ANALYSING THE RELATIONSHIP BETWEEN PHYSICAL PARAMETERS AND BALANCE ABILITY IN HEALTHY YOUNG MALES: An experience with sportKAT 550

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Abstract: Introduction: The aim of this study was to analyse the relationship between physical parameters and balance ability in healthy young males.
Methods: In this study, 55 healthy young males (mean age=19.38±0.73 yr; mean height=176±5.86 cm; mean weight=71.21±12.52 kg) were evaluated. Physical parameters (height, body weight, body mass index (BMI) recorded. The Portable Computerized Kinesthetic Ability Trainer (SportKAT 550) were used to evaluate balance ability.
Results: There were positive weak correlations between the height of the subjects and the dual foot static balance scores, the dominant foot static balance scores, and the dual foot dynamic balance scores (r = 0.410, r = 0.326, r = 0.436, respectively). There were strong positive correlations between the body weight of the subjects and the dual foot static balance scores and the dominant leg static balance scores (r = 0.813 / p = 0.0001, r = 0.769 / p = 0.0001, respectively). A moderate correlation was found between body weight and dual foot dynamic balance score (r = 0.573, p = 0.0001). There were strong positive correlations between body mass index (BMI) and dual foot static balance score (r = 0.723, p = 0.0001) and dominant foot static balance score (r = 0.714, p = 0.0001). There was a positive weak correlation between BMI and dual foot dynamic balance scores (r = 0.444, p = 0.001).
Conclusion: The balance score was found better in healthy subjects with decreased body length.Namely, increased body weigth has negative impact on balance score.
Keywords: *Physical parameters, Balance, Males*

Introduction

Balance is important to maintain postural stability. From biomechanical perspective, balance is the process that maintain the centre of gravity or centre of mass within the body's base of support [1]. Balance may be static when the body is at rest [static balance] or dynamic when the body is at steady state motion [dynamic balance] [2]. Balance control is complex and multifactorial process; it depends on a well-functioning postural control system. Maintaining balance requires integrated actions of the visual, vestibular and nervous systems to process sensory information and send appropriate motor responses continuously.Ability to maintain either static or dynamic balance has been found to be influenced by many factors [3]. There are many methods for evaluation of balance although none of them is accepted as a gold standard. Studies using various assessment tools in various populations have shown that there is association between anthropometric variables with balance [3,4,5,6,7]. Few studies have been carried out in this issue and have found poor correlation between anthropometrics and balance [1,3,4]. A number of questions remain unanswered in the literature. That's why; this study was designed to determine the relationship between physical parameters and balance ability in healthy young males.

Methods

The study was performed in Pamukkale University School of Physical Therapy and Rehabilitation. All participants gave their written informed consent to participate in this study, which was approved by the Medical Ethics Committee of Pamukkale University (B.30.2.PAÜ.0.20.05.09/90).
Volunteers with ages 18 to 20 years without any neurological, orthopedical, visual, hearing impairment, no operation performed from the lower extremity and/or waist region, and ongoing painful musculoskeletal problems were included in the study. Participants who were unable to

complete the tests were excluded from the study.

In this study, 55 healthy young males (mean age=19.38±0.73 yr; mean height=176±5.86 cm; mean weight=71.21±12.52 kg) were evaluated. Physical parameters such as height, body weight, body mass index (BMI), and dominant lower extremities of the subjects were recorded. The dominant lower limb was determined by asking "Which foot will you shoot first?"

The Portable Computerized Kinesthetic Ability Trainer (SportKAT 550) were used to test balance ability. The balance index scores (right, left, front, and back) were recorded for both static (standing on dual foot, and dominant foot) and dynamic (standing on dual foot) balance.

The Portable Computerized Kinesthetic Ability Trainer (SportKAT 550) (Fig. 1) provides a detailed assessment of the balance in a short period of time. This device provides sensitive information about postural stability. Quantitative and objective data can be obtained by this method. It has a centrally pivoted balance platform that utilizes a bladder system for adjusting the stability of the platform. As the pressure increases, the platform becomes more stable. The subject can tilt the movable platform in all directions to maintain his balance, without changing the position of his feet [8,9]

Two different protocols were used to assess static and dynamic balance. For both of the tests, the subjects were asked to stand barefoot on the platform with the knees flexed approximately 20 degrees. Arms were folded across the chest to prevent ballistic effects related to the arm position. The computer screen was positioned directly in front of the subject to provide a concurrent biofeedback of the subject's position. The subjects were informed that the red 'X' mark on the screen was representing the center of the platform.

Figure 1. **A basic, portable kinesthetic ability trainer. Manually adjusted stability with hand pump *(sportKAT 550).***

During the static test, the subject was asked to maintain the red 'X' mark in the middle of the screen. In the dynamic test, the subject was asked to superimpose the 'X' mark onto the moving cursor which is making a 360° clockwise circle on the screen. Before starting the test, the subjects were allowed to practice to become accustomed to the test procedure. Each test lasted for 30 seconds and repeated for 3 times and best of the three Balance Index scores was regarded as the final score of the subject. The Balance Index quantifies the person's ability to

keep the platform near the reference position (Fig. 2). The Balance Index (BI) ranges from 0 to 6000. A low BI means a good ability to perform the balance task [10,11,12].
Analysis of the data obtained from the study was performed using SPSS for Windows 18.0 statistical software package. The level of significance was taken as $p<0.05$. The demographic characteristics of the individuals were given as mean with standart deviation. Correlation of Bivariate Pearson Chi-Square test method was used in the study [13].

Figure 2. **Test position on sportKAT 550**

Results

Fifty five healthy young males (mean age=19.38±0.73 yr; mean height=176±5.86 cm; mean weight=71.21±12.52 kg) were enrolled in this study. The mean body mass index (BMI) of subjects was found 22.87 ± 3.61 kg / m^2 (Table 1). Table 2 shows the mean and median values for static and dynamic balance index of the subjects.

Table 1 Demographic characteristics of subjects

Variables	n=55	
	mean ± SD	min.- max.
Age (year)	19.38±0.73	18-20
Height (cm)	176±5.86	165-191
Body weight (kg)	71.21±12.52	54-112
BMI (kg/m^2)	22.87±3.61	17.63-35.19

Table 2 The portable computerized kinesthetic ability trainer (SportKAT-550) test results of subjects

Variables	n=55		
	mean±SD	Median	min.-max.
Static Balance Index Score Dual Foot	1035.85±522.16	950	497-3352
Right	453.32±293.25	415	53-1452
Left	582.41±372.68	448	150-1900
Front	526.05±295.48	480	82-1733

Back	509.70±374.90	441	45-2519
Static Balance Index Score Dominant Foot	1025.58±471.42	942	514-2760
Right	598.50±392.28	462	97-1777
Left	427.12±250.03	364	51-1121
Front	449.50±274.10	372	57-1545
Back	576.01±345.47	460	165-1778
Dynamic Balance Index Score Dual Foot	2062.14±589.02	1890	1180-3670
Right	1015.85±339.16	960	505-2005
Left	1047.30±303.07	958	604-2090
Front	1103.40±341.72	1063	529-1854
Back	958.67±302.16	888	507-1928

There was a positive weak correlation between the height of the subjects and dual foot static balance score, dominant foot static balance score, and dual foot dynamic balance score (r = 0.410, r = 0.326, r = 0.436, respectively) (Table 3).

Table 3 Relationship between body height and balance measurements.

Variables	**Height (cm) n=55**	
	r	**p**
Static Balance Index Score Dual Foot	0.410	**0.002***
Right	0.386	**0.004***
Left	0.276	**0.042***
Front	0.393	**0.003***
Back	0.266	**0.049***
Static Balance Index Score Dominant Foot	0.326	**0.015***
Right	0.232	0.089
Left	0.252	0.064
Front	0.147	0.284
Back	0.328	**0.014***
Dynamic Balance Index Score Dual Foot	0.436	**0.001***
Right	0.438	**0.001***
Left	0.364	**0.006***
Front	0.447	**0.001***
Back	0.349	**0.009***

p <0.05

A strong positive correlation was found between body weight of the subjects and dual foot static balance score and dominant foot static balance score (r = 0.813 / p = 0.0001, r = 0.769 / p = 0.0001, respectively). A positive moderate correlation was found between body weight and dual foot dynamic balance score [r = 0.573, p = 0.0001] (Table 4).

Table 4 The relationship between body weight and balance ability of the subjects

Variables	**Body Weight ((kg) n=55**	
	r	**p**
Static Balance Index Score Dual Foot	0.813	**0.0001***
Right	0.470	**0.0001***
Left	0.769	**0.0001***
Front	0.686	**0.0001***
Back	0.592	**0.0001***
Static Balance Index Score Dominant Foot	0.769	**0.0001***
Right	0.644	**0.0001***
Left	0.439	**0.001***
Front	0.534	**0.0001***
Back	0.626	**0.0001***
Dynamic Balance Index Score Dual Foot	0.573	**0.0001***
Right	0.577	**0.0001***
Left	0.469	**0.0001***
Front	0.482	**0.0001***
Back	0.575	**0.0001***

p<0.05

There was a strong positive correlation between body mass index (BMI) and dual foot static balance score (r = 0.723, p = 0.0001). There was a strong positive correlation between BMI and dominant foot static balance score (r = 0.714, p = 0.0001). A positive weak correlation was also found between BMI and dual foot dynamic balance score (r = 0.444, p = 0.001) (Table 5).

Table 5 The relationship between body mass index (BMI) and balance ability of the subjects

Variables	**Body Mass Index (BMI)**	
	r	**p**
Static Balance Index Score Dual Foot	0.723	**0.0001***
Right	0.362	**0.007***
Left	0.729	**0.0001***
Front	0.588	**0.0001***
Back	0.544	**0.0001***
Static Balance Index Score	0.714	**0.0001***

Dominant Foot		
Right	0.619	**0.0001***
Left	0.374	**0.005***
Front	0.531	**0.0001***
Back	0.552	**0.0001***
Dynamic Balance Index Score Dual Foot	0.444	**0.001***
Right	0.444	**0.001***
Left	0.366	**0.006***
Front	0.336	**0.012***
Back	0.488	**0.0001***

p<0.05

Discussion

The relationship between physical parameters and balance ability was examined in this study. The main objective of the study was to determine whether body weight, height, and body mass index could predict balance ability in healthy young males.

In this study, the balance scores were found to be better as the body length decreased, and the balance scores were found to be worse as the body weight increased. Therefore, as the body mass index increased, the balance scores were found to be worse. This suggests that body weight, height, and body mass index may be an important risk factor for falls and injuries due to balance problems and so it may affect activities of daily living.

This study result might be helpful to structure exercise programme which may eventually help in prevention of fall risk in their older age and will improve life expectancy.

These results obtained from our study are in parallel with some studies in the literature. Erkmen et al. [14] found that body weight and height were positively correlated with static balance in male athletes, but did not find any relationship between dynamic balance and body height and weight. This result is similar to the results of Era et al. [15]. Denerel [16] also found a statistically significant positive correlation between body weight, height and body mass index and dynamic balance score in men. Akgöl [17] reported that taller people are more successful in balance tests. For obese boys aged 10–21, Goulding et al. [18] reported a significant negative relationship between body weight, body mass index, percentage of fat and total fat mass and a clinical balance score (Bruininks– Oseretsky).

There is a consensus in the literature, which was also observed in the present study, that increased height worsens balance [19,20,21]. Alonso et al. [22] found poor correlations between postural balance and the anthropometric variables in subjects aged 20-40. Height was the anthropometric variable that most influenced postural balance for each gender. Postural balance was more influenced by anthropometric factors in males than females.

The study of Kostic and et.al [23] refers to high positive relationship between anthropometric measurements and the skills of coordination among boys and girls.

Andreasi et al. [24] examined the differences between both genders among the lower-elementary school children in static balance, and their relation to anthropometric measurements. They concluded that there is a marginal relationship between body height, body weight, lower limbs length, upper body length, and the static balance performance.

This summarized that the performance of static balance relatively depends upon the body weight and longitudinal measurements.

Sales et al. [25] examined the relation between balance and age, and found that balance relates to growth since grownups have more balance than adolescents. They also found that height and weight significantly affect the balance among kids. Nevertheless, height and weight didn't relate to balance among adolescents.

However, there are studies showing a reverse view on this issue in the literature. In these studies, it has been shown that body height, weight, body mass index are not related to balance tests [8,9]. We support the view that this inconsistency in the literature could be because of different balance tests, measurement and analysis methods performed by the researchers with different age groups [26].

Conclusion

Based on the findings, we recommend conducting similar studies including healthy young females and investigating further physical characteristics in different age groups. We also think that there is a need to conduct new studies determining how anthropometric measurements including lower limbs length, upper body length, leg and heel's width and so on affect the static and dynamic balance.

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