

Impact of Normal Weight, Overweight, and Obesity on Fundamental Motor Skills among 3-6-Year-Old Children in Tehran

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Abstract

Background: The prevalence of obesity in the world has increased dramatically, and it is an effective factor in the fundamental motor skills of children.

Objectives: This study aimed to compare the fundamental motor skills of 3-6-year-old boys and girls with normal weight, overweight, and obesity in Tehran, Iran.

Methods: This applied-field study was conducted on 774 children (378 girls and 396 boys) with an age range from 3 to 6 years. The subjects were selected randomly from the geographical regions of the north, east, south, west, and center of Tehran, Iran. They were then divided into three groups of normal weight, overweight, and obese based on the body mass index (BMI) value points of the Bouchard table. Height, weight, fat percentage, and fundamental motor skills (e.g., balance, jumping, receiving and throwing the ball) were assessed in this study. Finally, Kruskal-Wallis and Mann-Whitney U tests were used to analyze the data through SPSS software (version 25).

Results: The results showed that the distribution of normal weight, overweight, and obesity does not affect the balance skill of 3-6-year-old girls and boys ($P=0.632$; $P=0.555$). However, the girls showed more significant competence in the balance skill, compared to boys ($P=0.025$). On the other hand, boys outperformed significantly the girls in the other fundamental motor skills, including jumping, as well as receiving and throwing the ball ($P=0.000$). Moreover, the distribution of normal weight, overweight, and obesity was only effective in scores of boys ($P=0.039$; $P=0.007$; $P=0.001$) and did not affect those of girls ($P=0.103$; $P=0.189$; $P=0.693$).

Conclusion: Normal weight, overweight, and obesity did not affect the balance of girls and boys aged 3 to 6 years. However, they had effects on fundamental motor skills, such as jumping, as well as throwing and receiving the ball, especially in boys.

Keywords: Children, Fundamental Motor skills, Normal weight, Obesity, Overweight

1. Background

Children are the future adults of society. This has caused an increase in numerous strategies to reduce disease and mortality, as well as develop the health of this group of age in society (1). Since several decades ago, obesity has been one of the most critical problems that affect children and adolescents (1). In this regard, studies have reported the prevalence of overweight or obesity in 40 million children under the age of 5 years and more than 330 million people aged 5-19 years (2).

Obesity refers to an extremely high accumulation of fat in the body, which causes an increase in health problems, such as related morbidity and mortality worldwide (3). Studies have reported that most obese children will become obese adults in the future and are at risk for chronic diseases, such as hyperinsulinemia, hypertension, chronic inflammation, and orthopedic problems. On the other hand, these people are often considered psychologically and socially unhealthy, academically unsuccessful, and socially disabled (1, 4).

Therefore, it seems that childhood should be considered an essential period to prevent diseases and complications of physical inactivity and obesity in the later times of life. Finally, the inappropriate lifestyle of children and adolescents, especially

inactivity, is a big threat to the health of this vulnerable group. Furthermore, it puts society at risk of epidemics of non-communicable diseases, such as cardiovascular disease, diabetes, osteoporosis, heart attack, hypertension, psychological disorders, and even some cancers (5). Moreover, since a sedentary lifestyle reduces energy consumption and promotes overweight and obesity, most of the interventions perform to prevent obesity are in the field of diet and physical activity.

In most investigations, body mass index (BMI) is an index of body structure assessment (5). Although in addition to BMI, there are many other methods for measuring obesity, such as the measurement of the waist-to-hip ratio and body fat percentage (6), the assessment of BMI is the first step in determining obesity (6). BMI is an applied index to show acceptable results and is strongly related to body fat percentage. Additionally, it refers to the deviation of weight by the square of stature (7). It has also been shown to be related to physical activity, fundamental motor skills, health, and body composition (8). For instance, it has been shown that optimal body composition and physical activity increase fundamental motor skills in children, and physically active students also have more object control skills than sedentary peers. Fundamental motor skills are the elements of more advanced and complex

movements. They consist of movements, such as running, jumping, and object control skills (e.g., receiving and throwing), as well as stability skills (e.g., balance) (8). Human motor development has been divided into four periods: reflex movements, introductory movements, fundamental movements, and specialized movements. In the third period, the skill movements, manipulation, and stability or balance of children are more advanced. The child uses skills, such as running and jumping, instead of walking. In addition to grabbing and releasing, the kid can perform skills, such as hitting, throwing, and receiving. Balance has also been developed to the point where it can roll over or maintain balance on one leg since the fundamental movements in the fourth period are gradually refined for use in daily life, as well as recreational and sports activities (9). Fundamental motor skills do not develop naturally over time and must be under training. As a result, when combined with mastery, they become more complex skills that allow kids to be active in a variety of activities.

2. Objectives

Therefore, it can be assumed that any increase in physical activity will be associated with an increase in fitness-dependent health (8). Since fundamental motor skills are among the most important goals in the study of developmental disorders and the physical health of children, and due to the relationship between body composition and fundamental motor skills, this study aimed to compare the fundamental motor skills of 3-6-year-old children with normal weight, overweight, and obesity in Tehran, Iran.

3. Methods

Subjects

The statistical population of this study included all 3-6-year-old girls and boys who were enrolled in the kindergartens of Tehran. In total, 774 children aged 3 to 6 years, including 378 girls and 396 boys, were selected randomly using the cluster-stratified method from 10% of Tehran kindergartens (from the geographical regions of the north, east, south, west, and center of Tehran) based on the Morgan table.

Procedures

First of all, the stature, weight, and fat percentage of children were measured, and their BMI was calculated. Following that, they were divided into three groups of normal weight, overweight, and obesity based on the BMI value points of the Bouchard table (10). Afterward, fundamental motor skills, including balance, jumping, as well as receiving and throwing the ball were measured.

Measurement of variables

All participants' stature (cm) and weight (kg) were measured for calculating their BMI. Two anatomical sites were measured for skinfold thickness using calipers to estimate body fat percentage, and a related equation was used (4). The test of standing on one foot was used to determine the balance skill, and the time of balance maintenance was recorded as a score of balance skill. Moreover, the throwing test used in this study was the type of throwing the ball at a horizontal distance. The children were throwing the ball three times. The mean distance of the ball from the starting line was considered a record. In addition, to receive the ball, the examiner threw the ball so that the ball was landing just above the chest of the children. This operation was also performed five times with an interval of five seconds in stages 1, 2, and 3 meters. The maximum score in each stage was 5, for a total of 15. The children were also placed behind the line to perform the jump test. The distance between the legs was 5 to 10 cm. The child was bending the knees first and could perform the fluctuation of arms. Jumping was starting simultaneously with the opening of knees and fluctuation of hands forward. The subjects performed jumping three times. The mean distance of jumping from behind of jumping line to the region of foot contact on earth was recorded as a score.

Statistical analysis

The data were presented as mean \pm SD. The Kolmogorov-Simonov test determined the normality of data distribution. Furthermore, Kruskal Wallis and Mann Whitney tests were used to examine the differences of variables among three groups of normal weight, overweight, and obese using SPSS software (version 25).

4. Results

In this study, there were 378 girls and 396 boys. Based on the results of the frequency percentage of children in the category of body composition, the highest frequency percentage was assigned to the normal body composition category. This result is shown in Table 1. However, the percentage of overweight children was higher than that of obese children in both groups of girls and boys. In addition, a small percentage of children were in the underweight group. As a result, this group was excluded from the analysis. The results also showed the impact of these groups on fundamental motor skills outcomes. The distribution of normal weight, overweight, and obesity did not make a significant difference in the balance skill of girls and boys ($P>0.05$). However, in general, the balance was better in girls than in boys ($P\leq 0.05$). In addition, boys' jumping, throwing, and receiving skills were better than those of girls ($P\leq 0.05$). The distribution of

normal weight, overweight, and obesity in boys had only a significant effect on the results of these three

Table 1. Distribution of 3-6-year-old boys and girls in obese, overweight, and normal weight groups based on BMI according to Bouchard table, Tehran, Iran

Gender	Underweight	Normal	Overweight	Obese
Boy	%2.5	%76.3	%11.5	%9.7
Girl	%1.9	%80.2	%9.2	%8.3

Table 2. Descriptive results (mean± SD) and between-group differences of anthropometric variables of boys and girls separately and in general between 3-6-year-old boys and girls, Tehran, Iran

Group	Boys					Girls					P
	Normal	Overweight	Obese	Total	P	Normal	Overweight	Obese	Total	P	
Height (cm)	109.26±8.86	111.57±7.37	115.89±12.28	110.09±8.56	0.00 [§]	110.7±7.84	110.34±8.07	113.22±7.76	107.96±8.08	0.00 [§]	0.00 ^{1*}
Weight (kg)	17.92±3.08	22.36±3.19	30.46±9.27	19.53±5.72	0.00 [§]	17.07±2.87	21.93±3.11	26.93±4.49	19.53±5.72	0.00 [§]	0.00 ^{1*}
BMI (kg/m ²)	14.92±1.19	17.88±0.63	22.43±5	15.90±3.09	0.00 [§]	14.76±1.18	17.93±0.56	20.88±1.77	15.51±2.26	0.00 [§]	0.09 ¹
Fat (%)	19.79±2.97	22.62±4.17	28.48±9.25	20.89±4.94	0.00 [§]	21.04±2.51	23.73±3.52	29.04±5.61	21.95±3.75	0.00 [§]	0.00 ^{0*}

§. Significance differences in anthropometric variables between groups of boys through the Kruskal-Wallis test at a significant level $P \leq 0.05$

[§]. Significance differences in anthropometric variables between groups of girls through the Kruskal-Wallis test at a significant level $P \leq 0.05$

*. Significance differences in anthropometric variables between groups of girls and boys through the Mann-Whitney U test at a significant level $P \leq 0.05$

Table 3. Descriptive results (mean± SD) and between-group differences of fundamental motor skills variables of boys and girls separately and in general between 3-6-year-old boys and girls, Tehran, Iran

Group	Boys					Girls					P
	Normal	Overweight	Obese	Total	P	Normal	Overweight	Obese	Total	P	
Balance (s)	6.62±5.04	6.52±7.71	8.06±6.58	6.73±5.54	0.55 ¹	7.63±5.52	6.21±3.89	7±5.63	7.43±5.38	0.63 ²	0.02 ^{5*}
Jumping (cm)	66.5±23.76	70.23±25.29	77.05±21.05	67.87±24.22	0.03 ^{9§}	58.19±22.17	65.81±20.93	67.65±29.61	59.71±23.06	0.10 ³	0.00 ^{0*}
Ball Throwing (m)	2.17±0.68	2.43±0.59	2.54±0.60	2.23±0.68	0.00 ^{1§}	1.93±0.62	2.03±0.61	2.19±0.73	1.96±0.64	0.18 ⁹	0.00 ^{0*}
Ball Receiving (n)	12.84±3.06	13.42±2.70	14.34±1.12	13.45±6.36	0.00 ^{7§}	12.32±3.27	12.38±2.83	13.13±2.72	12.38±3.19	0.69 ³	0.00 ^{0*}

§. Significance differences in fundamental motor skill variables between groups of boys through the Kruskal-Wallis test at a significant level $P \leq 0.05$

*. Significance differences in fundamental motor skill variables between groups of girls and boys through the Mann-Whitney U test at a significant level $P \leq 0.05$

skills ($P \leq 0.05$). However, body composition grouping in girls had no significant effects on these three skills ($P > 0.05$). The results of anthropometric characteristics

and fundamental skills are shown in Tables 2 and 3 and Figures 1 to 4, respectively.

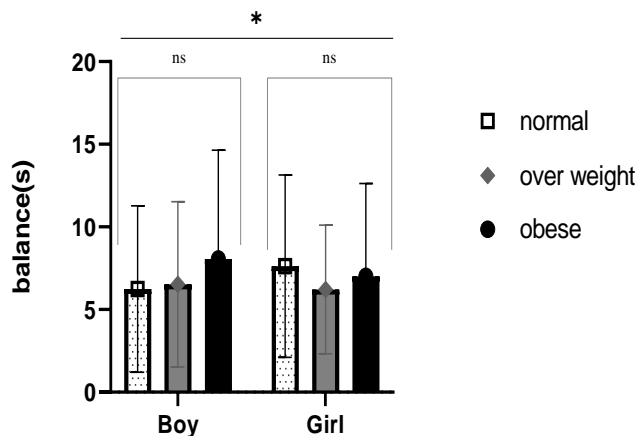


Fig 1. Between-group differences in balance maintenance time among girls and boys

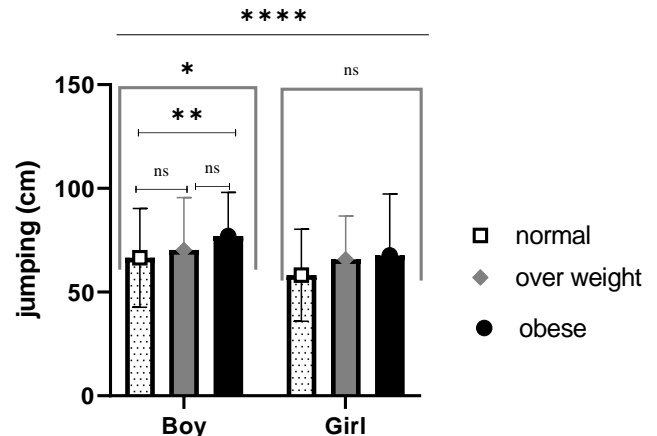


Fig 2. Between-group differences in jumping among girls and boys

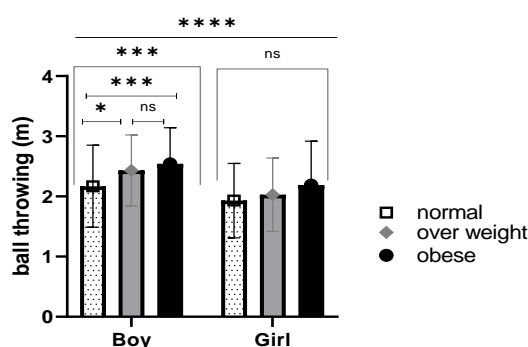


Fig 3. Between-group differences in ball throwing among girls and boys

5. Discussion

The present study determined the effects of different BMI states, including normal, overweight, and obesity on the fundamental motor skills (e.g., balance, jumping, ball throwing, and ball receiving) among 3-6-year-old children in Tehran, Iran. The results showed that BMI state affected balance skills neither in boys nor girls. However, the balance scores of girls were better than those of boys significantly. This is probably due to the negative relationship of stature, and especially, the height of legs with balance skills (11). In addition, since the girls are shorter and have shorter legs, and their center of gravity is closer to earth, they received higher scores on the balance test, compared to boys (11).

Furthermore, although the effects of different BMI states on balance performance were not significant, a descriptive comparison of the means showed that the balance scores in obese 3-6-year-old boys had been higher than those in boys with overweight and normal weight. The mean balance score of obese 3-6-year-old girls was also higher than that of overweight girls. These results were similar to the findings of the study by Sabzevari et al. (2020).

In that study, obese children had better balance than overweight children, and overweight children obtained better balance scores than normal-weight children (12). Additionally, the observed results were inconsistent with the findings of a study by Badami et al. (2014). In their results, balance and ball skills were better in normal-weight children than in overweight children, and they were better in overweight children, compared to obese children (9). However, these results were consistent with the results of 3-6-year-old girls in our study.

Because in the present study, despite the lack of significant differences, it was shown that the mean balance score in 3-6-year-old girls with normal weight was higher than that in obese children, but obese children obtained better balance scores, compared to overweight children. A possible justification for these results is probably the direct relationship of BMI and body size with the point of a

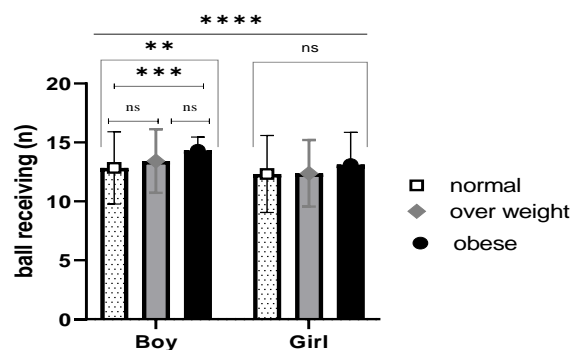


Fig 4. Between-group differences in ball receiving among girls and boys

support level. Because as it is known, increasing the level of reliance is associated with increasing balance, and vice versa, reducing the dimensions of the body, and the level of reliance is associated with decreasing balance (11). Regarding the jumping variable, the results of the present study showed the superiority of boys, compared to girls. Moreover, the distribution of normal weight, overweight, and obesity only in boys had a significant effect on the results of this skill so there was an upward trend in the weight distribution classes.

That means an increase in BMI was accompanied by a significant increase in jumping. However, in girls, although the increase in mean jumping scores was seen as inconsistent with the increase in BMI, it did not make a significant difference. In general, boys had much higher jumping scores than girls. This result was consistent with the results of a study by Sabzi et al. (2015), which emphasized the significant difference between girls and boys in fundamental motor skills (13). In their study, the results also showed that the scores of physical fitness and fundamental skills of boys were higher than those of girls (13). To justify these results, it can be said that the jumping record shows the amount of power of people, and power is the product of strength or maximum muscle force in speed, and its strength component is related to the amount of weight and BMI (11).

This issue was also shown in the results of the present study and the mean of jumping increased with increasing weight and BMI in girls and boys. Furthermore, since boys had more weight and BMI and less fat than girls, they probably had more lean body mass (lean weight) than girls, which in turn increased their muscle strength and power. They had also better jumping performance, compared to girls. This result was consistent with the results of a study by Sartorio et al. (2004), which showed that the leg strength of men was higher in comparison with women because they had higher BMI (14).

Furthermore, the results of the present study about the skills of throwing and receiving the ball showed the effect of the increase in BMI on the

superiority of the results in both boys and girls. These results were inconsistent with the findings of the investigation by Antunes (2015). They showed that children with normal weight were significantly better than their obese peers at motor coordination (15). While Chen et al. (2016) in their study have emphasized that boys had better handling skills, including throwing and receiving the ball in comparison with girls (16), which was consistent with the results of the present study.

In addition, Mak et al. (2010) have shown better performance of boys in the sit-up and running tests (17). Along the same line, Bolger et al. (2019) have observed better performance of boys in fundamental skills and manipulation (18). In another study, Tofghi et al. (2012) have also shown better results in cardiorespiratory fitness, muscular endurance, and agility in boys (19). In total, the results of the above studies were consistent with the results of the present study. Based on these studies, the results of the present study can also be justified considering the fact that boys are probably superior due to their greater weight and BMI and less fat, which indicates their greater net BMI. As previous studies have shown, boys are better than girls in tasks that require strength and speed, such as jumping, throwing, and running (20).

In justifying the inconsistency of the results of this study with the results of some studies that have shown a negative relationship between BMI and fundamental motor skills, it can be said that reaching the last stage of development of fundamental motor skills is not affected by obesity and is more related to learning (21). In fact, by learning the correct patterns of fundamental motor skills, experience is gained. While this learning did not exist in this study, this case is regarded as a limitation of this study. Another reason that could be referred to these children is that they had not reached school age and had not participated in physical education classes. On the other hand, although in the present study, better results were obtained from the performance of children with more body mass, overweight and obese children are always ridiculed and excluded from the group. They also face many hardships, including discrimination and exclusion from society. On the other hand, obese children avoid being in public to avoid being ridiculed, and often become isolated and take refuge at home. In addition, they have fewer friends, participate in fewer group games, and finally spend more time in inactivity (22). These cases have a devastating effect on the future of these children in the mental and physical fields. Accordingly, it is recommended that children in these age groups participate more in physical activity and exercise.

6. Conclusion

In general, normal weight, overweight, and

obesity had no effects on the balance scores of girls and boys aged 3 to 6 years. However, it affected the fundamental motor skills of jumping, ball throwing, and ball receiving, especially in boys.

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Conflicts of interest

There is no conflict of interest.

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