Sportif Bakış Spor ve Eğitim Bilimleri Dergisi
E-ISSN : 2148-905X
Year: 2026, Volume: 13, Issue: 3, pp.: 420-436

Effects of Fundamental Movement Training on Physical Fitness Parameters in Children Aged 8-10 Years*

Esra AKTAŞ[1], Harun GENÇ[2]

[1]Inönü University, Institute of Health Sciences, Malatya, Türkiye
[2]Bingöl University, Faculty of Sport Sciences, Bingöl, Türkiye

DOI: 10.70736/spjses.369		**Research Article**
Received:	*Accepted:*	*Published*:
15.08.2026	12.09.2026	15.09.2026

Abstract

Fundamental movement training may contribute to the development of physical fitness during childhood. This study investigated the effects of an eight-week fundamental movement training program on anthropometric characteristics and physical fitness parameters in children aged 8-10 years. Thirty-two primary school children were allocated to an experimental group (n=16; 8 girls and 8 boys) or a control group (n=16; 8 girls and 8 boys) using gender-stratified randomization. In addition to regular physical education classes, the experimental group participated in a fundamental movement training program three days per week for eight weeks, with each session lasting 50 minutes, whereas the control group continued routine physical education only. Anthropometric characteristics, strength, explosive performance, muscular endurance, speed, agility, flexibility, and shuttle-run performance were assessed before and after the intervention. Data were analyzed using a 2×2 mixed-design repeated-measures analysis of variance, with time as the within-subject factor and group as the between-subject factor. Significant time×group interactions favoring the experimental group were observed for vertical jump, anaerobic power, standing long jump, 10m sprint, T-test agility, handgrip strength, 30-s push-up, 30-s sit-up, and shuttle-run performance (all $p \leq .025$; $\eta p^2 = .156$-$.534$). The largest interaction effect was observed for shuttle-run performance ($p < .001$, $\eta p^2 = .534$). No significant time×group interactions were found for height, body mass, body mass index, flexibility, leg strength, or back strength (all $p \geq .062$). These findings indicate that eight weeks of fundamental movement training produced greater improvements than routine physical education alone in cardiorespiratory endurance, muscular endurance, explosive performance, speed, agility, and handgrip strength. However, the program did not produce differential changes in anthropometric characteristics, flexibility, leg strength, or back strength. Structured fundamental movement activities may therefore represent a useful component of school-based physical education, although studies with larger samples and longer follow-up periods are needed.

Keywords: Children, fundamental movement training, motor competence, physical fitness, school-based intervention

Correspondence: Esra AKTAŞ, **E-mail:** esra.akt6321@gmail.com

*This study is based on a master's thesis. It was also presented as an online oral presentation at the 7th International Uludağ Scientific Research Congress, held in Bursa, Türkiye, on October 3-4, 2025.

INTRODUCTION

Fundamental movement skills (FMS) are movement patterns that form the basis of children's participation in physical activity, games, and sports. These skills generally encompass locomotor skills such as running and jumping, object-control skills such as throwing, catching, and kicking, and stability skills involving balance and body control (Gallahue et al., 2012; Barnett et al., 2016). Developing these skills during childhood is important because it supports the acquisition of more complex movement patterns and helps children participate safely and effectively in various forms of physical activity.

Fundamental movement skill competence is closely associated with physical activity and physical fitness during childhood. Children with greater motor competence can participate in a wider range of physical activities, while regular participation in physical activity may also support the development of movement skills. This relationship has been proposed to be reciprocal and to become increasingly important as children develop (Stodden et al., 2008). Previous research has shown that FMS competence is positively associated particularly with health-related fitness components such as muscular strength, muscular endurance, and cardiorespiratory fitness. However, associations with other components, including body composition and flexibility, have yielded more variable findings (Liu et al., 2023). These findings suggest that developing fundamental movement skills may contribute not only to motor development but also to multiple dimensions of physical fitness.

Accordingly, structured FMS-based training programs may represent an appropriate approach to supporting children's physical development. Previous intervention studies and systematic reviews have shown that programs incorporating locomotor, object-control, balance, and other fundamental movement activities can improve children's motor skill competence (Logan et al., 2012; Tompsett et al., 2017; Yin et al., 2025). School-based interventions are particularly important because they provide children with regular opportunities to practice different movement skills in a structured environment. Nevertheless, a substantial proportion of existing intervention studies have focused primarily on FMS competence or physical activity levels, whereas the broader changes in physical fitness that may accompany FMS-based training have received comparatively limited attention.

Although some intervention studies have evaluated physical fitness outcomes, the available evidence is not comprehensive across the different components of physical fitness. Studies vary considerably in participant age, intervention duration and frequency, exercise content, and the fitness parameters assessed. Moreover, physical fitness has often been evaluated using only a limited number of parameters, such as muscular strength, speed, or cardiorespiratory endurance; relatively few studies have examined several components of physical fitness within the same experimental design (Lubans et al., 2010; Liu et al., 2023). It therefore remains unclear whether an FMS-based training program produces comparable improvements across multiple dimensions of physical fitness or whether its effects are specific to particular fitness components.

This issue is especially relevant for children aged 8-10 years. During this developmental period, children continue to refine fundamental movement patterns while also developing the physical

capacities required for more complex physical activities and sports skills. However, many studies focusing directly on this age group have assessed motor skill competence rather than a broad range of physical fitness components. For example, Costello and Warne (2020) reported that a four-week intervention improved motor skill competence in children aged 8-10 years but did not evaluate physical fitness components as a comprehensive set of outcomes. More generally, differences among previous studies in age ranges, intervention characteristics, and assessment methods make it difficult to determine how FMS-focused training affects different components of physical fitness specifically in children aged 8-10 years.

One important gap in the literature is therefore the limited evidence evaluating the effects of structured FMS-based training on multiple dimensions of physical fitness within a single intervention among children aged 8-10 years. In contrast to previous studies that have focused mainly on FMS competence or a limited number of fitness parameters, the present study jointly evaluated a broad range of outcomes, including anthropometric characteristics, muscular strength, muscular endurance, anaerobic performance, jumping performance, speed, agility, flexibility, and endurance. This approach was intended to provide a more comprehensive account of the physical adaptations that may occur in children aged 8-10 years following an FMS-based training program delivered three days per week for eight weeks.

Accordingly, this study aimed to examine the effects of an FMS-based fundamental movement training program, implemented three days per week for eight weeks, on physical fitness parameters in children aged 8-10 years. The primary hypothesis was that children participating in the FMS-based training program would demonstrate greater improvements than the control group in muscular strength, muscular endurance, anaerobic performance, jumping performance, speed, agility, flexibility, and endurance. Because the intervention period was relatively short and previous findings regarding the association between FMS and body composition have been inconsistent, no significant between-group difference in body mass index was expected.

METHOD

Research Model

This study used a randomized pretest-posttest control-group experimental design to examine the effects of an eight-week FMS training program on physical fitness parameters in children aged 8-10 years. The independent variable was the FMS-based training program, and the dependent variables were the physical fitness parameters assessed before and after the intervention.

Students attending Borsa İstanbul Mustafa Kemal Paşa Elementary School in Bingöl and regularly participating in physical education and sports classes were included in the study. Following baseline assessments, eligible participants were stratified by sex to ensure a balanced distribution of girls and boys between the groups. Randomization was performed by the researcher conducting the study using a drawing-lots procedure. Girls and boys were considered separately; each student's name or number was written on an individual piece of paper, folded, and placed in a closed box. Students were then assigned to the experimental or control group by drawing lots within each sex stratum. Consequently, two groups of 16 participants were formed, each comprising eight girls and eight boys, for a total sample of 32 children.

In addition to their routine physical education and sports classes, the experimental group participated in an FMS-based training program three days per week for eight weeks, with each session lasting 50 minutes. During the eight-week study period, the control group continued only its routine physical education and sports classes and received no additional FMS training.

Physical fitness assessments were conducted in both groups before the intervention (pre-test) and after completion of the eight-week intervention (post-test) using identical testing procedures. All measurements were administered by the same researcher. Because the researcher who conducted the measurements also performed the randomization, blinding the outcome assessor to group allocation was not possible.

Research Group

The study participants consisted of 32 students aged 8-10 years who were enrolled at Borsa İstanbul Mustafa Kemal Paşa Elementary School in the city center of Bingöl during the 2023-2024 academic year. Participants volunteered to participate and were assigned to the experimental and control groups using gender-stratified randomization. Each group consisted of 16 students, including eight boys and eight girls.

An a priori power analysis was performed using G*Power version 3.1.9.7 (Heinrich Heine University, Düsseldorf, Germany). The analysis was based on a mixed-design repeated-measures ANOVA examining the group×time interaction, with two groups and two measurement points. Assuming an effect size of f=.30, an alpha level of .05, a statistical power of .80, a correlation of .50 between repeated measurements, and a nonsphericity correction of 1.00, the minimum required total sample size was calculated as 24 participants. The final sample of 32 participants therefore exceeded the minimum required sample size.

Students in the experimental group participated in a fundamental movement training program for eight weeks, whereas the control group received no additional intervention during the study period. Written informed consent was obtained from the parents or legal guardians of all participants. The study was reviewed and approved by the Bingöl University Health Sciences Scientific Research and Publication Ethics Committee at its meeting held on November 21, 2023 (meeting no. 23/27, decision no.3; approval document no.E-33117789-604.01.01-132654).The descriptive characteristics of the participants are presented in Table 1.

Table 1. Descriptive characteristics of the participants by group and sex ($\bar{X}$± SD)

Group	Sex	n	Age (years)	Height (m)	Body weight (kg)	BMI (kg/m²)
Experimental	Female	8	9.00±.76	1.33 ±.08	27.99±4.68	15.79±1.33
	Male	8	8.88±.83	1.36±.06	33.74±7.49	18.03±2.74
Control	Female	8	8.75±.89	1.35±.05	27.68±2.79	15.14±1.05
	Male	8	9.00±.93	1.34±.08	28.75±4.80	16.23±3.27

EG: Experimental Group; **CG:** Control Group; **BMI:** Body Mass Index

A total of 32 children participated in the study, with 16 participants allocated to the experimental group and 16 to the control group. Each group comprised eight girls and eight boys. The mean ages of the experimental and control groups were 8.94±.77 and 8.88±.89 years, respectively. In the experimental group, girls and boys had mean body mass values of 27.99±4.68 kg and 33.74±7.49 kg, respectively, with corresponding BMI values of 15.79±1.33 and 18.03±2.74 kg/m². In the control group, mean body mass was 27.68±2.79 kg for girls and

28.75±4.80 kg for boys, while the corresponding BMI values were 15.14±1.05 and 16.23±3.27 kg/m². The descriptive characteristics of the participants according to group and sex are presented in Table 1.

Data Collection Tools

Physical fitness assessments were conducted at two different time points: a pre-test prior to the intervention and a post-test following the completion of the eight-week fundamental movement training program. The measurement battery assessed body composition, muscle strength, explosive and anaerobic performance, speed, agility, flexibility, cardiovascular endurance, and muscular endurance.

Anthropometric Measurements: Body height was measured to the nearest .1 cm using a stadiometer (brand and model, country) while participants stood barefoot in an upright position, with their heels together and head positioned in the Frankfurt horizontal plane. Body mass was measured to the nearest .1 kg using a calibrated electronic scale (brand and model, country), with participants barefoot and wearing light clothing. Body mass index (BMI) was calculated as body mass in kilograms divided by height in meters squared (kg/m²).

Muscle Strength: Handgrip strength of the dominant hand was assessed using a digital handgrip dynamometer (Grip-D, TKK 5401; Takei Scientific Instruments Co., Ltd., Tokyo, Japan). Participants performed the test in a seated position with the shoulder adducted and neutrally rotated, the elbow flexed at 90°, and the forearm and wrist maintained in a neutral position. The dynamometer was adjusted to fit each participant's hand size. Participants were instructed to squeeze the dynamometer as strongly as possible for approximately 3-5 s without moving the arm or trunk. Two trials were performed with approximately 60 s of rest between trials, and the highest value was recorded in kilograms and used in the statistical analysis (Mathiowetz et al., 1985; Tamer, 2000).

Leg strength was assessed using a digital leg-back dynamometer (Back-D, TKK 5402; Takei Scientific Instruments Co., Ltd., Tokyo, Japan). Participants stood on the dynamometer platform with their feet approximately shoulder-width apart, knees flexed, trunk upright, and arms extended while holding the dynamometer bar with both hands. The chain length was adjusted according to each participant's body dimensions. At the researcher's verbal signal, participants extended their knees and applied the greatest possible force while maintaining their grip on the bar and keeping their trunk stable. Two trials were conducted, with approximately 60 s of rest between trials, and the highest value was recorded in kilograms (Kamar, 2008).

Back strength was measured using the same digital leg-back dynamometer (Back-D, TKK 5402; Takei Scientific Instruments Co., Ltd., Tokyo, Japan). Participants stood on the platform with their knees extended, trunk slightly flexed forward, arms extended, and both hands holding the dynamometer bar. The chain length was individually adjusted to ensure an appropriate starting position. Participants were instructed to pull the bar vertically by extending the trunk and to apply maximal force without bending the knees or leaning backward. Two trials were performed, with approximately 60 s of rest between trials, and the highest value was recorded in kilograms (Özer, 2001). All strength measurements were administered by the same researcher using standardized verbal instructions and encouragement.

Explosive and Anaerobic Performance: Vertical jump performance was assessed using a Newtest electronic jump measurement system (Newtest Oy, Oulu, Finland). Participants began the test in an upright standing position with their feet approximately shoulder-width apart and their hands placed on their hips. They then performed a countermovement by rapidly flexing the knees and hips, followed immediately by a maximal vertical jump. Participants were instructed to keep their hands on their hips throughout the test and to land on the measurement mat with both feet. Two trials were performed, with approximately 60's of rest between trials, and the highest jump height was recorded in centimeters (Akbari et al., 2018).

Anaerobic power was estimated from body mass and vertical jump height using the Lewis formula (Tamer, 2000): $P=\sqrt{4.9}\times W\times\sqrt{D}$ where PP represents anaerobic power, WW represents body mass in kilograms, and DD represents vertical jump height in meters. Anaerobic power was expressed as kg·m/s.

Standing Long Jump: Lower-limb explosive strength was assessed using the standing long jump test. Participants stood immediately behind the take-off line with their feet approximately shoulder-width apart. Following a preparatory countermovement involving knee and hip flexion and a backward-forward arm swing, participants jumped forward as far as possible, taking off and landing simultaneously on both feet. The distance from the take-off line to the nearest point of contact made by the heels upon landing was measured to the nearest centimeter using a measuring tape. A trial was considered invalid if the participant stepped on or crossed the take-off line before jumping, failed to take off or land on both feet, or lost balance and touched the ground behind the heels after landing. Two valid trials were performed, with approximately 60's of rest between trials, and the longest distance was used in the statistical analysis (Muratlı et al., 2007).

Speed: Linear sprint speed was assessed using a 10-m sprint test. Participants started from a stationary standing position with their preferred foot forward and the toe of the front foot positioned immediately behind the starting line. At the researcher's signal, participants accelerated maximally and sprinted through the finish line without decelerating. Sprint time was measured in seconds using a stopwatch. Two trials were performed, with approximately 2 min of rest between trials, and the shortest completion time was used in the statistical analysis. A shorter completion time indicated better sprint performance (Tamer, 2000).

Agility: Agility was assessed using the T-test. Four cones were arranged in a T-shaped configuration. From the starting cone, participants sprinted forward 9.14 m to the central cone, shuffled 4.57 m to the right, shuffled 9.14 m to the left, returned 4.57 m to the central cone, and then moved backward 9.14 m through the starting line. Participants were instructed to face forward throughout the test, touch the base of each cone with the designated hand, avoid crossing their feet during lateral movements, and complete the course as quickly as possible. Completion time was measured in seconds using a stopwatch. Two valid trials were performed, with approximately 2 min of rest between trials, and the shortest completion time was used in the statistical analysis. A shorter completion time indicated better agility performance (Özbay et al., 2018).

Cardiovascular Endurance: Cardiovascular endurance was assessed using the 20-m multistage shuttle run test. Two parallel lines were marked 20 m apart, and participants were instructed to run continuously between the lines in time with prerecorded audio signals. The test began at a running speed of 8.5 km/h, which increased by .5 km/h approximately every minute. Participants were required to reach the relevant line before or at each audio signal. The test was terminated when a participant voluntarily stopped because of fatigue or failed to reach the line in time with the audio signal on two consecutive occasions. The total number of successfully completed 20-m shuttles was recorded and used in the statistical analysis (Léger et al., 1988; Tamer, 2000).

Muscular Endurance: Upper-body muscular endurance was assessed using the 30-s push-up test. Participants assumed a standard push-up position with their hands approximately shoulder-width apart, arms fully extended, feet together, and the head, trunk, and legs aligned in a straight line. At the researcher's signal, participants lowered their bodies by flexing their elbows and then returned to the starting position by fully extending their arms. Participants were instructed to maintain the correct body alignment throughout the test. The number of correctly completed push-ups within 30 s was recorded; repetitions performed with improper technique were not counted.

Trunk muscular endurance was assessed using the 30-s sit-up test. Participants lay in a supine position with their knees flexed, feet placed flat on the floor, and hands placed lightly over their ears. Their feet were stabilized by a researcher throughout the test. At the researcher's signal, participants raised their upper bodies toward their knees until their elbows touched their knees and then returned to the starting position until their shoulder blades contacted the floor. The number of correctly completed sit-ups within 30 s was recorded; repetitions that did not meet the required technique were not counted.

8-Week Fundamental Movement Training Protocol: Following the baseline assessments, participants in the intervention group completed an eight-week fundamental movement training program consisting of three 50 min sessions per week, conducted on nonconsecutive days (Monday, Wednesday, and Friday). The program comprised 24 sessions and provided a total training duration of 1,200 min. Each session included a standardized warm-up, a main activity phase involving age-appropriate locomotor, balance, object-control, coordination, and game-based activities, and a cool-down phase. The activities were progressively modified across the eight weeks by increasing movement complexity and combining multiple motor tasks. Table 2 summarizes the primary focus and training content for each week.

Table 2. Weekly focus, activities, and session duration of the eight-week fundamental movement training program

Week	Main focus	Activities / training content	Duration
1	Basic endurance, coordination, and jumping	Warm-up with low-intensity jogging and dynamic stretching; walking and running at different tempos; bilateral and unilateral jumping activities; educational games including Fishing Net, Tail Tag, and Hoop Game; cool-down with walking and static stretching	50 min
2	Running, change of direction, strength/teamwork, and manipulative skills	Warm-up; running at different tempos and directions; forward-backward and lateral movement tasks; tug-of-war; walking while controlling a ball; educational games including Caterpillar Game, 51 Game, and Dangerous Ball; cool-down	50 min

3	Locomotor skills, agility, rhythm, and coordination	Warm-up; toe walking, movement through cones, and galloping; locomotor and rhythmic tasks; hoop-based movement activities; zig-zag galloping and ball-control tasks; educational games including Hoop Game, Tunnel Game, and Directional Ball Passing Game; cool-down	50 min
4	Rhythm, creative movement, manipulative skills, and strength/team activities	Warm-up; rhythm- and music-based movement activities; rope-turning activities; body-weight and core-control tasks; individual and group strength/team activities; educational games including rope-jumping activities; cool-down	50 min
5	Balance, displacement, rhythm, and coordination	Warm-up; balance and displacement tasks using floor markers; slalom-type movement; forward, backward, lateral, and cross-step movements; running according to clapping rhythm; Pin Knock-Down Game; cool-down	50 min
6	Combined movement skills and object control	Warm-up; mini-station obstacle courses combining different motor tasks; object-control activities; ball control along predetermined lines and target throwing; jumping inside a hoop combined with throwing and catching; cool-down	50 min
7	Displacement, object control, and integrated movement skills	Warm-up; forward rolls on mats; ball dribbling, bouncing, catching, and controlling the ball along straight and zig-zag pathways; multi-stage movement and target-throwing activities; Capture the Flag; cool-down	50 min
8	Locomotor, coordinative, balance, object-control, and manipulative skills	Warm-up; sequential movement and rolling on mats; floor-marker displacement tasks; ball dribbling combined with single-leg jumping; controlled climbing; ball-change and target games; passing game; cool-down	50 min

Data Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as $\bar{X}\pm SD$, and categorical variables as frequencies and percentages. The distributions of the model residuals were evaluated using Q-Q plots and the Shapiro-Wilk test, while homogeneity of variance was assessed using Levene's test. Potential baseline differences between the experimental and control groups were examined using independent-samples t-tests for continuous variables and the chi-square or Fisher's exact test, as appropriate, for categorical variables.

The effects of the fundamental movement training program on each physical fitness outcome were examined using a 2×2 mixed-design repeated-measures analysis of variance (ANOVA), with time (pre-test and post-test) as the within-subject factor and group (experimental and control) as the between-subject factor. The group×time interaction was considered the primary effect of interest because it indicated whether the change over time differed between the two groups. When a significant interaction was observed, Bonferroni-adjusted pairwise comparisons were conducted to examine within-group changes over time and between-group differences at each measurement point. Within-group percentage changes were calculated and reported for descriptive purposes only.

Effect sizes for the main and interaction effects were reported as partial eta squared (ηp^2), together with the corresponding F statistics and exact p values. Partial eta squared values of .01, .06, and .14 were interpreted as small, medium, and large effects, respectively. All statistical tests were two-sided, and statistical significance was set at $p<.05$.

FINDINGS

Table 3. Changes in anthropometric outcomes in the experimental and control groups

Variable	Group	Pre-test X̄±SD	Post-test X̄±SD	Change (%)	Within-group p	Time F (p; ηp²)	Group F (p; ηp²)	Time × Group F (p; ηp²)
Height (m)	EG (n=16)	1.34±.072	1.35±.074	+1.02	**.001**	69.429	.024	3.429
	CG (n=16)	1.34±.064	1.35±.063	+.65	**.001**	(**.001**; .698)	(.878; .001)	(.074; .103)
Body mass (kg)	EG (n=16)	30.86±6.73	31.61±7.06	+2.43	**.013**	3.978	2.301	1.286
	CG (n=16)	28.21±3.83	28.42±3.29	+.73	.612	(.055; .117)	(.140; .071)	(.266; .041)
BMI (kg/m²)	EG (n=16)	16.91±2.38	17.13±2.53	+1.29	.112	.050	3.212	1.434
	CG (n=16)	15.68±2.42	15.53±1.63	-.96	.599	(.825; .002)	(.083; .097)	(.241; .046)

Note: Values are presented as X̄±SD. Percentage change was calculated as [(post-test-pre-test)/pre-test]×100. Within-group p-values were obtained using paired-samples t-tests. Time, group, and time×group effects were evaluated using a 2×2 mixed-design repeated-measures ANOVA. BMI: body mass index; ηp²: partial eta squared. Bold values indicate p<.05.

A significant main effect of time was observed for height, F(1, 30)=69.429, p<.001, ηp²=.698. However, neither the group main effect, F(1, 30)=.024, p=.878, ηp²=.001, nor the time×group interaction, F(1, 30)=3.429, p=.074, ηp²=.103, was significant. Height increased from 1.344±.072 m to 1.358±.074 m in the experimental group and from 1.343±.064 m to 1.352±.063 m in the control group. Within-group comparisons indicated significant increases in both the experimental and control groups (both p<.001). For body mass, the main effects of time, F(1, 30)=3.978, p=.055, ηp²=.117, and group, F(1, 30)=2.301, p=.140, ηp²=.071, were not significant. The time×group interaction was also not significant, F(1, 30)=1.286, p=.266, ηp²=.041. Body mass increased from 30.86±6.73 kg to 31.61±7.06 kg in the experimental group and from 28.21±3.83 kg to 28.42±3.29 kg in the control group. Although the within-group increase was significant in the experimental group (p=.013), it was not significant in the control group (p=.612). Nevertheless, the changes did not differ significantly between groups. No significant main effect of time was observed for BMI, F(1, 30)=.050, p=.825, ηp²=.002. The group main effect, F(1, 30)=3.212, p=.083, ηp²=.097, and time×group interaction, F(1, 30)=1.434, p=.241, ηp²=.046, were also not significant. Within-group changes in BMI were not significant in either the experimental (p=.112) or control group (p=.599).

Table 4. Changes in physical fitness outcomes in the experimental and control groups

Variable	Group	Pre-test X̄±SD	Post-test X̄±SD	Change (%)	Within-group p	Time F (p; ηp²)	Group F (p; ηp²)	Time × Group F (p; ηp²)
Shuttle test (pcs)	EG (n=16)	26.06±4.11	30.50±3.74	+17.03	**.001**	50.983	2.372	34.324
	CG (n=16)	25.88±4.33	26.31±4.32	+1.69	.069	(**.001**; .630)	(.134; .073)	(**.001**; .534)
30-s push-up (repetitions)	EG (n=16)	11.75±3.62	13.44±3.71	+14.36	**.001**	17.181	.131	9.458
	CG (n=16)	12.06±2.91	12.31±2.60	+2.07	.534	(**.001**; .364)	(.720; .004)	(**.004**; .240)
30-s sit-up (repetitions)	EG (n=16)	13.94±3.34	16.00±4.12	+14.80	**.001**	23.857	.085	10.080
	CG (n=16)	15.13±3.61	15.56±3.74	+2.89	.186	(**.001**; .443)	(.773; .003)	(**.003**; .251)
Leg strength (kg)	EG (n=16)	29.25±6.95	35.03±9.34	+19.77	**.001**	14.008	4.811	1.534
	CG (n=16)	25.87±5.13	28.78±5.98	+11.23	.155	(**.001**; .318)	(**.036**; .138)	(.225; .049)
Back strength (kg)	EG (n=16)	29.69±8.46	38.13±11.36	+28.42	**.001**	21.592	1.428	3.760
	CG (n=16)	28.59±6.44	32.06±9.33	+12.13	.081	(**.001**; .419)	(.223; .047)	(.062; .111)

Note: Values are presented as X̄±SD. Percentage change was calculated as [(post-test-pre-test)/pre-test]×100. Within-group p-values were obtained using paired-samples t-tests. Time, group, and time×group effects were evaluated using a 2×2 mixed-design repeated-measures ANOVA. ηp²=partial eta squared. Bold values indicate p<.05.

The physical fitness results are presented in Table 4. Significant main effects of time were observed for the shuttle test, F(1, 30)=50.983, p<.001, ηp²=.630; 30-s push-up, F(1, 30)=17.181, p<.001, ηp²=.364; 30-s sit-up, F(1, 30)=23.857, p<.001, ηp²=.443; leg strength, F(1, 30)=14.008, p=.001, ηp²=.318; and back strength, F(1, 30)=21.592, p<.001, ηp²=.419.

Significant time×group interactions were observed for the shuttle test, F(1, 30)=34.324, p<.001, ηp^2=.534; 30-s push-up, F(1, 30)=9.458, p=.004, ηp^2=.240; and 30-s sit-up, F(1, 30)=10.080, p=.003, ηp^2=.251. The experimental group demonstrated improvements of 17.03%, 14.36%, and 14.80% in these outcomes, respectively, compared with improvements of 1.69%, 2.07%, and 2.89% in the control group. Within-group analyses showed significant improvements in the experimental group for the shuttle, push-up, and sit-up tests (all p<.001), whereas the corresponding changes in the control group were not significant (p=.069, p=.534, and p=.186, respectively). For leg strength, the experimental group improved by 19.77%, whereas the control group improved by 11.23%. However, the time × group interaction was not significant, F(1, 30)=1.534, p=.225, ηp^2=.049. Similarly, back strength increased by 28.42% in the experimental group and by 12.13% in the control group, but the time×group interaction did not reach statistical significance, F(1, 30)=3.760, p=.062, ηp^2=.111. Although within-group increases in leg and back strength were significant in the experimental group (both p<.001), they were not significant in the control group (p=.155 and p=.081, respectively). Therefore, the larger numerical increases in the experimental group cannot be interpreted as significant intervention effects for leg or back strength. No significant group main effects were found for the shuttle test, push-up, sit-up, or back strength (all p>.05). A significant group main effect was observed for leg strength, F(1, 30)=4.811, p=.036, ηp^2=.138; however, this finding reflects the overall difference between the groups across the two measurement occasions and does not indicate a differential intervention response.

Table 5. Changes in physical performance outcomes in the experimental and control groups

Variable	Group	Pre-test X̄±SD	Post-test X̄±SD	Change (%)	Within-group p	Time F (p; ηp^2)	Group F (p; ηp^2)	Time × Group F (p; ηp^2)
Vertical jump (cm)	EG (n=16)	19.63±2.70	23.19±3.83	+18.15	**.002**	15.162	.491	5.561
	CG (n=16)	20.06±4.04	20.94±5.05	+4.36	.155	(**<.001**; .336)	(.489; .016)	(**.025**; .156)
Anaerobic power (kg·m·s⁻¹)	EG (n=16)	55.30±6.94	61.06±5.48	+10.42	**<.001**	7.423	.093	6.121
	CG (n=16)	57.48±5.87	57.76±5.82	+0.48	.884	(**<.001**; .198)	(.763; .003)	(**.019**; .169)
Standing long jump (cm)	EG (n=16)	128.25±15.85	148.50±16.91	+15.79	**.001**	26.356	2.116	8.088
	CG (n=16)	126.56±19.48	132.38±22.11	+4.59	**.003**	(**<.001**; .468)	(.156; .066)	(**.008**; .212)
Flexibility (cm)	EG (n=16)	21.16±6.27	23.56±5.45	+11.37	**.006**	13.712	1.102	1.577
	CG (n=16)	19.88±4.63	21.06±4.57	+5.97	.072	(**<.001**; .314)	(.302; .035)	(.219; .050)
10-m sprint (s)	EG (n=16)	3.17±0.24	2.85±.14	-10.02	**<.001**	49.527	4.267	21.406
	CG (n=16)	3.20±0.24	3.14±.28	-2.05	**.035**	(**<.001**; .623)	(**.048**; .125)	(**.001**; .416)
T-test agility (s)	EG (n=16)	17.46±1.41	16.70±1.41	-4.36	**<.001**	25.621	.025	8.232
	CG (n=16)	17.27±1.74	17.06±1.80	-1.22	.206	(**<.001**; .461)	(.876; .001)	(**.007**; .215)
Handgrip strength (kg)	EG (n=16)	12.24±3.04	13.77±2.45	+12.46	**.001**	18.961	.178	7.708
	CG (n=16)	12.45±2.67	12.79±2.47	+2.71	.156	(**<.001**; .387)	(.676; .006)	(**.009**; .204)

Note: Values are presented as X̄±SD. Percentage change was calculated as [(post-test-pre-test)/pre-test]×100. Within-group p-values were obtained using paired-samples t-tests. Time, group, and time × group effects were evaluated using a 2×2 mixed-design repeated-measures ANOVA. ηp^2=partial eta squared. Bold values indicate p<.05.

The motor performance outcomes are presented in Table 5. Significant main effects of time were observed for vertical jump, F(1, 30)=15.162, p=.001, ηp^2=.336; anaerobic power, F(1, 30)=7.423, p=.011, ηp^2=.198; standing long jump, F(1, 30)=26.356, p<.001, ηp^2=.468; flexibility, F(1, 30)=13.712, p=.001, ηp^2=.314; 10-m sprint, F(1, 30)=49.527, p<.001, ηp^2=.623; T-test agility, F(1, 30)=25.621, p<.001, ηp^2=.461; and handgrip strength, F(1, 30)=18.961, p<.001, ηp^2=.387. Significant time×group interactions were found for vertical jump, F(1, 30)=5.561, p=.025, ηp^2=.156; anaerobic power, F(1, 30)=6.121, p=.019, ηp^2=.169; standing long jump, F(1, 30)=8.088, p=.008, ηp^2=.212; 10-m sprint, F(1, 30)=21.406, p<.001, ηp^2=.416;

T-test agility, $F(1, 30)=8.232$, $p=.007$, $\eta p^2=.215$; and handgrip strength, $F(1, 30)=7.708$, $p=.009$, $\eta p^2=.204$. These interactions indicated significantly greater improvements in the experimental group than in the control group. Specifically, the experimental group improved by 18.15% in vertical jump, 10.42% in anaerobic power, 15.79% in standing long jump, and 12.46% in handgrip strength. The corresponding improvements in the control group were 4.36%, 0.48%, 4.59%, and 2.71%, respectively. The experimental group also demonstrated greater reductions in 10-m sprint time (-10.02%) and T-test agility time (-4.36%) than the control group (-2.05% and -1.22%, respectively), with reductions in completion time indicating improved performance. Within-group comparisons showed significant improvements in the experimental group for all outcomes presented in Table 5 (all $p\leq.006$). In the control group, significant within-group improvements were observed only for standing long jump ($p=.003$) and 10-m sprint performance ($p=.035$); the remaining changes were not statistically significant (all $p>.05$). A sensitivity analysis using the Mann-Whitney U test for the non-normally distributed handgrip change scores also confirmed a significant between-group difference ($U=49.500$, $Z=-2.971$, $p=.003$). Although flexibility improved by 11.37% in the experimental group and 5.97% in the control group, the time×group interaction was not significant, $F(1, 30)=1.577$, $p=.219$, $\eta p^2=.050$. Therefore, the difference between groups in flexibility change was not statistically significant. No significant group main effects were identified for vertical jump, anaerobic power, standing long jump, flexibility, T-test agility, or handgrip strength. A significant group main effect was observed for 10-m sprint performance, $F(1, 30)=4.267$, $p=.048$, $\eta p^2=.125$; however, this represents the overall difference between groups across measurement occasions and should not be interpreted independently as an intervention effect.

DISCUSSION

This study examined the effects of an eight-week fundamental movement training program on anthropometric characteristics and physical fitness outcomes in children aged 8-10 years. Intervention effects were evaluated primarily using time×group interactions, which directly indicate whether changes over time differed between the experimental and control groups. Significant interactions favoring the experimental group were observed for vertical jump, anaerobic power, standing long jump, 10-m sprint, T-test agility, handgrip strength, 30-s push-up, 30-s sit-up, and shuttle-run performance. In contrast, the time×group interactions were not significant for height, body mass, BMI, flexibility, leg strength, or back strength. These findings suggest that the program was associated primarily with improvements in selected motor performance and physical fitness outcomes rather than with anthropometric changes or uniform improvements across all measured parameters.

Effect on Physical Characteristics

Height increased significantly over time in both groups; however, the time×group interaction was not significant. Therefore, the observed increase in height cannot be attributed specifically to the fundamental movement training program. In children aged 8-10 years, changes in height over an eight-week period are more appropriately interpreted in the context of normal growth and biological development. Physical growth during childhood is influenced by nutrition, health status, physical activity, lifestyle, and maturation (Senemoğlu, 2005). Body mass increased

significantly within the experimental group but not within the control group. Nevertheless, the time×group interaction was not significant, indicating that the changes in body mass did not differ significantly between groups. Similarly, neither the time effect nor the time×group interaction was significant for BMI. Accordingly, the findings do not provide sufficient evidence that the program altered body mass or BMI. Because body fat percentage, fat mass, and fat-free mass were not measured, no conclusions can be drawn regarding changes in body composition or the prevention of excessive weight gain.

Effect on Strength

Handgrip strength demonstrated a significant time×group interaction, indicating a greater improvement in the experimental group than in the control group. The experimental group showed a 12.46% increase, whereas the control group showed a 2.71% increase. This finding was also supported by the sensitivity analysis of change scores. Improvements in handgrip strength may be related to the manipulative and weight-bearing components of the program, including pushing, pulling, carrying, supporting body weight, and object-control activities. Similar improvements following game- and movement-based programs have been reported by (Aynacıyan & Özer 2020; Kaya, 2023).

Leg and back strength increased significantly within the experimental group. However, the corresponding time×group interactions were not significant. Therefore, the larger numerical increases observed in the experimental group cannot be interpreted as statistically significant intervention effects. Both groups may have been influenced by normal growth, regular physical education, daily physical activity, familiarization with the testing procedures, or other unmeasured factors. The present findings thus provide evidence for an intervention-related improvement in handgrip strength, but not for differential improvements in leg or back strength.

Effect on Anaerobic Performance

Significant time×group interactions were observed for vertical jump, standing long jump, and anaerobic power. The experimental group improved by 18.15% in vertical jump, 15.79% in standing long jump, and 10.42% in anaerobic power, compared with improvements of 4.36%, 4.59%, and .48%, respectively, in the control group. These findings indicate that the experimental group achieved greater gains in lower-limb explosive performance. The dynamic content of the program-including jumping, running, climbing, landing, and rapid movement transitions-may have provided repeated opportunities to develop neuromuscular coordination, force production, and movement efficiency. This interpretation is consistent with the conceptual relationship between motor competence and health-related physical fitness described by (Stodden et al., 2014). Nevertheless, the significant within-group improvement in standing long jump observed in the control group should also be acknowledged. This change may reflect normal development, regular school activity, test familiarization, or physical activity performed outside the intervention.

Effect on Muscular Endurance

Significant time×group interactions were found for both the 30-s push-up and 30-s sit-up tests. Push-up performance improved by 14.36% in the experimental group and 2.07% in the control group, while sit-up performance improved by 14.80% and 2.89%, respectively. These findings

support a differential effect of the program on upper-body and trunk muscular endurance. The program included activities requiring repeated body support, stabilization, pushing, and trunk control, which may have contributed to the observed improvements. Başal and Yüksel (2021) similarly reported improvements in 30-s push-up and sit-up performance following an educational-game program. However, because field tests may also be influenced by motivation, technique, pacing, and familiarity, the results should be interpreted as improvements in test performance rather than isolated changes in specific muscle groups.

Effect on Speed

A significant time×group interaction was observed for 10-m sprint performance. Sprint time decreased by 10.02% in the experimental group compared with 2.05% in the control group, indicating a greater improvement in short-distance speed in the experimental group. The sprinting, acceleration, jumping, and rapid-transition activities included in the program may have supported neuromuscular coordination and movement efficiency over short distances. Jose and Sudheesh (2018) similarly reported improved speed following an eight-week motor-skill program. The control group also showed a significant within-group improvement in sprint performance. This finding highlights the potential contributions of growth, regular physical education, habitual activity, motivation, and repeated exposure to the test. Nevertheless, the significant time×group interaction indicates that the reduction in sprint time was greater in the experimental group.

Effect on Agility

T-test agility performance demonstrated a significant time×group interaction. The experimental group reduced completion time by 4.36%, compared with a reduction of 1.22% in the control group. Agility requires the integration of acceleration, deceleration, balance, coordination, and rapid directional changes. These components were repeatedly practiced through the program's direction-changing, jumping, stopping, and starting activities. Comparable agility improvements following movement- and game-based interventions have been reported by (Özkatar-Kaya et al. 2019; Karaman & Süel 2020; Başal & Yüksel 2021). The present findings support these observations while indicating that the experimental group's improvement exceeded the change observed in the control group.

Effect on Flexibility

Flexibility increased significantly over time, and the experimental group showed a significant within-group improvement. However, the time×group interaction was not significant. Therefore, the difference in flexibility change between the experimental and control groups cannot be attributed to the intervention. The stretching, reaching, squatting, balancing, and multidirectional movement tasks may have contributed to the numerical improvement in the experimental group, but the present statistical findings do not demonstrate superiority over the control condition. Previous studies have reported flexibility improvements following game- and movement-based programs (Anamurluoğlu, 2020; Bozkurt et al., 2021; Kaya, 2023). Differences between those findings and the present results may be related to intervention duration, training frequency, exercise content, baseline flexibility, measurement procedures, or sample characteristics.

Effect on Cardiovascular Endurance

A significant time×group interaction was observed for shuttle-run performance. The experimental group improved by 17.03%, whereas the control group improved by 1.69%. This result indicates that the change in shuttle-run performance was greater in the experimental group. The rhythmic running, repeated directional changes, and continuous movement activities included in the program may have increased the children's ability to sustain intermittent exercise. Comparable improvements in endurance-related outcomes have been reported by (Lämmle et al., 2016; Kaya, 2023). In contrast, Sindić et al. (2021) did not identify a significant improvement following an integrated program. Differences in exercise intensity, program duration, session frequency, participant characteristics, and outcome assessment may explain the inconsistency across studies.

Conclusion

The eight-week fundamental movement training program was associated with greater improvements in vertical jump, anaerobic power, standing long jump, 10-m sprint, T-test agility, handgrip strength, 30-s push-up, 30-s sit-up, and shuttle-run performance compared with the control condition. These conclusions are supported by significant time×group interactions.

Although leg strength, back strength, and flexibility improved significantly within the experimental group, their time×group interactions were not significant. Therefore, the findings do not demonstrate that the program produced greater improvements than the control condition in these outcomes. Similarly, changes in height, body mass, and BMI did not differ significantly between groups and should not be interpreted as intervention effects. Height changes were more likely related to normal growth and development.

Overall, the findings suggest that structured fundamental movement activities may improve selected components of motor performance and physical fitness in children aged 8-10 years. However, the conclusions should be considered in light of the small sample, the study design, the number of outcomes examined, and the potential influence of maturation, test familiarization, and unmeasured physical activity.

Limitations

Several findings should be interpreted in light of alternative explanations. Significant improvements in some control-group outcomes, particularly standing long jump and 10-m sprint performance, indicate that changes over time may also have been influenced by normal growth and maturation, test familiarization, regular physical education lessons, motivation, or unmeasured physical activity outside school. These factors were not fully controlled.

The relatively small sample size limits statistical power and the precision of effect estimates. Although each group included equal numbers of girls and boys, the sex-specific subgroups comprised only eight participants; therefore, sex-specific inferential analyses and conclusions were not considered sufficiently reliable. The quasi-experimental design also limits causal inference. In addition, multiple physical fitness outcomes were examined, increasing the possibility of type I error. Nutritional intake, biological maturation, habitual physical activity,

and psychosocial factors were not objectively monitored. The findings should therefore be interpreted cautiously and should not be generalized beyond children with characteristics similar to those included in the present study.

Recommendations

Fundamental movement activities may be considered as one component of physical education and school-based activity programs for children. However, the present findings do not support a definitive recommendation regarding a minimum weekly frequency or mandatory curriculum-wide implementation.

Future studies should include larger and more diverse samples, longer follow-up periods, and adequately powered randomized designs. Biological maturation, nutritional intake, habitual physical activity, and participation in activities outside school should be monitored. Further research should also examine whether observed improvements are maintained over time and whether they transfer to broader motor, cognitive, psychosocial, and health-related outcomes.

REFERENCES

Akbari, H., Sahebozamani, M., Daneshjoo, A., & Amiri-Khorasani, M. (2018). Effect of the FIFA 11+ programme on vertical jump performance in elite male youth soccer players. *Montenegrin Journal of Sports Science & Medicine, 7*(2), 17-22. https://doi.org/10.26773/mjssm.180903

Anamurluoğlu, İ. (2020). *3-5 yaş grubu çocuklarda eğitsel oyunlarla desteklenmiş temel klasik bale eğitiminin kaba motor becerilere etkisi*. Yüksek Lisans tezi, İstanbul Gelişim Üniversitesi, Lisansüstü Eğitim Enstitüsü, Antrenörlük Eğitimi Anabilim Dalı, İstanbul.

Aynacıyan, N., & Özer, M. K. (2020). Çocuklara uygulanan eğitsel oyun aktivitelerinin motorik özelliklerine etkisi. *Journal of Health and Sport Sciences, 3*(1), 24-31.

Barnett, L. M., Stodden, D., Cohen, K. E., Smith, J. J., Lubans, D. R., Lenoir, M., & Morgan, P. J. (2016). Fundamental movement skills: An important focus. *Journal of Teaching in Physical Education, 35*(3), 219-225. https://doi.org/10.1123/jtpe.2014-0209

Başal, V., & Yüksel, M. F. (2021). 12-13 yaş grubu kız çocuklarının fiziksel özelliklerinin gelişiminde eğitsel oyunların etkisi. *Beden Eğitimi ve Spor Bilimleri Dergisi, 15*(3), 412-428. https://izlik.org/JA85EB73RM

Bozkurt, T. M., Kavuran, K., & Erdoğan, R. (2021). Comparison of the physical profiles of children aged 10-12 years receiving football training and those playing football through educational games. *Journal of Sports Education, 5*(3), 61-69.

Costello, K., & Warne, J. (2020). A four-week fundamental motor skill intervention improves motor skills in eight to 10-year-old Irish primary school children. *Cogent Education, 7*(1), 1724065. https://doi.org/10.1080/23311886.2020.1724065

Gallahue, D. L., Ozmun, J. C., & Goodway, J. D. (2012). *Understanding motor development: Infants, children, adolescents, adults* (7th ed.). McGraw-Hill.

Jose, M. J., & Sudheesh, M. (2018). Effect of motor skill training programme on motor proficiency in 8-10 year old children. International *Journal of Movement Education and Social Science, 7*(2), 1-4.

Kamar, A. (2008). Talent, skill, and performance tests in sport (2nd ed.). Nobel Publishing.

Karaman, B., & Süel, E. (2020). Effects of physical activity-based games played in preschool educational institutions on psychomotor development. *Journal of Physical Education and Sport Sciences, 14*(3), 529-539.

Kaya, E. (2023). *Çocuklarda eğitsel oyun egzersizlerinin fiziksel uygunluk parametreleri üzerine etkisi*. Yüksek Lisans tezi, Balıkesir Üniversitesi, Sağlık Bilimleri Enstitüsü, Beden Eğitimi ve Spor Anabilim Dalı, Balıkesir.

Lämmle, C., Kobel, S., Wartha, O., Wirt, T., & Steinacker, J. M. (2016). Intervention effects of a school-based health promotion program on children's motor skills. *Journal of Public Health, 24*, 185-192. https://doi.org/10.1007/s10389-016-0715-x

Leger, L. A., Mercier, D., Gadoury, C., & Lambert, J. (1988). The multistage 20 metre shuttle run test for aerobic fitness. *Journal of Sports Sciences, 6*(2), 93-101.

Liu, C. L., Cao, Y. C., Zhang, Z. Z., Gao, R. G., & Qu, G. Q. (2023). Correlation of fundamental movement skills with health-related fitness elements in children and adolescents: A systematic review. *Frontiers in Public Health, 11*, 1129258. https://doi.org/10.3389/fpubh.2023.1129258

Logan, S. W., Robinson, L. E., Wilson, A. E., & Lucas, W. A. (2012). Getting the fundamentals of movement: A meta-analysis of the effectiveness of motor skill interventions in children. *Child: Care, Health and Development, 38*(3), 305-315. https://doi.org/10.1111/j.1365-2214.2011.01307.x

Lubans, D. R., Morgan, P. J., Cliff, D. P., Barnett, L. M., & Okely, A. D. (2010). Fundamental movement skills in children and adolescents: Review of associated health benefits. *Sports Medicine, 40*(12), 1019-1035. https://doi.org/10.2165/11536850-000000000-00000

Mathiowetz, V., Weber, K., Volland, G., & Kashman, N. (1984). Reliability and validity of grip and pinch strength evaluations. *Journal of Hand Surgery, 10*(2), 222-226. https://doi.org/10.1016/S0363-5023(84)80146-X

Muratlı, S., Kalyoncu, O., & Şahin, G. (2007). *Training and competition (1*st *ed.).* Ladin Printing House.

Özbay, S., Ulupınar, S., & Özkara, A. B. (2018). Agility performance in sport. *National Journal of Sport Sciences, 2*(2), 97-112. https://doi.org/10.30769/usbd.463364

Özer, M. K. (2001). *Physical fitness (7th ed.).* Nobel Academic Publishing.

Özkatar-Kaya, E., Köroğlu, Y., Sarıtaş, N., Kaya, M., & Sucan, S. (2019). Effects of participation in educational games on balance, reaction, and agility in children. *Journal of Sport Sciences Research, 4*(1), 35-42. https://doi.org/10.25307/jssr.516296

Senemoğlu, N. (2005). Development, learning, and teaching: From theory to practice (12th ed.). Gazi Publishing.

Sindić, M., Mačak, D., Todorović, N., Purda, B., & Batez, M. (2021). Effect of integrated neuromuscular exercise in physical education class on health-related fitness in female children. *Healthcare, 9*(3), 312. https://doi.org/10.3390/healthcare9030312

Stodden, D. F., Gao, Z., Goodway, J. D., & Langendorfer, S. J. (2014). Dynamic relationships between motor skill competence and health-related fitness in youth. *Pediatric Exercise Science, 26*(3), 231-241. https://doi.org/10.1123/pes.2013-0027

Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Roberton, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. *Quest, 60*(2), 290-306. https://doi.org/10.1080/00336297.2008.10483582

Tamer, K. (2000). *Measurement and evaluation of physical and physiological performance in sport* (1st ed.). Bağırgan Publishing.

Tompsett, C., Sanders, R., Taylor, C., & Cobley, S. (2017). Pedagogical approaches to and effects of fundamental movement skill interventions on health outcomes: A systematic review. *Sports Medicine, 47*(9), 1795-1819. https://doi.org/10.1007/s40279-017-0697-z

Yin, X., Zhang, D., Shen, Y., Wang, Y., Wang, Z., & Liu, Y. (2025). Effectiveness of school-based interventions on fundamental movement skills in children: A systematic review and meta-analysis. *BMC Public Health, 25*, 1522. https://doi.org/10.1186/s12889-025-22696-2

Contribution Rate	**Contributors**
Idea or Notion	Harun GENÇ
Research Design	Esra AKTAŞ, Harun GENÇ
Literature Review	Esra AKTAŞ
Data Collecting	Esra AKTAŞ
Data Analysis	Harun GENÇ
Discussion and Commentary	Esra AKTAŞ, Harun GENÇ
Statement of Ethics Committee	
This research was conducted with the protocol decision dated 21/11/2023 and numbered 23/27 of the Ethics Committee of Bingöl University.	
Statement of Conflict	
Researchers do not have any personal or financial conflicts of interest with other people and institutions related to the research.	
Statement of Support and Acknowledgment	
No contribution and/or support was received during the writing process of this study.	
Generative AI Use Statement	
It was used only for language editing and improving the clarity of the manuscript.	

This study is licensed under a **Creative Commons Attribution-NonCommercial 4.0 International License (CC BY 4.0).**