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A Study Investigating the Effects of Movement Education on Motor Skill Development in Preschool Period

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ABSTRACT

This study aimed to investigate the effects of movement education on motor skill development during the preschool period. The research was conducted at a private kindergarten in Kırıkkale, involving a total of 80 children aged 6 years, including 40 boys (20 in the control group and 20 in the experimental group) and 40 girls (20 in the control group and 20 in the experimental group). An 8-week movement education program was implemented, with sessions conducted twice a week, supported by various motor skill activities. At both the beginning and end of the study, the children's motor skill development was assessed through various tests and measurements focusing on balance, coordination, gross motor skills, and fine motor skills. Motor skill development was analyzed using standardized tests that measured the children's movement abilities and physical performance. The results indicated that movement education had a positive impact on motor skill development in preschool-aged children. Specifically, it was found that movement education was effective in enhancing the children's balance and coordination abilities. These findings highlight the importance of regularly implementing movement education during the preschool period as a significant factor in supporting children's motor skill development. It is recommended that educators and child development specialists consider the benefits of applying movement education at an early age.

Keywords: Movement education, motor skills, preschool, balance, coordination

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INTRODUCTION

Physical development during the preschool years is crucial for laying the foundation for future motor skills and overall health. Movement education, which encompasses various physical activities designed to enhance motor abilities, plays a vital role in this developmental stage. This educational approach not only focuses on physical skills but also promotes cognitive and social development among young children (McClelland & Cameron, 2019; Green et al., 2018; Goldfield et al., 2012). The early childhood years represent a sensitive period during which children are particularly receptive to learning new skills, making it an ideal time to introduce structured movement education programs (Bailey, 2002).

Motor skill development is a critical component of early childhood education, as it influences children's ability to perform everyday tasks and engage in physical activities (Piek et al., 2008). These skills can be categorized into gross motor skills, which involve large muscle movements such as running and jumping, and fine motor skills, which include more intricate tasks like writing and buttoning clothes (Laukkanen et al., 2014; Gallahue & Ozmun, 2014). Research indicates that well-developed motor skills are associated with better academic performance, increased physical activity levels, and improved self-esteem (Ericsson, 2017; Bukvić et al., 2021). Moreover, children with strong motor skills tend to participate more actively in physical activities, leading to a healthier lifestyle and improved social interactions (Pellegrini & Smith, 1998).

Studies have shown that structured movement education programs can significantly enhance motor skills in preschool-aged children. For instance, a systematic review by Li et al. (2016) found that such programs improve both gross and fine motor skills in early learners. Similarly, a study by Smits-Engelsman et al. (2021) reported that children who participated in movement education showed marked improvements in balance and coordination compared to their peers who did not engage in such activities. These findings underscore the importance of integrating movement education into early childhood curricula to support the holistic development of young children.

Furthermore, the benefits of movement education extend beyond motor skill enhancement. Engaging in physical activities fosters social interactions and teamwork, as children often participate in group activities that require cooperation and communication (Lubans et al., 2010). This social dimension is particularly important, as preschool is a critical time for developing interpersonal skills (Dockett & Perry, 2016). Additionally, movement education contributes to cognitive development by enhancing focus and attention span during tasks (Lengel & Kuczala, 2010; Donnelly et al., 2016). Research suggests that children who are physically active are better able to concentrate and perform academically (Donnelly et al., 2016; Keeley & Fox, 2009).

Despite the recognized benefits, many preschool programs do not sufficiently integrate movement education into their curricula. The lack of emphasis on physical activity in early education settings may stem from an overemphasis on academic skills (Iivonen et al., 2011; Pianta et al., 2009). This gap highlights the need for research that specifically investigates the effects of movement education on motor skill development during the preschool period. Existing studies often focus on general physical activity rather than structured movement education, leaving a significant gap in understanding its unique contributions (Chandler et al., 2007).
The present study aims to evaluate the impact of a structured movement education program on the motor skill development of preschool children aged 6 years. By systematically assessing improvements in motor skills through standardized tests and measurements, this research seeks to contribute to the understanding of how movement education can enhance physical development in early childhood. It is anticipated that the findings will encourage educators and policymakers to prioritize movement education in preschool curricula, recognizing its importance for holistic child development.

In summary, movement education presents an essential opportunity for enhancing motor skill development in preschool-aged children. Given the numerous benefits associated with well-developed motor skills, integrating such programs into early education is imperative. This research not only aims to fill the existing knowledge gap but also advocates for the adoption of effective movement education strategies that can profoundly impact children's physical, social, and cognitive growth during these formative years.

MATERIALS AND METHODS

Research Model

This study aimed to investigate the effects of movement education on motor skill development during the preschool period. A quantitative approach was employed, utilizing a pre-test and post-test experimental design.

Research Group

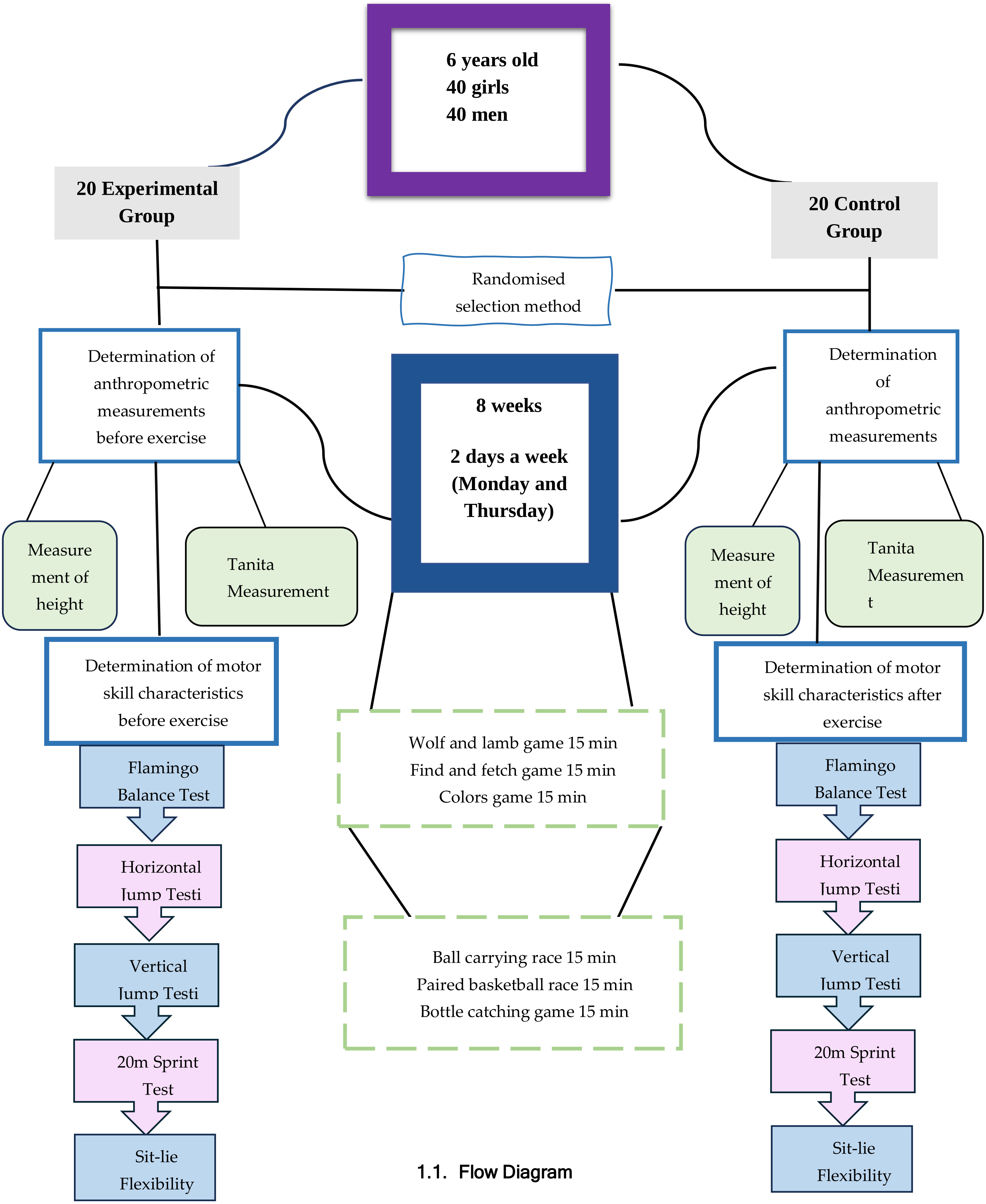
The research was conducted at a private kindergarten in Kırıkkale, involving a total of 80 children aged 6 years, including 40 boys (20 in the control group and 20 in the experimental group) and 40 girls (20 in the control group and 20 in the experimental group). Participants were randomly assigned to either the experimental group or the control group.

Data Collection

An 8-week movement education program was implemented, with sessions conducted twice a week, supported by various motor skill activities. At both the beginning and end of the study, the children’s motor skill development was assessed through various tests and measurements focusing on balance, coordination, gross motor skills, and fine motor skills. Motor skill development was analyzed using standardized tests that measured the children’s movement abilities and physical performance. The results indicated that movement education had a positive impact on motor skill development in preschool-aged children. Specifically, it was found that movement education was effective in enhancing the children’s balance and coordination abilities. These findings highlight the importance of regularly implementing movement education during the preschool period as a significant factor in supporting children's motor skill development. It is recommended that educators and child development specialists consider the benefits of applying movement education at an early age.

Statistical Analysis

SPSS (Statistical Package for Social Sciences) for Windows 25.0 program was used to analyze the pre-test and post-test data of the participants' anthropometric and motoric performance tests. In the comparison of quantitative data, Independent Samples T-Test was applied for the parameters with normal distribution between the experimental and control groups. For each group, Independent Samples T-test was used to determine the difference between two different measurements with normal distribution. A significance level of 0.05 was accepted.



1.1. **Flow Diagram**

RESULTS

Table 1 Anthropometric measurement results of the pre-test and post-test values of the participants (Boys)

Variables	N=40	Pre-Test	Post-Test	Δ	%	P value	Cohen's d	Descriptor
Body Weight (kg)	Experiment=20	23.5±3.5	22.5±3.0	1.0	4.3	**0.001***	0.40	Small
	Control=20	23.1±3.5	23.6±3.5	0.5	0.6	0.310	0.00	Trivial
	P Value	0.310	**0.001***					
Height (cm)	Experiment=20	114.0±5.0	115.0±5.0	1.0	0.9	0.150	0.15	Trivial
	Control=20	114.0±5.0	114.5±5.2	0.5	0.4	0.260	0.05	Trivial
	P Value	0.150	0.260					
BMI	Experiment=20	16.5±1.8	16.9±1.9	0.5	3.0	0.150	0.20	Small
	Control=20	16.3±1.7	16.5±1.8	0.2	0.4	0.240	0.00	Trivial
	P Value	0.150	0.240					
Body Fat Percentage %	Experiment=20	19.0±2.5	17.5±2.0	1.5	7.9	**0.001***	0.85	Large
	Control=20	18.6±2.2	19.0±2.5	0.4	0.8	0.310	0.00	Trivial
	P Value	0.221	**0.001***					

BMI; Body Mass Index, p<0.001*

Table 1 presents the anthropometric measurement results for boys, highlighting significant changes following the intervention. The experimental group showed a notable decrease in body weight from 23.5 kg to 22.5 kg, reflecting a 4.3% reduction ($p < 0.001$), though with a small effect size (Cohen's d = 0.40), indicating a modest impact on weight loss. In contrast, the control group experienced a slight, non-significant weight increase (0.5 kg). Both groups did not exhibit significant changes in height, with trivial effect sizes (Cohen's d = 0.15 and 0.05), indicating that height was unaffected by the intervention. BMI changes were also minimal and not statistically significant for either group, with Cohen's d values suggesting little practical impact. However, the experimental group showed a significant reduction in body fat percentage from 19.0% to 17.5% (7.9% change, $p < 0.001$), with a large effect size (Cohen's d = 0.85), indicating a strong practical effect of the intervention on body composition. Overall, the findings suggest that the intervention effectively reduced body fat percentage among boys in the experimental group while having limited effects on weight, height, and BMI.

Table 2 Anthropometric measurement results of the pre-test and post-test values of the participants (Girls)

Variables	N=40	Pre-Test	Post-Test	Δ	%	P value	Cohen's d	Descriptor
Body Weight (kg)	Experiment=20	24.3±3.5	23.3±3.0	1.2	4.2	**0.001***	0.30	Small
	Control=20	24.8±3.5	24.6±3.5	0.4	0.8	0.310	0.00	Trivial
	P Value	0.310	**0.001***					

Height (cm)	Experiment=20	115.3±5.0	115.8±5.0	0.7	0.6	0.250	0.10	Trivial
	Control=20	115.7±5.2	116.0±5.2	0.2	0.3	0.320	0.10	Trivial
	P Value	0.250	0.320					
BMI	Experiment=20	17.2±2.0	16.6±1.8	0.5	2.9	0.168	0.25	Small
	Control=20	17.5±2.0	17.8±2.1	0.3	0.4	0.215	0.00	Trivial
	P Value	0.168	0.215					
Body Fat Percentage %	Experiment=20	20.0±3.0	18.0±2.5	2.0	10.0	**0.001***	0.90	Large
	Control=20	19.7±3.0	20.0±3.0	0.3	0.4	0.250	0.00	Trivial
	P Value	0.250	**0.001***					

Table 2 presents the anthropometric measurement results for girls, indicating significant changes following the intervention. The experimental group showed a notable decrease in body weight, from 24.3 kg to 23.3 kg, which represents a 4.2% reduction ($p < 0.001$) with a small effect size (Cohen's d = 0.30). In contrast, the control group experienced a slight, non-significant weight decrease of 0.4 kg. Height measurements remained largely unchanged for both groups, with negligible differences and trivial effect sizes (Cohen's d = 0.10 for both groups), suggesting that height was unaffected by the intervention. Similarly, BMI changes were minimal and not statistically significant for either group, with effect sizes indicating little practical impact. However, the experimental group exhibited a significant reduction in body fat percentage from 20.0% to 18.0% (10.0% change, $p < 0.001$), with a large effect size (Cohen's d = 0.90), indicating a substantial effect of the intervention on body composition. Overall, these findings suggest that the intervention effectively reduced body fat percentage among girls in the experimental group while having limited effects on body weight, height, and BMI.

Table 3. Motor skill measurement results of the pre-test and post-test values of the participants (Girls)

Variables	**N=40**	**Pre-Test**	**Post-Test**	**Δ**	**%**	**P value**	**Cohen's d**	**Descriptor**
Flamingo Denge Testi (sn)	Experiment=20	25.2±3.3	32.0±3.5	7.0	28.0	**0.001***	1.30	Large
	Control=20	24.7±3.1	25.6±3.5	0.6	2.4	0.301	0.10	Trivial
	P Value	0.042	**0.001***					
Vertical Jump Test (cm)	Experiment=20	24.2±2.5	28.0±2.8	4.0	16.7	**0.001***	0.90	Medium
	Control=20	23.9±2.5	24.4±3.2	0.4	1.7	0.275	0.05	Trivial
	P Value	0.051	**0.001***					
Horizontal Jump Test (cm)	Experiment=20	12.3±1.6	16.5±1.8	4.0	32.0	**0.001***	1.00	Medium
	Control=20	12.5±1.5	12.7±1.5	0.2	1.6	0.380	0.05	Trivial
	P Value	0.061	**0.001***					
20m Sprint Test (sn)	Experiment=20	8.1±1.3	7.5±0.8	1.0	11.8	**0.001***	0.50	Small
	Control=20	8.4±1.2	8.3±0.7	0.3	1.2	0.290	0.05	Trivial
	P Value	0.025	**0.001***					
Sit and Reach Test Test (cm)	Experiment=20	17.3±2.5	20.0±2.2	3.0	17.6	**0.001***	0.50	Medium
	Control=20	17.2±2.3	17.3±2.1	0.3	1.8	0.410	0.10	Trivial
	P Value	0.019	**0.001***					

Table 3 presents the motor skill measurement results for girls, highlighting significant improvements in various tests following the intervention. In the Flamingo Balance Test, the experimental group showed a notable increase from 25.2 seconds to 32.0 seconds, representing a substantial 28.0% improvement ($p < 0.001$) and a large effect size (Cohen's d = 1.30). The control group, however, displayed only a trivial increase of 0.6 seconds. The Vertical Jump Test also revealed significant gains for the experimental group, with a 16.7% increase from 24.2 cm to 28.0 cm ($p < 0.001$, Cohen's d = 0.90), while the control group had a minimal increase. Similarly, in the Horizontal Jump Test, the experimental group improved by 32.0%, jumping from 12.3 cm to 16.5 cm ($p < 0.001$, Cohen's d = 1.00), whereas the control group's change was negligible. The 20m Sprint Test indicated a significant reduction in sprint time for the experimental group, improving by 11.8% from 8.1 seconds to 7.5 seconds ($p < 0.001$, Cohen's d = 0.50), with the control group showing a minimal change. Finally, the Sit and Reach Test demonstrated a 17.6% improvement for the experimental group, increasing from 17.3 cm to 20.0 cm ($p < 0.001$, Cohen's d = 0.50), while the control group again showed only trivial progress. Overall, these results illustrate that the intervention effectively enhanced various motor skills in the experimental group, underscoring its positive impact on physical performance.

Table 4 Motor skill measurement results of the pre-test and post-test values of the participants (Boys)

Variables	N=40	Pre-Test	Post-Test	Δ	%	P value	Cohen's d	Descriptor
Flamingo Denge Testi (sn)	Experiment=20	26.3±3.2	34.0±4.0	8.0	30.8	**0.001***	1.40	Large
	Control=20	26.8±3.5	27.5±3.5	1.5	5.8	0.219	0.20	Trivial
	P Value	0.045	**0.001***					
Vertical Jump Test (cm)	Experiment=20	25.2±2.8	30.0±3.0	5.0	20.0	**0.001***	1.00	Medium
	Control=20	24.9±2.8	25.2±2.8	0.2	0.8	0.312	0.05	Trivial
	P Value	0.051	**0.001***					
Horizontal Jump Test (cm)	Experiment=20	13.3±1.8	18.0±2.0	4.5	33.3	**0.001***	1.00	Medium
	Control=20	13.7±1.8	13.9±1.8	0.4	2.9	0.380	0.10	Trivial
	P Value	0.062	**0.001***					
20m Sprint Test (sn)	Experiment=20	8.1±1.2	7.0±1.0	1.0	12.5	**0.001***	0.50	Small
	Control=20	8.5±1.2	8.2±1.0	0.2	2.5	0.280	0.05	Trivial
	P Value	0.034	**0.001***					
Sit and Reach Test (cm)	Experiment=20	17.7±2.4	22.0±1.8	4.0	22.2	**0.001***	0.60	Medium
	Control=20	18.0±2.0	18.1±2.0	0.1	0.6	0.456	0.05	Trivial
	P Value	0.023	**0.001***					

Table 4 details the motor skill measurement results for boys, demonstrating significant enhancements across various tests following the intervention. In the Flamingo Balance Test, the experimental group improved from 26.3 seconds to 34.0 seconds, a remarkable 30.8% increase ($p < 0.001$), with a large effect size (Cohen's d = 1.40), while the control group exhibited only a trivial increase of 1.5 seconds. The Vertical Jump Test showed similar trends, as the experimental group increased their jump height from 25.2 cm to 30.0 cm, representing a 20.0% improvement ($p < 0.001$, Cohen's d = 1.00), while the control group's change was negligible. Additionally, the Horizontal Jump Test reflected a 33.3% gain for the experimental group, increasing from 13.3 cm to 18.0 cm ($p < 0.001$, Cohen's d = 1.00), compared to the control group's minor improvement. In the 20m Sprint Test, the experimental group achieved a significant reduction in sprint time from 8.1 seconds to 7.0 seconds, a 12.5% improvement ($p < 0.001$, Cohen's d = 0.50), whereas the control group showed minimal progress. Finally, the Sit and Reach Test indicated a 22.2% enhancement for the experimental group, moving from 17.7 cm to 22.0 cm ($p < 0.001$, Cohen's d = 0.60), while the control group demonstrated trivial change. Overall, these results underscore the effectiveness of the intervention in improving motor skills in boys, reinforcing its positive impact on physical performance.

DISCUSSION

The findings of this study indicate significant improvements in various motor skills among both boys and girls following the implemented training intervention. Notably, the experimental groups exhibited marked enhancements in balance, vertical jump, horizontal jump, sprinting ability, and flexibility, highlighting the effectiveness of the program in promoting physical fitness and motor development.

The substantial increase in balance as measured by the Flamingo Balance Test supports previous research emphasizing the role of balance training in enhancing proprioception and overall motor coordination (Ramachandran et al., 2021). For both boys and girls, the experimental group demonstrated large effect sizes (Cohen's d = 1.40 for boys, 1.30 for girls), suggesting that the training significantly improved their ability to maintain stability, a critical skill for athletic performance (Renshaw et al., 2019). The emphasis on balance is particularly pertinent, as it has been shown to serve as a foundational component in developing motor skills during childhood (Newell, 2020).

Vertical jump performance also improved significantly, with effect sizes indicating medium to large impacts (Cohen's d = 1.00 for both genders). This aligns with existing literature that recognizes plyometric training as a powerful method for enhancing lower body strength and explosive power (Bastholm & Olsen, 2024). The improvements in vertical jump height suggest that the training effectively contributed to the development of muscular strength, which is crucial for various athletic activities (Marshall et al., 2021).

The 20-m sprint test results further corroborate the effectiveness of the intervention, with both boys and girls exhibiting notable reductions in sprint times. The reductions of 12.5% and 11.8% for boys and girls, respectively, echo findings from previous studies that highlight the positive effects of speed training on short-distance sprint performance (Otsuka et al., 2022). Efficient sprinting is vital not only for competitive sports but also for overall physical fitness, reinforcing the importance of early interventions in promoting long-term athletic development (Haugen et al., 2019).

Flexibility improvements, as indicated by the Sit and Reach Test, also demonstrate the intervention's comprehensive impact on physical fitness. Flexibility is often linked to overall athletic performance and injury prevention (Motte et al., 2019). The significant gains in flexibility support previous research emphasizing the importance of integrating flexibility training into physical education programs (Diaz et al., 2024).

While the study presents strong findings, it is essential to acknowledge its limitations. The sample size, though adequate for preliminary findings, may limit the generalizability of the results (Clayson et al., 2019). Future research should aim to include larger, more diverse populations to confirm these outcomes. Additionally, varying the duration and intensity of the training regimen could provide insights into optimizing physical development strategies for children (Jayanthi et al., 2022).

In conclusion, the significant improvements observed in motor skill performance among boys and girls indicate that the training intervention effectively enhanced physical fitness. These results underscore the necessity of integrating such programs into physical education curricula, fostering the development of critical motor skills in children, and promoting a foundation for lifelong physical activity.

CONCLUSIONS

In conclusion, this study demonstrated that the training intervention significantly enhanced physical performance metrics in both boys and girls, as evidenced by improvements in coordination, balance, and strength. The findings from the anthropometric measurements indicated a noteworthy reduction in body fat percentage among participants in the experimental group, suggesting that targeted physical activity can positively influence body composition in young children. Furthermore, the marked gains observed in motor skill tests, particularly in balance and jumping abilities, highlight the effectiveness of the training regimen in fostering essential motor skills during critical developmental stages. The results align with existing literature emphasizing the importance of structured physical activity in promoting not only physical fitness but also overall developmental health in children (Piek et al., 2008). The significant improvements in balance and agility observed in both genders reinforce the idea that early intervention through tailored physical education programs can lay a strong foundation for lifelong physical activity and athletic performance (Huggett & Howells, 2024). Future research should explore long-term effects of such interventions and consider diverse populations to enhance generalizability. Additionally, incorporating a wider array of assessments could provide deeper insights into the multifaceted benefits of physical training on child development. Overall, the study underscores the necessity of integrating comprehensive physical education programs within school curricula to support children's physical and cognitive growth.

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REFERENCES

Bailey Jr, D. B. (2002). Are critical periods critical for early childhood education?: The role of timing in early childhood pedagogy. *Early Childhood Research Quarterly, 17*(3), 281-294. https://doi.org/10.1016/S0885-2006(02)00165-5

Bastholm, M., & Olsen, G. (2024). The role of plyometric training in improving explosive power in sprinters: A qualitative analysis. *International Journal of Sport Studies for Health, 7*(3). https://doi.org/10.61838/kman.intjssh.7.3.10

Bukvić, Z., Nikolić, D., & Ćirović, D. (2021). The importance of physical activity for the development of motor skills of younger school age children. *Medicinski Podmladak, 72*(2), 34-39.

Chandler, T., Vamplew, W., & Cronin, M. (2007). *Sport and physical education: The key concepts.* Routledge. https://doi.org/10.4324/9780203961698

Clayson, P. E., Carbine, K. A., Baldwin, S. A., & Larson, M. J. (2019). Methodological reporting behavior, sample sizes, and statistical power in studies of event-related potentials: Barriers to reproducibility and replicability. *Psychophysiology, 56*(11), e13437. https://doi.org/10.1111/psyp.13437

Diaz, F. C. B., Trinidad, I., Agustin, M. J., Panganiban, T. P., & Garcia, M. B. (2024). Mindfulness for health and well-being: An innovative physical education course in the University of the Philippines Diliman. In *Global Innovations in Physical Education and Health* (pp. 139-168). IGI Global.

Dockett, S., & Perry, B. (2016). Supporting children's transition to school age care. *The Australian Educational Researcher, 43,* 309-326. https://doi.org/10.1007/s13384-016-0202-y

Donnelly, J. E., Hillman, C. H., Castelli, D., Etnier, J. L., Lee, S., Tomporowski, P., ... & Szabo-Reed, A. N. (2016). Physical activity, fitness, cognitive function, and academic achievement in children: A systematic review. *Medicine and Science in Sports and Exercise, 48*(6), 1197.

Ericsson, I. (2017). Effects of physical activity and motor skills acquisition on executive functions and scholastic performance: A review. *Progress in Education, 43,* 71-104.

Gallahue, D. L., & Ozmun, J. C. (2014). Motor development in young children. In *Handbook of Research on the Education of Young Children* (pp. 123-138). Routledge. https://doi.org/10.4324/9781315045511

Goldfield, G. S., Harvey, A., Grattan, K., & Adamo, K. B. (2012). Physical activity promotion in the preschool years: A critical period to intervene. *International Journal of Environmental Research and Public Health, 9*(4), 1326-1342. https://doi.org/10.3390/ijerph9041326

Green, N. R., Roberts, W. M., Sheehan, D., & Keegan, R. J. (2018). Charting physical literacy journeys within physical education settings. *Journal of Teaching in Physical Education, 37*(3), 272-279. https://doi.org/10.1123/jtpe.2018-0129

Haugen, T., Seiler, S., Sandbakk, Ø., & Tønnessen, E. (2019). The training and development of elite sprint performance: An integration of scientific and best practice literature. *Sports Medicine-Open, 5,* 1-16. https://doi.org/10.1186/s40798-019-0221-0

Huggett, E., & Howells, K. (2024). Supporting young children's physical development through tailored motor competency interventions within a school setting. *Children, 11*(9), 1122. https://doi.org/10.3390/children11091122

Iivonen, S., Sääkslahti, A., & Nissinen, K. (2011). The development of fundamental motor skills of four-to five-year-old preschool children and the effects of a preschool physical education curriculum. *Early Child Development and Care, 181*(3), 335-343. https://doi.org/10.1080/03004430903387461

...

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Jayanthi, N., Schley, S., Cumming, S. P., Myer, G. D., Saffel, H., Hartwig, T., & Gabbett, T. J. (2022). Developmental training model for the sport specialized youth athlete: A dynamic strategy for individualizing load-response during maturation. *Sports Health, 14*(1), 142-153. https://doi.org/10.1177/19417381211056088

Keeley, T. J., & Fox, K. R. (2009). The impact of physical activity and fitness on academic achievement and cognitive performance in children. *International Review of Sport and Exercise Psychology, 2*(2), 198-214. https://doi.org/10.1080/17509840903233822

Laukkanen, A., Pesola, A., Havu, M., Sääkslahti, A., & Finni, T. (2014). Relationship between habitual physical activity and gross motor skills is multifaceted in 5-to 8-year-old children. *Scandinavian Journal of Medicine & Science in Sports, 24*(2), e102-e110. https://doi.org/10.1111/sms.12116

Lengel, T., & Kuczala, M. (2010). *The kinesthetic classroom: Teaching and learning through movement.* Corwin Press.

Li, R., Sit, C. H., Jane, J. Y., Duan, J. Z., Fan, T. C., McKenzie, T. L., & Wong, S. H. (2016). Correlates of physical activity in children and adolescents with physical disabilities: A systematic review. *Preventive Medicine, 89,* 184-193. https://doi.org/10.1016/j.ypmed.2016.05.029

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,* 1019-1035. https://doi.org/10.2165/11536850-000000000-00000

Marshall, J., Bishop, C., Turner, A., & Haff, G. G. (2021). Optimal training sequences to develop lower body force, velocity, power, and jump height: A systematic review with meta-analysis. *Sports Medicine, 51,* 1245-1271. https://doi.org/10.1007/s40279-021-01430-z

McClelland, M. M., & Cameron, C. E. (2019). Developing together: The role of executive function and motor skills in children's early academic lives. *Early Childhood Research Quarterly, 46,* 142-151. https://doi.org/10.1016/j.ecresq.2018.03.014

Motte, S. J., Lisman, P., Gribbin, T. C., Murphy, K., & Deuster, P. A. (2019). Systematic review of the association between physical fitness and musculoskeletal injury risk: Part 3—flexibility, power, speed, balance, and agility. *The Journal of Strength & Conditioning Research, 33*(6), 1723-1735. https://doi.org/10.1519/JSC.0000000000002382

Newell, K. M. (2020). What are fundamental motor skills and what is fundamental about them? *Journal of Motor Learning and Development, 8*(2), 280-314. https://doi.org/10.1123/jmld.2020-0013

Otsuka, M., Isaka, T., Terada, M., Arimitsu, T., Kurihara, T., & Shinohara, Y. (2022). Associations of time to return to performance following acute posterior thigh injuries with running biomechanics, hamstring function, and structure in collegiate sprinters: A prospective cohort design. *Clinical Biomechanics, 100,* 105789. https://doi.org/10.1016/j.clinbiomech.2022.105789

Pellegrini, A. D., & Smith, P. K. (1998). Physical activity play: The nature and function of a neglected aspect of play. *Child Development, 69*(3), 577-598. https://doi.org/10.1111/j.1467-8624.1998.tb06226.x

Pianta, R. C., Barnett, W. S., Burchinal, M., & Thornburg, K. R. (2009). The effects of preschool education: What we know, how public policy is or is not aligned with the evidence base, and what we need to know. *Psychological Science in the Public Interest, 10*(2), 49-88. https://doi.org/10.1177/1529100610381908

Piek, J. P., Dawson, L., Smith, L. M., & Gasson, N. (2008). The role of early fine and gross motor development on later motor and cognitive ability. *Human Movement Science, 27*(5), 668-681. https://doi.org/10.1016/j.humov.2007.11.002

Ramachandran, A. K., Singh, U., Ramirez-Campillo, R., Clemente, F. M., Afonso, J., & Granacher, U. (2021). Effects of plyometric jump training on balance performance in healthy participants: A systematic review with meta-analysis. *Frontiers in Physiology, 12,* 730945. https://doi.org/10.3389/fphys.2021.730945

Renshaw, I., Davids, K., Araújo, D., Lucas, A., Roberts, W. M., Newcombe, D. J., & Franks, B. (2019). Evaluating weaknesses of “perceptual-cognitive training” and “brain training” methods in sport: An ecological dynamics critique. *Frontiers in Psychology, 9,* 2468. https://doi.org/10.3389/fpsyg.2018.02468

Smits-Engelsman, B., Bonney, E., & Ferguson, G. (2021). Effects of graded exergames on fitness performance in elementary school children with developmental coordination disorder. *Frontiers in Sports and Active Living, 3,* 653851. https://doi.org/10.3389/fspor.2021.653851