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Enhancing advanced motor skills through small-sided game-based physical education learning

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ABSTRACT

This study aimed to examine the effect of small-sided game-based learning on the advanced motor skills of seventh-grade students at SMP Negeri 05 Kepahiang, Indonesia. The study employed a quantitative approach using a pre-experimental one-group pretest–posttest design involving 32 seventh-grade students selected through total sampling. Advanced motor skills were assessed through five components, namely speed, agility, lower-body explosive strength, balance, and coordination. Data were analyzed using descriptive statistics, the Shapiro–Wilk normality test, and a paired-sample t-test. The findings revealed improvements across all motor components following the intervention. The composite motor skill score increased from a pretest mean of −0.001 to a posttest mean of 3.967. The paired-sample t-test demonstrated a statistically significant difference between pretest and posttest scores ($t = -17.266$, $p < 0.001$). Small-sided game-based learning effectively enhanced students' advanced motor skills and can be considered an innovative pedagogical strategy for promoting multidimensional motor development in junior secondary school physical education.

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Introduction

Motor skill development is one of the primary objectives of physical education because it contributes to students' physical competence, participation in physical activity, and long-term health outcomes. During early adolescence, motor development enters the specialized movement phase, in which individuals refine and integrate fundamental movement patterns into more complex and sport-related movements (Kaya et al., 2026; Kharatzadeh, Morgans, et al., 2025). In this phase, advanced motor skills encompass multidimensional physical capacities, including speed, agility, lower-body explosive strength, balance, and coordination, which collectively support efficient movement performance in various physical activities and sports. Students who possess higher levels of motor competence tend to demonstrate greater participation in physical activity, superior physical fitness, and more positive psychosocial outcomes than those with lower motor competence (Fessi et al., 2026; Stanković et al., 2026).

Early adolescence represents a critical period for motor development because rapid biological growth and neuromuscular maturation make students highly responsive to movement-based learning experiences. Significant improvements in motor coordination, movement efficiency, and muscular function occur during this stage as a consequence of neural adaptation and physical growth (Borges et al., 2024). Likewise, Kharatzadeh, Vazgen, et al. (2025) emphasized that appropriate movement experiences during early adolescence may produce

long-lasting adaptations in physical capacities and motor performance. Therefore, physical education at the junior secondary school level should provide meaningful and diversified learning experiences that facilitate the simultaneous development of multiple dimensions of motor competence.

Despite the recognized importance of motor competence, the motor performance of many school-aged children and adolescents remains suboptimal. Declining levels of physical activity, increasing sedentary behavior, and limited opportunities for structured movement experiences have negatively influenced students' motor development (Trotta & Sannicandro, 2025; Xu et al., 2025). Initial observations at SMP Negeri 05 Kepahiang similarly indicated that several students still experienced difficulties in coordination, agility, and balance during physical education activities. These conditions highlight the need for pedagogical approaches that actively engage students in movement experiences capable of simultaneously stimulating various components of advanced motor skills.

One instructional approach that has received increasing attention in physical education is game-based learning through small-sided games. Small-sided games are modified activities characterized by reduced playing areas, simplified rules, and a limited number of participants, thereby increasing movement frequency and opportunities for decision-making (Yang et al., 2024; Zeng et al., 2026). Their dynamic characteristics repeatedly expose learners to acceleration, deceleration, multidirectional movements, jumping, object manipulation, and interactions within unpredictable environments. Consequently, small-sided games may simultaneously stimulate speed, agility, lower-body explosive strength, balance, and coordination. Previous studies have demonstrated that game-based activities improve physical fitness, movement engagement, and sport-specific skills by increasing active participation and providing meaningful movement experiences (Koekoek et al., 2022; Shahid, 2026).

However, previous studies have predominantly examined the effects of small-sided games in competitive sports settings, particularly among athletes and soccer players, with greater emphasis on physiological adaptations and sport-specific technical performance (Guo et al., 2025; Sannicandro et al., 2026). Comparatively limited evidence has investigated the effectiveness of small-sided game-based learning in improving multidimensional motor competence among junior secondary school students in formal physical education contexts. Furthermore, motor competence has frequently been evaluated through isolated motor components rather than as an integrated construct representing overall motor proficiency (Hammami et al., 2023; Jin, 2025). Considering that motor competence is inherently multidimensional and consists of interrelated physical capacities, more comprehensive approaches are needed to capture students' overall motor development (Reis et al., 2026; Silva et al., 2025).

Based on these considerations, the present study aimed to examine the effect of small-sided game-based learning on the advanced motor skills of seventh-grade students at SMP Negeri 05 Kepahiang, Indonesia. The novelty of this study lies in three aspects. First, it investigated the implementation of small-sided game-based learning within a junior secondary school physical education setting rather than a competitive sport environment. Second, the study assessed advanced motor skills comprehensively through five integrated components, namely speed, agility, lower-body explosive strength, balance, and coordination. Third, standardized composite motor scores derived from Z-score transformations were employed to provide a holistic representation of students' multidimensional motor competence. It was hypothesized that participation in small-sided game-based learning would significantly improve students' advanced motor skills and provide empirical evidence supporting the implementation of game-based pedagogical strategies in school-based physical education.

Method

Research Design

This study employed a quantitative approach using a pre-experimental one-group pretest–posttest design. This design was selected to examine changes in students' advanced motor skills following participation in small-sided game-based learning within an authentic school setting where random assignment and the establishment of a control group were not feasible. Participants completed an initial assessment (pretest), received the intervention, and subsequently undertook a final assessment (posttest). Although this design does not permit strong causal inference because of the absence of a control group, it is considered appropriate for preliminary evaluations of educational interventions and for identifying changes in motor performance before and after treatment.

Participants

The study was conducted at SMP Negeri 05 Kepahiang, Bengkulu, Indonesia, during the 2025/2026 academic year. The population consisted of all seventh-grade students enrolled in the school. Because the target population comprised only 32 students, total sampling was employed and all students were included as research

participants. The sample consisted of 18 boys and 14 girls aged between 12 and 13 years. All participants regularly attended physical education classes and had no reported musculoskeletal disorders, neurological impairments, or medical conditions that could restrict participation in physical activity. Prior to data collection, permission was obtained from the school administration, and informed consent was secured from participants and their parents or guardians.

Instruments and Measures

Advanced motor skills were evaluated using a battery of standardized physical performance tests representing five interrelated motor components. Speed was assessed using the 30-m Sprint Test and recorded in seconds. Agility was measured using the Illinois Agility Test and recorded as completion time in seconds. Lower-body explosive strength was assessed through the Standing Broad Jump and recorded in centimeters. Balance was evaluated using the Stork Stand Test and recorded in seconds, whereas coordination was measured through the Wall Pass Test and recorded as the number of successful repetitions. These instruments were selected because they are widely used in motor performance and sports science research and demonstrate satisfactory levels of validity and reliability for assessing motor competence among school-aged populations.

Intervention Procedures

The study was implemented in three stages: preparation, intervention, and final evaluation. During the preparation stage, participants completed the pretest assessments using standardized testing procedures. Subsequently, students participated in three instructional sessions of small-sided game-based learning conducted during regular physical education lessons. Each session consisted of five motor-oriented activities designed to stimulate multidimensional motor development: relay sprinting activities to enhance speed, cone-running activities to improve agility and change-of-direction ability, hula-hoop jumping activities to develop lower-body explosive strength, one-leg blind statue activities to improve balance and postural control, and one-handed ball throwing and catching activities to facilitate coordination and perceptual-motor integration. All activities were implemented in small groups, using simplified rules and limited playing areas to maximize movement engagement, active participation, and opportunities for repeated motor execution.

Data Analysis

Because the five motor tests used different measurement units, all scores were standardized using Z-score transformations before analysis. The standardized scores were subsequently aggregated to generate a composite motor skill score representing overall advanced motor competence. Descriptive statistics, including minimum scores, maximum scores, means, and standard deviations, were calculated to describe participants' motor performance. The normality assumption was examined using the Shapiro–Wilk test. Changes in advanced motor skills between pretest and posttest measurements were analyzed using a paired-sample t-test with a significance level of 0.05. To determine the practical magnitude of the intervention effect, Cohen's d effect size was also calculated and interpreted according to conventional criteria (small = 0.20, medium = 0.50, and large = 0.80). All statistical analyses were performed using IBM SPSS Statistics software.

Results and Discussions

This study investigated the effect of small-sided game-based learning on the improvement of advanced motor skills among seventh-grade students at SMP Negeri 05 Kepahiang. Advanced motor skills were assessed through five components, namely speed, agility, lower-body strength, balance, and coordination. Data were collected before and after the intervention and subsequently standardized using Z-scores to obtain composite motor skill scores. Descriptive statistics, normality testing, and paired-sample t-tests were conducted to examine changes in students' motor performance following the intervention.

Table 1. Descriptive Statistics of Pretest Advanced Motor Skills (n = 32)

Variable	Minimum	Maximum	Mean	SD
Speed (s)	5.15	9.42	6.51	1.12
Agility (s)	14.10	21.14	16.62	1.87
Strength (cm)	108	204	140.00	29.00
Balance (s)	12.15	70.90	38.19	20.19
Coordination (times)	0	18	8.38	4.66

Table 1 presents the baseline condition of students' advanced motor skills before the implementation of small-sided game-based learning. The average speed performance was 6.51 seconds (SD = 1.12), while the mean agility score was 16.62 seconds (SD = 1.87). Students achieved an average standing broad jump distance of 140.00 cm (SD = 29.00). The mean balance score was 38.19 seconds (SD = 20.19), indicating considerable variability among participants. Meanwhile, the average coordination score was 8.38 repetitions (SD = 4.66), with some

students unable to complete the task successfully. Overall, the pretest findings indicate that students' advanced motor skills were heterogeneous and had not yet developed evenly across all components.

Table 2. Descriptive Statistics of Posttest Advanced Motor Skills (n = 32)

Variable	Minimum	Maximum	Mean	SD
Speed (s)	4.16	8.84	5.91	1.13
Agility (s)	13.10	20.91	15.77	1.97
Strength (cm)	116	222	149.06	30.77
Balance (s)	36.56	133.29	74.05	23.50
Coordination (times)	6	21	12.53	4.44

Table 2 demonstrates improvements in all components of advanced motor skills following the intervention. The mean speed score decreased from 6.51 seconds to 5.91 seconds, indicating faster running performance. Similarly, agility performance improved, as evidenced by the reduction in average completion time from 16.62 seconds to 15.77 seconds. Lower-body strength increased, with the mean standing broad jump improving from 140.00 cm to 149.06 cm. The balance score nearly doubled, increasing from 38.19 seconds to 74.05 seconds. Coordination performance also improved substantially, increasing from an average of 8.38 repetitions to 12.53 repetitions. These findings suggest that participation in small-sided games positively influenced all dimensions of advanced motor skills.

Table 3. Composite Pretest and Posttest Motor Skill Scores

Variable	Minimum	Maximum	Mean	SD
Composite Pretest Score	-6.28	8.39	-0.001	4.11
Composite Posttest Score	-4.03	10.72	3.97	4.07

Table 3 presents the standardized composite scores of advanced motor skills derived from the five motor components. The pretest composite score produced a mean value of approximately zero (M = −0.001, SD = 4.11), indicating successful standardization of the data. After the intervention, the mean composite score increased substantially to 3.97 (SD = 4.07). Furthermore, the maximum score increased from 8.39 to 10.72, suggesting that several students achieved considerable gains in motor performance. The higher posttest mean indicates an overall improvement in advanced motor skills after participation in small-sided game-based learning activities. The figure illustrates the overall trend of students' motor performance before and after participating in small-sided game-based learning activities.

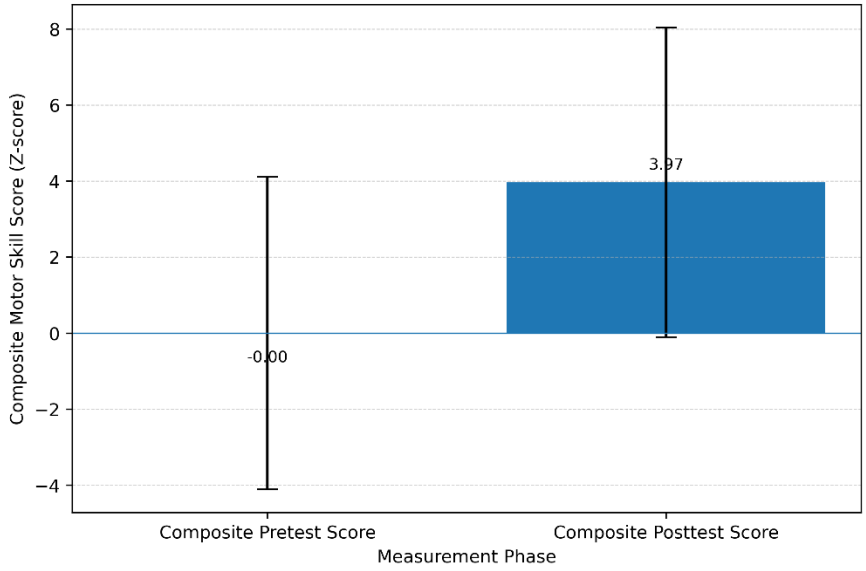

Figure 1. Comparison of Composite Pretest and Posttest Scores of Advanced Motor Skills

Table 4. Normality Test of Composite Motor Skill Scores

Variable	Shapiro–Wilk Statistic	df	Sig.
Composite Pretest Score	0.961	32	0.286
Composite Posttest Score	0.964	32	0.347

Table 4 shows the results of the normality assessment using the Shapiro–Wilk test. The pretest data produced a significance value of 0.286, while the posttest data yielded a significance value of 0.347. Both values exceeded the significance threshold of 0.05, indicating that the distributions of pretest and posttest scores did not significantly deviate from normality assumptions. Therefore, the data met the requirements for subsequent parametric analyses.

Table 5. Paired-Sample t-Test of Advanced Motor Skill Scores

Variable	Mean Difference	SD	t	df	Sig. (2-tailed)
Pretest – Posttest	-3.968	1.300	-17.266	31	<0.001

Table 5 presents the results of the paired-sample t-test comparing composite motor skill scores before and after the intervention. The analysis revealed a statistically significant difference between pretest and posttest scores ($t = -17.266$, $p < 0.001$). The mean difference of -3.968 indicates that posttest scores were substantially higher than pretest scores, reflecting marked improvements in students' motor abilities after the implementation of small-sided games. The magnitude and direction of the mean difference demonstrate that small-sided game-based learning effectively enhanced advanced motor skills, particularly in the domains of speed, agility, lower-body strength, balance, and coordination.

The findings of this study demonstrated that small-sided game-based learning produced a meaningful improvement in students' advanced motor skills. The composite motor skill score increased from a pretest mean of -0.001 to a posttest mean of 3.967, indicating a substantial positive change following the intervention. This finding suggests that structured game-based activities provide sufficient movement experiences to stimulate various dimensions of motor competence simultaneously. During early adolescence, diverse and meaningful movement experiences play an essential role in motor development because they promote the integration of neuromuscular functions and facilitate the refinement of fundamental movement capacities into more specialized motor skills (Dese et al., 2025; Li et al., 2024). Similar evidence has shown that game-based physical education environments encourage higher levels of physical engagement and motor learning compared with conventional instructional approaches (Arif et al., 2026; Pahlevi & Munir, 2023).

Improvements were observed in both speed and agility following the intervention. The mean speed score improved from 6.51 seconds to 5.91 seconds, while agility improved from 16.62 seconds to 15.77 seconds. Because lower completion times indicate better performance, these findings suggest that the small-sided games effectively stimulated rapid acceleration, deceleration, and directional changes. Such movement characteristics are inherent in small-sided activities, which repeatedly expose students to dynamic situations requiring quick decision-making and immediate motor responses. Previous studies have demonstrated that repeated multidirectional movements during game-based activities significantly enhance sprinting ability and agility by improving neuromuscular coordination and movement efficiency (Neag et al., 2024; Tognozzi Jamkosián, n.d.).

Lower-body explosive strength also increased following the intervention, as evidenced by the improvement in standing broad jump performance from 140.00 cm to 149.06 cm. This finding indicates that the intervention provided adequate stimuli for developing muscular power. Small-sided games frequently require jumping, sprinting, and explosive changes of movement, thereby promoting adaptations in the neuromuscular system and enhancing force production capacity. According to Machado et al., (2024), explosive strength develops optimally when individuals are repeatedly exposed to activities involving rapid force generation and movement transitions. Similarly, Mikalonytė et al., (2022) emphasized that adolescence represents a critical period for developing muscular power because neuromuscular plasticity is highly responsive to appropriately designed physical activities.

The largest improvement was observed in balance performance. The mean balance score increased markedly from 38.19 seconds during the pretest to 74.05 seconds in the posttest. This substantial improvement suggests that the intervention effectively enhanced postural control and body stability. Small-sided games typically require students to maintain balance while accelerating, changing direction, jumping, stopping, and interacting with peers in unpredictable environments. These repeated challenges stimulate sensory integration and proprioceptive adaptation, which are fundamental mechanisms underlying balance development. Previous research has shown that activities involving multidirectional movement patterns and environmental variability

significantly improve static and dynamic balance among school-aged children and adolescents (Arslan et al., 2022; Bibić et al., 2025).

Coordination performance also improved considerably, increasing from an average of 8.38 successful repetitions to 12.53 repetitions. Moreover, the minimum score increased from 0 to 6, indicating that students with initially poor coordination achieved meaningful progress after participating in the intervention. Coordination is a complex motor capacity involving the integration of perceptual, cognitive, and motor processes to execute movements efficiently. The throwing, catching, and object-manipulation activities incorporated into the small-sided games likely contributed to the enhancement of perceptual-motor integration and movement synchronization. (Hatta et al., 2026; Perdima et al., 2024) emphasized that repeated exposure to tasks requiring object control and body coordination facilitates improvements in motor planning, movement precision, and neuromuscular organization. Similar findings have been reported in school-based physical activity interventions that successfully improved coordination performance through playful and engaging movement experiences (Perdima et al., 2026; Yan et al., 2022).

The inferential analysis further confirmed the effectiveness of the intervention. The paired-sample t-test revealed a statistically significant difference between pretest and posttest scores ($t = -17.266$, $df = 31$, $p < 0.001$), with a mean difference of -3.968, indicating that posttest performance was substantially better than baseline performance. These results provide strong evidence that small-sided game-based learning can serve as an effective pedagogical approach for improving advanced motor skills among junior secondary school students. The findings are consistent with previous literature suggesting that game-based physical education promotes higher movement engagement, diversified motor experiences, and improvements in physical competence compared with teacher-centered approaches (Civan et al., 2026; Rumpf et al., 2026; Salter, 2025). Nevertheless, because this study employed a one-group pretest–posttest design without a control group, future studies should incorporate experimental control conditions and longer intervention periods to strengthen causal inference and examine the sustainability of motor improvements over time.

Conclusions

This study concludes that small-sided game-based learning significantly improves the advanced motor skills of seventh-grade students at SMP Negeri 05 Kepahiang. The intervention produced positive changes across all measured motor components, including speed, agility, lower-body explosive strength, balance, and coordination, as evidenced by the increase in composite motor skill scores and the statistically significant difference between pretest and posttest results ($p < 0.001$). These findings indicate that small-sided games provide meaningful, enjoyable, and movement-rich learning experiences that effectively stimulate multidimensional motor development. Therefore, small-sided game-based learning can be considered an effective pedagogical approach for enhancing advanced motor skills among junior secondary school students in physical education settings.

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