ANTHROPOMETRIC MEASUREMENTS AND THEIR RELATION TO STATIC AND DYNAMIC BALANCE AMONG JUNIOR TENNIS PLAYERS

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Abstract

This study aimed to identify the anthropometric measurements and their relation to the static and dynamic balance among junior tennis players. Twenty four male junior tennis players (under the age of 19) who were registered to compete in the 2015 national age-group championships participated in this study. Twenty three anthropometric and morphological measurements were conducted (weights, heights, widths, circumferences, and skinfold thickness). The results showed that the most significant contributor to the static balance was the pelvic width (P=0.011). Calf circumference and ankle width were most significant in the Dynamic balance (P=0.001 & P=0.004) respectively. Based on the findings we recommend that the anthropometric and morphological measurement be taken into consideration when selecting junior tennis-players. We also recommend conducting similar studies for female athletes and investigating further physical characteristics and multiple age-groups and compare it with elite athletes from countries better known in tennis.

Key words*: Anthropometric measurements, Static balance, Dynamic balance, Tennis player*

Introduction

Tennis is the most popular worldwide sport which is characterized by high intensity, short-term actions and pauses of varying length (Gupta, 2007). To succeed in sport, players need the optimal combination of technical, tactical, physical and anthropometric characteristics and mental motivation. Indeed, many experts in the field such as coaches, managers and scientists believe that the success of this sport can be associated with anthropometric characteristics of players (USTA, 1995). Anthropometric measures and motor abilities provide important information about normality of body size, health condition, and body shape (Munoz-Catol, 2007; Kurt, Catokkas & Atalog, 2011). Scientists define anthropometric measurements as the study of human body measurements and its different parts and revealing its structural differences. Zawawi (2012) pointed out that anthropometric measurements depend on calculating the amounts of external body structures (heights, widths, and circumferences). The importance of anthropometric measurements in physical education can be summarized as the important factor for selection process of players. Anthropometric measurements also contribute to the refining of athletes' physical skills starting with the junior stage until the Olympic level (Sa'eid, 2008). Therefore, anthropometric and morphological requirements came into seen as a decisive factor in many sports and were also linked to many physical abilities (Zawawi, 2012). Additionally, Anthropometric measurements became very important in talent identification and a major predictor of success in competitive sport (Abdullah, Aziz, Ismail & Muhammad, 2011). Many researchers pointed out that each sport skill needs specific physical trait which positively affects performance (Ahmad, 1999; Al-Harhouri, 1994, Cox, 2011, Babayigit, 2014). That was also assured by Al-Bisati (1998) who refers to the existence of high relationship between the physical abilities and anthropometric measurements for all performance levels of different sport activities. Thus, it is important to consider the body structure and physical requirements when selecting athletes for each sport (Ben Brahim, Bougatfa & Mohamed, 2013). Coordination skills are complex motor skills which can be further developed by means of exercise. During exercise, complete movement structures are repeated, in which the movement of all body parts or just certain sections of the body are connected (Kostic, Duraskovic, Zivkovic, Uzunnovic, & Zivkovic, 2009). Coordination skills are especially pronounced during physical activities, sport, recreational activities, fitness or kinesitherapy (Wang1991). Neuro-muscular activity represents the basic function in all forms of physical activity and is used to harmonize the movement of the body and all its parts in time and space (Liliana, Hazar, & Puni, 2014). Bahman, David, Ioannis and Navid (2011) referred to balance ability as one of the most coordination skill. Balance ability plays significant role in achieving motor skill by the two types of balance, the static and the dynamic. Static balance is the one in which the individual retains poise in one single situation, whereas the dynamic balance is the body's ability to retain poise or steadiness when moving or shifting from one balanced situation to another. Viviane, Edilaine, Ana, Rinaldi and Carlos (2010) 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 standing 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, Browne, Asano, Olhera, Novad, and Simoes (2014) examined the relation between balance and age, and found that balance

relates to growth since grownups have more balance than adolescents. They he also found that height and weight significantly affect the balance among kids. Nevertheless, height and weight didn't relate to balance among adolescents. Most studies have been identified the level of motor abilities, anthropometric characteristics for identification of talents, the level of body development; and the harmony of the body. The study of Kostic and et.al (2009) refers to high positive relationship between anthropometric measurements and the skills of coordination among boys and girls. Sa'eid (2008) pointed out that there is a statistically significant relationship between straight smashing skill and each of shoulders and pelvis width, as well as between this skill and the width of the open hand's palm. Abdullah et al (2001) proved that sportsmen are distinguished in some games from their counterparts in many anthropometric measures such as trunk height, width of the shoulders, and the narrowness of pelvic. Tennis is considered one of the most popular racket sports. it is an integrated game regarding its dependence on the skillful, planning, physical, mental, intellectual requirements, as well as the suitable body structure (Gupta, 2007; USTA, 1995). Al-Hammouri (1996) pointed out in his study that tennis players outperformed badminton players in the following anthropometric measurements: age, body fat percent, weight, fat-free mass, chest width, pelvic width, chest circumference, abdominal circumference, pelvic circumference, upper arm circumference, pelvic depth, and abdominal depth. Additionally, he reported that tennis players outperformed table tennis players in body weight, upper arm circumference and chest depth. Abbas (2008) indicated a significant relation between some anthropometric, functional measurements and skill performance. The most important functional and anthropometric measurements contributing to skill performance were (Body height, arm length, upper arm circumference, pre-effort Heart rate, post-effort heart rate, vital capacity and maximal Oxygen consumption). Given the great importance of anthropometric measurements in selecting junior tennis players, and the fact that tennis requires special body requirements and characteristics to be available among players as well as certain physical abilities different from any other game, in addition to the scarcity of studies examining the relationship between balance and anthropometric measurements, this scientific research was conducted in order to identify the special body characteristics needed for junior tennis players. The results could possibly play a major role in improving the players' performance levels.

Statement of problem:

Tennis game didn't capture the needed attention within the field of scientific research. Most researches in tennis game focused on physical fitness and abilities. Little attention was directed to the relation between the anthropometric measures and physical abilities. Also, interest in junior groups, which form the base of any sport, is still suffering from lack of needed attention, despite the fact that it has become a field of research and study in many countries all over the world and for a very long time. Moreover, there is lack in information related to anthropometric measurements, motor and physical factors related to tennis in Arab countries, particularly those related to motor abilities such as balance. These points altogether help set up the problem of the study, which will hopefully reveal logical solutions based on scientific foundations through studying the anthropometric measurements contributing to some static and dynamic balance for Jordanian tennis junior players.

Study aim

The aim of the present study was to identify the impact of some anthropometric measurements on static and dynamic balance among junior tennis players in Jordan.

Methodology

Study design: The descriptive approach was used for its suitability to the nature of the study. *The sample:* Twenty four junior tennis players were selected randomly from the participants in the local tennis championship that held in Amman in May 2014. Table (1) shows the features of the study sample.

Table 1 Sample description

Variables	Age year	Height cm	weight kg
Mean	17.8	176.3	61.2
Std.	1.50	6.931	5.651

The tools of the study:

The devices and tools used for anthropometric measurements and balance: 1) Tape measures for measuring heights and circumferences, 2) Skin fold caliper to measuring fat thickness; 3) Restmeter for measure height and weight; 4) Pelvimeter device for measuring widths; 5) Balance beam for measuring static balance; 6) Octagonal figure device for dynamic balance.

The tests and measurements conducted

The following measurements and tests were conducted as tools for gathering data from the study sample: First: the anthropometric measurements (NHANES, 2005):Weight, heights/lengths: (total body length; total arm length; total leg length; upper arm length; forearm length; wrist length; trunk length from sitting; thigh length; leg length), Widths of (shoulders, chest, pelvic; hand), circumferences: (pelvic, thigh, chest, upper arm, calf circumference, fore arm), Body mass index and fat thickness for the following areas: (Sub scapular, triceps, chest, abdominal, supraspinale, thigh, medial calf). After recording these measurements, the body intensity was extracted from 7 areas according to the following formula (for men): (Howley & Franks, 2002): Body intensity= 1.112 – 0.00043499(K1) + 0.0000055(K1)2 – 0.00028826 (age) Where: K1 means the total of fat percentages in the pre-

mentioned 7 areas. K1 (2) means the square of fat percentages total in the pre-mentioned 7 areas, Then, Siri's formula was adopted for calculating the amount of fat in the body, and it is as follows: (Viviane & et.al, 2010): Fat amount= (495/body intensity) - 450 Second: the following balance tests: Tests of standing on the balance beam (longitudinal method) to measure the statistic balance; Octagonal figure device for measuring dynamic balance.

The procedures

These are the procedures: a) The researcher and his assistants (MA and PHD coordinated with the Jordanian Tennis Federation and the committee organizing the championship and teams in order to implement the required measurements and tests; 2) Defining the study variables; c) Defining the anthropometric measurements: In light of the researcher's personal experience in the field of tennis in specific, and racket games in general, and after reviewing the related literature and studies, the anthropometric measurements were adopted which, in their own point of view, play a great role and directly affect players' achievement and skill performance. Then, these measurements were reviewed by five qualified experts who were chosen from the national teams' coaches and specialists in this field in order to ensure the importance of these measurements. The survey results indicated that all anthropometric measurements suggested by the researcher were significant and affective. D) Defining balance tests: After identifying the two abilities of static and dynamic balance as motor abilities, a set of tests were suggested for measuring these abilities, and they were reviewed by a group of experts. Then, the test of standing on the balance beam was chosen for measuring the static balance, and octagonal figure test for measuring the dynamic balance.

Conditions for conducting measurements

There are some important conditions that were taken into considertion when conducting and implementing the anthropometric measurements: a) Conducting measurements using one method; b) Implementing the 1st and the 2nd measurement using the same tools if it is repeated; c) Conducting measurements within a unified daily timing; d) Defining the physiological points that facilitate implementing measurements using one method (NHANES, 2005).

Data Analysis

Multi-regression analysis was used in its Stepwise method to achieve the aim using SPSS software.

Results and Discussion:

For achieving the study aim, which refers to “identifying the anthropometric measurements and their contribution to static and dynamic balance among Jordanian junior tennis players", multi-regression analysis was used, as clarified in tables.

Table 2 Multi-regression analysis results for the variable of static balance

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
				R Square Change	F Change	df1	df2	Sig. F Change
.55[a]	.30	.26	9.26	.30	8.02	1	19	.011

Predictors: (Constant), hip width

Table 3 Multi-regression analysis results for the variable of dynamic balance

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
				R Square Change	F Change	df1	df2	Sig. F Change
.29[a]	.08	.08	4.90	.08	14.67	1	19	.000
.36[a]	.13	.12	4.79	.05	8.49	1	18	.004

Predictors: (Constant), Calf circumference

Predictors: (Constant), Calf circumference, Ankle width

The table shows that the value of correlation coefficient between the dependent variable (static balance) and the independent variable (hip width), which was included in the regression formula, was (0.545), and the value of (R Square) which refers to the entire contribution percentage was (0.297). It is also clear in the table that the value of (Adjusted R Square), which refers to the contribution amount for the independent variable in explaining variance within the variable of static balance, was (0.260), and this is a statistically significant value because its F-value was (8.018), with a significance level of (p = 0.011). This indicates that the only independent variable from the anthropometric measurements having a statistically significant effect on the dependent variable (static balance) is the hip width, whereas the other independent variables were not statistically significantly affective on the variable of static balance. That could be explained in that the hip's extension and width contribute to maintaining static balance as a good base for the player. Also, the hip's extension allows a large moving scope for the players' legs, and consequently increases the exerted power that would in turn increase the player's ability to largely overcome and achieve more strength. It also has an impact on increasing the legs' muscular strength, the more the hip's width increases, the moving scope of the hip knee increases (Bahman, Mirzaei; David, Curby; Ioannis, Barbas & Navid, Lotfi, 2011). As a result, the legs' movement speed increases. Moreover, the increase in thigh's length and the player's entire length raise the circle's half perimeter which would lead to

increasing the perimeter speed, and then increase the legs' movement speed that would contribute effectively to maintaining and reinforcing balance (Kostic et.al, 2009). Commenting on what has been mentioned, the movement speed for the legs' muscles depends upon the functional competence of the flexor and extensor muscles in the hip, knee and foot joints. Also, the hip's muscles play a role in the legs' movements given that the hip area is where the thighs' bones start, and which is attached to the legs' bones through the knee joint. But the bottom muscles in particular play a role in extending the hip joint (thigh), especially the maximus gluteus muscle which is considered the strongest muscle in the human body, as well as rotating thighs outwards (Bahman, et.al, 2011). Since the movements of walking and running are mainly interchanging movements between flexor and extensor the hip joint (thigh), knee and the legs' pushing power on the ground which mainly depends on the hip's moving power, the hip muscles, particularly the maximums gluteus muscle, are the main muscles being trained when performing the tennis skills, in which quick exchanging movements of flexor and extensor the hip joint occur (Bahman, et.al 2011). Accordingly, that the hip width showed the impact in static balance variable through the role of the hip muscles in flexor and extensor the hip joint. The table clearly shows that the value of correlation coefficient between the dependent variable (dynamic balance) and the independent variables (calf circumference, ankle width), which were included in the regression formula, was (0.355), and the value of (R Square) which refers to the entire contribution percentage was (0.126). It is also clear in the table the value of (Adjusted R Square), which refers to the contribution amount for the independent variable in explaining variance within the variable of dynamic balance, was (0.116), and this is a statistically significant value because its F-value was (8.486), with a significance level of (P=0.004). It is also clear that there were only two independent variables which contributed significantly in predicting the dependent variable (dynamic balance), calf circumference and ankle width, where the highest contribution was for the calf circumference variable, (0.081) at a significance level of (P=0.001), then comes the variable of ankle width, (0.045) as a significance level of (P=0.004). This means that only two variables from all the independent variables related to anthropometric measurements have an effect on dynamic balance, the calf circumference and the ankle width. This indicates that the more the calf circumference increases, the more the calf's entire strength increases. Consequently, the muscles' tolerance increases as well and that directly contribute to increasing the ability to maintain balance. The leg's strength depends on the strength of foots' and thighs' muscles. In general, they are the main working muscles in the movements of foot joint when moving in different directions while playing tennis, and they offer players the freedom of moving while maintaining balance and the move's significant compatibility (Jyoti, Gopal, Shrilaxmi, Lata, & Manjunath, 2012). In light of what has been mentioned, it is clear that the calf circumference plays a significant role for the leg's balance while performing movements in different directions in doing the game's special motor skills (Kreighbaum & Barthels, 1990). Allawi (1995) pointed out that the legs represent the body's balance base, the more their width increases, the more we have a good balance base. DiNucci (2014) found positive relationship between the static balance and the heel's width, as well as simple negative relations between dynamic balance and leg's length.

Conclusions

1) The most contributing variable of static balance is the variable of hip's width, 2) The most contributing variables of mobile balance are the variables of calf circumference and ankle width.

Recommendations: 1) Considering the results of this study when selecting the junior tennis players; 2) Conducting similar studies regarding different physical abilities; 3) Conducting similar studies that involve female samples and different age groups for national clubs and teams, as well as comparing between them.

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ANTROPOMETRIJSKA MJERENJA I NJIHOV ODNOS PREMA STATIČKOJ I DINAMIČKOJ RAVNOTEŽI JUNIORA TENISAČA

Sažetak

Ova studija imala je cilj identificirati antropometrijska mjerenja i njihovu povezanost sa statičkom i dinamičkom ravnotežom kod mladih tenisača. Dvadeset i četiri muška tenisača juniora (do 19 godina) koji su bili registrirani za natjecanje u nacionalnih dobnoj skupini prvenstva 2015. je sudjelovalo u ovom istraživanju. Dvadeset tri antropometrijske i morfološke mjerenja su provedena (težina, visina, širine, opsezi, i debljina kožnog nabora). Rezultati su pokazali da je najznačajniji doprinos statičkoj ravnoteži širina prsnog koša (P = 0,011). Opseg koljena i širina gležnja su najznačajniji u dinamičkoj ravnoteži (P = 0,001 i P = 0,004) respektivno. Na temelju nalaza preporučujemo da antropometrijski i morfološka mjerenja treba uzeti u obzir pri odabiru junior tenisača. Preporučujemo provođenje sličnih studija za sportašice i istražuivanja daljnjih tjelesnih značajki u više dobnih skupina i usporedbe s elitnim sportašima iz zemalja poznatijih u tenisu.

***Ključne riječi**: antropometrijska mjerenja, statička ravnoteža, dinamička ravnoteža, tenisač*

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