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The Effect of Selected Exercises on the Motor Development of Overweight and Obese Iraqi Children Aged 8 to 9 Years: The Moderating Role of Gender

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A B S T R A C T

The objective of this study was to examine the effect of selected exercises on the motor development of overweight and obese Iraqi children aged 8 to 9 years, considering the moderating role of gender. This research employed a quasi-experimental design with a pre-test and post-test structure, including both control and experimental groups. The statistical population consisted of overweight and obese children aged 8 to 9 years in the city of Baghdad. The sample included 40 children from Baghdad, selected voluntarily and based on inclusion and exclusion criteria using convenience sampling. To measure motor development, the short form of the second edition of the Bruininks-Oseretsky Test of Motor Proficiency was utilized. The selected exercises were derived from the SPARK training protocol. Data analysis was conducted using factorial analysis of variance (ANOVA) and univariate analysis of covariance (ANCOVA). All statistical procedures were performed using SPSS version 25, with a significance level set at $p < 0.05$. The results indicated a significant difference in fine motor skills between the experimental and control groups following the implementation of the selected exercises ($p < 0.05$). However, the effect of gender was not significant ($p > 0.05$). Furthermore, the mean scores of the experimental group in both gross motor skills and fine motor skills were significantly higher than those of the control group ($p < 0.001$). The effect of gender was significant for gross motor skills ($p < 0.05$) but not for fine motor skills ($p > 0.05$). The findings suggest that the selected exercises effectively enhance the fine motor skills of overweight and obese Iraqi children aged 8 to 9 years, with no significant difference between boys and girls. However, the effectiveness of the selected exercises on gross motor skills differs between overweight and obese boys and girls in this age group.

Keywords: *Selected exercises, obesity, overweight, motor development*

1. Introduction

Fundamental motor skills (FMS) serve as the foundation for children's movement. Numerous studies in recent years have emphasized the critical importance of mastering fundamental motor skills for children's overall development and long-term physical literacy (1). These skills function as basic movements or precursor patterns for more advanced sports techniques (1, 2), as many motor skills used in track and field and daily activities are advanced versions of FMS. For example, javelin throwing and baseball pitching are advanced forms of overarm throwing (3). Consequently, proficiency in FMS is essential for achieving excellence in a sport or game and for becoming an elite athlete. Additionally, FMS provide children with the necessary skills to explore their environment and learn about the world around them, thereby promoting physical activity (4) while also supporting cognitive and social development during childhood (5). However, the reality is that children worldwide lack sufficient FMS, and various studies conducted on children in different countries have yielded similar findings (6-8). A comprehensive systematic review of 65 independent studies on children's FMS levels concluded that, compared to normative data from the Test of Gross Motor Development, Second Edition (TGMD-2), children exhibit "below average" to "average" FMS levels (9). Low levels of FMS can hinder children's positive development in various aspects (9). Growing evidence suggests that inadequate FMS competence in childhood may lead to insufficient physical activity and obesity-related issues, which, in turn, contribute to health risk factors for children (10).

According to Gabbard's perceptual-motor theory, children are often advised to actively participate in activities that encompass multiple general movement domains (11). Accordingly, providing a conducive environment and familiarizing children with appropriate methods for cultivating and training these skills can play a crucial role in their present and future quality of life (12). Moreover, differences have been observed in the motor performance of boys and girls, such that boys excel in tasks requiring strength and speed (e.g., jumping, throwing, and running), whereas girls perform better in tasks requiring balance (e.g., hopping) (5, 11). Notably, such differences can be attributed to genetics and socio-cultural variations among individuals (11).

It appears that an active physical lifestyle during childhood positively influences brain development in terms of both structure and function. Research on the role of physical activity in executive functions and academic performance has yielded promising results (13-15). While this research agenda has made strides forward, further studies are necessary to better understand the physiological and cognitive-motor aspects of various physical activities that may help explain the relationships between executive function and academic performance (13, 15, 16). Currently, several theoretical arguments suggest that different forms of physical activity, based on activity levels (dose) and cognitive-motor challenges (type), may be differentially associated with core executive functions (16). Supporting the notion that the level and type of physical activity may play a role, Best (16) proposed three mechanisms through which physical activity can influence executive functions: (a) through physiological changes in the brain, (b) through the intrinsic cognitive demands of engaging in enjoyable games, and (c) through the cognitive demands required for executing complex motor movements. Cross-sectional studies using objective measures of physical activity have demonstrated that moderate-to-vigorous physical activity (MVPA) is associated with reduced reaction time (17) and improved executive attention (18).

Intervention studies that manipulate cognitive engagement in physical activity by increasing coordination and cognitive demands have shown superior effects on executive functions compared to physical activities without such enhancements (Crova et al., 2014; Pesce et al., 2016; Schmidt et al., 2015). For instance, Pesce et al. (2016) found that physical education enriched with coordination and cognitive play improved inhibition, with the improvement being mediated by motor coordination. Cross-sectional studies have identified a positive correlation between motor skills and executive functions in children (19). However, inconsistencies in the literature report variations in the executive function components that are influenced by or associated with physical activity, potentially due to the presence of different executive function components with distinct developmental pathways (16). Therefore, examining the actual relationships between motor skill performance and

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individual aspects of executive function is crucial for further clarification. Gains in motor skill performance through participation in group games and complex motor tasks may contribute to neurogenesis in the hippocampus and physiological changes in the cerebellum. Additionally, since group games and executive tasks require similar cognitive skills, the skills acquired during cognitively demanding motor tasks and group games may transfer to executive functions (16). The close relationship between motor control and executive functions is further characterized by (1) simultaneous activation of the prefrontal cortex, cerebellum, and basal ganglia during various motor and cognitive tasks, (2) their similar developmental timelines (Diamond, 2000), and (3) their shared fundamental processes, such as sequencing, monitoring, and planning (20, 21).

Given the findings of previous studies and the impact of a sedentary lifestyle on children's physical and motor development due to modern technology, the present study aims to enhance the motor skills and physical fitness of overweight and obese children aged 6 to 9 years through selected exercise programs. This initiative seeks to contribute to the promotion of a healthy lifestyle among future generations while also raising awareness among researchers and education policymakers about the importance of motor development in educational planning. Based on these considerations, investigating the effect of selected exercises on the development of motor skills and physical fitness in overweight and obese Iraqi children aged 8 to 9 years is deemed essential. The findings of this study could increase awareness among stakeholders responsible for children's physical and motor health, encouraging them to take steps toward fostering children's latent abilities. With the growing prevalence of electronic games and the decline in physical activity due to space constraints, providing appropriate physical activities in educational centers appears to be imperative. In light of these issues, overweight or obese children and adolescents are more likely to meet the criteria for pediatric inactivity triad (PIT) (22). Considering the aforementioned research, the present study seeks to examine the effect of selected exercises on the motor development and physical fitness of overweight and obese Iraqi children aged 8 to 9 years, with a focus on the moderating role of gender.

2. Methods and Materials

2.1. Study Design and Participants

This study employed a quasi-experimental design with a pre-test and post-test structure, incorporating both control and experimental groups. The statistical population consisted of overweight and obese children aged 8 to 9 years in the city of Baghdad. The study sample comprised 40 children from Baghdad, selected voluntarily and based on inclusion and exclusion criteria using convenience sampling. To assess motor development, the short form of the second edition of the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2) was used. The inclusion criteria were as follows: being within the age range of 8 to 9 years, obtaining parental consent and verbal assent from the child, absence of a history of neurological disorders, and no physical, motor, or mental impairments that would prevent participation in the exercises. The exclusion criteria included missing more than three training sessions, lack of appropriate participation and cooperation in the exercises, injury or illness preventing engagement in training, and unwillingness to continue participation in the study.

2.2. Measure

2.2.1. Motor Development

The primary instrument used in this study was the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (Short Form), which is commonly employed to assess perceptual-motor skills. This norm-referenced test evaluates motor proficiency in children aged 4.5 to 14.5 years. The complete battery consists of eight subtests, covering 46 separate items, that assess motor proficiency or motor impairments in gross motor skills, bilateral coordination, speed, agility (strength), fine motor integration, manual dexterity, upper limb coordination, and precise and refined movements. Bruininks initially developed this test in 1972 by modifying Oseretsky's motor assessments. The full version of this test requires approximately 45 to 60 minutes for completion. It comprises four subtests for gross motor skills, three subtests for fine motor skills, and one subtest assessing both types of motor skills. To systematically record each participant’s attempts during the sessions, a scoring sheet was used, where the

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corresponding score for each trial was documented. Notably, all items in this test were adapted from the work of Carmosino et al. (2014), which meticulously examined both the short and long forms for motor skill assessment. The reliability coefficient for this test is 0.96 for boys and 0.97 for girls, indicating high internal consistency. The test-retest validity coefficient for the long version is 0.87, while for the short version, it is 0.86 (23).

2.3. Intervention

2.3.1. SPARK Training

The SPARK (Sports, Play, and Active Recreation for Kids) training protocol was utilized in accordance with the study objectives and the participants' conditions. The training program was divided into three phases: warm-up, main exercise, and cool-down. Participants in the experimental groups followed this protocol for eight weeks, with three sessions per week.

The intervention protocol consisted of 24 sessions designed to enhance motor skills in overweight and obese children aged 8 to 9 years. Each session lasted 60 minutes, divided into two 30-minute segments. The first segment focused on warm-up and Type I activities, which aimed to develop fundamental movement skills such as walking on heels, hopping, jumping with rotation, and coordination drills. These activities gradually progressed in complexity, incorporating games like tag, frog jumps, skipping rope, and balance-based movements. The warm-up phase ensured that children were physically prepared for more dynamic exercises while improving their agility, flexibility, and coordination.

The second segment included Type II activities and cool-down exercises. This part emphasized skill-based games such as ball handling, dribbling, passing, target aiming, and reaction-based movements. Activities like throwing the ball against a wall, dribbling in different patterns, and keeping the ball in the air were incorporated to develop fine motor skills and hand-eye coordination. Additionally, group activities such as relay races, tug-of-war, and cooperative ball exchanges were included to encourage teamwork, social interaction, and engagement. The cool-down phase focused on gradual relaxation through stretching, breathing exercises, and light mobility movements to aid in muscle recovery and reduce post-exercise fatigue.

Throughout the intervention, the progressive structure of the activities ensured an incremental improvement in motor skills, allowing children to develop movement proficiency in a structured and enjoyable manner. Game-based activities played a crucial role in maintaining motivation and participation, ensuring that children remained engaged while improving their gross and fine motor skills. By integrating playful elements such as hide and seek, relay challenges, and obstacle courses, the sessions provided a holistic approach to motor skill development while fostering an active and enjoyable learning environment.

2.4. Data Analysis

Data analysis was conducted at both the descriptive and inferential levels. At the descriptive level, mean, standard deviation, and graphical representations were used. At the inferential level, the Shapiro-Wilk test was applied to assess the normality of data distribution, while Levene's test was employed to examine the homogeneity of variances.

Since two essential assumptions of covariance analysis (homogeneity of regression slopes and a linear relationship between the covariate and the post-test) were not met for agility, flexibility, and balance, factorial analysis of variance (ANOVA) was used for comparisons. However, for power and speed, as the assumptions were satisfied, univariate analysis of covariance (ANCOVA) was applied.

Data analysis was performed using SPSS software (version 26), with the significance level set at $p < 0.05$.

3. Findings and Results

The study sample consisted of 40 children aged 8 to 9 years from Baghdad. Half of the participants in the experimental group were girls, and the other half were boys. Similarly, in the control group, half of the participants were girls, and the other half were boys.

Table 1

Demographic Data of the Experimental and Control Groups

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Variable	Gender	Experimental Group M (SD)	Control Group M (SD)	p-value
Age (years)	Girls	8.5 (0.53)	8.5 (0.51)	1.000
	Boys	8.2 (0.42)	8.4 (0.51)	0.355
Height (cm)	Girls	129.9 (5.47)	130.0 (5.39)	0.968
	Boys	129.6 (6.11)	129.7 (6.11)	0.971
Weight (kg)	Girls	36.8 (3.55)	37.3 (2.87)	0.733
	Boys	35.5 (3.27)	37.4 (3.89)	0.253
BMI	Girls	21.99 (1.94)	22.08 (1.42)	0.905
	Boys	20.83 (3.61)	22.19 (1.14)	0.270

The age range of children in both the experimental and control groups was between 8 and 9 years. The results of the independent t-test indicated that there were no significant differences between the experimental and control groups in terms of age, height, weight, or body mass index (BMI) ($p > 0.05$).

The Shapiro-Wilk test for normality showed that none of the study variables deviated significantly from a normal distribution ($p > 0.01$), confirming that the data were normally distributed. The Levene's test for homogeneity of variances indicated that variance equality was maintained for gross motor skills ($p > 0.05$), meaning the assumption was satisfied. However, for fine motor skills, Levene's test was significant ($p < 0.05$), indicating that the assumption of homogeneity of variance was violated.

To examine the linear relationship between the covariate and the post-test, a scatter plot of the data was used. Since the scatter plots for gross motor skills were parallel, the assumption of a linear relationship between the covariate (pre-test) and post-test was met for this variable. However, for fine motor skills, this assumption was violated.

The next assumption tested was the homogeneity of regression slopes for fine and gross motor skills, as shown in Table 2.

Table 2

Homogeneity of Regression Slopes for the Studied Variables

Dependent Variable	SS	df	MS	F	p-value
Fine Motor Skills × Group × Gender	54.82	3	18.27	6.22	0.002
Gross Motor Skills × Group × Gender	5.93	3	1.98	2.41	0.084

Table 2 shows that the assumption of homogeneity of regression slopes was met for gross motor skills ($p > 0.05$). Since two key assumptions of ANCOVA (homogeneity of regression slopes and a linear relationship between the covariate and post-test) were not met for fine motor skills, a factorial ANOVA was used for comparisons. However, for gross motor skills, since the assumptions were satisfied, a univariate ANCOVA was used.

Table 3

ANCOVA Results for Fine Motor Skills in the Experimental and Control Groups

Variable	Source of Variation	SS	df	MS	F	p-value	Effect Size
Pre-test Fine Motor Skills	Group	1.22	1	1.22	0.24	0.626	0.01
	Gender	1.22	1	1.22	0.24	0.626	0.01
	Group × Gender Interaction	3.02	1	3.02	0.57	0.445	0.02
	Error	182.3	36	5.06			
Post-test Fine Motor Skills	Group	476.1	1	476.1	69.73	< 0.001	0.66
	Gender	25.6	1	25.6	3.75	0.061	0.09
	Group × Gender Interaction	0.9	1	0.9	0.13	0.719	0.01
	Error	245.8	36	6.83			

Table 3 shows that there was no significant difference in pre-test scores between the two groups ($p > 0.05$), and there was no significant gender difference in pre-test scores ($p > 0.05$). However, the significant effect of the group in the post-test of fine motor skills ($p < 0.05$) indicates that a meaningful change occurred between the experimental and

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control groups after the selected exercises. In contrast, the effect of gender was not significant ($p > 0.05$), meaning that boys and girls showed no significant differences in response to the exercises, and the effectiveness of the exercises was equally beneficial for both genders. Thus, the first hypothesis was rejected.

Table 4

ANCOVA Results for Gross Motor Skills in the Experimental and Control Groups

Source of Variation	SS	df	MS	F	p-value	Effect Size
Group	282.37	1	282.37	364.93	< 0.001	0.91
Gender	7.12	1	7.12	9.2	0.005	0.21
Group × Gender Interaction	5.89	1	5.89	7.61	0.009	0.18
Error	27.08	35	0.77			

Table 5

Adjusted Post-Test Means for Gross Motor Skills

Dependent Variable	Gender	Group	Adjusted Mean	Standard Error
Gross Motor Skills	Girls	Experimental	24.98	0.29
	Boys	Control	26.61	0.28
	Girls	Experimental	20.37	0.28
	Boys	Control	20.43	0.28

Tables above indicate that after controlling for the pre-test effect, the difference in post-test scores between the experimental and control groups for gross motor skills was significant ($p < 0.001$), with the experimental group showing significantly higher scores than the control group. Additionally, the effect of gender was significant ($p < 0.05$), suggesting that the selected exercises had a greater impact on gross motor skills in boys compared to girls. Therefore, the second hypothesis was confirmed.

4. Discussion and Conclusion

The objective of this study was to examine the effect of selected exercises on the motor development of overweight and obese Iraqi children aged 8 to 9 years, considering the moderating role of gender.

The results indicated that the selected exercises were effective in enhancing fine motor skills in overweight and obese Iraqi children aged 8 to 9 years, with no significant differences between boys and girls. This finding aligns with the results of prior studies (24-28).

The findings also demonstrated that the effectiveness of the selected exercises on gross motor skills differed between boys and girls, with a greater impact observed in boys. This suggests that the selected exercises were more effective in improving gross motor skills in overweight and obese Iraqi boys aged 8 to 9 years compared to girls. This result is consistent with the prior findings (29-31).

Additionally, the findings of this study were in agreement with prior findings (23, 32) regarding the effectiveness of SPARK exercises on both fine and gross motor skills. Although the characteristics of the participants differed between these studies and the present research, the similar results indicate that these exercises can be effective for individuals with different characteristics.

Adequate facilities, equipment, and time are essential for the development of motor skills. Parents and coaches who fail to provide opportunities for learning motor skills fundamentally restrict children's developmental potential and, consequently, their success in sports skills—particularly during childhood, adolescence, and adulthood. Training opportunities alone may not be sufficient for most children to develop proficient motor movements. Without a well-structured developmental program, many children may never achieve mastery in fundamental motor skills. The quality of a developmental program plays a crucial role in its effectiveness. A comprehensive program that includes a broad range of target skills and serves as a motivational tool to encourage children's participation in physical activities is considered a key factor in a successful developmental program (32).

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Play can be considered a motivational factor because children are inherently inclined toward play. Play serves as a means for personal enjoyment and introduces variety into daily life. Many physical exercises are embedded within different games, which can encourage and motivate children to participate in physical activities. The opportunity to engage with peers, compete, and assess their abilities serves as a strong intrinsic motivation for children to engage in play and physical activities. Elementary school games are diverse and allow for unrestricted execution in any environment, without the constraints of location, time, or cumbersome equipment.

Authors' Contributions

F. B. M. conceptualized the study, designed the research framework, and conducted data collection. H. A. contributed to the methodology, statistical analysis, and interpretation of results. A. H. A. assisted in implementing the selected exercises and participant recruitment. Z. S. was responsible for data processing, literature review, and manuscript preparation. M. F. supervised the research process, revised the manuscript for intellectual content, and ensured adherence to ethical considerations. All authors reviewed and approved the final version of the manuscript.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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