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Comparing the Static and Dynamic Balances and Their Relationship with the Anthropometrical Characteristics in the Athletes of Selected Sports

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Abstract: The purpose of this study was done to compare the static balance with the dynamic one and their relationship with the anthropometrical characteristics in the athletes of selected sports. 50 healthy athlete students (16 handball players, 9 basketball players, 15 futsal players and 10 volleyball players) who had participated in the sport events of Azad University's region 1, were involved voluntarily. By the use of caliper, tape measure and digital scale, anthropometrical characteristics were measured. The static balance was measured by the stork test and the dynamic balance was evaluated by using the YBT in three directions. The results of the study showed that the static balance has a significant difference between the handball and volleyball groups (P= 0.018). Also, the dynamic balance between the handball and volleyball groups (P = 0.010) and basketball and volleyball groups (P= 0.017) showed a significant difference. The results of Pearson correlation coefficient showed that the significant difference exists only among the height, weight, pelvis perimeter, thigh perimeter and shin perimeter variables and the static balance of the athletes ($P\leq0.05$). The results of Pearson correlation coefficient also showed that the athletes' dynamic balance has significant relationship with only the weight, pelvis perimeter, thigh perimeter, shin perimeter, body fat and the BMI variables ($P\leq0.05$). In order to determine effectiveness of predictive anthropometrical variables on the standard variable of static and dynamic balances, the Enter multiple regression method was used. The variables are brought in one block, which was not significant statistically. In general, the results of the present study, showed a correlation between the anthropometrical characteristics and the static and dynamic balances parameters.

Key words: Static Balance · Dynamic Balance · Anthropometric

INTRODUCTION

Stability of the height is regarded as an important health index of the skeletomuscular system and it is highly significant clinically. The importance of balance in the athletic performance and the injury prevention has also been disclosed [1-8]. Balance means the power to keep the body's center of mass in its base of support with the least oscillation or the most stability [2-5, 9]. Keeping the body balance requires the coordination of sensory, neurotic and skeletomuscular systems [2-5, 10]. The height status control or balance can be classified as static (the ability to remain in a basic status with the least movement) or dynamic (the ability to perform an action in a stable status) [11]. In the sport fields, the athletes face situations where their balance changes by each step they take, their sprint and jump [12]. The athletes normally have better balance ability than the non-athlete individuals. Also, the higher level athletes have better balance than the lower level athletes [5, 13]. Some evidences in the studies express that the better balance in the experienced athletes is mainly due to the repetitive exercises they do, which affects the kinetic responses and it does not related to the better sensitivity of the sight system [14]. Some other researchers believe that the better balance is the result of the exercise experiences that influences the person's ability in gaining the related sight and proprioceptive signs. Although the experts in the

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field may not agree with this mechanism, the studies suggest that the changes in both sensory and kinetic systems, affect the balance performance [14].

Every sport needs various levels of sensorimotor processes to perform skills and to protect the muscular system against the injuries. For instance, the basketball players often do skills such as passing, shooting and dribbling with the upper limb, while they wear shoes on flat and rough surfaces. Their skills need joints' high speed while jumping, landing and the quick sudden maneuvers. The footballers often do skills such as passing, shooting and dribbling with the lower limb, while they wear studded or simple football boots in different situations of the pitch [14]. The skill needs and the environmental situations of the said sports probably will create different challenges for the sensorimotor systems, which finally affect the athletes' balance ability [5, 14].

In general, it is accepted that the anthropometrical and performance characteristics, are necessary to achieve success in different sports. As a result, the recent studies have gone for identifying the required characteristics for participating in the sports. In the recent three decades, multitudes of anthropometrical and physiological measures have been done. Various types of measures such as age, athletic record, height, weight, the weight of fatless body mass, fat weight, somatotype, muscular strength, muscular stamina, body fat and vertical jump were done in the studies [15].

Various neurophysiological and mechanical factors can affect the balance. Features such as height, weight, body composition, base of support, the distance of center of mass from the ground, the length and weight of each limb, the length of muscles' torque arm and the mass distribution in different body points can mechanically affect the individuals' balance [16]. Identifying the factors which enhance the performance in a certain field is the goal of any coach, trainer and athlete so that by the use of them, a correct and complete training plan can be designed for that field [14].

Although some studies have compared the balance among the athletes of different sports, according to our information, the investigation of the relationship between anthropometrical characteristics and body composition and balance in different sports is an issue less considered. Therefore, the purpose of this study is to create a multiple regression model for determining the effect of anthropometrical indexes such as weight, height, BMI, skinfold, back perimeter, pelvis perimeter, leg length, shin length, thigh length on the static or dynamic performance change. It is hoped that the results of this study give useful information to the athletes and coaches about the detection of the anthropometrical characteristics effect and also be useful for the sport experts in the issue of scouting beginners with various body features or even in selecting different sports.

MATERIALS AND METHODS

For achieving the goals of the study, 50 athlete students (16 handball players, 9 basketball players, 15 futsal players and 10 volleyball players) participating in university events, were used as subjects, selected by the convenience sampling method. Before doing the test, the health of the subjects was assured, by using the injury questionnaire. After selecting the subjects, a complete explanation of the goals and the methodology was given and the subjects were asked to read and confirm the research participation consent.

For measuring the weight of the subjects, a scale with 100-gram accuracy and for measuring the height, waist, pelvis perimeter, leg length, shin length and thigh length 0.1 centimeter accuracy were used. After measuring the height and the weight of the subjects, the body mass index was calculated. The skinfold at three regions of triceps brachii muscle, thigh, upper pelvis and belly was measured by using the Lafayette caliper and the body fat percentage was calculated by using the Jackson-Pollock formula. An instance of dynamic performance test is the Y balance test, introduced by Plisky and Hertel as a modified version of Star Excursion Balance Test (SEBT). The researcher reported the intra-test reliability excellent (ICC=0.88-0.99, $p \leq 0.01$) [17].

For evaluating the static balance, the stork stand static test was used. The sequence of static and dynamic balance tests was random. Some of the subjects would do the static test first and then they would proceed to do the dynamic one, while some others did so vice versa. Meanwhile the two static and dynamic tests, a 5-minute interval was considered for rest.

Firstly, the naturalness of the data distribution was determined by using the Kolmogorov–Smirnov test. For investigating the difference of static balance and dynamic balance among various sports, the one-variable variance analysis and in case of observing any meaningful difference, in order to determine the difference point, the Tukey's post-hoc test were used. Also by the use of Pearson correlation coefficient, the measured parameters' correlation was evaluated and the static and dynamic balances were determined. In order to define the predictability (effectiveness) of the parameters on static and dynamic balances, the Enter multiple regression method was used. The meaningfulness level for all the calculations was regarded $P \leq 0.05$. The statistical calculations were done by the SPSS software (Version 16.0, SPSS Inc.).

RESULTS

In Table 1, the descriptive data of the subjects are put, for each sport separately.

The results of one-way variance analysis showed that the static balance among different groups has meaningful difference ($P = 0.034$, $F_{3, 46} = 3.142$). In order to investigate more and to observe this matter that the difference among the groups, exactly arose from the difference of what groups with each other, the Tukey's post-hoc test was used. The results of post-hoc test showed that the static balance between handball and volleyball groups has meaningful difference (P=0.018), but the static balance between the handball and futsal groups (P=0.554), handball and basketball (P=0.557), basketball and volleyball (P=0.449) and futsal and volleyball (P=0.259) does not have meaningful difference (Figure 1).

In order to investigate the dynamic balance difference among the different handball, basketball, volleyball and futsal groups, the one-way variance analysis (ANOVA) in the meaningfulness level of α=0.05 was used. The one-way variance analysis showed that the dynamic balance between different groups has meaningful difference ($P=0.004$, $F_{3, 46} = 5.072$). In order to investigate more and to observe this matter that the difference among the groups, exactly arose from the difference of what groups with each other, the Tukey's post-hoc test was used. The results of post-hoc test showed that the dynamic balance between handball and volleyball (P=0.010) and basketball and volleyball (P=0.017) groups, has meaningful difference, but the dynamic balance does not show meaningful difference among the handball and futsal (P=0.150), handball and basketball (P=0.996), basketball and futsal (P=0.180) and futsal and volleyball (P=0.532) groups (Figure 2).

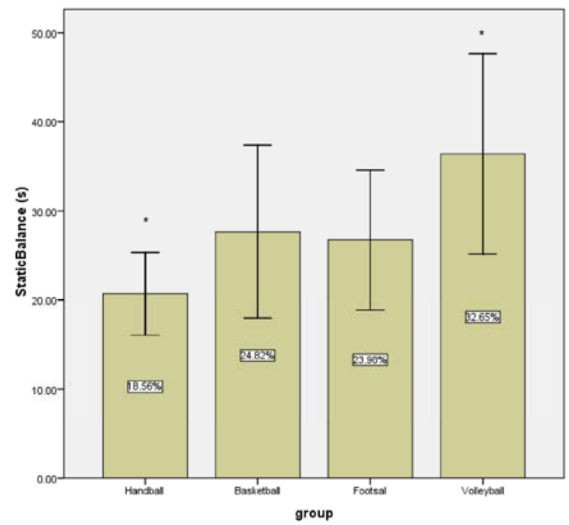

Fig. 1: The mean static balance in groups. ?differences at p-level of 0.05

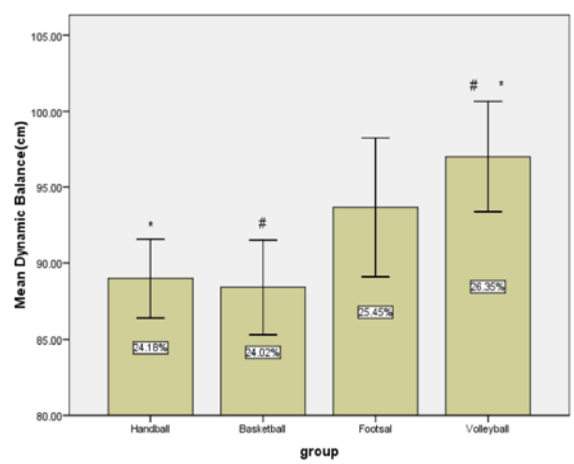

Fig. 2: The mean dynamic balance in groups. ?#differences at p-level of 0.05

Table 1: descriptive data of subject in each group

Sport	Number	Age	Height	Mass	Waist	Pelvis Perimeter	Body Fat Percentage	BMI	Static Balance	Dynamic Balance
Handball	16	22.13	1.82±0.05	80.84±1.14	85.84±8.22	90.62±7.05	15.59±5.28	24.72±3.00	20.68±8.68	88.99±4.86
Basketball	9	20.89	1.81±0.05	70.72±1.00	77.11±5.79	95.22±6.36	10.63±6.69	21.49±2.83	27.66±1.26	88.42±4.04
Futsal	15	21.93	1.81±0.07	69.26±7.10	76.40±5.12	94.40±5.05	10.18±4.06	21.07±2.26	26.73±1.41	93.67±8.25
Volleyball	10	23.50	1.81±0.07	73.00±9.28	79.70±6.34	95.00±5.73	11.74±5.99	22.10±2.49	36.40±1.57	97.01±5.04

For showing the relation and the correlation among the measured parameters and also the static and dynamic balances, the statistical method of Pearson correlation coefficient was used. Then for showing this issue that which one of these measured parameters is a better predictive for static and dynamic balances variables, the multiple regression method was used. The Pearson correlation coefficient showed that there is not a meaningful relation among the variables of height (P=0.023, r = 0.38), weight (P= 0.004, r = 0.48), pelvis perimeter (P = 0.033, r = 0.51), thigh perimeter (P = 0.003, r = 0.44), shin perimeter (P = 0.002, r = 0.45) and BMI (P = 0.023, r = 0.43) with the static balance of the athletes. The Pearson correlation coefficient showed that there is a meaningful relation among the variables of weight (P= 0.013, r = 0.42), pelvis perimeter (P = 0.023, r = 0.45), thigh perimeter (P= 0.001, r = 0.43), shin perimeter (P =0.002, r = 0.39), body fat (P = 0.004, r = 0.44) and BMI (P = 0.022, r= 0.45) with the dynamic balance of the athletes. While between the other variables and the dynamic balance of the athletes, no meaningful relation was observed (P < 0.05).

For determining the effectiveness of predictive variables such as height, weight, waist, pelvis perimeter, thigh perimeter, shin perimeter, thigh length, shin length, leg length, body fat and BMI on static balance standard variable, the Enter multiple regression was used. The variables was put in one block, which is not meaningful statistically ($P < 0.05$, R^2adjusted = 0.031, $F_{11,\ 38} = 1.143$). For determining the effectiveness of predictive variables such as height, weight, waist, pelvis perimeter, thigh perimeter, shin perimeter, thigh length, shin length, leg length, body fat and BMI on dynamic balance standard variable, the Enter multiple regression was used. The variables was put in one block, which is not meaningful statistically ($P < 0.05$, R^2adjusted = 0.022, $F_{11,38} = 1.101$).

DISCUSSION AND CONCLUSION

The main purpose of this study was to investigate the possibility of presenting a regression model for determining the effect of anthropometrical indexes such as weight, height, BMI, skinfold, waist, pelvis perimeter, shin perimeter, leg length and body fat on the static and dynamic balance performances. Comparing static and dynamic performances among different sports is an issue investigated in some studies. For instance, the results of a study on the female athletes showed that the gymnasts and footballers have similar static and dynamic balances. In contrast, basketball players, have lower static balance compared to the gymnasts and lower dynamic balance compared to footballers [14]. According to our information, a part of the statistical differences observed among sports, is related to the facing challenges of every sport. For example, gymnasts often do the immobile balance skills on the balance beam like the BESS static balance. Hence, the gymnasts may have more concentration on the signs changing the balance performance, such as the little changes in the joint position and speed. On the other hand, the basketball players rarely have immobile balance on one leg and often pay attention to the signs related to the ball and the players' positions. As a result, it is possible that the static balance in them be less developed than the gymnasts. Also in case of dynamic balance, footballers often do one-leg movements outside their base of support such as passing, receiving and shooting, maybe this is the reason why they have better dynamic balance than the basketball players. However, there is no direct evidence in this case. The exercise experiences which develop the neuromuscular harmony, joint power and the motion range may be the mechanisms which improve the balance [14]. The results of our research showed that the static balance has significant difference only between handball and volleyball groups. Also the dynamic balance between handball and volleyball, as well as between basketball and volleyball showed meaningful difference.

The results of the present study, showed a meaningful correlation between static balance and the anthropometrical indexes such as height, weight, pelvis perimeter, thigh perimeter, shin perimeter and BMI; this means that the taller a person is, the lower the static balance will be. Our research results were compatible with the results of Chiari *et al.* [18]. They also showed that the height has a meaningful and positive relation with the center of mass movement in both anterior-posterior and internal-external directions. But our results were not compatible with those of the Berger *et al.* [19]. They investigated the relation of height with the body's swing regulator movements in the ankle joint while keeping the balance with the limited base of support. Their results showed that the shorter a person is, the coactivation and the electrical activity of the plantar flexor muscles and the ankle's dorsiflexors are higher and the ankle movement is also more, that means more movements are done to control the pressure center movements in the base of support. But the important issue is that they considered the base of support exactly the same size the sole's size. Their other important result was that the produced torques of tall individuals in the ankle joint is higher than those of the short people. This issue shows that as the tall people have longer torque arms, consequently considering the computational formula of torque, there is no need for their muscles to produce high muscle tension to have similar muscular torque (equal to short individuals). From this aspect, it can be said that our study was compatible with theirs, as they showed that tall people despite having less regulator movements in ankle joint, have proper control on the height swing due to their advantage of having longer torque arm [19]. This issue can be because of this reason that, the taller a person is, the higher the center of mass will be and by considering the relation of center of mass's height and the base of support and the balance [20, 21], it seems reasonable that the more the height is, the less the balance will be. The results also showed a positive meaningful relation between the weight and the static balance. This result is probably due to this fact the higher the weight is, the more power is needed for disturbing the static balance and the stability of a person and as a result the person would have higher stability and static balance. As said before, the higher perimeter of the limb is an index of more percentage of muscles in the limb. The higher muscle percentage and higher BMI with less fat can produce more force and dynamic stability in the lower limb joints and this can lead to the athletes' more static balance [20, 21].

The results of the present research showed that the reach distances in the dynamic balance evaluated by YBT, has a positive relation with the height, but this relation was not statistically meaningful. As Gribble *et al.* [22] showed, it is correct that the height has a meaningful relation with the reach distance, but this relation is not meaningful and if it is meaningful, compared to other anthropometrical indexes has less predictive power and its relation intensity is low. However, it should be noted that Gribble *et al.* did a study only on SEBT and did not study other dynamic balance tests. In our study, the YBT test was used which was an adjusted form of SEBT, therefore it is probable that these tests be essentially not sensitive to height, otherwise if we evaluate the dynamic balance in other test, we probably find that the height is an important variable in the dynamic balance. Also the results showed a negative and meaningful relation between the weight and the dynamic balance and also a positive and meaningful relation between dynamic balance and the characteristics namely the pelvis perimeter, the thigh perimeter, the shin perimeter, the body fat and the BMI. Similar to the explanation presented for the relation between static balance and the mentioned indexes, it seems that the increase in the perimeter of lower limbs leads to a decrease in the body fat percentage and also by considering the higher BMI which is an index of the athletes' muscular posture and his/her high physical fitness, it can be argued that by increasing the mentioned indexes, the athlete can have more fitness in order to change the existing pressure center in the sole, for actively disturbing one's balance and this issue has led to more dynamic balance in the athletes [20, 21].

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