. To better understand these age-related differences, longitudinal studies—tracking the same participants over extended periods—are needed to monitor performance changes through puberty and explore the factors that influence these variations.

Conclusions

This study highlights the significant impact of age on explosive strength and endurance in schoolboys aged 9 to 11 years. The results indicate that 11-year-olds demonstrate greater explosive strength and endurance than their younger counterparts, with substantial mean differences in both the standing broad jump and sit-up tests. These findings emphasize the importance of considering age in physical education programs to effectively enhance fitness levels in children. Tailoring interventions to these age-related differences can support the physical development and health of young athletes, contributing to improved athletic performance and reduced obesity risk.

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Conflicts of interest: The authors declare no conflicts of interest.

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