YAŞ VE VÜCUT KÜTLE İNDEKSİNİN ESNEKLİK VE DENGE PERFORMANSI ÜZERİNE ETKİSİ

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THE EFFECTS OF AGE AND BODY MASS INDEX ON FLEXIBILITY AND BALANCE PERFORMANCE

RESEARCH ARTICLE

ABSTRACT

Purpose: This study was conducted to examine the effects of age and Body Mass Index (BMI) on flexibility and balance in individuals aged between 18-80.

Methods: Four hundred and four (n=404) individuals were included in the study. Timed Up and Go Test (TUG) and Sit to Stand Test (SST) were used in order to evaluate dynamic balance; Sit and Reach Flexibility Test as well as Lateral Trunk Flexion test were used for flexibility.

Results: A correlation was found between age, TUG, SST and flexibility values ($p<0.05$). There was a correlation in a negative direction between BMI, and right-left trunk flexibility tests. There was a correlation in a positive direction between TUG and SST.

Conclusion: The increase in age and BMI causes restrictions in daily life activities of individuals by leading to decrease in important parameters that affect their physical fitness such as balance and flexibility.

Key Words: Age; Body Mass Index; Balance; Joint Flexibility.

YAŞ VE VÜCUT KÜTLE İNDEKSİNİN ESNEKLİK VE DENGE PERFORMANSI ÜZERİNE ETKİSİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışma 18-80 yaş arası bireylerde yaş ve vücut kütle indeksinin(VKİ) esneklik ve dinamik denge performansı üzerine etkisini belirlemek amacıyla planlandı.

Yöntemler: Çalışmaya 404 birey dahil edildi. Dinamik dengeyi değerlendirmek için zamanlı kalk yürü testi (ZKYT) ve sandalyeden otur kalk testi kullanıldı; Esneklik için Otur ve uzan esneklik testi ile gövde lateral fleksiyon testi kullanıldı.

Sonuçlar: Yaş ile ZKYT, sandalyeden otur kalk testi ve esneklik ölçümleri arasında ilişki saptandı ($p<0.05$). VKİ gövde LF ölçümleri arasında negatif yönde ilişki bulundu ($p<0.05$). VKİ ile ZKYTve sandalyeden otur kalk testi ölçümleri arasında negatif yönde ilişki bulundu ($p<0.05$).

Tartışma: Yaş ve VKİ'deki artış, bireylerin günlük hayatlarındaki faaliyetlerinde kısıtlamalara sebep olarak denge ve esneklik gibi bireylerin önemli fiziksel yeterlilik parametrelerinde düşüşe neden olmaktadır.

Anahtar kelimeler: Yaş; Vücut Kütle İndeksi; Denge; Eklem Esnekliği

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INTRODUCTION

Along with the inrease in life expectancy, several physiological and anatomical changes occur in the human body (1). In particular, losses of muscle strength and lack of balance/stability and mobility occurring with the aging process affect the quality of life and the functional capacity of the individual in a negative way (1,2). For this reason, the studies conducted for protecting the quality of life and the functional independence pertaining to community healthcare are gaining momentum, while the physical fitness parameters over health are gaining more importance (3,4). Balance and flexibility are among the physical fitness parameters regarding health. Balance is the main component of several daily activities and sportive motor skills such as sitting, standing and walking (1,2). In previously conducted studies, balance performance was shown to be associated with age, gender, anthropometric structure and points of support (5). With aging, the center of gravity changes, and then it affects the characteristics of balance. It is stated that there is a strong correlation between balance and the decrease in visual acuity along with increasing age, while the postural stance and balance weaken (6).

Flexibility, however, is defined as the ability of the muscle to extend its length when it is allowed by the joint to do this all along the range of motion (7). Flexibility is affected by various factors such as the differences seen in the articular/joint structures genetically, the elasticity of the connective tissue, muscle viscosity, reciprocal muscular coordination as well as age, gender, weight and body type (8). The decrease in the muscular flexibility results in an increase in the occurrence of injuries (7).

Along with the aging process, the energy spent declines, and the metabolism rate slows down. The major reason for this is that physical activities of individuals decrease with aging, which leads to an inactive and sedentary life style (9). An inactive and sedentary life style may cause disruption in the energy balance, which leads to obesity (4). Obesity is defined as a chronic disease that emerges when the adipose tissue is accumulated in excessive amounts within the organism. Particularly in recent years, obesity has been an ongoing common problem throughout the world, notably in developed and developing countries (10). In previous studies conducted on obese individuals, it was explained that flexibility had declined, and losses of balance were seen. Maintaining balance and postural stability in obese individuals becomes more and more challenging when particularly walking style and position change (11,12).

In the studies within the literature, either only obese individuals were incorporated into a study, or the flexibility and balance status of adolescents and the elderly individuals were separately discussed. In our study, however, we aimed to evaluate and compare all the groups together. This study was planned to determine the effects of age and Body Mass Index (BMI) on flexibility and balance performance in individuals aged between 18-80.

METHODS

Female and male individuals aged between 18-80 who lived in the City Center of Kırıkkale were incorporated in our study. Individuals were informed about our study through announcement. Individuals were selected by using convenience sampling method which is an improbable sampling method. For the power analysis and sampling size, 'The Power and Sample Size Program' was used. As the result of the analysis, the calculations indicated to the fact that 95% reliability and 90% power would be obtained according to the alpha margin of error 0.05, and the required number of individuals was determined to be 400 people. A total of 450 individuals were reached. 46 individuals comprising 2 individuals who had no cooperation, 25 individuals who did not volunteer to take part in the study, 11 individuals whose BMI values were below 18,5; and 8 individuals with orthopedic problems were excluded from the study. The study was completed along with 404 individuals.

The inclusion criteria for the study were determined to involve the individuals between the ages of 18-80, who accepted to cooperate and participate in the study. The exclusion criteria for the study, on the other hand, were accepted to involve the individuals with auditory and visual problems, those with any orthopedic or neurological problem, those with malignancy as well as the individuals receiving chemotherapy and radiotherapy that caused malignancy, those who were too thin according to BMI

Table 1: Socio-demographic parameters of the participants

	(X±SD), n (%)
Age, mean (X±SD), year	46.05±17.21
Age groups, n (%)	
Young adult	171(42.3)
Middle aged	166(41.1)
Elderly	67(16.6)
BMI, mean (X±SD), kg/m2	26.58±5.11
BMI, n (%)	
Normal	169 (41.8)
Overweight	150 (37.1)
Obese	85(21.1)
Gender, n (%)	
Women	217 (53.7)
Men	187 (46.3)
Marital status, n (%)	
Married	267 (66.1)
Single	137 (33.9)
Education, n (%)	
No education	3 (0.7)
Primary school	119 (29.5)
Middle school	70 (17.3)
High school	69 (17.1)
University and upper	143 (35.4)
Occupation, n (%)	
Working	192 (47.5)
Non-working	124 (30.7)
Student	88 (21.8)

BMI: Body Mass Index

value, and pregnant women. The written informed consent was obtained from all participants before the study. As for carrying out the research, the required permission and approval were received from the Ethical Committee of the Clinical Researches in Kırıkkale University (28/03.15.12.2015). The study was completed along with 404 individuals who were suitable for the inclusion criteria of the study.

The socio-demographic information of the individuals was recorded with the help of an evaluation form prepared beforehand. The dynamic balance of the individuals was evaluated through the use of the Timed Up and Go Test (TUG) and the Sit to Stand test (SST), whereas the evaluation of flexibility was performed through the Sit and Reach Flexibility test as well as the Lateral Trunk Flexion test.

Lateral Trunk Flexion Test: For right and left lateral flexion, subjects stood on the floor with arms in the neutral position, heels together, knees and back straight. Subjects bent toward the right with elbow and fingers straight and attached hand on their lateral side of leg. The distance between the tip of third finger and the floor was measured (13).

TUG, on the other hand, is one of the functional tests that assess the dynamic balance. In this test, the individual is asked to rise from the chair s/he has been sitting on and to go and walk for three meters and then return back to the chair and sit down again, during which the elapsed time is recorded. During the study, this test was repeated for three times, and the mean values were obtained (14).

In the Sit to Stand test (SST), which is performed for the purpose of evaluating the dynamic balance and the physical fitness levels of the individuals, an individual is allowed to sit down on the middle part of a chair of 43 cm-height in the way that her/his back is in upright position while the feet will be fully touching the floor and the arms crosswise in front of the chest (the right hand will rest on the left shoulder while the left hand will rest on the right shoulder). While the individual is staying in this position, s/he begins this test with a start command, and in the final repetition, the test ends when the individual touches her/his pelvic region on the chair. The duration of sitting- rising for 5 times is recorded in terms of seconds (15)

The Sit and Reach test was used to evaluate the flexibility of the trunk as well as the flexibility of the lower extremity of the individuals. During this test, a sit-and-reach table was used, and the individual was asked to lean her/his sole against the table in a long-term sitting position and to reach with both hands towards the ruler/scale while the knees were in extension. The edge of the table was accepted as 0, while the values above were taken as positive and the values below were taken as negative. The difference at the outset and after the reaching position was recorded in centimeters (cm). This test was repeated for three times, after which the highest value was recorded (16).

Table 2: Comparison of TUG, Sit-To-Stand Test, and Flexibility according to BMI values

	Normal X±SD	Overweight X±SD	Obese X±SD	p value
TUG (sn)	6.57±5.27	6.68±5.06	8.96±5.80	0.002
SST (sn)	10.39±5.71	11.31±6.34	13.79±6.09	0.001
Sit and Reach Test (cm)	-0.60±8.71	0.89±8.57	-0.45±8.09	0.257
Right Trunk LF (cm)	16.79±5.26	15.70±6.45	12.27±5.78	0.001
Left Trunk LF (cm)	16.86±5.25	15.79±6.45	12.27±5.78	0.001

TUG, Time-Up and Go Test; SST, Sit-To-Stand Test; right trunk LF, right trunk Lateral flexion; Left Trunk LF, Left Trunk Lateral flexion; BMI, Body Mass Index.

Table 3: Comparison of TUG, Sit-To-Stand Test and Flexibility according to different age groups

	Young adult X±SD	Middle aged X±SD	Elderly X±SD	p value
TUG (sn)	5.34±2.05	5.83±4.10	14.80±7.20	0.001
SST (sn)	8.99±3.73	11.39±5.47	17.83±7.97	0.001
Sit and Reach Test (cm)	2.77±8.94	-1.04±7.50	-4.59±7.38	0.001
Right Trunk LF (cm)	18.25±5.01	14.64±5.84	9.99±4.40	0.001
Left Trunk LF (cm)	18.29±5.17	14.74±5.87	10.27±4.53	0.001

TUG, Time-Up and Go Test; SST, Sit-To-Stand Test; right trunk LF, right trunk Lateral flexion; Left Trunk LF, Left Trunk Lateral flexion

Statistical Analysis

The compliance of the variables with the normal distribution was checked through the Kolmogorov Smirnov test. The $p<0.05$ level was accepted as being statistically significant. The descriptive statistics were given in the form of mean±standard deviation (mean±sd). The categorical data analysis was evaluated through the Chi-Square Test.

As for the measurements of correlation, Pearson's Correlation tests were performed. The correlation was expressed to be 'strong' ($r > 0.5$), 'medium' ($r=0.3-0.5$) or 'small' ($r < 0.3$) (22). Statistical significance level was set at $p<0.05$. The data analysis was performed through the use of SPSS 17.0 (SPSS Inc., Chicago, Illinois, USA) program.

RESULTS

The values regarding height, weight, BMI, educational and marital status and profession pertaining to 404 individuals whose mean age was 46.05±17.21 are shown in Table 1.

When the individuals were compared according to the BMI values, a significant difference was detected between the TUG, Sit-To-Stand Test and Flexibility except for the Sit and Reach Test ($p<0.05$) (Table 2). When the individuals were compared according to different age groups, Sit and Reach Test, TUG, Sit-To-Stand Test and Flexibility values ($p<0.05$) (Table 3).

The relationship of the measurements of balance

Table 4: The relationship between age-BMI and flexibility-balance

	Age r(p)	BMI r(p)
TUG (sn)	0.555 (0.001)*	0.203(0.001)*
SST (sn)	0.469 (0.001)*	0.241(0.001)*
Sit and Reach Test (cm)	0.216 (0.001)*	0.018(0.722)
Right trunk LF (cm)	0.517(0.001)*	-0.280(0.001)*
Left Trunk LF (cm)	0.493(0.001)*	-0.269(0.001)*

TUG, Time-Up and Go Test; SST, Sit-To-Stand Test;right trunk LF, right trunk Lateral flexion; Left Trunk LF, Left Trunk Lateral flexion, *p<0.05, r: Pearson correlation.

and flexibility with age and BMI is shown in Table 4. A positive correlation was ascertained between TUG, The Sitting-Rising test and the flexibility values with age ($p<0.05$). A negative correlation was found between BMI and right-left trunk flexibility tests, while a positive correlation was found between TUG and Sit-To-Stand Test ($p<0.05$). No correlation was determined between BMI and Sit and Reach Test. While the correlation between age and TUG, right trunk LF were strong, Sit-To-Stand Test and left trunk LF values were found medium. A weak correlation was observed between age and Sit and Reach Test ($p=0.001$, $r=0.216$). A weak correlation was observed between BMI values and TUG (($p=0.001$, $r=0.203$), Sit-To-Stand Test ($p=0.001$, $r=0.241$), right trunk LF ($p=0.001$, $r=-0.280$), left trunk LF ($p=0.001$, $r=-0.269$).

DISCUSSION

Balance and flexibility are associated with various factors such as age, gender, weight, body type, anthropometric structure and points of support (6). In our study, it was aimed that the effects of age and BMI on flexibility and balance performance would be examined. As the result of our study, it was put forth that the increase in age and BMI had negatively affected balance while declining flexibility.

The physiological changes emerging along with the aging process cause negativity in some activities even though there may be no apparent health problem. The effects of normal aging can be restrictive for an individual's activities. Along with normal aging, problems of balance are often observed in individuals (17). Nakano et al., in their study, showed that while the elderly people in their 60s and 70s exhibited similar functional capacities, the balance, physical performance, muscle strength and mobility of these people, along with the increasing age, seemed to decline when they reached the age of 80 (2). On the other hand, Tsuyama et al., in their study, evaluated 100 women aged between 20-85, and as the result of their study, they stated that the dynamic balance had declined along with aging and had showed rather a rapid decline after the age of 60 (18). According to the results of our study, a correlation was ascertained between age, balance and flexibility. It was seen that as the individuals' ages progressed, their balance and flexibility declined along with that process.

Also in some previous researches, the effect of age on the balance control in the youth and in the elderly while performing their walking activity was examined, and it was reported that the balance strategies in the youth had changed during fast walking (trotting), whereas these strategies did not change in the elderly whose own speed and the length of the steps they took increased, which probably occurred for the purpose of protecting the balance (19, 20). The posture and the developed walking strategies that change along with the aging process are for protecting most individuals' balance as well as minimizing the risk of falling down.In the conducted studies, it is emphasized that as the age advances, the center of gravity in individuals changes, while the postural swings decrease, and walking and balance patterns change as well (20, 21).

It was put forward that this situation occurred along with the decreasing muscle strength, motor control and soft tissue elasticity during the aging process as the result of the frequency of falling down on the ground increasing (2, 22). As the result of our study, it was seen that the performance of balance decreased along with aging, and that the durations of static balance performance, such as TUG and sit-rise activity, were extended. Our study, supporting the literature, has shown that age affects balance in a negative way. In order to develop the balance performance that declines with aging and to allow the elderly to become more independent during their daily life activities, it is required that among the treatment approaches to be applied to the elderly, the treatment approaches which will definitely develop their balance performances be applied.

It is reported that humans' characteristics, such as age, height and weight, affect flexibility. In several studies conducted so far, it has been observed that there is a decline in flexibility along with aging. It has also been highlighted that the advancement of age along with the decline in flexibility triggers the incidents of falling down more and more. It was also explained that the incidents of falling down were seen when the flexibility of the lower extremity in particular declined (23).

Pangrazi et al., in their study, could not find a significant difference in the age-related flexibility change (24). Youdas et al., in their study, stated that flexibility was not affected by age. It is stated that the characteristics of humans, such as age, height and weight, affect flexibility (25).

As the result of our study, a correlation in a positive direction was determined between age and flexibility values. It was also determined that as the age advanced, flexibility declined. As the result of our study, it was also seen that balance and flexibility declined when the BMI values in individuals, apart from the age factor, increased. Some of the studies emphasizing the fact that flexibility is in accordance with the physical condition have shown that as BMI increases, flexibility declines while physical problems increase.

A few studies included in the literature seem to support our study results (26, 27). The decline in flexibility as the body weight increases, the decrease in the joint range of motion and the decline in muscle strength causes more and more incidences of physical problems in both the youth and the individuals in advancing age (26). In our study, however, a negative correlation was found between BMI and right-left trunk flexibility tests, whereas no correlation was determined between them and the Sit and Reach test.

In a study conducted by Greve et al., it was reported that an increase in BMI had negatively affected the postural balance (28). Authors involved put forward the fact that obesity (high BMI) had affected the motor strategies that formed the postural balance (29). In another study, the correlation between BMI and the postural dynamic balance in women aged 35-45 was investigated, and it was stated that as BMI increased, the balance ability weakened (30). In a study conducted by Hue et al., it was expressed that weight gain in male individuals was associated with loss of balance, which increased the risk of falling down (17).

In another study found in the literature, it was emphasized that there was a negative correlation between BMI and dynamic balance, and that maintaining the proper BMI was of great importance for balance (18).

In our study, a positive correlation between TUG and the Sitting and Rising test were found. Protecting BMI by staying away from a sedentary life style is of great importance in terms of balance and flexibility as well as all the body systems and psycho-social conditions.

Conclusions

Along with the aging process, the physical activities of individuals decrease, which lead them to live a sedentary life style. This situation causes BMI values to increase in individuals. Both advancing age and increasing BMI values cause restrictions in daily life activities of individuals by also affecting major parameters which affect their physical fitness such as balance and flexibility along with the changes in all the bodily systems. To resolve this problem, it must be advised to individuals that they stay away from a sedentary life style and perform physical activities appropriate for their age together with proper exercise programs involving balance and flexibility.

Limitations

The primary limitation of this study can be considered to be the fact that only the BMI values were calculated, and the body types were not taken into consideration. Another limitation of our study is that physical activity level of individuals is not determined.

Conflict of Interest: The authors declare that there is no conflict of interests regarding the publication of this article.

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