Comparison of Core Muscles Endurance, Static and Dynamic Balance in Girls with Normal Body Mass Index & Obese

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ABSTRACT

Background: Overweight and obese are increasing concerns in societies. Obesity has harmful effects on various body systems, including the musculoskeletal system and can affect important muscles such as core muscles. **Objectives**: The aim of this study was to compare core muscle endurance, static and dynamic balance in adolescent girls (12-17) with normal body mass index and Obese. **Methods:** This cross-sectional study was conducted on non-athlete girls (12-17 years old) in Shiraz high schools with different BMI. A total of 137 girls (80 samples in the normal and 57 samples in the obese group) participated in this study on non-probability simple convenient sampling based on the World Health Organization definition of BMI. The Biering-Sorensen test was used for core muscle endurance (extensor muscles), one leg stance test was used to assess static balance, and for dynamic balance, Timed "Up & Go" was used. **Results:** There was no significant difference between normal weight and obese girls in static balance with eyes closed on the left and right leg ($P<0.05$). While there was a significant difference between the two groups in endurance, dynamic balance and static balance with eyes open ($P>0.05$). The normal weight group had a higher endurance score and Static balance with eyes open in the left and right leg compared to the obese group. The obese group had a higher score in dynamic balance than the normal weight group. **Conclusion:** The results of this study showed that obesity reduces core muscle endurance and balance in adolescent girls.

Keywords: endurance, core muscle, body mass index, Obese, static balance, dynamic balance.

INTRODUCTION

One of the common and increasing problems in today's society is overweight and obesity. Obesity is caused by an imbalance between energy intake and consumption, and leads to the accumulation of fat in the body(1). According to WHO, in 2005, approximately 1.6 billion teenage at the age of 15 were obese, and the number of overweight people reached 2.3 billion in 2015(2). The obesity is almost prevalent in all age groups and causes harmful effects on different body systems. The risk of developing diabetes, cardiovascular diseases, respiratory problems, musculoskeletal disorders and some cancers is higher in obese people. Due to the health problems associated with obesity, the increasing prevalence of obesity affects the health care system and individual economy(3). In addition, the occurrence of obesity during adolescence causes an increase in cardiovascular problems and mortality in adulthood(4). Today's generation has a higher weight and BMI compared to the previous generation(5). Obese children have less desire to do physical activities and have less self-confidence(6). Based on studies, it was found that obese children spend less time doing exercise and sports than non-obese children and this lack of participation in physical activities leads to an increase in the prevalence of obesity, reduced fitness and disease(7, 8). Adolescence and maturation lead to changes in body composition, such as changes in insulin sensitivity and adipokines density (A chemical produced by fat cells). The increase in body mass during maturation in girls is more than the boys, and obese girls have a more significant increase in fat than other girls(9). The stability provided by the core muscles is necessary for the normal functioning of the lumbopelvic region , maintaining the balance and coordination of the body (10). These muscles play a role in movement control, weight stress distribution, energy transfer and body weight (11). Since the core muscles cause the voluntary movement of the trunk and limbs through balance control, the stabilizing movement commands of these muscles occur before the

movement of the limbs(12). Dysfunction of these muscles causes damage to the upper and lower limb segments, therefore, strong core muscles help the vertebrae and pelvis to maintain stability and prevent situations that disturb the balance of a person(13). An increase in body weight and mass is accompanied by an increase in the movement commands sent to these muscles. In the study of Li and Aruin (2007), it was shown that overweight (overweight 20-40%) leads to an increase in the activity of the postural muscles, and overweight could be a potential risk for falling(14). Also, Teasale et al, showed that overweight has a negative effect on postural stability and weight loss has a direct effect on reducing postural fluctuations(3). Considering the effects of obesity on various body systems, including the musculoskeletal system, the core muscles are also affected by obesity. On the other hand, considering the importance of these muscles in optimal performance in all age groups, especially teenagers, as well as the problems caused due to the disorder in these muscles, this requires the investigation of these muscles in obese teenagers. Since the teenagers are the future workforce and no study has been done for the adolescent population in Iran, so the purpose of this study was to compare core muscles endurance, static and dynamic balance in adolescent girls (12-17) with normal BMI & Obese.

MATERIAL AND METHODS

This cross-sectional study was conducted on teenage non-athlete girls (12-17 years old) in Shiraz city high schools with different BMI. A total of 137 girls (80 samples in the normal weight group and 57 samples in the obese group) participated in this Study on non-probability simple convenient sampling based on the World Health Organization (WHO) definition of BMI. According to the description of the WHO, a person with a BMI of 39.39-30 kg/m2 was considered obese, and a person with a BMI of 18.5-25 kg/m2 was considered normal weight.

The number of samples was determined using NCSS software and considering the first type error of 5% and power of 80% using information from similar articles for the core muscles endurance factor(15) (۱۳۰ participants in both groups). Exclusion criteria include a history of cardiovascular and systemic diseases, orthopedic problems and head trauma, anatomical or surgical damage in the lower limb and spine based on radiographic evidence, presence of severe current back pain, presence of current mental disorder, history of the middle ear and balance disorders, vision, hearing and nervous disorders. Written consent was obtained from the participants to enter the study. In this research, extensor muscles were emphasized and flexor muscles were not considered. The Biering-Sorensen test was used to evaluate the endurance of core muscles. In this test, the person was placed on the bed in the palm position. The anterior superior iliac spine (ASIS) of the person was on the edge of the bed, the hands were crossed on the chest, and the areas of the ankles, knees, and thighs were fixed on the bed with three straps. The surface of the bed is approximately 60 cm above the ground. During this test, the person should be able to keep the head, neck and trunk in line with the horizon and maintain this position. The stopwatch was done at the point when the person was in a horizontal position. If the person is lowered by 10 degrees from the initial horizontal position (the angle was measured using a ruler), the test is stopped(13). One leg stance test was used to assess static balance. The person was placed in a standing position on one leg for 30 seconds with the hands beside the body. This test was repeated for both left and right legs with eyes open and closed. This test was repeated three times and the best record was included(16). Timed "Up & Go" (TUG) was used to check dynamic balance(17). In this test, a person gets up from a standard chair, walks a distance of three meters and returns and sits on the chair again (maximum speed without running).

Statistical analysis. The Kolmgrove-Smirnoff test was performed for the distribution of quantitative variables in two groups. Independent t-test and Mann-Whitney test were used to compare the mean of quantitative variables. In all tests, values of $p<0.05$ were accepted as a significant level.

RESULTS

A total of 137 cases were recruited and examined. Of these samples, 80 participants were in the normal weight group and 57 cases were in the obese group. The mean (±standard deviation) of their age in the normal weight and obese groups was 15.3 (±1.1) and 15.2 (±1.4), respectively. Mann-Whitney test showed that there is no statistically significant difference between ages in the two groups (P=0.8). Endurance factors, dynamic balance and static balance with eyes open and closed were compared for the left and right legs in two groups (Table 1). The results showed that there was no significant difference between normal weight and obese people in static balance with eyes closed in the left and right leg (P<0.05), while there was a significant difference in endurance, dynamic balance and static balance with eyes open between the two groups (P<0.05).

The normal weight group had a higher endurance score compared to the obese group (Figure 1). Static balance with eyes open in the left and right leg was also higher in the normal weight group. Also, the results showed that the obese group had a higher score in dynamic balance than the normal weight group.

DISCUSSION

BMI is one of the important indicators for evaluating body mass and it has been found that BMI has an inverse relationship with body balance(18, 19). In the study of Kejonen, et al., it was found that BMI is the most important index related to anterior-posterior balance control(20). Also, in the

study of Teasdale, et al., it was shown that by losing weight and achieving a normal body weight, balance control improves significantly, and dynamic balance decreases with weight gain(21). In obese people, it is difficult to control their balance and perform balance movements. The reason for the decrease in balance can be due to the fact that in obese people, a large part of the increase in body weight is in the amount of fat mass and the muscle mass has grown less(18, 19, 22). On the other hand, extra muscle mass has a significant relationship with dynamic balance and not with static balance, because dynamic balance is an active skill and requires more neuromuscular system than static balance(23). It has also been clearly shown that increased weight and BMI index lead to a decrease in core muscular endurance(15).

In the present study, it was found that there is no significant difference between normal weight and obese people in static balance with eyes closed on the left and right leg, while there was a significant difference with eyes open. The results of the present study are consistent with the study of Mi et al(24). Also, in the study of Leszczak et al., it is clear that the balance with closed eyes is much lower than with open eyes(25). Also, in this study, it was found that there is a significant difference in the dynamic balance between obese and normal weight groups, and dynamic balance decreases with increasing BMI. In the study of Gao et al., it has been reported that dynamic balance decreases significantly with an increase in BMI, the results of our study are in line with the study of Gao et al(26). In George et al.'s study, the results obtained were in line with the present study and emphasized that an increase in BMI causes a decrease in dynamic balance(27). In the current study, another result that examined the relationship between weight and endurance showed that the normal weight group had a higher endurance score compared to the obese group. In the study of Mahmoud Amin et al., it was found that increasing BMI leads to reduced endurance and strength of the core muscles. Our study was consistent with the study of Al Abdulwahab et al.,(28) and

Mahmoud Amin et al.,(29) which showed that increasing BMI leads to a decrease in endurance and strength of the core muscles.

To further investigate the effect of overweight and BMI on body muscles, core muscles, endurance, and static and dynamic balance, the authors suggest that in subsequent studies, the studied population should be larger, and different criteria such as diet, exercise, lifestyle, genetics and other factors affecting people's weight should also be evaluated.

CONCLUSION

Due to the change in lifestyle in today's societies, the rate of weight gains and obesity is increasing. Obesity leads to disorders in the musculoskeletal system and affects a person's daily activities. Body composition indices change the body's mechanical characteristics. It can be concluded that body composition factors, especially BMI, fat percentage, fat amount, height and overweight are important factors related to core muscles endurance, and static and dynamic balance.

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AUTHOR'S CONTRIBUTIONS

Study concept and design: N.S, F.J, M.M and K.R. Analysis and interpretation of the data: N.S, F.J and M.M. Drafting of the manuscript: N.S, F.J, M.M and K.R. Critical revision of the manuscript for important intellectual content.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table 1: Comparison of core muscles endurance and static and dynamic balance in teenagers with normal and obese BMI.

Outcome measure		BMI				P-value
		Normal		Obesity		
		median	Interquartile range	median	Interquartile range	
Endurance		57.4	20.1	29.0	23.3	<0.001
Dynamic Balance		4.8	0.6	5.0	0.6	0.001
Static Balance with eye open	Right leg	120.3	179.8	60.4	65.4	<0.001
	Left leg	60.6	120.3	60.3	7.1	0.002
Static Balance with eye closed	Right leg	15.8	26.5	13.0	17.0	0.511
	Left leg	12.7	17.1	13.0	14.6	0.879

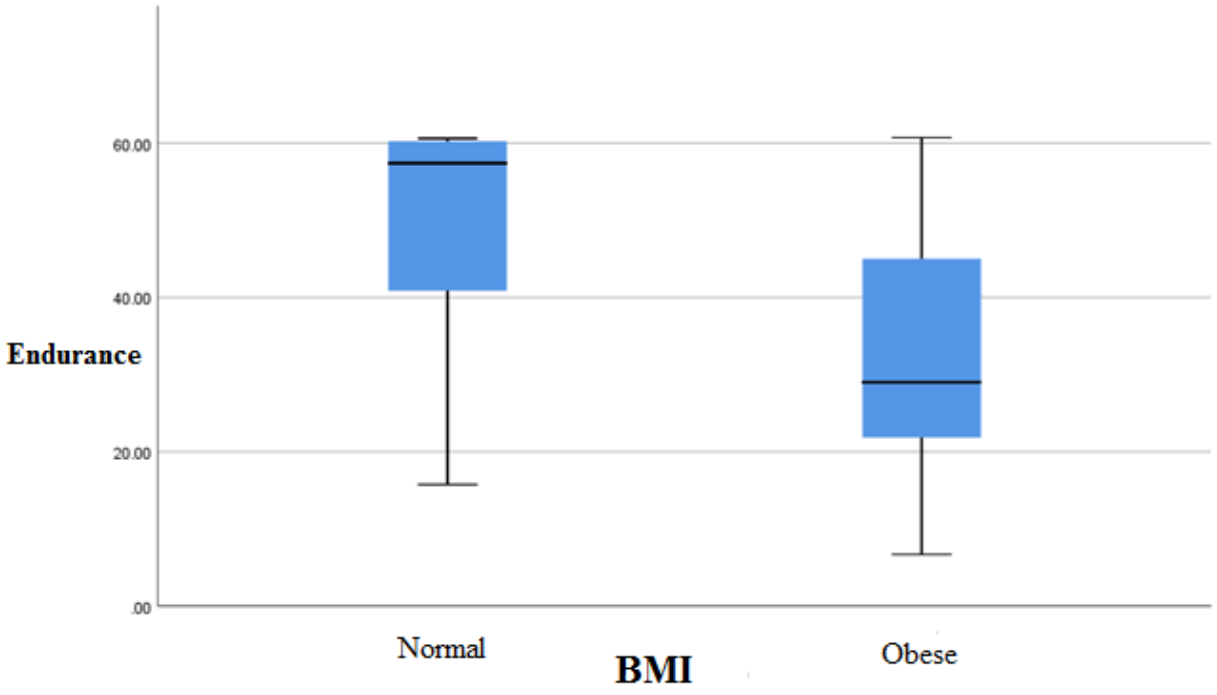

Figure 1: Comparison of endurance in teenagers with normal and obese BMI.