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Male Athlete's Body Composition and Postural Balance Correlation

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Abstract
Balance is the ability to maintain a stable body position that resists forces (gravity, inertia) as a continuous process of detection of spatial understanding of body position (proprioception) and selecting the appropriate responders body (activation of muscle stabilizers). Postural balance, both unilaterally and bilaterally, greatly contributes to the efficient execution of movement structures in sport whether it is cyclic or complex content, with or without props. In addition to the complex nerve - muscle system, which largely contributes to the manifestation of better equilibrium characteristics of the postural balance of the body has a major influence the composition and structure of the body. The aim of the research is to determine the relationship between parameters of body composition and bilateral balance. The study was conducted on a sample of 23 active athletes, high competitive level, age 19-25., height 176 -198 cm and weight 62-98 kg. Bilateral postural balance was measured Biodex Balance System (BBS) standardized procedure, and expressed by the coefficient of overall stability (OSI). Body composition was determined using a Tanita system based on electrical bioimpedance strictly established protocol. Connections are established using the software package SPSS 22.0 and applying bivariate correlation analysis. Set body composition variables have an influence on postural balance. It was found that in this group of athletes extremely negative impact on the statistically significant level ($r > 0.7$, $p < 0, 01$), the overall postural balance with variable amount and percentage of body fat in the body. Positive influence on postural balance ($r < -0.7$, $p < 0.01$) showed a variable percentage of muscle tissue and the percentage of bone tissue within the body. Athletes with the percentage of body fat above 8% grouped worse postural balance. From the standpoint of procedures and systems of measurement, the results are completely valid and impose the importance of body composition in sports dominated balance as fine motor skills.

Key words: **Balance, sensor-motor characteristics, body composition**

Introduction

Balance is the ability to maintain the center of mass of the body within the area of leg support which is common for humans. Human represents the reverse pendulum and therefore can easily lose their stable equilibrium position. Maintaining dynamic balance in humans is a complex process and can be compromised by some kind of neuromuscular diseases or sensor-motor invalid response that leads to movement failure (Beard, 2000). This process depends on the constant possibility of obtaining information through sensory inputs and their interpretation in the central nervous system and determining the appropriate neural muscular action. Muscular control and dynamic maintenance of balance involve the activity of coordinates of muscular kinetic chains (Beynon, et al. 2000; Lephart, et al. 1997). Overall stability indexes (OSI) were found using Biodex Balance System. This index (OSI) is a quantitative estimate used for the evaluation of an individual's neuromuscular control as it pertains to the ability to maintain postural stability on an unstable surface (Pugh,et al. 2012; Biodex Medical System, 2003). Excess adipose tissue and subcutaneous adipose tissue as well as the lack of muscle mass can decrease dynamic stability (McGraw,et al. 2000). The aim of this paper is to reveal correlations between the variables of body composition and overall bilateral balance of male athletes on competitive level.

Method

Sample

The study was cross-sectional character without added intervention and presents view of the situation of athletes and their postural balance and body composition. Research was conducted on a sample of 23 athletes mean 21.04 ± 1.46 (19-25) with an average height of 184.47 ± 5.29 (176-198 cm). All subjects were perfectly healthy, without any knee or ankle injury and clinical instability, vestibular or neuromuscular disease. All participants were actively involved in sports on competitive level. Five in basketball, three in volleyball, ten in football and five in athletics - sprint technical disciplines.

Body composition assessment protocol

Each participant signed the informed consent and the protocol of testing. Body composition was measured using a medically approved scale Tanita BC420SMA (Tanita Corp, Tokyo, Japan), a commercially available foot to foot bioelectrical impedance analysis system (BIA) (Nunez et al., 1997; Utter et al., 2001), which analyzes body composition using electrical impedance drop (Jebb et al., 2002). The measurement was performed in the morning after a period of overnight fast. All the subjects at the time of measurement wore only shorts and did not have any metal or jewelry on their body. Variables of body composition obtained by this protocol are shown in table 1.

Overall stability index (OSI) assessment procedure

Overall postural balance is measured using Biodex Balance System (BBS- Model 945-300, Biodex Medical Systems; Shirely, New York) at the level 4 (range from 1- most difficult to 8- least difficult) protocol stability. The degrees of tilt from horizontal are measured and used to calculate an overall stability index (OSI) (Arnold, 2005). Protocol for general postural stability - dynamic bilateral stance assessment, means a dual test of 20 seconds (Finn, et al, 1999; Nevitt,et al. 1991; Biodex Medical System, 2006) was derived for each subject. For each subject identical protocol of 5 trials of 20 seconds and 30 seconds rest period at level 4 difficulties were implemented for determining overall balance index (OSI). For each repeated attempt the exact foot position, on balance board, was re-entered.

Software package SPSS 22.0 IBM has been used for data analyze. Data were recorded and basic calculations of central tendencies and variability of data distribution were calculated. To determine the relation between body composition variables and postural balance bi-variant cross correlation analysis were applied. Tables and charts are used for displaying the results.

Results

Reviewing table 1 it can be concluded that data recorded in all of the variables are within the normal distribution range and as such can be used for further processing.

Table 1. Basic measures of data distribution

Descriptive statistics								
		N	Min	Max	Mean	SD	Skewness	Kurtosis
Age	AGE	23	19	25	21,04	1,46	1,35	1,52
Body height	AHIG	23	176	198	184,47	5,29	0,684	0,597
Body mass	AMASS	23	62,7	97,7	78,82	9,24	0,193	-0,512
Fat tissue mass	AFATMASS	23	2,2	14,4	6,57	3,49	0,851	-0,215
Fat percentage	AFATper	23	3,2	15,6	8	3,45	0,73	-0,219
Fat free mass	FFM	23	59,3	87,8	72,24	6,4	0,074	0,487
Muscle mass	AMUSCMS	23	56,3	83,5	69,01	6,23	-0,056	0,225
Muscle mass percentage in body mass	AMUSCMSper	23	80,22	97,91	87,87	3,94	0,147	0,897
Total body water	TBW	23	40,5	60,5	49,93	4,31	0,109	0,748
Total body water percentage	TBWper	23	54,5	68,8	63,18	3,36	-0,648	0,742
Bone mass	ABONMS	23	3	4,3	3,56	0,3	0,165	0,287
Bone mass percentage	ABONMSper	23	4,13	4,78	4,54	0,18	-0,475	-0,294
Basal metabolic rate	BMR	23	7259	11025	8906,6	849,44	0,212	0,564
Body mass index	BMI	23	19,1	27,2	23,15	2,48	0,257	-1,215
Overall stability index	OSI	23	1,2	4,7	2,31	1,03	1,096	0,557

Table 2 reveals that extremely high positive correlation ($r > 0.69$ statistically significant *at* $p < 0{,}01$) were found between overall stability index (OSI) and variable fat tissue mass (AFATMASS) ($r = ,758$) - Figure 1, as well as variable fat percentage (AFATper) ($r = 0{,}775$) - Figure 2. Knowing that better OSI result represents a lower value it can be said that adipose tissue and the percentage of fat in the body decreases overall stability index (OSI). Negative correlation ($r < -0{,}69$; $p < 0{,}01$) are found between overall stability index (OSI) and variable muscle mass percentage in body mass (AMUSCMSper) ($r = -0{,}736$) – Figure 3, as well as variable bone mass percentage (BONMSper) ($r = -0{,}715$) - Figure 4. Knowing that better OSI result represents a lower score this result suggests that higher muscle and bone percentage in the body can increase postural balance and overall stability index (OSI).

All of the other variables of body composition also have a correlation with the overall stability index that is on statistically significant level, but the correlation coefficient *r* is below ± 0,7. High positive correlation coefficients with

overall stability index (OSI) were found between body mass (AMASS) (*r* -0,648) and variable body mass index (BMI) (*r* -0,604). As the result of postural balance is inversely scaled it can be concluded that higher body mass and a higher coefficient of body mass index (BMI) may adversely affect the overall stability index (OSI).

Table 2. Bivariate cross correlation

Correlations coefficients	
	OSI
AGE	,423*
AHIG	,501*
AMASS	,648**
AFATMASS	,758**
AFATper	,775**
FFM	,521*
AMUSCMS	,465*
AMUSCMSper	-,736**
TBW	,486*
TBWper	-,569**
ABONMS	,554**
ABONMSper	-,715**
BMR	,543**
BMI	,604**

** - p < ,01 * - p < ,05

Discussion

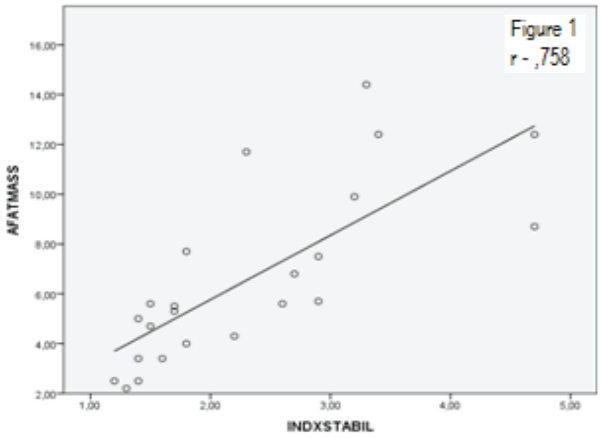
On postural balance in athletes may adversely affect the value of higher total body weight with all structures (adipose tissue, muscle tissue, bone tissue and water) in body composition. Extremely negative effect on postural stability in has percentage of adipose tissue within the total mass of the human body, especially in the extremely obese teenagers and adult patients (Ledin, 1993; McGraw, et al. 2000). Due to the high levels of performance and increased energy consumption (Mayer et al, 1954) athletes have decreased the amount of total fat in subcutaneous tissues. Based on these findings is a conclusion that athletes should have a better overall stability index. Also, their sensor-motors characteristics are on extremely high level so that fat can have a real role in the level of postural balance in athletes. The authors report that obesity (high BMI) will affect the selection of the engine strategies employed to maintain postural balance (McGraw et al., 2000).

Looking at the results it is evident that athletes with the amount of fat that exceeds 8 % of total body weight have significantly reduced the overall test result in the index of stability - postural balance. Muscle mass and its share in body composition based on the results contribute to a better postural balance. Based on Figure 3 it can be concluded that athletes who have less than 85% of muscle tissue grouped significantly worse results. The fact is that muscles are the main generators of stabilization of the joints, and thus the overall balance of the body. Muscle tissue (muscles) is the executive body of the sensor - motor apparatus, which is in general responsible for balancing the body. Given that greater weight of the body impairs postural balance and larger muscle mass improves stability it is a must to find an appropriate ratio in body composition and "design'' of body composition to the specifics of the different sport. Most authors in their researches confirmed the fact that the lack of muscle mass impairs postural balance and can lead to falls among senior population and mead age population (Kejonen et al., 2003). The percentage of bone tissue in the body contributes to better postural balance. Studies conducted in the elderly have shown that a greater percentage of bone tissue in the body prevents falls in the elderly for up to 89% (Nevitt et al., 1991). Given that bone tissue in athletes has characteristics of a healthy and strong tissue same conclusion is derived - bigger and better bone structure contributes to better postural balance. BMI is commonly linked with balance of the body. This study, as well as numerous previous studies, has shown that a high BMI, according the percentage of fat in body composition, can have distinctly negative influence on postural balance and overall body balance.

Conclusion

As the stability index is calculated based on the data entered for each subject with the given instability parameters at multi-axial platform ("Biodex" Balance System), as well as the data obtained with the body composition by entering identical data and the resistance flow of electric through the body ("Tanita"). Proper measurement with strict adherence to the protocol provides a valid starting point for this research, so it can be concluded that the results provided in the discussion are credible at all.

In interpreting these results, interesting is that a relatively homogeneous group of athletes achieved different levels of posture stability index with the key conclusion that the respondents, with lower body weight, which highly correlates with the body height, reaches lower values of the stability index at multi-axial balance board. High correlation coefficients were calculated for variables that tells of subcutaneous adipose tissue and body weight, which negatively affect the stable projection of the body center of gravity on unstable moving platform where the respondent standing.



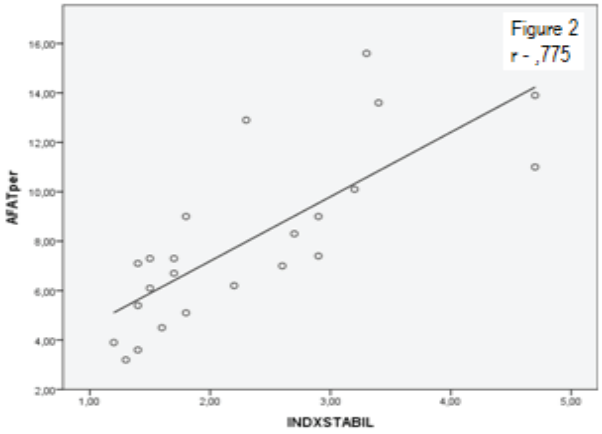


Figure 1and Figure 2 Adipose tissue and postural balance relations

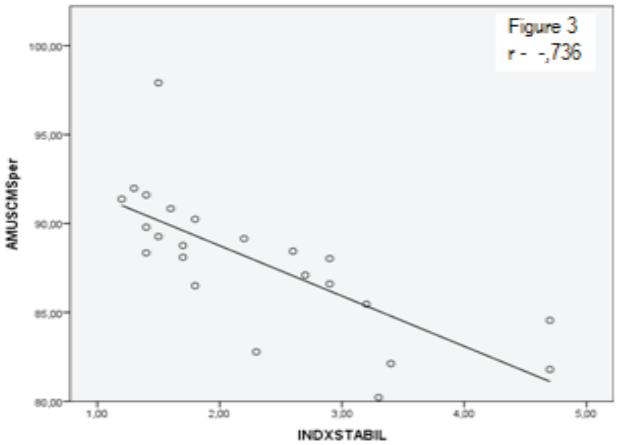


Figure 3. Muscle mass percentage and postural balance relation

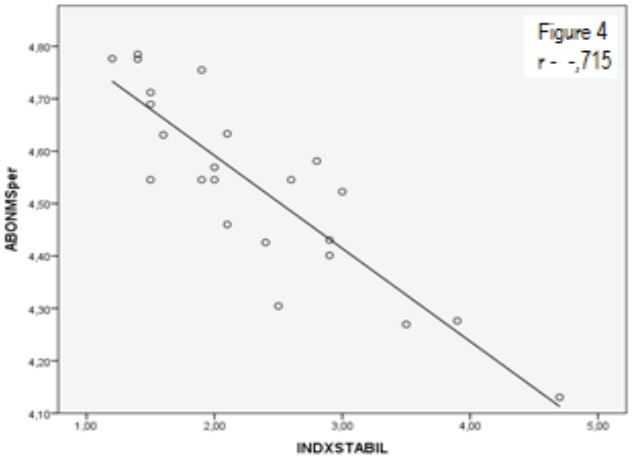


Figure 4. Bone mass pecentage and postural balance relation

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