Original Article

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The impact of basic movement skills on early childhood development with a focus on gender differences

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Abstract: Introduction: The aim of this study was to investigate the influence of motor developmental processes on basic movement skills in early childhood, with a focus on gender differences. Methods: The study was conducted with preschool children from five schools in different areas of Ankara with gym facilities, using the Test of Gross Motor Development (TGMD-2) to assess motor skills, the "Dunn Sensory Integration" scale for sensory processing, the "Frankfurter Concentration Test" test for attention skills, and a dynamic balance test to assess balance skills. Results: The results indicate that motor skill development differs between the sexes and that specific educational programmes have significant effects on motor skill outcomes. In particular, boys showed significant improvements in object control skills. In addition, early motor skill development was found to contribute positively to children's overall growth and academic success. These findings provide an important basis for the development of educational strategies and intervention programmes. Conclusions: In conclusion, the results of this study show that the Basic Motor Skills programme did not have a significant impact on children's motor skills. However, significant differences were observed between male and female participants in terms of object control and sensory integration skills.

Keywords: basic movement skills, sensory integration, attention, balance, early childhood

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INTRODUCTION

Studies on the development of motor skills in early childhood, and in particular on gender differences, are of considerable importance [1-4]. Matarma et al. investigated the implications of these differences for teaching strategies [1]. Assaiante investigated the relationships between object control and balance skills, highlighting the effects of different teaching methods [5]. Such studies play an important role in understanding how motor skill development can vary according to individual and cultural factors [6-8].

There is a large literature on motor skill development [9]. A meta-analysis by Barnett et al. comprehensively reviewed the relationship between motor skill development, physical activity and educational strategies in children [10]. This study highlights the impact of motor skill development on children's physical health and overall quality of life. In addition, a study by Castelli et al. examined the relationship between motor skill development and academic achievement, demonstrating the positive effects of early motor skill education on academic achievement [11].

Several important studies also focus on the effectiveness of different training methods in improving balance skills [12]. Several studies emphasise the positive effects of early motor skills training on academic performance [13,14]. Research also discusses the positive effects of balance training on children's social interaction skills. Balance skills play a critical role in children's physical development and effectiveness in everyday activities. Balance, defined as the ability to control body weight, is a distinct area of development related to motor skills from early childhood [15].

Research shows that the development of balance skills has a significant impact on children's overall motor skills [15]. Therefore, balanced and controlled movements increase children's participation in physical activity and improve their overall quality of life. Balance skills have also been linked to social and academic success. Studies show the positive effects of balance training on children's social interaction skills and academic performance [16,17]. One study found that regular balance training improved children's social interaction skills and increased their participation in group activities [17].

The development of motor skills should be supported not only through physical activity but also through appropriate educational strategies. Studies by Lopes et al. and Okely et al. emphasise that physical activity programmes and balanced play support the development of children's motor skills and improve physical health [3,9]. In addition, studies on the validity and reliability of motor skill assessment tools recommend the use of standardised tests to effectively measure balance skills [18].

Bailey found a relationship between motor skill development and children's social skills and examined in detail the effects of motor skill training on children's social interaction skills [17]. A study by Okely et al. evaluated the effectiveness of different physical activity programmes in promoting motor skill development in children, highlighting the positive effects of regular physical activity on motor skill development [9].

The development of motor skills in early childhood is crucial for supporting children's overall development and improving educational strategies. Such studies contribute to a broader understanding of motor skill development and provide an important foundation for future research. In addition, a better understanding of the relationship between motor skill training and balance skills may help to develop more effective educational strategies that support children's physical and social development [19].

Motor skill development in early childhood is one of the fundamental building blocks of children's physical and cognitive abilities. This developmental process is measured by performance assessments based on specific age groups. The early childhood period shows that children perform at a higher level than the expected performance and indicators. This finding suggests that children's motor skill development progresses faster and more effectively than expected when appropriate educational methods and pedagogical approaches are used.

In sport education, the concept of gamification plays an important role in this development process. Educational processes are enriched with game-based methods such as songs, puzzles and stories to engage and motivate children. These gamified approaches include general and specific warm-up activities, main movements and cooling phases. This supports both physical activity and cognitive development. Children not only learn by having fun, but also develop motor skills effectively. Assessment processes are also an essential part of this pedagogical approach. In these processes, the children perform athletic movements that improve their body awareness and concentration while singing songs. Rhythmic tools such as a metronome and a whistle are used to help children perform movements in a specific rhythm. These methods used in educational processes are characterised by their positive effects on the development of motor skills.

Several studies show that early motor skill development has a positive impact not only on children's physical health but also on their academic success. These studies emphasise the significant contribution of motor skills, supported by physical activity programmes and balanced play, to children's physical and cognitive development [13].

In summary, motor skill development in early childhood is considered an important part of both physical and cognitive development. The use of gamification, self-assessment methods and rhythmic tools in educational processes supports and accelerates this developmental process. Future studies will contribute to a more comprehensive understanding by investigating the effects of these methods on different age groups and socio-cultural contexts.

This research aims to investigate the effects of basic movement skills training on different aspects of early childhood development, including gross motor skills, sensory integration, attention and balance, with a particular focus on gender differences. The study hypothesises that while the training may not have a significant effect on motor skills, it will have a positive effect on object control skills, sensory integration and overall motor development. It will also examine how these developmental outcomes differ between boys and girls, providing insights into the role of gender in early childhood motor skill acquisition. The findings will contribute to the development of targeted educational strategies and intervention programmes tailored to improve motor skills and support holistic growth in preschool children.

MATERIAL AND METHODS

Participants

The experimental group consisted of 456 preschool children, 233 boys with an average age of 6.87±0.57 years and 223 girls with an average age of 6.85±0.73 years, selected from five school in different areas of Ankara with access to gym facilities. The average school age for boys is 60.34±6.49 months, and 59.84±6.13 months for girls. While 556 children participated in the pre-tests, children who did not attend the programme for a long time or did not come to the tests were excluded from the analysis. Parental consent forms were obtained beforehand and the study was conducted in accordance with the Helsinki Declaration.

Date Collection Tools

Gross Motor Skills Test: The Gross Motor Skills Test, known as TGMD (Test of Gross Motor Development), was used to assess the motor skills of children. TGMD is a comprehensive test that evaluates children’s gross motor skills. There are two versions of it, namely TGMD-2 and TGMD-3. TGMD-2 was developed by Dale A. Ulrich in 2000 and comprises a Locomotor subtest and an Object Control subtest. The Locomotor Subtest assesses basic movements such as walking, running, and jumping, while the Object Control Subtest measures motor skills like throwing and catching. During the test, children perform movements demonstrated by the test administrator. Movements are repeated 2-3 times and are scored for accuracy and smoothness based on specific criteria. The raw scores obtained are converted to standardized scores, considering age and gender [18]. This provides detailed insight into children's motor development and skills.

Dunn Sensory Integration Scale: The Dunn Sensory Integration Scale was used to evaluate sensory processing. The scale gives insight into how individuals respond to environmental sensory stimuli and its implications for daily life. The scale can be applied directly to subjects or their parents or teachers to determine sensory processing styles. The Dunn Sensory Integration Scale has various versions for different age groups, providing a detailed understanding of individuals' sensory perceptions and processing styles. This assessment is important for tracking children's sensory development and developing intervention strategies when necessary [20].

The Dunn Sensory Integration Scale evaluates how children process environmental sensory stimuli and has four sub-dimensions. The Sensory Seeking sub-dimension indicates that the child actively seeks sensory stimuli, showing a desire to move constantly or touch objects. The Sensory Avoidance sub-dimension shows that the child has a tendency to avoid excessive sensory stimuli, suggesting that the child my find noise or touch unpleasant. The Sensory Sensitivity sub-dimension suggests that the child is overly sensitive to stimuli, reacting more intensely to noise or bright light. The Low Registration sub-dimension indicates that the child has a low response to sensory stimuli and may struggle to notice environmental cues. These sub-dimensions help in understanding individual differences in sensory processing in children.

Frankfurter Concentration Test: The Frankfurter Concentration Test (Frankfurter Tests Für Fünfjährige-Konzentration, FTF-K), which is a short-term attention test developed for children aged five years or 60 to 72 months, was used to measure attention skills. The test takes approximately 90 seconds and measures children's attention level using images of fruits. It is a psychometric evaluation tool designed specifically for preschool and primary school children. During the test, children are asked to focus their attention on specific stimuli for a set period of time and accurately identify the specified stimuli. Children's correct responses, incorrect responses, and missed stimuli are recorded, allowing for a comprehensive analysis of attention skills. The Frankfurter Concentration Test is an effective tool for measuring children's attention and focus skills. The results of this test provide significant data on attention levels affecting children's academic success. The test has been found to have moderate reliability with a test-retest correlation of approximately 0.79 [21].

Balance Test: The Performa.nz© Balance device was used to measure the balance skills of the experimental group. The Performa.nz Balance device has shown a high correlation with the Berg Balance Scale in assessing balance skills [22].

Research Design

A longitudinal and experimental design was used to evaluate the motor skills and attention processes of children. The experimental study was conducted over seven months, with activities three days a week, one hour a day (no activities were conducted during the midterm break). The programme comprises three activities per week, categorized as easy, medium, and hard, covering 28 sub-dimensions in motor, balance, and object control movements. Each day began with warm-up exercises, followed by activity-based games, and ended with a cooldown. The games used to measure skills were selected by expert trainers and shared in booklets.

For pre-test and post-test data collection, the TGMD Scale, Dunn Sensory Integration Scale, Frankfurter Concentration Test, and Balance Test were applied. The TGMD Scale allowed for a detailed evaluation of children's motor skills, and the data obtained were used to determine their developmental levels. The Dunn Sensory Integration Scale provided insight into the children's sensory processing skills, contributing to understanding their sensory perception and processing styles. The

Frankfurter Concentration Test provided comprehensive information on children's attention levels and focus skills. The balance device measured children's static and dynamic balance skills, helping assess the relationship between motor development and balance skills. All tests used for data collection were subjected to detailed validity and reliability analyses. The validity analysis of the TGMD Scale was measured with Pearson's correlation coefficient ($r=0.658$, $p<0.05$). The Cronbach's alpha coefficient was set at 0.724, indicating sufficient internal consistency for the tests.

Statistical Analysis

Kurtosis and Skewness values were used to test data normality. The Shapiro-Wilk test was applied to check the homogeneity of distribution. As a result, it was seen that the group showed a normal distribution, and it was decided to apply the parametric tests. ANOVA was used to analyse the differences and mixed measurements between the parameters obtained before and after the basic training programme was applied to the experimental group. Intraclass correlation and Cronbach's alpha coefficients were checked for the balance test. All analyses were conducted using SPSS 27 (IBM, Armonk, New York, USA), with a significance level of $p<0.05$.

RESULTS

The statistical analysis results of the parameters obtained before and after basic motor skills programme was applied to the experimental group are presented below. In all statistical processes, Mauchly's sphericity test was conducted, which confirmed that the assumption of sphericity was met, so no corrections were necessary. The table and interpretations below provide the pre-test and post-test statistics for boys ($n_{experimental}=146$; $n_{control}=87$) and girls ($n_{experimental}=127$; $n_{control}=96$).

Table 1 shows the pre-test and post-test mean values for motor, object control, sensory integration, attention and balance skills of boys and girls as well as the results of pre-test and post-test ANOVA analysis. Figure 1 shows the line graphs of pre-test and post-test mean results by boys and girls for the selected tests: A1. motor skills - boys, A2. motor skills - girls, B1. object control - boys, B2. object control - girls; C1. sensory integration - boys, C2. sensory integration - girls, D1. attention - boys, D2. attention - girls, E1. balance - boys, E2. balance - girls.

ANOVA analysis of the pre-test and post-test results for motor skills in boys showed that, in the between-group comparison, the p-value was 0.895, indicating no significant difference ($p>0.05$). In addition, the p-value for the time factor was 0.877, and 0.507 for the time*group interaction. These results indicate that training did not have an effect on motor skill outcomes in both the experimental group and control group.

ANOVA analysis of the pre-test and post-test results for motor skills in girls showed that, although the post-test scores in the experimental group were higher, there was no statistically significant difference between groups ($F_{(1,218)}=0.360$, $p=0.549$). The time*experimental-control group interaction was also at significance threshold ($F_{(1,218)}=3.421$, $p=0.066$). These results indicate that the training programme applied within the scope of this study may only have limited effect.

ANOVA analysis of the pre-test and post-test results for object control in boys showed that the post-test scores in the experimental group were significantly higher than those in the control group ($F_{(1, 231)}=65.957$, $p=0.000$). Significant effects were also found for time and time*experimental-control group interaction ($F_{(1, 231)}=214.006$, $p=0.000$; $F_{(1, 231)}=33.473$, $p=0.000$). The results indicate a marked and statistically significant improvement in the experimental group's object control performance.

ANOVA analysis of the pre-test and post-test results for object control in girls showed that post-test scores were significantly higher in the experimental group compared to the control group ($F_{(1, 218)}=22.260$, $p<0.001$). Significant effects were also found for time and time*group interaction ($F_{(1, 218)}=288.548$, $p<0.001$; $F_{(1, 218)}=17.200$,

$p<0.001$). These findings demonstrate a marked and statistically significant improvement in the experimental group's object control skills.

As seen in Table 1, the training programme improved the sensory integration scores of the boys in the experimental group, but without significant difference compared to the control group. The increase in the post-test mean scores of the experimental group indicates an improvement in sensory integration skills. However, according to ANOVA results, the difference between the experimental and control groups (time*group interaction) was found to be statistically non-significant ($F_{(1, 231)}=1.263$, $p=0.262$). This finding suggests that the intervention did not provide a distinct advantage over the control group. The effects of the time variable were found to be significant ($F_{(1, 231)}=337489.390$, $p<0.001$), indicating that both groups made progress in their sensory integration skills.

When Table 1 is examined, it is is seen that the pre-test and post-test results for sensory integration in girls improved significantly in the experimental group compared to the control group. ANOVA analysis results show that the difference between groups is significant ($F_{(1,218)}=4.049$, $p=0.045$). The effect of the time variable was also found to be significant ($p<0.001$), indicating that, while both groups made progress, the experimental group achieved greater improvement. These results support the effectiveness of interventions aimed at improving sensory integration skills.

As seen in Table 1, the mean attention pre-test scores in boys of both the experimental and control groups increased. The multivariate tests showed that the time variable was significant ($F_{(1,231)}= 2091.200$, $p<0.001$, $\eta^2=0.901$), and the interaction between time and group was also significant ($F_{(1,231)}=31.362$, $p< 0.001$, $\eta^2=0.120$). Comparison between groups showed a significant difference in the experimental group's attention performance compared to the control group ($F_{(1,231)}=31.362$, $p< 0.001$, $\eta^2=0.120$).

When Table 1 is examined, it is seen that according to ANOVA analysis of pre- and post-test results for attention in girls, the main effect of the time variable was significant ($F_{(1,218)}=2546.461$, $p<0.001$, $\eta^2=0.921$), and the interaction between time and group was also significant ($F_{(1,218)}=23.277$, $p<0.001$, $\eta^2=0.096$). These results indicate that attention levels in the experimental group increased significantly. However, the increase in the control group was more pronounced. Overall, the difference between the experimental and control groups was in favour of the experimental group, supporting the effect of the training programme on improving attention.

The pre-test and post-test results for balance in boys revealed significant differences between the experimental and control groups. According to ANOVA analysis results, the effect between groups was not statistically significant ($F_{(1, 231)}=0.700$, $p=0.403$, $\eta^2=0.003$). However, the interaction between time and group was significant ($F_{(1, 231)}=7.596$, $p=0.006$, $\eta^2=0.032$). These results show that the experimental group's balance skills improved remarkably, , while the control group did not demonstrate significant improvement. In addition, Mauchly's test of sphericity showed that the sphericity assumption for time was met. These findings support the effectiveness of interventions aimed at improving balance skills and suggest that the experimental group benefited positively from the training programme.

As can be seen in Table 1, the pre-test and post-test results for balance in girls show that the experimental group performed better in post-tests compared to the control group. The multivariate test results revealed that the effect of time was significant ($p=0.006$), but the interaction between the experimental and control groups did not create a significant difference. Mauchly's test of sphericity showed that the sphericity assumption for time was met. As a result, while "time" has evident effect on balance performance, no overall difference was observed between the experimental and control groups. These findings suggest that the applied training programme has the potential to improve balance performance over time.

Table 1. Two-Way ANOVA pre- and post-test score test results for motor skills, object control, sensory integration, attention and balance in boys and girls.

Variables	Gender	Test	Experimental	Control	SI	Group	Time	Time x Group
			M ± SD	M ± SD				
Motor skill	Boys	Pre Test	15.68 ± 4.02	16.14 ± 3.42	$F_{(1.231)}$	0.018	0.024	0.442
		Post Test	16.01 ± 3.24	15.71 ± 3.03	p	0.895	0.877	0.507
					η2	0.001	0.001	0.002
	Girls	Pre Test	15.58 ± 3.91	16.00 ± 3.89	$F_{(1.218)}$	0.360	3.149	3.421
		Post Test	16.92 ± 2,64	15.97 ± 2,95	p	0.549	0.077	0.066
					η2	0.002	0.014	0.015
Object Control	Boys	Pre Test	9.11 ± 2.78	8.67 ± 2.45	$F_{(1.231)}$	65.957	214.006	33.473
		Post Test	15.66 ± 2.97	10.84 ± 2.16	p	<0.001**	<0.001**	<0.001**
					η2	0.222	0.481	0.127
	Girls	Pre Test	8.36 ± 2.62	8.12 ± 2.13	$F_{(1.218)}$	22.260	288.548	17.200
		Post Test	14.67 ± 2.60	11.83 ± 2.26	p	<0.001**	<0.001**	<0.001**
					η2	0.093	0.570	0.073
Sensory Integration	Boys	Pre Test	22.52 ± 5.18	20.71 ± 6.80	$F_{(1.231)}$	3.370	337489.39	1.263
		Post Test	30.70 ± 5.20	26.93 ± 6.58	p	0.068	<0.001**	0.262
					η2	0.014	0.999	0.005
	Girls	Pre Test	22.26 ± 4.92	20.29 ± 6.89	$F_{(1.218)}$	4.049	330931.81	4.813
		Post Test	30.44 ± 4.93	26.53 ± 6.88	p	0.045*	<0.001**	0.029*
					η2	0.018	0.999	0.022
Attention	Boys	Pre Test	20.04 ± 6.42	20.23 ± 5.94	$F_{(1.231)}$	31.362	2091.20	31.362
		Post Test	25.98 ± 8.65	23.86 ± 3.54	p	<0.001**	<0.001**	<0.001**
					η2	0.120	0.901	0.120
	Girls	Pre Test	20.60 ± 5.46	20.23 ± 4.67	$F_{(1.218)}$	23.277	2546.46	23.277
		Post Test	27.75 ± 8.63	28.58 ± 5.30	p	<0.001**	<0.001**	<0.001**
					η2	0.096	0.921	0.096
Balance	Boys	Pre Test	46.82 ± 23.90	50.23 ± 21.56	$F_{(1.231)}$	0.700	3.253	7.596
		Post Test	56.65 ± 21.18	47.94 ± 26.44	p	0.403	0.073	0.006*
					η2	0.003	0.014	0.032
	Girls	Pre Test	54.83 ± 25.12	50.24 ± 22.24	$F_{(1.218)}$	1.879	3.253	7.596
		Post Test	60.94 ± 21.70	54.38 ± 22.75	p	0.172	0.073	0.006*
					η2	0.009	0.014	0.032

M: mean; SD: standard deviation; SI: statistical indicators; F: ANOVA; p: statistical significance; η2: effect size; *: p<0.05; **: p<0.001

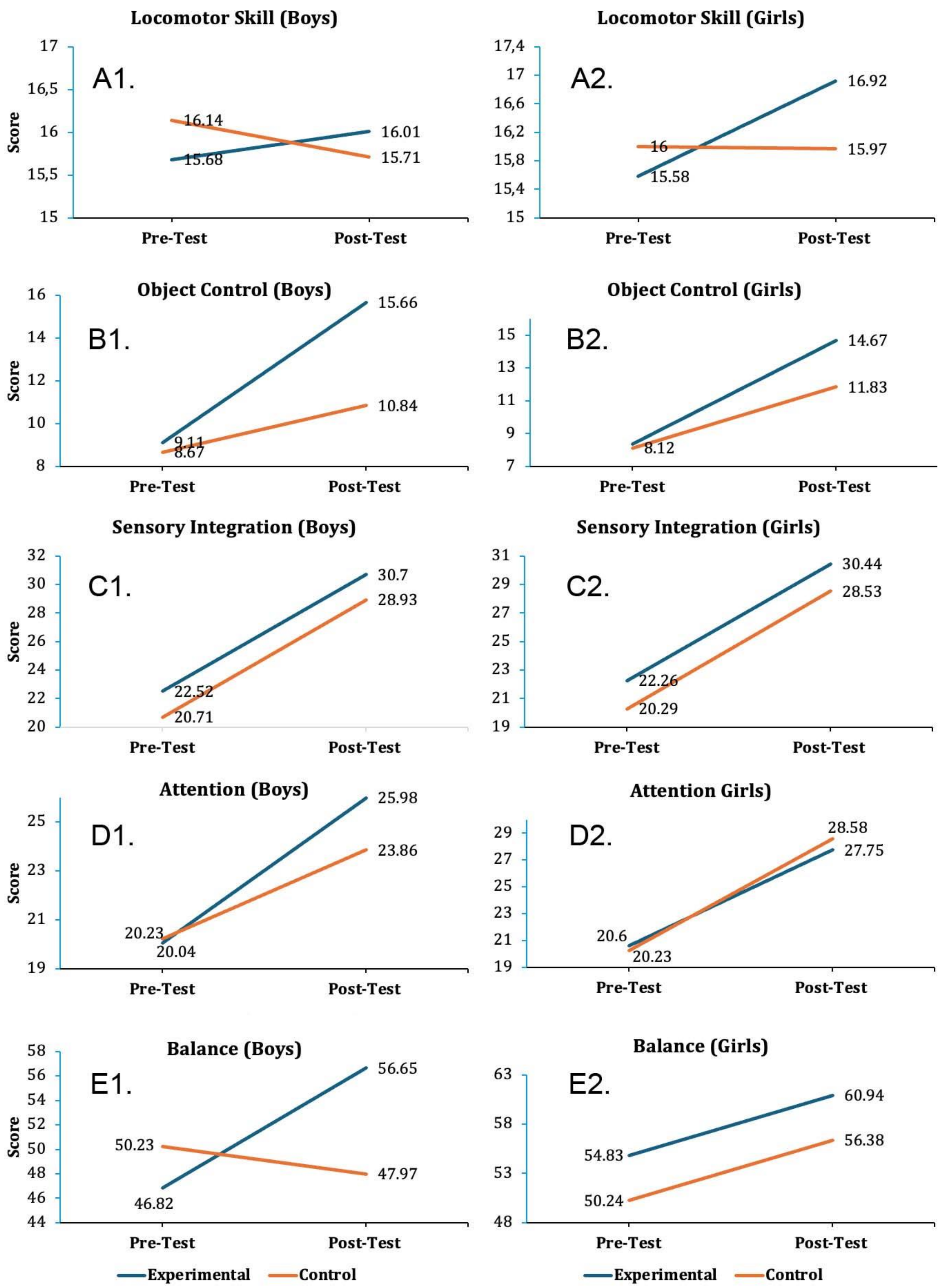

Figure 1. Pre- and post-test results by boys and girls for selected tests (respectively): A1, A2 –motor skill; B1, B2 - object control; C1, C2 - sensory integration; D1, D2 – attention; E1, E2 – balance.

DISCUSSION

This study investigated the impact of a basic motor skills programme on children. No significant difference was found between pre-test and post-test results for motor skills among both boys and girls (p>0.05). This result suggests that the basic movement skills training programme did not create an effective change during its implementation. This outcome may be due to the duration, content, or application methods used in the training programme [23]. It may also stem from children's frequent engagement in activities such as walking, running, and jumping in their out-of-school experiences. In this context, it can be concluded that the training programme needs to be supported over a longer period of time or with different teaching methods.

The results for object control skills showed significant improvement in boys. The post-test scores of the experimental group showed a statistically significant difference compared to the control group. This finding indicates that the training programme was effective in improving object control skills. The improvement in object control skills was particularly significant in boys. Similar results have been reported in other studies, indicating that improvement of object control skills contributes positively to children's physical activities and motor development [24].

The test results for object control in girls also showed significant improvement in the experimental group compared to the control group. According to ANOVA results, the post-test scores of the experimental group were significantly higher than those of the control group. This finding suggests that the basic movement skills training programme could also be effective in girls if and to the extent girls' participation in physical activities is increased and their physical competence is improved [3].

The sensory integration test results indicated significant improvement in boys of the experimental group compared to the control group, but ANOVA results showed that the difference between the experimental and control groups was not statistically significant. However, the effect of the time factor was found to be significant, with both groups showing overall improvement in sensory integration skills. This suggests that the development of sensory integration skills may be a natural process associated with age and experience [25].

For girls, sensory integration test results demonstrated significant improvement. This finding highlights the effectiveness of the training programme for girls and underscores the importance of similar training programmes aimed at improving their physical competence [25]. Improving a child's sensory integration skills plays a critical role in supporting their motor skills and improving their overall physical development.

Analysis of attention test results showed significant differences between the experimental and control groups, particularly in boys. The interaction between time and group was found to be significant. These results indicate that the experimental group showed significant improvement in attention performance. This demonstrates that the training programme affected attention in boys positively over time. Consistent with previous research, it can be concluded that structured intervention programmes are important for improving cognitive and attention-related skills in children [26].

For girls, the analysis revealed a significant main effect of the time variable, and the interaction between time and group was also significant. Although both groups showed improvement in attention performance, the increase in the control group was more pronounced compared to the experimental group. This unexpected result may be explained by external factors influencing attention performance in the control group. Overall, the observed improvement in the experimental group supports the notion that targeted educational strategies have a positive effect on attention performance [26].

Findings on balance skills in boys showed a significant interaction between time and group. This result indicates that balance skills in the experimental group improved more notably compared to the control group. Although the difference between groups was not significant (p=0.403), the interaction between time and group suggests that the intervention was effective in improving balance skills. The literature emphasizes the importance of physical education programmes that support motor coordination and balance development in boys [27].

Similar results were obtained for girls. Although the difference between groups was not significant (p=0.172), the interaction between time and group was significant (p=0.006). These results indicate that the experimental group improved their balance skills over time. While no overall difference was observed between groups, the training programme had an evident positive impact on balance improvement. This finding supports the conclusion that physical training interventions aimed at improving balance skills are effective in girls [27].

In conclusion, the training programmes under this study were effective in improving attention and balance skills. However, the differences between male and female participants and the results between the experimental and control groups indicate a need for further research into the reasons behind these differences.

CONCLUSION

The results of this study show that the basic motor skills programme did not have a significant impact on children's motor skills. However, differences were observed between male and female participants in terms of object control and sensory integration skills. To make educational programmes more effective, further research should explore programme content, implementation durations, and methods. Future studies involving a larger sample across different age and gender groups could enhance the generalizability of the findings and contribute significantly to supporting children's motor development.

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