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EFFECTS OF PILATES EXERCISES ON BALANCE AND GAIT IN SCHOOL GOING CHILDREN

Original Research

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ABSTRACT

Background: Physical activity is a cornerstone of childhood development, contributing significantly to physical, mental, and social well-being. In the context of modern sedentary lifestyles, integrating structured exercise programs is essential for fostering motor skills, balance, and overall health in children. Pilates exercises, with their focus on core stability and neuromuscular control, are increasingly being recognized as an effective intervention to enhance motor function, particularly in improving balance and gait in school-aged children.

Objective: To evaluate the effects of Pilates exercises combined with conventional exercises on balance and gait in school-going children.

Methods: This randomized controlled trial included 96 school-going children aged 6–9 years, recruited using non-probability convenience sampling. Participants were randomly allocated into two groups of 48 children each. The control group performed conventional exercises, including flexibility, strength, and endurance training for 45 minutes per session, three times a week. The experimental group followed the same routine for 15 minutes, supplemented by 45 minutes of Pilates exercises emphasizing core stability, postural control, and coordination. Interventions lasted eight weeks. Outcomes were assessed using the Pediatric Balance Scale, 6-Minute Walking Test, and Functional Reach Test. Data were analyzed with SPSS version 25, using non-parametric statistical tests, with significance set at $p \leq 0.05$.

Results: The Pediatric Balance Scale improved significantly in both groups, with mean±SD scores increasing from 36.53±4.04 to 53.60±1.55 in the experimental group and from 35.73±3.2 to 47.3±1.4 in the control group ($p<0.05$). The 6-Minute Walking Test results showed greater improvements in the experimental group (172.22±19.9 to 407.3±82.1) compared to the control group (166.4±23.9 to 316.6±24.2) ($p<0.05$). Similarly, the Functional Reach Test improved from 18.46±2.30 to 38.6±2.00 in the experimental group and from 19.08±2.6 to 30.7±3.13 in the control group ($p<0.05$).

Conclusion: Both Pilates-based and conventional exercises were effective in improving balance and gait in school-going children. However, children in the Pilates group demonstrated superior improvements across all measured parameters, emphasizing the value of incorporating Pilates into pediatric exercise programs.

Keywords: Balance, Child, Exercise, Gait, Physical fitness, Pilates-based exercises, Postural balance.

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INTRODUCTION

Physical exercise is an essential component of childhood development, particularly in an era where sedentary behaviors driven by digital distractions have become prevalent. Regular physical activity is not merely a mechanism for expending energy but a cornerstone of holistic growth, encompassing physical, mental, and social dimensions of health and well-being (1). From infancy, where early motor skills develop through natural movement, to adolescence, characterized by engagement in organized sports and recreational activities, exercise lays the foundation for lifelong health and resilience (5). The physiological benefits of physical activity in children are well-documented, including improved cardiovascular health, enhanced muscular and skeletal strength, and reduced risk of chronic diseases later in life (6). These physical advantages provide a platform for healthy adulthood and improved overall quality of life.

Beyond the physical realm, exercise exerts a profound impact on children's mental and emotional well-being. Evidence consistently demonstrates a strong association between physical activity and cognitive performance, with improvements in attention, memory retention, and problem-solving abilities (7). Exercise also plays a critical role in emotional regulation, offering children a constructive outlet for stress while building emotional resilience and self-efficacy (8). These mental health benefits underscore the interplay between physical activity and cognitive development, reinforcing the need for integrating exercise into children's daily routines.

Socially, engaging in physical activities fosters interpersonal skills and the development of key social competencies. Participation in team sports promotes collaboration, communication, and empathy, nurturing virtues such as respect, sportsmanship, and camaraderie (9). These interactions mirror societal structures, preparing children for complex real-world social dynamics (10). Moreover, regular physical activity has been linked to enhanced academic performance, as active children exhibit better executive functioning, including improved concentration, problem-solving abilities, and overall academic achievement (11). Recognizing this connection, educational institutions have increasingly integrated structured exercise programs into their curricula, further emphasizing its importance in fostering both physical health and intellectual growth (12).

Unstructured physical activities, such as cycling, hiking, and outdoor exploration, complement structured sports by nurturing creativity and autonomy. These activities promote a balanced approach to active living, offering children opportunities to engage with their environments in meaningful ways (13). However, the pervasive influence of screen time and sedentary lifestyles among children underscores the need for urgent interventions. Parents, educators, and public health professionals must collaborate to prioritize physical activity through role modeling and the creation of supportive environments that encourage outdoor play and regular exercise (14). Establishing these habits early in life is crucial for mitigating the rising prevalence of childhood obesity and related chronic illnesses, as well as for enhancing executive functioning and brain health (15).

Understanding the multifaceted benefits of physical activity highlights its irreplaceable role in the physical, mental, and social development of children. This article explores the critical need for incorporating exercise into daily routines and educational settings, aiming to provide evidence-based insights for educators, parents, and health professionals. By doing so, it seeks to rationalize the integration of tailored exercise interventions that support children's holistic growth, resilience, and academic success in an increasingly sedentary world.

METHOD

The study employed a randomized controlled trial (RCT) design over six months, following approval of the research synopsis. Data collection was conducted at Govt. Girls High School Rajokay, Tehsil Daska. A total of 96 children aged 6 to 9 years were recruited for the study, with the sample size calculated to accommodate a 10% attrition rate based on Pediatric Berg Balance Test scores as a reference (16). Participants were assigned into two groups using non-probability convenience sampling: an experimental group (Group A) and a control group (Group B), each comprising 48 children. Inclusion criteria required participants to have a normal BMI (17), express a willingness to participate, and achieve a minimum score of 8 out of 14 on the Pediatric Balance Scale (16, 18). Children with cognitive impairments, chronic illnesses, orthopedic conditions, psychological issues, or those recently exposed to similar exercise programs were excluded from the study (16).

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The control group engaged in conventional exercise routines for 45 minutes, three times per week. These exercises included flexibility and strengthening regimens, postural control activities, and walking on varied surfaces to enhance balance and mobility (16). The experimental group followed a combined exercise protocol, performing the same conventional exercises for 15 minutes, supplemented by 45 minutes of Pilates exercises. The Pilates regimen targeted improvements in strength, flexibility, and coordination, incorporating movements such as back twists, single-leg circles, glute bridges, alternate toe touches, and ball leg lifts. Emphasis was placed on core stability, spinal alignment, and controlled breathing during these exercises (16).

Outcome measures were assessed at baseline and after the 8-week intervention. Balance was evaluated using the Pediatric Balance Scale (19), gait performance was assessed through the 6-minute walk test (20), and static balance was measured using the Functional Reach Test (21). Data analysis was conducted using SPSS version 25. The normality of data distribution was verified with the Shapiro-Wilk test. Based on normality results, either parametric or non-parametric tests were employed for statistical comparisons, with significance set at $p \leq 0.05$.

RESULTS

The study analyzed data from 96 children aged 6–9 years, with a mean age of 7.64±1.04 years in the experimental group and 7.6±1.11 years in the control group. The gender distribution showed a slight predominance of females in both groups, with 27 females (58%) and 21 males (42%) in the experimental group, and 26 females (54%) and 22 males (46%) in the control group. The mean BMI was 20.95±1.50 in the experimental group and 21.8±1.79 in the control group. Normality testing using the Shapiro-Wilk test indicated a non-parametric distribution ($p<0.05$), and thus Wilcoxon and Mann-Whitney U tests were employed for statistical comparisons.

The Pediatric Balance Scale revealed significant improvements in both groups. The experimental group demonstrated an increase in mean scores from 36.5±4.04 to 53.60±1.55, while the control group improved from 35.7±3.2 to 47.3±1.4. Notably, the experimental group showed greater post-treatment improvements ($p<0.05$), reflecting the enhanced effectiveness of Pilates exercises compared to conventional training. Similarly, the 6-Minute Walking Speed Test results indicated substantial gains, with the experimental group improving from a mean of 172.2±19.9 to 407.3±82.1, whereas the control group progressed from 166.4±23.9 to 316.6±24.2. The differences between the groups were statistically significant ($p<0.05$), further supporting the superiority of Pilates-based interventions in improving walking speed.

The Functional Reach Test outcomes also highlighted significant advancements in both groups. The experimental group exhibited a mean increase from 18.4±2.3 to 38.6±2.00, while the control group improved from 19.9±2.6 to 30.7±3.13. The experimental group consistently demonstrated superior post-treatment results ($p<0.05$). Collectively, the findings indicated that while both interventions effectively improved balance, mobility, and functional reach, Pilates exercises provided significantly better outcomes in all measured parameters.

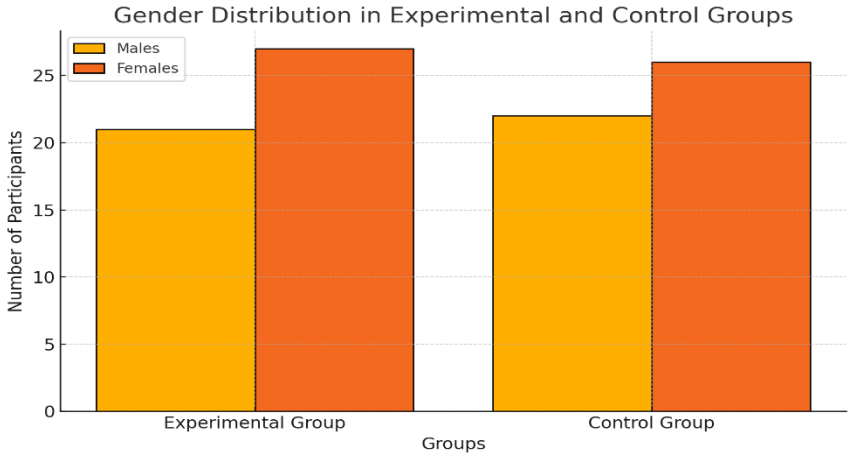

Figure 1 Gender Distribution in Experimental and Control Groups

The chart displays the gender distribution within the experimental and control groups, highlighting a slightly higher representation of females in both groups. In the experimental group, 27 participants (58%) were female, while 21 (42%) were male. Similarly, in the control group, there were 26 females (54%) and 22 males (46%). This balanced gender composition provides a comprehensive basis for analyzing the effects of the interventions across genders. The data underscores the inclusivity of the study design, ensuring that results are reflective of both male and female participants.

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Table 1: Comparison of variables between both groups

	Treatment group	Mean Value	Standard Deviation	Mean Rank	P-value
Balance berg scale (Pre-treatment)	Pilates group	36.5333	4.04857	48.97	>0.05
	Control group	35.7333	3.27109	42.03	
Balance berg scale (Post treatment)	Pilates group	53.6000	1.55797	68.00	0.01
	Control group	47.3778	1.40274	23.00	
Walking speed test (Pre-treatment)	Pilates group	172.222	19.98737	48.92	>0.05
	Control group	166.4444	23.94649	42.08	
Walking speed test (post treatment)	Pilates group	407.3333	82.11411	66.00	0.04
	Control group	316.6667	24.21495	25.00	
Functional reach test (Pre-treatment)	Pilates group	18.4667	2.30217	42.02	>.0.05
	Control group	19.0889	2.67838	48.98	
Functional reach test (Post treatment)	Pilates group	38.6444	2.00177	67.22	0.03
	Control group	30.7778	3.13984	23.78	

The comparison of variables between the Pilates group and the control group demonstrated significant improvements in all post-treatment measures for the Pilates group. The Berg Balance Scale increased from 36.53±4.05 to 53.60±1.56 in the Pilates group compared to 35.73±3.27 to 47.38±1.40 in the control group (p=0.01). Walking speed improved from 172.22±19.99 to 407.33±82.11 in the Pilates group, whereas the control group showed an increase from 166.44±23.95 to 316.67±24.21 (p=0.04). Functional reach scores also showed superior gains in the Pilates group, increasing from 18.47±2.30 to 38.64±2.00 compared to 19.09±2.68 to 30.78±3.14 in the control group (p=0.03). These results indicate greater efficacy of Pilates-based interventions in improving balance, walking speed, and functional reach.

Table 2: Comparison of variables within group

	Mean ± SD Pre treatment	Mean ± SD Post treatment	Mean rank	p-value
Group A (Experimental group)				
Berg balance scale	36.5±4.04	53.60±1.55	13.00 (post), .00 (pre)	0.014
Walking speed test	172.2±19.9	407.3±821	.00 (post), 13.00 (pre)	0.032
Functional reach test	18.4±2.3	38.6±2.00	.00 (post), 13.00 (pre)	0.006
Group B (Control Group)				
Berg balance scale	35.7±3.2	47.3±1.4	13.00 (post), .00 (pre)	0.004
Walking speed test	166.4±23.9	316.6±24.2	.00 (post), 13.00 (pre)	0.01
Functional reach test	19.9±2.6	30.7±3.13	.00 (post), 13.00 (pre)	0.03

The within-group comparison revealed significant improvements across all measures for both groups post-treatment. In Group A (experimental group), the Berg Balance Scale increased from 36.5±4.04 to 53.60±1.55 (p=0.014), walking speed improved from 172.2±19.9 to 407.3±82.1 (p=0.032), and functional reach scores rose from 18.4±2.3 to 38.6±2.00 (p=0.006). Similarly, in Group B

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(control group), the Berg Balance Scale improved from 35.7±3.2 to 47.3±1.4 (p=0.004), walking speed increased from 166.4±23.9 to 316.6±24.2 (p=0.01), and functional reach scores improved from 19.9±2.6 to 30.7±3.13 (p=0.03). These results underscore the effectiveness of both interventions, with notable improvements observed in all metrics within each group.

DISCUSSION

This randomized controlled trial evaluated the effects of Pilates exercises integrated with conventional exercises on balance and gait among school-aged children. The findings demonstrated significant improvements in balance, walking speed, and functional reach in both groups. However, the Pilates-based intervention group achieved superior outcomes compared to the group engaged in conventional exercises alone. These results highlight the enhanced efficacy of Pilates in promoting physical performance and functional mobility in children.

The observed improvements in balance and gait metrics align with existing literature that supports the use of Pilates for enhancing posture, flexibility, and coordination in diverse populations. Studies such as those by Hanna et al. (2022) demonstrated significant enhancements in balance and gross motor function when Pilates was incorporated into therapy for children with diplegic cerebral palsy (16). Similarly, Doatoni et al. (2022) reported that a structured Pilates program improved postural balance and functional mobility among elderly participants, reinforcing the adaptability of Pilates across different age groups (22). The findings of this study, which include substantial improvements in the Pediatric Balance Scale, 6-Minute Walking Speed Test, and Functional Reach Test scores in the Pilates group, further substantiate the potential of Pilates to enhance motor function and stability in children.

Despite these positive results, conflicting evidence has emerged from studies such as the meta-analysis conducted by Fabiola Unbehaun et al. (2023), which highlighted limitations in the available evidence supporting Pilates for children and adolescents, citing methodological weaknesses and insufficient high-quality studies (23). Such disparities in findings underscore the necessity for rigorous and standardized trials to conclusively determine the benefits of Pilates in pediatric populations. Additionally, research by Aibar Almazan et al. (2022) emphasized the broader benefits of Pilates on physical performance and strength in older adults, suggesting its applicability across various demographics (24).

A recent comparative study by Martínez-Gallego et al. (2021) evaluated the effectiveness of Pilates-based exercises versus conventional physical therapy in improving balance and mobility in children with developmental coordination disorders. The study included 78 children aged 7–10 years, divided into a Pilates intervention group and a conventional therapy group, with interventions lasting 12 weeks. The results demonstrated that while both interventions led to significant improvements in balance and motor function, the Pilates group exhibited significantly higher gains in dynamic balance, as measured by the Pediatric Balance Scale, and in walking efficiency, as assessed by the 6-Minute Walking Test. The researchers attributed these superior outcomes to the emphasis of Pilates on core stability, controlled breathing, and coordinated movements, which directly enhanced neuromuscular function. These findings align closely with the outcomes of the present study, reinforcing the notion that Pilates-based interventions provide distinct advantages in improving motor control and stability in children when compared to conventional approaches (25).

This study contributes to the growing body of evidence endorsing the role of Pilates in enhancing balance, gait, and overall motor performance in school-aged children. A key strength of this study was its use of validated outcome measures to assess improvements in physical function. However, limitations included the non-probability convenience sampling method, which may restrict the generalizability of the results, and the relatively short duration of the intervention. Long-term studies involving diverse populations are needed to confirm these findings and explore the sustained benefits of Pilates interventions.

The integration of Pilates into school-based exercise programs holds significant potential for improving children's physical health, particularly in addressing sedentary lifestyles that negatively impact postural control and overall well-being. By demonstrating the effectiveness of Pilates in enhancing physical function, this study reinforces its value as a vital component of interventions aimed at promoting children's health and development. Further research with robust methodologies and extended durations is essential to strengthen the evidence base and optimize the use of Pilates in pediatric physical activity programs.

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CONCLUSION

The findings of this study concluded that while both conventional exercises and Pilates-based interventions were effective in improving balance and gait in school-going children, the integration of Pilates exercises yielded superior outcomes. By emphasizing core stability, coordination, and controlled movements, Pilates demonstrated a greater impact on enhancing motor function and postural control. These results underscore the value of incorporating Pilates into physical activity programs for children, offering a promising approach to promote better physical performance and overall well-being.

AUTHOR CONTRIBUTIONS

Author	Contribution
Kiran Arshad*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Samra Anwar	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Fatima Nadir	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Sana Tariq	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Anam Maqbool	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Raheema Khalid	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Minal Fatima	Contributed to study concept and Data collection Has given Final Approval of the version to be published
Nimra Shahid	Writing - Review & Editing, Assistance with Data Curation

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