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RELATIONSHIP BETWEEN AGE, SEX AND BODY MASS INDEX WITH FUNDAMENTAL MOTOR SKILLS AMONG 3 TO 6 YEARS-OLD CHILDREN

Abstract: The prevalence of childhood obesity is a serious public health problem. This problem is a multi-component disease and several factors are involved in its development. The childhood obesity led to poor mastery of fundamental motor skills (FMS) and failure to develop in specialized skills that required in organized sports and activities. Thus, the purpose of this study was to examine the relationship between age, sex and body mass index (BMI) with FMS in 3 to 6 years-old children. A total of 600 preschool children (300 boys and 300 girls) between the ages of 3 to 6 years old participated in this research. Subjects were selected through multi-stage cluster random sampling in five regions in Tehran. Using the Ohio State University Scale of Intra Gross Motor Assessment (OSU-SIGMA) FMS were assessed. Body mass index (BMI) was directly measured from height (m)²/weight (kg) for each child. The results showed that the negative correlations between jumping, skipping, hopping and throwing skills and BMI in any 3 groups children were significant ($P < 0.05$), but correlations between other FMS and BMI were not significant ($P > 0.05$). The boys were performed better than girls in all FMS except hopping and skipping skills. In these skills the girls were better performed

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in all ages. These results highlight the need to provide organized opportunities which facilitate FMS and decreased high BMI levels in preschool children.

Key words: Body Mass Index; Fundamental Motor Skills; OSU-SI-GMA

Introduction

The prevalence of childhood overweight and obesity are a serious public health problem.¹ The prevalence of overweight and obesity among children is rapidly increasing worldwide, so that this problem in 2010 was estimated about 46 percent in the Americas and 38 percent in European regions.^{2,3} In addition, Booth et al.⁴ reported that one in four Australian children and adolescent were overweight and obese. This increase is alarming, because obesity associated with health disease (e.g. hypertension, the development of cardiovascular disease, sleep apnea, type 2 diabetes, high blood pressure, abnormal lipid profiles) and psychological risks.⁵⁻⁷ Studies have shown that adult obesity is directly associated with childhood obesity so that in obese children, the prevalence of adult obesity is 2 to 3 times more than normal children.⁸

Accordingly, researchers believe that the lack of adequate physical activity is one of the important reasons for obesity.^{1,9} Cools et al.¹⁰ also believed that we are often unaware on importance of physical activity, but plays and physical activities are vital and inseparable part of human life. Thus, the main elements of motor development, in addition to its biological foundation, are fundamental motor skills (FMS) that involved the gross and fine (including locomotor, stability and object control skills) motor skills.¹¹ Motor development specialists believed that preschool years (ages 3-6 years) are critical period to a development and proficiency of FMS.¹¹ The acquisition of these skills are dependent in several internal and external factors (including biological, social, environmental) and the range of play/game experiences.¹² The development of FMS is critical to establishing the foundation for participation in many sports and physical activities. Failure to development and improvement of FMS during the preschool and elementary school years often leads to privation and failure the mastery skills during adolescence and adulthood.¹³ Also this problem leads to decreased activity and mobility in children and increase the prevalence of overweight and obesity risks.^{10,14,15}

The FMS assessment tools are often classified to norm-reference and criterion-reference scales. The purpose of norm-reference scales is to evaluate and compare an individual or groups with previously established norms, but criterion-reference scales are designed to indicate where a child falls on a continuum of skills.^{11,16} Researchers argued that the criterion-reference scales are attention to the qualitative change in FMS, and this scales have been less well-known and rarely used. Accordingly based

on norm-referenced studies, researchers found that the obesity is negatively related to the performance of FMS, so that obese children have delays in these skills. Other studies also reported that the level of FMS in overweight and obese children was significantly lower than normal children³ but, no research has done in this field with using criterion-reference scales. On the other hand, the researchers believed that in addition to body mass index, the age and sex variables are important impact on the development of FMS.¹⁷ Based on criterion-reference studies, Loovis et al.^{17,18} and Loovis & Butterfield¹⁹ found that with increasing age, children in these skills (e.g. catching, kicking and striking) more skilled and matured, but in this studies no significant reported between sex. Also, Butterfield & Loovis^{20,21} in other studies stated that the performance of FMS in boys were significantly better than girls. In most studies the researchers have separately examined the relationship between age, sex, and body mass index with FMS. Some studies that are considered all of these factors, only have evaluated one or two FMS (e.g. kicking, throwing and catching). Thus, consider to the limitations of the previous studies, the purpose of this study was to examine the relationship between age, sex and BMI with FMS in 3-6 years-old children.

Methods

A total of 600 preschool children (300 boys and 300 girls) between the ages of 3-6 years-old participated in this research. Subjects were selected through multi-stage cluster random sampling from 5 geographic regions of Tehran (north, south, west, east and center). With children dressed in light clothing, barefoot, stood erect against a wall and feet flat on the floor, standing height was measured to the nearest 0.1 cm using a portable stadiometer and body mass was measured to the nearest 0.1 kg using a digital scale (Seca Model, Germany). From those two measurements, BMI was calculated as $\text{weight (kg)} / \text{height (m)}^2$ for each subject. Children z-BMI scores was calculated based on their age and sex using ImsGrowth and the UK reference curves.²²

To measure fundamental motor skills, each child was individually administered with the Ohio State University Scale of Intra Gross Motor Assessment (OSU-SIGMA). The OSU-SIGMA is a criterion-referenced assessment scale and designed to assess eleven FMS in age range of 2.5 to 14 years old.²³ This FMS divided to locomotor skills (walking, running, jumping, hopping, skipping, stair climbing and ladder climbing) and objective control skills (throwing, catching striking and kicking) and presented in four developmental levels.²³ Prior to data collection, a pilot study was conducted to estimate intra and inter-rater agreement. Each investigator independently rated video performance of children skills on OSU-SIGMA. The results showed that intra and inter-rater agreement was 90 to 97 percentile for all skills.

Statistical analysis

The data have been analyzed with using descriptive statistics (mean, standard deviation and percentiles). To find out the correlation between BMI and FMS among boys and girls were using Kendall's tau-b test at the significance level of $P < 0.05$. Furthermore, the differences among boys and girls in FMS were compared with using Mann-Whitney U test. All analyses were conducted using SPSS software version 15.

Results

The descriptive results related to the development levels of FMS by age and sex were summarized in tables 1 to 3. For example, in 3-4 years old children only 25% in girls and 27% in Boys demonstrated mastery of walking skill. Also, the results of Mann-Whitney U test showed that the boys were performed better than girls in walking, running, jumping, ladder climbing throwing, catching, striking and kicking skills ($P < 0.05$) in all ages. The results also showed that the girls were performed better than boys hopping and skipping skills ($P < 0.05$) in all ages. Furthermore, the stair climbing skills was not significant.

Table 1. The levels of FMS in 3-4 years-old children

Boys (n=100)				Girls (n=100)			
Performance Levels							
4	3	2	1	4	3	2	1
27%	73%	----	----	25%	75%	----	----
19%	81%	----	----	12%	88%	----	----
----	25%	55%	20%	----	6%	45%	49%
----	----	14%	86%	----	4%	29%	67%
----	----	4%	96%	----	----	14%	86%
----	53%	47%	----	----	48%	52%	----
----	20%	25%	55%	----	10%	30%	60%
----	----	14%	86%	----	----	10%	90%
----	----	13%	87%	----	----	13%	87%
----	----	2%	98%	----	----	1%	99%
----	----	19%	81%	----	----	8%	92%

Table 2. The levels of FMS in 4-5 years-old children

Boys (n=100)				Girls (n=100)			
Performance Levels							
4	3	2	1	4	3	2	1
69%	31%	----	----	45%	55%	----	----
45%	55%	----	----	27%	73%	----	----
4%	82%	14%	----	----	72%	28%	----
----	1%	37%	62%	----	24%	75%	1%
----	----	17%	83%	----	----	23%	77%
43%	57%	----	----	43%	57%	----	----
----	47%	51%	2%	----	34%	64%	2%
----	13%	62%	25%	----	4%	49%	47%
----	2%	62%	36%	----	----	53%	47%
----	----	14%	86%	----	----	9%	91%
----	----	53%	47%	----	----	38%	62%

Table 3. The levels of FMS in 5-6 years-old children

Boys (n=100)				Girls (n=100)			
Performance Levels							
4	3	2	1	4	3	2	1
81%	19%	----	----	65%	35%	----	----
61%	38%	----	----	51%	49%	----	----
----	35%	65%	----	9%	82%	9%	----
----	30%	48%	22%	----	54%	41%	5%
----	9%	58%	33%	6%	38%	51%	5%
63%	37%	----	----	58%	42%	----	----
8%	52%	40%	----	----	37%	63%	----
----	52%	43%	5%	----	24%	62%	14%
----	69%	30%	1%	----	20%	51%	29%
----	48%	48%	5%	----	7%	40%	53%
----	40%	54%	6%	----	16%	58%	26%

The results related to the correlations between FMS and BMI in 3-6 years old children are presented in table 4. The results showed that the negative correlations between jumping, skipping, hopping skills (in locomotor cluster) and throwing skill (in objective control cluster) and BMI in any 3 groups children were significant ($P < 0.05$), but correlations between other FMS and BMI were not significant ($P > 0.05$), except kicking skill in 5-6 year-old boys .

Table 4. Correlations between FMS and BMI in 3-6 years old children

FMS	BMI				
	3-4 years old		4-5 years old		5-6 years old
	Girls	Boys	Girls	Boys	Girls
Walking	-0.06	-0.110	-0.031	-0.183	-0.154
Running	-0.013	-0.115	-0.133	-0.098	-0.098
Jumping	-0.215*	-0.238*	-0.265*	-0.208*	-0.234*
Hopping	-0.201*	-0.211*	-0.215*	-0.241*	-0.226*
Skipping	-0.209*	-0.203*	-0.237*	-0.233*	-0.280*
Stair Climbing	-0.014	-0.074	0.075	-0.064	-0.109
Ladder Climbing	-0.064	-0.088	0.024	0.136	-0.077
Catching	0.148	0.082	0.126	0.091	0.024
Throwing	0.217*	0.231*	0.241*	0.288*	0.202*
Striking	-0.028	-0.020	-0.056	-0.133	-0.099
Kicking	0.195	0.069	0.114	0.124	0.157

* Significant at the level of $P < 0.05$

Discussion

The purpose of this study was to examine the relationship between age, sex and BMI with FMS in 3-6 years-old children. Our results related to locomotor skills cluster showed that the negative significant correlation between jumping, hopping and skipping skills with BMI in all ages, but correlation between walking, running, stair and ladder climbing skills with BMI were not significant (see table 4). Our results are consistent with findings of Morrison et al.¹ Siahkoughian and colleagues,⁷ Catenassi et al.,²³ Southall et al.²⁴ and Okley et al.⁶ Accordingly, in the proper performance of these skills, BMI and body mass transport have a great impact, so that children with high BMI Level have a lower performance. On the other hand, due to these skills are more difficult, and more components thus, are negatively affected on BMI. Moreover, our results related to hopping and skipping skills showed that the girls have better performance than boys, but only 6% of girls 5-6 years-old were preformed skipping skill at the level 4 (mature level). Our results are consistent with finding of Catenassi et al.²⁴ These researchers stated that no significant difference in this area, perhaps because the children in walking and running skills are more practice and mastery faster than the other FMS. Gabard¹¹ mentioned that these skills are less affected by BMI, because the proficiency in these skills leads to better transport of excess fat in children. Also, Researchers argued that the performance of FMS that requires are more motor components, are affected by BMI.^{3,6} Therefore, the walking, running, stair and ladder climbing skills are fewer motor components, thus, are less affected by BMI.

For object control skills cluster, the results showed that only the negative significant correlation between throwing skill with BMI in all ages, but correlation between kicking (except 5-6 years-old boys), catching and striking skills with BMI were not significant (see table 4). Also, in this skills cluster, the boys were performed better than girls in all ages. These results are consistent with the findings of Loovis et al.^{17,18} and Butterfield and Loovis,^{20,21} but with the results of Okley et al.⁶ and Southall et al.²⁵ were inconsistent. In this context, D' Hondt et al.³ reported that BMI is limited the range of motion in arms so that excess fat can also limit the movement in the shoulder and leads to poor performance.

Conclusions

In general, the results of this study revealed that negative significant correlation between FMS (jumping, hopping, skipping and throwing) with BMI in all ages. The results are consistent with the findings of other studies in this area that have used both norm-reference^{1,6,7,24} and criterion-reference^{17,18,21} scale assessments. These results are usually explained and described from a mechanical point of view. Accordingly, the body fat affects on body geometry and increases the mass of different body segments. Hence, noncontributory mass could lead to biomechanical movement inefficiency and could be detrimental for motor proficiency,³ so that our results indicate that. On the other hand, the negative impact of BMI on FMS can be explained by some other mechanisms. Children with higher BMI level are often failure to perform the difficult activities and FMS. Thus, this leads to a decrease regular physical activity and plays. These children are less likely to be physically active and show preference for sedentary pastime.

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