Investigation of the Relationship between Body Mass Index and Motor Abilities in Children

Emrah ATAY

School of Physical Education and Sport, Mehmet Akif Ersoy University, Burdur 15100, Turkey
emrahatay@windowslive.com

Abstract: The aim of this study is to examine of the relationship between Body Mass Index (BMI) and motor abilities in children. 354 middle-school students existing in 11-14 age group participated to research voluntarily. Height and body weight of participants were measured and BMI values were established as body weight/height*height formula. Vertical jump, dominant handgrip strength, flexibility, balance, plates tapping and standing long jump tests were applied to determine motoric skills. One Way ANOVA, Kruskal-Wallis H, Pearson Correlation and Spearman Correlation analyzes in SPSS 15.0 for Windows Package program were used in analyze of data obtained. In result of committed analyzes, it was established that thin children showed the best performance in vertical jump, dominant handgrip strength, balance, plates tapping and standing long jump tests. In flexibility test, children having normal body weight showed the best performance. It was established that their motoric skills were decreased as long as participants' BMI values were increased ($p<0,05$). According to the findings of this study, it was concluded that the increase of BMI has an adverse effects on motoric skills.
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1. Introduction

Obesity is an energy metabolism disorder revealed in result of excessive fat storage in body and can cause physical and mental problems (Süzek, 2005).

In recent years, pediatric obesity has been increased in worldwide (Slyper, 2004; Kavey, 2003; Petersen, 2004). Researches showed that it is possible that individuals who are obese in their childhood will be obese their adulthood (Herman, 2009). Overweight and obesity are risk factor for hypertension, hyperlipidemia, diabetes, osteoarthritis, sleep apnea, cardiovascular disease and some cancer type (U.S. Department of Health and Human Services, 1996). So, obesity is an important problem of public health (Koplan, 2005; Ambrose, 2001). Degree of obesity is determined by combination of malnutrition, inactive life and genetic factors (Bar-Or, 1998). Physical activity have an important role regarding overcome of obesity (Ambrose, 2001).

To reduce children's BMI rate and body fat, It is recommended to attend physical activity daily 45 minutes moderate to severe, 15 minutes severe (Wittmeier, 2008). On the other hand, it is prevented to take weight that children participate 210-360 minutes middle intensive exercise in a week (Saris, 2003).

To participate regular physical activities contribute to fitness component as body composition, muscular strength, cardiovascular endurance and flexibility (U.S. Department of Health and Human Services, 1996). Therefore, physical activity provide well in terms of mental and social health by improving body image (Strauss, 2001). Also, participate in regular physical activity causes an increase in motoric skills and thus improves the quality of life of individuals. (Penedo, 2005; Shoup, 2008).

It is noticed that in literature obese and normal body weight children' some motor skills (strength, endurance, flexibility etc.) is similar but when evaluated generally, obese children have worse performance than normal body weight children (Chen, 2006; Deforche, 2003; Shultz, 2011). But, there is too little research which examined relationship between children' BMI and motor skills. In this study, the relationship between children' BMI and motor skills was examined.

2. Material and Methods

2.1. Study group

354 middle-school student, whose their ages are between 11-14, participated to study voluntarily. Participants were selected from 3 different schools. Descriptive knowledge belonging to participants was given at Table 1.

Participants' BMI scores were found as kg/m^2 with division of body weight to height (in terms of meter) and classification of BMI groups were made as World Health Organization (WHO) criterions (URL 1). WHO, BMI classification was given at Table 2.

2.2. Measurement of motoric features

2.2.1. Vertical jump

Vertical Jump was measured with Takai brand jump meter. Subject stood at vertical position on plate, subject jumped above by twisting knees when subject' hands were on waist. Successively three jumping were made and the best score were recorded (Oja, 1995).

Table 1. Descriptive knowledge's belonging to participants

BMI groups	Descriptive statistics	Weight (kg)	Height (cm)	BMI (kg/m^2)
Thin	X	40,27	156,18	16,40
	N	165	165	165
	Sd	6,551	9,700	1,314
Normal	X	53,47	159,80	20,85
	N	153	153	153
	Sd	7,793	8,858	1,750
Overweight	X	69,34	162,68	26,14
	N	28	28	28
	Sd	7,952	8,680	1,391
Obese	X	81,98	160,88	31,67
	N	8	8	8
	Sd	5,697	4,390	1,733
General means	X	49,22	158,37	19,44
	N	354	354	354
	Sd	12,380	9,401	3,804

Table 2. World Health Organization, Body Mass Index classification

Underweight	Normal weight	Overweight	Obese
<18,5	18,5-24,9	>=25,0-29,9	>=30,0

2.2.2. Handgrip strength

Measurements were taken by using Takei brand hand dynamometer. Subject stood at vertical position and their hands at lateral. Dynamometer was held as parallel to body. Dynamometer was griped as possible as power. Successively three jumping were made and the best score were recorded (Oja, 1995). It was expressed as kg*kg with division of result obtained to body weight (relative strength).

2.2.3. Plates tapping

The two yellow discs are placed with their centers 80 cm apart on the table. 10x20 cm size rectangle plate was placed in center of these discs. Subject placed his/her preferred hand on plate, and placed other hand to disc which exists in contrary direction. With a "start command", subject touched discs at maximum speed and 25 times with her/his hand which was placed on plate. Later, total time was recorded (Oja, 1995).

2.2.4. Flamingo balance test

Two reinforcement, which is 2 cm wideness, were placed metal plate, which is 50 cm length, cm height and 3 cm wideness, to supply stability. Subject removed his/her preferred leg on plate. He/she held other leg with same side hand. While this action was made, subject was supported by researcher. When subject was ready, he/she left researcher and time was started. When subject lost his/her balance and press on place, time was stopped. When subject was again ready on plate, time was started. To fall as possible as little was wanted from subject and number of falling was recorded (Oja, 1995).

2.2.5. Standing long jump

Subject' foot finger tips stood at the back of jumping line in manner adjacent, he/she jumped as possible as forwards by wring his-her knees and shaking handles. Three trials were made and the best score was recorded (Oja, 1995).

2.2.6. Flexibility test

Flexometer was placed on table which is 50 cm height. When subject was at standing and vertical position, bending to front was wanted from subjects by not wiring knees and to push quadrant of flexometer towards front was wanted from subject. To wait least two seconds at point, that quadrant was existed, was wanted. Three trials were made and the best score was recorded.

2.3. Statistical analyze

SPSS 15.0 for Windows Package program was used in analyze of data obtained. Before main statistical analyzes, which will be used, were determined, by using One-Sample Kolmogorov-Smirnov test it was looked whether data suit normal distribution or do not normal distribution. In case data don't suit normal distribution, parametric tests can't be used and non-parametric test is used instead of parametric tests (Yılmaz, 2005). Asymp. Sig. (2-tailed) value in One-Sample Kolmogorov-Smirnov Test was found as "p>0,05" for all data obtained from

this research excluding balance. If founded "p" value is bigger than 0,05, it is said that examining distribution is normal (Alpar, 2006). One Way ANOVA and Pearson Correlation analyzes, which is parametric test, were used for data suited normal distribution. Analyzes related to balance, Kruskal-Wallis H and Spearman Correlation analyzes, which is non-parametric test, were used. Besides, descriptive statistics were utilized.

3. Results

To compare of motoric features of participants as BMI state was given at Table 3.

Thin participants showed the best performance at vertical jump, dominant handgrip strength, balance, plates tapping and standing long jump tests. As to flexibility test, normal weight participants showed the best performance. It was found that there were statistically significant differences between participants' vertical jump, dominant handgrip strength, flexibility, balance and standing long jump performances as BMI state ($p<0,05$), but it was found that there was no statistically significant difference at plates tapping test ($p>0,05$).

As post-hoc test results made to determine that there was difference among which groups; statistically significant difference was found between overweight participants (p=,039) and obese participants (p=,048) with thin participants at vertical jump test. Statistically significant difference was found between overweight participants (p=,001) and obese participants (p=,001) with thin participants at dominant handgrip strength test. Besides statistically significant difference was found between overweight participants (p=,039) and obese participants (p=,009) with normal weight participants. As to flexibility test, statistically significant difference was found between normal weight participants (p=,017) with thin participants, it was found no difference between other groups ($p>0,05$). When balance scores were compared, statistically significant difference was found among normal weight participants (p=,025), overweight participants (p=,000) and obese participants (p=,000) with thin participants. Besides, statistically significant difference was found between overweight participants (p=,003) and obese participants (p=,001) with normal weight participants. As to standing long jump test, statistically significant difference was found between obese participants (p=,010) with thin participants and obese participants (p=,039) with normal weight participants.

Table 3. To compare of motoric features of participants as BMI state

Motoric features	BMI Groups	N	X	Sd	F-X²	P
Vertical jump	Thin	165	35,33	9,89	4,822[a]	,003[a]
	Normal	153	32,61	11,89		
	Overweight	28	29,39	10,13		
	Obese	8	25,13	11,56		
Dominant handgrip strength	Thin	165	,49	,101	25,874[a]	,000[a]
	Normal	153	,44	,090		
	Overweight	28	,36	,088		
	Obese	8	,30	,059		
Flexibility	Thin	165	,33	7,71	3,063[a]	,028[a]
	Normal	153	2,73	6,82		
	Overweight	28	1,72	6,12		
	Obese	8	,05	6,93		
Balance	Thin	165	6,30	4,25	32,901[b]	,000[b]
	Normal	153	7,82	5,18		
	Overweight	28	11,25	4,73		
	Obese	8	14,38	7,24		
Plates tapping	Thin	165	14,82	2,54	2,588[a]	,053[a]
	Normal	153	15,45	3,01		
	Overweight	28	15,66	2,50		
	Obese	8	16,77	2,97		
Standing long jump	Thin	165	147,72	26,77	4,733[a]	,003[a]
	Normal	153	143,43	26,64		
	Overweight	28	135,43	24,22		
	Obese	8	117,88	12,48		

[a]One Way ANOVA, [b]Kruskal-Wallis H

The relationship between BMI values and motoric features of participants was shown at Table 4.

Table 4 was examined; it was established that vertical jump, dominant handgrip strength, balance, plates tapping and standing long jump performances were decreased at significant level as long as participants' BMI values were increased (p<0,05). In contrast with flexibility performances were increased at significant level (p<0,05).

Table 4. Analyze of the relationship between BMI values and motoric features of participants

		Vertical jump	Dominant handgrip strength	Flexibility	Balance	Plates tapping	Standing long jump
BMI (n=354)	r	-,194	-,443	,108	,275	,116	-,183
	p	,000[a]	,000[a]	,042[a]	,000[b]	,029[a]	,001[a]
	n	354	354	354	354	354	354

[a]Pearson Correlation, [b]Spearman Correlation

4. Discussion

BMI is a useful method giving knowledge about body fat state of people. Researches shown that there is a negative correlation between BMI and motoric features. In this research, it is shown that main bio-motoric features as strength and balance are decreased as long as BMI values are increased.

In this study, it was found that thin participants' vertical jump performance was found better than overweight and obese participants. Furthermore, it was established that vertical jump performances were decreased as long as participants' BMI values were increased. Own study, Nikolaidis (2012) found contrary directional relationship between children' BMI values and vertical jump performances. Vertical jump performance related to leg strength directly. Duncan et al. (2013), in their study, found contrary directional relationship between children'BMI values and deep squat performances. Referring to this knowledge, it can be said that obesity affect children leg strength adversely. In other words, if it is wanted that children have good vertical jump features, obesity state should be decreased.

As to findings of this research, it was shown that thin and normal weight participants have the best relative handgrip strength and as long as BMI values were increased, handgrip strength was decreased. In literature, there was limited number research which was examined the relationship between BMI and handgrip strength. In a research which was committed above making sport children, a contrary directional and significant relationship was found between children' BMI values and handgrip strength (Nikolaidis, 2012). Committed this research result shows analogy with knowledge existing literature.

In this research, it was established that normal weight participants have the best flexibility performance, as to thin participants have worst flexibility performance. While statistically significant difference was found between flexibility performances of thin and normal weight participants (p<0,05), a significant difference was no found between other groups (p>0,05). Besides, a linear directional significant relationship was found between BMI and flexibility performance (p<0,05). In literature, there are contradictions in research examining the relationship between BMI and flexibility performance. In their study committed on children, Frey and Chow (2006) found a linear relationship, which was not statistically significant, between BMI and flexibility performance. Another study committed on children making sport; a contrary directional relationship, which was not statistically significant, was found between BMI and flexibility performance (Nikolaidis, 2012). As to another research, it was found that normal weight children have better flexibility feature than obese children but no statistically significant difference was found between flexibility performances (Karppanen, 2012). It is known a fact that making sport improves flexibility performance. In this context, different results can be revealed while relationship BMI and flexibility performance is examined. It is thought that researches should be made over sedentary children to examine the relationship between BMI and flexibility performance accurately.

In this research, it was shown that their balance performances were decreased as long as participants' BMI values were increased. In their study, Zhu et al. (2011) established that normal weight children have better balance than obese children. Similar findings were found other researches in literature (Karppanen, 2012; D'Hondt, 2009). Finding of committed this study shows parallelism with literature. As these findings, it can be said that balance performance is affected adversely when BMI values are high.

It was found that plates tapping performances was decreased as long as BMI values were increased but this decline was no statistically significant. In a research existing in literature, it was found that normal weight children have better plates tapping performance than overweight children but there was no significant difference between weight and plates tapping performances (Zhu, 2011). Hand is moved at plates tapping test actively. Other parts of body aren't moved. So, disadvantages of overweight or obese aren't occurred in this test. Research examines the relationship between BMI and plates tapping. In this context, it is thought that committed this research supply an important source to literature.

As findings of this research, it was shown that standing long jump performances were decreased as long as BMI values were increased. Fernhall and Pitetti (2000) found a contrary directional relationship between BMI and leg strength. Leg strength is an important factor effecting standing long jump. Leg strength of children having high BMI is low and this is main reason that children having high BMI values can't success at standing long jump. A research in literature, it was found that normal weight children have better standing long jump as obese children (Karppanen, 2012).

Reason of overweight and obesity is that fat above normal accumulates. Children are obliged to carry dead weight because of fat mass above normal and this state put pressure on locomotor system unnecessarily. Because of this press, decline at motor abilities can be occurred. Committed this research shown that there was a contrary proportional relationship between children' BMI and motor abilities.

Corresponding author
Dr. Emrah ATAY
School of Physical Education and Sport, Mehmet Akif Ersoy University, Burdur 15100, Turkey
Telephone: +902482131103
E-mail: emrahatay@windowslive.com

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