Original Article

doi: 10.16926/par.2024.12.08

Relationship between body mass index, fundamental movement skills, and quality of life in primary school children

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Authors' Contribution: A – Study Design, B – Data Collection, C – Statistical Analysis, D – Manuscript Preparation, E – Funds Collection

Abstract: Background: Obesity in children is a serious public health problem, affecting their physical health and quality of life. Fundamental movement skills (FMS) have been suggested to play an important role in reducing the risk of obesity in primary school children and improving their health-related quality of life (HRQoL). Objectives: This study aims to investigate the relationship between body mass index (BMI), FMS, and HRQoL in primary school children. Methods: 193 primary school children (81 boys, 112 girls) aged 6 to 8 years were included in this cross-sectional study. Weight and height, FMS, and HRQoL were measured using BMI percentiles, the Test of Gross Motor Development, Second Edition (TGMD-2) including the object control, locomotor subtests and the total gross motor quotient, and the Pediatric Quality of Life Inventory (PedsQL™) respectively. Results: There was a negative significant correlation between BMI and gross motor quotient, and between BMI and the locomotor subscale of the TGMD. There was also a negative significant correlation between BMI and the PedsQL scale. There was a positive significant correlation between TGMD and PedsQoL scales. According to linear regression analysis, BMI significantly predicted TGMD gross motor quotient and PedsQL total score. In addition, the TGMD gross motor quotient significantly predicted the total PedsQL score. Conclusion: Mastery of FMS might be an important factor in avoiding obesity and improving HRQoL in primary school children.

Keywords: Body mass index; Children; Fundamental movement skills; Quality of life

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Recevied: 25.08.2023; Accepted: 4.10.2023; Published online: 3.01.2024

Citation: AL-Nemr A, Reffat S. Relationship between body mass index, fundamental movement skills, and quality of life in primary school children. Phys Act Rev 2024; 12(1): 80-87. doi: 10.16926/par.2024.12.08

INTRODUCTION

Childhood obesity is a serious public health problem with an alarming increase in prevalence in both developing and developed countries [1]. Millions of children worldwide are obese, and the total number of obese children aged 5-10 years has increased more than tenfold in the last years [2]. A higher body mass index (BMI) in childhood indicates an increased risk of developing cardiovascular disease and prediabetes in adulthood [3]. In addition, children's postural health may be negatively affected by being overweight or obese [4,5].

Fundamental movement skills (FMS) could be defined as the ability to link motor patterns with basic motor skills, which include stability, object control, and locomotion [6]. FMS are involved in every part of a person's daily activities, such as catching, throwing, running, and writing. They also play an essential role in children's mental, physical, and social health. FMS are also an essential component of students' overall development [7]. Proficiency in FMS is important for improving fitness, muscle strength and endurance, and thus increasing children's self-confidence [8]. Some studies have shown that obesity acts as a barrier to the development of FMS and that children's proficiency in FMS may be related to their weight [9,10]. However, other studies have found that only girls show this association [11], while others show no association between BMI and FMS [12,13]. More research is needed, especially in primary school children, as the results and conclusions of different studies are contradictory.

Health-related quality of life (HRQoL) describes how a person feels about his / her own mental, physical, and social functioning. The extent and quality of a person's adult life may be influenced by his/her HRQoL during childhood. School-aged children between the ages of 6 and 10 are in a crucial period for their physical, mental and social development [14]. To our knowledge, there are few previous studies evaluating the relationship between FMS, BMI, and HRQoL in primary school children. Therefore, this study aimed to investigate the relationship between BMI, FMS, and HRQoL in primary school children.

We hypothesized that there is no relationship between these outcomes in primary school children

MATERIALS AND METHODS

Participants

This cross-sectional study was held from March to September 2023 and included 200 primary school children. They were recruited from three public primary schools in Giza Governorate. 193 children entered the final analysis (81 boys and 112 girls), while seven children didn't complete the required assessments and were excluded due to their incomplete data. The study included primary school-aged children with normal weight, overweight, and obese types, aged 6 - 8 years from both sexes. Children who had vision or hearing impairments, motor, neurologic, or behavioral abnormalities, learning difficulties, or any medical condition that might interfere with the study were excluded.

Outcomes

Body mass index

The weight was determined while children were wearing light clothes and barefoot by a digital scale, to the nearest 0.1 kilogram (MediRhein, model MRCMT14, Germany), and the height was determined by a portable stadiometer, to the nearest 0.1 centimeter (SECA model 213, Germany), with the back touching the stadiometer and the arms held laterally to the child's sides. BMI percentiles were derived from the formula weight (kg)/height (m2) and following age and sex growth charts from the United States Centers for Disease Control and Prevention [18]. Under the 5^{th} percentile, the child was classified as underweight; over the 85^{th} percentile, was classified as overweight; and above the 95th percentile, was classified as obese. A child with a BMI percentile between the 5th and 85th percentile was considered of normal weight [18].

Fundamental movement skills

The test of Gross Motor Development-2 (TGMD-2) is a reliable and valid scale for measuring the FMS of children aged 3-10 years [15,16]. It includes object control and locomotor subtests. The object control subtest includes six skills: catching, kicking, stationary dribbling, striking a stationary ball, underhand rolling, and overhand throwing. The locomotor subtest also includes six skills: leap, gallop, hop, run, horizontal jump, and slide. Each skill is divided into three to five components, and a score of 1 or 0 is provided for each component. The child received 1 if the criterion was fulfilled and 0 if it wasn't. Each skill was twice requested from the child (2 trials), and a raw score for each skill was created by adding the raw scores of the two trials. The skill scores were added to form a raw subtest score, which was then transformed into a standard score. The Gross Motor Quotient was calculated by adding the standard scores of the two subtests [17].

Pediatric quality of life

The PedsQL™ generic core scale (version 4.0) is a valid and reliable ordinal scale assessing the quality of children's lives [19]. Physical, emotional, social, and school functioning are its four dimensions. The physical score includes the results from the physical domain; the psychosocial score includes the sum of the results of the emotional, social, and school domains; and the total score includes the sum of all four dimensions. The scale scoring criteria ranged from 0 (never a problem) to 4 (almost always a problem), then inversely transformed into a scale ranged from 0–100, as the lowest score (0) was transformed into 100; and the highest score (4) was transformed into 0. Higher scores represented greater HRQoL [20]. Self-report and parent report forms were included with the measure. The only difference between the two forms was the language expression. In this study, children who have problems understanding the scale items, expressing their feelings, or reporting their own perceived HRQoL were allowed to use the parent report form.

Ethics

The Ethical Committee of the Faculty of Physical Therapy, Cairo University, provided approval number P.T. REC\012\004733 for this cross-sectional study. In order for children to participate in this study, all parents had to sign a written consent form after being informed of its purpose and methods. Clinical Trial Number: NCT06009328.

Sample size calculation

G*POWER statistical software was used to estimate the sample size of this study (version 3.1.9.7, Franz Faul, Universitat Kiel, Germany), using an effect size of 0.2 from a pilot study, $\alpha=0.05$, and 80% power, and suggested that N = 193 was the suitable sample size. 200 children were recruited for possible dropouts.

Statistical analysis

The statistical software for social sciences was used to analyze the data (SPSS Inc., Chicago, Illinois, USA; version 23). Scores of BMI, FMS, and PedsQol were examined for normality using the Kolmogorov-Smirnov test. The data representing children's characteristics were shown as mean (SD). To evaluate the strength of the correlation between variables, the Pearson's correlation coefficient (r) test was chosen. To assess the significance of BMI measurements on children's FMS and HRQoL, linear regression analysis was chosen. $p < 0.05$ was the significance level used for all statistical analyses.

RESULTS

Descriptive statistics of participants' variables, including BMI, TGMD, and PedsQL, according to their age and gender are described in Table1.

Table 1. Descriptive statistics for participants' variables according to their age and gender

Indicator	6 years (n= 45)	7 years (n= 72)	8 years (n= 76)	Boys (n=81)	Girls (n=112)	Total (n=193)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Height (cm)	124.4 (4.3)	127.1(3.9)	129.5 (4.01)	128.5 (4.5)	126.3 (3.9)	127.4 (4.1)
Weight (kg)	24.6 (0.49)	26.4 (0.48)	27.8 (0.42)	26.1 (0.5)	26.7 (0.8)	26.5 (0.6)
BMI	17.6 (2.2)	17.1 (1.8)	16.7 (1.7)	17.2 (1.8)	16.4 (1.9)	16.8 (1.7)
Test of gross motor development (TGMD)						
Gross motor quotient	71.4 (3.8)	79.8 (3.4)	81.7 (3.6)	77.7 (3.7)	79.2 (3.9)	78.6 (3.6)
Locomotor subscale	6.4 (0.49)	7.7 (0.43)	8.5 (0.5)	7.3 (0.5)	8.1 (0.4)	7.7 (0.6)
Object control subscale	5.1 (0.4)	6.2 (0.3)	6.5 (0.5)	5.6 (0.4)	6.1 (0.6)	5.9 (0.3)
Pediatric quality of life generic core scale (PedsQol)						
Total score	80.6 (5.2)	80.7 (4.9)	84.1 (4.6)	81.3 (5.1)	82.6 (4.8)	81.8 (4.7)
Physical	77.6 (3.9)	79.3 (4.2)	81.6 (4.3)	79.1 (4.1)	80.3 (3.8)	79.7 (3.8)
Psychosocial	81.4 (4.2)	81.5 (3.8)	84.4 (4.1)	81.8 (3.9)	83.2 (3.7)	82.5 (4.1)

BMI - Body mass index; n - number; SD - standard deviation

Table 2. Correlation between BMI, TGMD, and PedsQol in total participating children

Indicator		PedsQol Total score		PedsQol Physical		PedsQol psychosocial		BMI	
		r	p	r	p	r	p	r	p
Test of gross motor development (TGMD)	Gross motor quotient	0.28	0.0001*	0.47	0.0001*	0.34	0.0001*	-0.26	0.003*
	Locomotor subscale	0.47	0.0001*	0.63	0.0001*	0.47	0.0001*	-0.34	0.0001*
	Object control subscale	0.33	0.0001*	0.42	0.0001*	0.33	0.0001*	-0.13	0.076
BMI		-0.53	0.0001*	- 0.55	0.0001*	-0.51	0.0001*		

BMI - Body mass index; n - number; PedsQol - Pediatric quality of life generic core scale; SD - standard deviation; * statistical significance

Table 3. Linear regression analysis

Indicators		Unstandardized Coefficients B	Unstandardized Coefficients SE	Standardized Coefficients Beta	t-value	p-value
BMI as a predictor for FMS (gross motor quotient score)	Constant	87.13	2.8	-	31.02	0.0001*
	BMI	-0.51	0.16	-0.26	-3.05	0.003*
BMI as a predictor for quality of life (total PedsQol score)	Constant	96.32	1.66	-	57.74	0.0001*
	BMI	-0.86	0.098	-0.53	-8.69	0.0001*
Fundamental movement skills (gross motor quotient score) as a predictor for quality of life (PedsQol total score)	Constant	66.74	3.74	-	17.81	0.0001*
	Gross motor quotient score	0.19	0.05	0.28	4.05	0.0001*

BMI - Body mass index; n - number; PedsQol - Pediatric quality of life generic core scale; B, - Regression coefficient; SE - Standard error; * statistical significance

Correlations between BMI, TGMD, and PedsQL in total participating children were reported in Table 2. There was a negative significant correlation between BMI and gross motor quotient (p<0.003), and between BMI and the locomotor subscale of TGMD (p< 0.0001). Also, there was a negative significant correlation between BMI and PedsQL total score, physical and psychosocial scores (p<0.0001). While there was a positive significant correlation between gross motor quotient, locomotor, and object control subscales of TGMD and PedsQL total score, physical and psychosocial scores (p<0.0001).

According to linear regression analysis, BMI significantly predicted the gross motor quotient of TGMD (p<0.003) and the total PedsQL score (p<0.0001). In addition, gross motor quotient significantly predicted PedsQL total score (p<0.0001) (Table 3).

DISCUSSION

This research attempted to determine how children's BMI, FMS, and HRQoL are related in primary school children. The study's hypothesis was rejected as the findings revealed that there was a negative significant correlation between FMS and BMI, as well as between BMI and HRQoL, while there was a positive significant correlation between FMS and HRQoL. BMI was a significant predictor of FMS and HRQoL. Also, FMS were significant predictors of HRQoL, as revealed by linear regression analysis.

The FMS demand a synchronized movement of one's entire body mass and/or center of gravity through space [21]. The inability of the body to perform stabilization and propulsion in overweight and obese children could illustrate the inverse relationship between FMS and BMI in childhood. Therefore, gaining weight could make it harder for children to complete these tasks until they could better coordinate their limbs in a rhythmic pattern [22].

Although several studies on primary school children supported our results and found a negative significant association between BMI and FMS [23–25], other studies on preschool children showed that FMS were not correlated with BMI [12,13]. The lack of significant correlation in these studies may be because these fundamental movement abilities have not yet been fully acquired by preschoolers. Although a negative significant correlation between BMI and FMS was detected in this study, when split into locomotor and object control subscales, the significant correlation was detected in the locomotor subscale only. The significant findings for locomotor skills only have a number of plausible interpretations. First, compared to object-control abilities, locomotor movements demand a greater overall movement of body mass which may be difficult for obease children. Also, many object- control skills are more static and don't require complete displacement of body mass. Due to their extra fat mass, obese children have reduced body control and functionality, which affects their ability to use their motor skills and engage in physical exercise [26]. In addition, the prevalence of musculoskeletal pain, reduced mobility, and lower extremity malalignment is higher in overweight children, which could cause more pain when engaging in physical exercise [27]. Our results are consistent with prior research, which reported the presence of significant correlation between BMI and the locomotor subscale [22,28], with no or non-significant correlation between BMI and the object control subscale [22,29].

The FMS facilitates the engagement of school- aged children with others, and it is essential for their future peer social interaction [30,31]. Our study results indicated a substantial positive association between BMI and physical, psychosocial, and total score of PedsQol, and these findings agree with prior studies [8,32]. School aged children with high FMS are more able to socially interact with their peers and participate in various activities [33,34]. In contrast, children with low FMS are easily exhausted, and have limited after-school and recreational activities, resulting in an increase in the likelihood of having a relatively poor health [34].

Limitations

This study has certain limitations. First, the causality of the association was not determined by the cross-sectional study design. Future longitudinal research is necessary to better understand how these factors interact. Second, selecting BMI for classifying weight status in this study, as it couldn't distinguish between lean body mass and body fat [35]. So, using other tools such as bioelectrical impedance analysis and skin fold calipers is recommended. Finally, other individual and environmental factors, such as eating habits, social and economic status were not evaluated or considered in this study. Future research should consider all the factors that might affect the relationship between BMI, FMS, and HRQoL in primary school children to increase the research's accuracy.

CONCLUSION

The current study concluded that BMI is inversely and significantly related to both FMS and HRQol, while FMS are directly and significantly related to HRQoL. Also, BMI is a significant predictor for FMS and HRQol. In addition, FMS are significant predictors of HRQol. So, obese primary school children may suffer from problems in achieving their FMS and their overall health and life satisfaction. These findings also suggest that FMS might have an important role in preventing obesity and improving HRQoL in those children.

Conflict of interest: The authors have no conflict of interest to declare.

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