

The Comparison of Static Balance among the Elite Shooters of the Iranian National Rifle and Pistol Shooting Team with an Emphasis on Principle Anthropometric Indicators

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Abstract

Introduction: Based on the role of static balance and anthropometric indicators in shooters' performance, the present study aimed to compare the static balance of female and male shooters in two fields of rifle and pistol with an emphasis on main anthropometric indicators. **Materials and Methods:** Two static balance tests (Sharpened Romberg and Stork) and 18 anthropometric indicators as well as the descriptive statistics and inferential statistics including: Shapiro-Wilk test, multiple correlation coefficient, PCA, Spearman test, and the one-way analysis of variance test were used to determine the relationship between the static balance and main anthropometric indicators in four groups of female and male rifle and pistol shooters ($P \leq 0.05$). **Results:** The findings showed a significant relationship between stork balance test and anthropometric indicators of knee width among male pistol shooters as well as significant relationship between Sharpened Romberg balance test and anthropometric indicators of weight and BMI among the female rifle shooters and height, sitting height, the length of two hands, and lower limb length among the male rifle shooters. Comparison of the balance mean score among four participating groups in the study indicated that the male pistol shooters had a higher balance than the female pistol shooters and male and female rifle shooters. **Discussion:** The postural balance of the male pistol shooters and female rifle and pistol shooters was associated with the main anthropometric indicators of weight, BMI, standing height, sitting height, the length of two hands, lower limb length, and knee width. The maximum mean value of stork balance was related to male pistol shooters while the minimum one was related to female rifle shooters. In the Sharpened Romberg test, the maximum mean value was related to male pistol shooters while the minimum value was related to female rifle shooters.

Keywords: Anthropometric Indicators, Elite, Pistol, Rifle, Static Balance

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Introduction

Shooting is a competitive sport based on precision and speed and it is considered as one of the oldest sports field in the world with a long history in the Olympics. By the sport officials of different countries, this sport is considered as one of the most medal fields in the world. Shooting is classified into two areas of Fixed Targets (rifle and pistol) and Flight Shooting. In general, a certain and different position is recommended for different limbs in each rifle

and pistol shooting because the shooting conditions and the weight of weapon differ in each field (1).

Balance, which refers to the ability of keeping the center of body mass in the base of support with the minimum swing and maximum stability (3-6, mine), is known as the main basic of sport skills and daily activities that must be maintained before, during, and after using each skill (2). Every kind of sport requires different levels of balance based on its features, needs, type of exercises, and skills (3), because the environmental conditions and skill needs in each sport field cause different changes in the sensory-motor



Figure 1. Positioning in Rifle and Pistol Shooting

system, which is affecting the ability of keeping the athlete's balance (4). Thus, the balance evaluation and measurement is known as a necessity for identifying how the athletes keep their balance and its role in the performance of each athlete as well as preventing any injuries in each sport field (4). In a kind of classification, balance is classified as static (the ability of keeping the body in the static mode with the minimum movement), semi-dynamic (keeping the balance while the base of support is moving), or dynamic (the ability of doing an activity in the moving mode) (2, 5, 6). Obviously, keeping the body balance requires the coordination of sensory, neural, and musculoskeletal systems (3, 7-9). And an appropriate relationship must be provided between the visual perception, proprioception, and motor system to achieve a desirable balance (10, 11).

In general, some specific functional and anthropometric indicators are needed for the success of each sport field. The studies have showed that having the specific physical and anthropometric features in each sport can show whether the athlete can be in the highest level or not (10, 12, 13). These different anthropometric, biomechanical, and neurophysiological factors such as weight, height, body composition, base of support, the distance between the center of mass from the ground, the length of each limb, the torque of arm's muscles and athletes' mass distribution in different body parts, etc. can affect the athlete's balance (3, 14-16). Thus, comparing and detecting these factors which affected on a specific sport field and the goals of coaches, athletes, and also use of a more appropriate and complete exercise program, and more success in that sports (17).

Since keeping the static balance in two fields of rifle and pistol is one of the main principles and considering the two different positions in each sport field (Figure 1), it can be concluded that each field of rifle and pistol shooting requires different levels of balance and anthropometric indicators (18). In this regard, Koli and Gupta (2012) studied the relationship between the static balance and anthropometric indicators among the Indian rifle and pistol shooters. Based on the findings of their study, there was a significant difference between the indicators of triceps brachialis fat, hand power, and standing balance test among the shooters

and their peers in the control group. In addition, there was a significant relationship between the stork balance test and the abilities and anthropometric indicators of shooters (10). Furthermore, Hawkinz and Sefton (2011) studied the effect of standing width on the performance and postural stability of pistol shooters. In this study, 12 pistol shooters fired 10 times at five different feet widths and the postural stability of each person was measured by Force-Platform. The findings showed that the standing width affected the postural stability of pistol (19).

Studying the relationship between balance and anthropometric indicators is a challenging subject in different sport fields (12) but it was studied less. By achieving the anthropometric and balance profile among the rifle and pistol shooters and comparing them to each other as well as comparing the two groups of men and female of these sports, this group of athletes can be aware of their functional capacities. Furthermore, they can be compared to other successful shooters to develop an appropriate exercise and prevent the probable injuries of this field. Thus, based on the role of static balance and anthropometric indicators in shooting sport and its effect on the performance of rifle and pistol shooters, the present study aimed to compare the static balance of elite shooters Iranian national rifle and pistol shooting team with an emphasis on main anthropometric indicators.

Materials and Methods

The population of this study included 45 members of Iranian national rifle and pistol shooting team (20 rifle shooters and 25 pistol shooters). Among the statistical population, 32 players in the national team including 16 rifle shooters and 16 pistol shooters who had gained the best record in the last few years (based on recording by the coaches of national teams and announcing the best players by the federation), were selected as the statistical sample of this study. After the approval of Ethics Committee of the Islamic Republic of Iran Volleyball Federation and the written consent of all participants before the study, all information of the subjects was collected in the natural and open environment in the morning from 8:00 a.m. to 12 p.m.

The measurements were included anthropometric indicators such as weight, height (standing and sitting), the length of two hands, the length of arm, the real length of foot, sole length, knee width, arm circumference in relaxed and contracted modes, forearm circumference, hip circumference, mid-thigh circumference, knee circumference, leg circumference, ankle circumference, BMI, body fat percentage, waist to hip ratio (WHR), and two functional tests of static

Table1. Mean (SD) of pistol and rifle shooter's Anthropometric Indicators (AI)

Field	Group	AI	Mean(SD)	AI	Mean(SD)	AI	Mean(SD)	AI	Mean (SD)
Pistol	Female	Weight (kg)	60 (9.4)	Height (cm)	165 (3.6)	Forearm circumference (cm)	19.8 (2.2)	Pelvic Circumference (cm)	95.8 (5.7)
	Male		78.5 (7.6)		175.3 (4.7)		29.1 (2.8)		104.1 (5.3)
Rifle	Female		56.1 (6.5)		163.3 (4.8)		21.3 (1.1)		94.3 (4.8)
	Male		69.8 (7.2)		179.7 (4.5)		28 (1.9)		97.7 (2.9)
Pistol	Male	Sitting Height (cm)	78.4 (17.3)	Length of tow Arms (cm)	164.8 (4.9)	Mid-Thigh Circumference (cm)	47.3 (3.7)	Knee Circumference (cm)	43.7 (3.5)
	Female		79.8 (5.1)		178.8 (6)		51.6 (3.4)		39.6 (1.5)
Rifle	Male		93 (4.1)		164 (4.2)		46.8 (2.6)		42.3 (2.3)
	Female		30.1 (1.2)		1.181 (4.7)		50.5 (1.6)		39.9 (2)
Pistol	Male	Length Of Arm (cm)	33.6 (1.7)	Length of Leg	85.3 (3.3)	Leg Circumference (cm)	33.5 (2.9)	Ankle Circumference (cm)	25 (1.7)
	Female		30.1 (1.5)		89 (5)		41 (1.9)		24.8 (1.2)
Rifle	Male		35.5 (1.8)		84.6 (2.9)		34.7 (1.3)		24 (0.5)
	Female		30.1 (1.2)		94 (2)		40.8 (1.7)		24.8 (1)
Pistol	Male	Width of Knee (cm)	9.1 (1.2)	BMI (height/ weight) ²	22.2 (3.7)	WHR	0.8 (0.06)	Length Of Foot (cm)	26.3 (2.6)
	Female		9.6 (1.1)		25.5 (2.3)		0.8 (0.03)		32.6 (1.3)
Rifle	Male		8.8 (0.4)		21 (2.4)		0.7 (0.03)		27.2 (2.8)
	Female		9.2 (0.3)		21.5 (1.3)		0.7 (0.02)		31.2 (1.1)
Pistol	Male	Fat Percentage (cm)	5.22 (0.7)	Age (year)	23.1 (1.3)	Arm Circumference In Contraction (cm)	28.1 (2.7)	Arm Circumference In Rest (cm)	26.2 (3.1)
	Female		2.8 (0.7)		30.7 (5.5)		35.3 (1.3)		31.3 (1)
Rifle	Male		5.32 (0.9)		23.1 (1.8)		28.5 (2.6)		26.1 (1.9)
	Female		2 (0.4)		26.5 (2.1)		33 (1)		30.1 (1.3)

balance included the Sharpened Romberg and stork balance tests on all shooters. All anthropometric measurements were made by the confirmed technique of Lumen *et al* (20). And each measurement was repeated for three times and the average of all three repetitions was considered as the main amount for the measurement.

The weight of individuals was measured by the standing digital balance SD-410 model, made in Tokyo, Japan with a degree of 0.1 kg. The subject was asked to stand barefoot on the digital balance. Then, the findings were recorded per kg (21).

The height of the subject had been measured while breathing by using a Stadiometer in Hallin brand, made in England, with a 1-cm distance. The subject was asked to stand barefoot on the Stadiometer for measuring the standing height. The horizontal bar of the Stadiometer was placed on the subject's head and the findings were recorded. For measuring the sitting height, the subject was asked to sit straight on a box or a flat high surface and put his hands at the relaxed mode beside the body and then the height of the subject was measured from the box or chain surface to above his head (21). Other anthropometric measurements were made by a flexible strip meter made in China with a length of 1.5 m and sensitivity of 1 mm. In order to measure the length of both hands, the subject was asked to stand facing a wall in the crosswise direction and then the distance between the two middle fingers was marked and the length of the subject's hand was recorded (21). The length of the subject's arm, while his arm was bent 90

degrees from the elbow, was measured from the Acromion to the Olecranon process (21).

The distance between the anterior superior iliac spine (ASIS) and medial malleolus was calculated for measuring the real length of lower limbs (22). The sole length was measured from the end part of the heel in the middle to the end of the middle finger (22). For measuring the arm circumference at the relaxed and contracted modes, the meter was placed from the right side of shooters to around their arms (around the biceps) at two modes of relaxed (arm next to the body) and contracted (arm at 90 degree of flexion) and its value was recorded (21, 22). The forearm circumference of the subject was measured while his right arm was at the relaxed mode and the left arm was bent from the shoulder but completely open at the elbow. The meter was placed on the widest area of the elbow below the epicondyles of the arm bone and its value was recorded (22).

The hip circumference of the subject was measured while his both arms were crossed on the chest and his feet were next to each other and the Gluteal muscles were at the relaxed mode. The meter was placed around the bumpiest area of hip on the back and around the Pubic symphysis area on the front and then the value was recorded. For the mid-thigh circumference, the subject was stood while his two arms were crossed on the chest (21), then his feet were opened from each other so that his weight was divided equally between his both feet. The meter was placed around the middle part between the hip trochanter and external bump of Tibia and the value was recorded (22).

Table 2. Variance percentages extract from principle components

Component	Pistol		Rifle	
	Female	Male	Female	Male
PCA1	31	44	37	56
PCA2	23	26	24	17
PCA3	21	10	19	9
PCA4	10	9	8	7
PCA5	8	5	5	-
Total	86	91	90	83

Table3. Effective values extract from Principle Anthropometric Indicators (PAI)

PAI	Component			
	Pistol		Rifle	
	Female	Male	Female	Male
Arm Circumference	0.846	-	-	-
Mid-thigh Circumference	0.864	-	-	0.921
Knee Circumference	0.800	0.870	-	0.874
Leg Circumference	0.923	0.993	0.934	-
Pelvic Circumference	0.877	-	-	-
Weight	-	0.898	0.936	0.963
Forearm Circumference	-	0.988	-	0.885
Ankle Circumference	-	0.810	-	-
BMI	-	0.900	0.871	0.859
Fat Percentage	-	0.967	-	0.881
Height	-	0.975	-	0.971
Length of two Arms	-	0.971	-	0.951
Length of Lower Limb	-	0.828	-	0.852
WHR	-	0.928	-	-
Arm Circumference (In Rest)	-	0.800	0.948	-
Arm Circumference (In Contraction)	-	-	0.951	0.800
Sitting Height	-	-	0.906	0.957
Knee Width	-	-	-	0.830

For measuring the knee circumference, the meter was placed around the knee of the standing subject on the middle transverse axis of the Patella and the value was recorded. For measuring the leg circumference, the subject was stood while his both feet hands were at the relaxed mode and his feet were a little apart from each other, so his weight was equally distributed between his two feet. The meter was placed around the bumpiest part of the leg and its value was recorded (21).

For measuring the ankle circumference, the subject was stood while his both hands were at the relaxed mode, so his weight was equally distributed between his feet. The meter was placed around the area of the leg with the minimum width (the lowest part of the leg) around the ankle. For measuring the knee width, the shooter sat while his knee was bent at 90 degree and then the distance between the lateral and medial epicondyles of his thigh was measured based on centimeter by using Vogel Caliper, made in Germany with an accuracy of 1 mm (23). The BMI of the subjects had been obtained through the formula of dividing the weight (kg) by the height to the

power 2 (m) (21). The fat percentage had been obtained through the following equation:

$$\text{Body fat percentage} = [(4.57 \div \text{density}) - 4.142] \times 100$$

In this formula, the density of men and women was obtained through the following formula:

$$\text{Men's density} = 1.10938 - (0.0008267 \times \text{SF}) + 0.0000016 \times \text{SF}^2 - (0.0002574 \times \text{age})$$

$$\text{Women's density} = 1.0994921 - (0.0009929 \times \text{SF}) + (0.0000023 \times \text{SF}^2) - (0.0001329 \times \text{age})$$

In these equations, SF shows the total subcutaneous fat in three parts of men (abdomen, chest, and thigh) and three parts of women (thigh, arm, and pelvis). In order to calculate this subcutaneous fat in such areas, the Vogel Caliper, made in Germany with an accuracy of 1 mm was used by applying a uniform pressure of 10 g/millimeter per square on the skin. The waist to hip ratio were obtained by dividing the waist circumference by the hip circumference that measured by a strip meter (21).

Table 4. Relationship between balance tests and Principle Anthropometric Indicators (PAI) ($P \leq 0.05$)

Tests	Groups	PAI	Mean (SD)	R	Sig	
Sharpened Romberg	Female	Weight	56.13 (6.5)	0.82	0.012	
		BMI	21.04 (2.45)	0.73	0.039	
	Male	Height	179.75 (4.59)	-0.78	0.022	
		Sitting height	93 (4.17)	-0.82	0.011	
		Length of two Arms	181.13 (4.79)	-0.79	0.019	
		Length of Lower Limb	24.48 (2.37)	-0.66	0.007	
Stork	Rifle	Male	Knee Width	27 (0.75)	0.85	0.007

Sharpened Romberg test and stork test were used for measuring the static balance. In the Sharpened Romberg test, the subject was stood barefoot on a flat surface, put the dominant foot in front of the non-dominant foot, so that the heel of his front foot hit the toe of the back foot. His arms were crossed on the chest and his palm was on the shoulder of the opposite side. This test was performed by closed eyes for 60 seconds. In case of occurring any of the following errors while keeping the balance, one second was reduced from the score of the subjects: too much swinging, losing the balance, opening the eyes, and moving the hands. The above-mentioned test was run for three times with a rest interval of one minute between each time of running the test and the average of three times was recorded. In stork test, the subject was asked to put his hands on the hip and then put his non-dominant barefoot in front of the internal part of his dominant foot on the ground. Then, he lifted his foot that was on the ground. In this section, the stopwatch was activated for measurement and then stopped in the following cases: A) Hand(s) were taken off the hip, B) The foot which was on the ground twirled or skipped, C) The foot that was not on the ground lost its contact to the knee of the front foot or touched the heel of the foot that its toe was on the ground. This test was run for three times and the best time of the subject was recorded and used (one minute before the measurement, the subject had time to practice the test). The test scoring was as follows: 20s<strong, 40-50 s=good, 25-39 s=average, 10-24 s: weak, 10s> very weak (10, 24).

In order to analyze the data, the descriptive statistics (mean and standard deviation) and inferential statistics including Shapiro-Wilk were used to study the normality of data distribution, and multiple correlation coefficients were used to reduce the overlapping anthropometric indicators. In addition, the PCA method was used to determine the main anthropometric indicators. Finally, the Spearman test was used to determine the relationship between static balance and main anthropometric indicators. The one-way analysis of variance was used to compare the average static balance and main anthropometric indicators among four groups of female rifle shooters, male rifle shooters, female pistol shooters, and male pistol shooters at $P \leq 0.05$.

Results

The mean and standard deviation of anthropometric indicators had been presented in Table 1. As it is clear, the maximum mean value was related to the height of male rifle shooters but the minimum value was related to the WHR of female rifle shooters. In addition, comparing the intragroup average of all these four groups separately, showed that the WHR value was the lowest mean value in all groups. The length of two hands allocated the maximum value in female rifle shooters and male pistol shooters as well as the average height of female pistol shooters and male rifle shooters. Comparing intergroup of female rifle and pistol shooters and male rifle and pistol shooters have showed that the height of pistol female shooters had a higher average but the height of rifle male shooters had a more average. In addition, both rifle male and female shooters had a lower WHR than the male and female pistol shooters.

Based on the importance and role of identifying the different and measured variables (in this study the anthropometric indicators), two measures were taken before analyzing the data. Firstly, the multiple correlation coefficients were used for identifying the overlapping variables. The results have showed that in all four groups of male and female rifle and pistol shooters, the variables of weight had a high correlation with BMI, height with the length of two hands, and hip circumference with fat percentage. Secondly, the Principle Component Analysis (PCA) method was used for studying the main variables after selecting the overlapping variables among the variables related to high correlation. By this method, the corresponding variance of the factor was obtained by Varimax rotation. As Table 2 shows, the extracted variance from five main structures of variables layout was shown in the column of total coefficients of initial specific factors for each factor in form of total variance

Based on the extracted variance, most extracted variances can be observed indicating in the main five layout of information. As observed, not common indicators can be observed for all four groups and leg circumference, knee circumference, weight, and BMI were the variables among the three groups of main index. In

the female groups, the minimum of main indicator was observed among the pistol females (five variables) and the maximum of main variable was observed among the pistol males (13 variables). Among the pistol and rifle shooters, 11 variables and among the pistol and male rifle shooters, 25 variables were extracted as the main variables (Table 3).

After studying and determining the main indicators, the Spearman test was used to determine the relationship between the balance score of Sharpened Romberg and Stork balance tests with main anthropometric indicators among all four groups. They are based on the obtained results and Table 4.

The Sharpened Romberg balance was related to the weight index, BMI among the female rifle shooters, and length of two hands, lower limb length, and sitting height among the rifle male shooters. Stork balance was only related to knee width among the male rifle shooters.

In comparing the mean score of stork and Sharpened Romberg balance among four participating groups and (female pistol shooters, male pistol shooters, female rifle shooters, and male rifle shooters) that used the one-way analysis of variance. The maximum mean value of stork balance was related to the male pistol shooters and the minimum mean value was related to the female pistol shooters. In the Sharpened Romberg test, the maximum mean value was related to the male pistol shooters while the minimum mean value was related to the female rifle shooters. Furthermore, in the ANOVA test, a significant relationship was found in these two types of balance in terms of intergroup and intragroup. In comparison to the mean anthropometric indicators among four groups participating in this study that used the one-way analysis of variance, the maximum mean role of weight, knee width, hip circumference, mid-thigh circumference, and BMI was related to male pistol shooters while the minimum mean value was related to female rifle shooters. The maximum mean value of standing height, the length of two hands, lower limb length, and foot length was related to male rifle shooters but the minimum value was related to female rifle shooters. In sitting height indicator, the maximum mean value was related to pistol male shooters but the minimum mean value was related to male rifle shooters. In the forearm circumference, the arm circumference at the relaxed mode, and arm circumference at the contracted mode, the maximum mean value was observed among the male pistol shooters but the minimum mean value was observed among the female pistol shooters. In knee circumference indicator, the maximum mean value was related to pistol male shooters but the minimum mean value was related to male pistol shooters. In the angle circumference and WHR, the maximum mean value was related

to female pistol shooters but the minimum average mean value was related to female rifle shooters. In the fat percentage indicator of three points, the maximum mean value was related to female rifle shooters but the minimum mean value was related to male rifle shooters. In age and arm length indicators, the maximum mean value was related to male rifle shooters but the minimum mean value was equally related to the female rifle shooters and female pistol shooters. In the ANOVA test, there was a significant difference between all indicators except knee width, ankle circumference, and WHR in terms of intragroup and intergroup.

Discussion

The present study aimed at comparing the static balance of elite shooters of Iranian national rifle and pistol shooting team with an emphasis on main anthropometric indicators. Choosing the appropriate human resources is the most important factor for the qualitative and quantitative improvement of sports skills and many researchers are trying to identify the predictive indicators of susceptible subjects in different sports. Understanding the anthropometric characteristics and its main indicators in each sport is one of the important determinants affecting the performance of male and female athletes and their balance. Fixed target is a competitive sport based on the accuracy and speed in the two sports of rifle and pistol. Given the fact that shooting record requires good physical and balance requirements, the balance of rifle and pistol shooting is also important due to the different positions and the effective variables in it, among the main anthropometric indicators. The main objective of this study was to compare the static balance and the main anthropometric indicators of elite shooters of Iranian national rifle and pistol shooting team. In this study, 32 players including 16 male and female rifle shooters and 16 male and female pistol shooters from the national team were compared for the main anthropometric indicators by Sharpened Romberg and Stork test.

The results showed that anthropometric indicators were considered as important indicators in shooters and there was a significant difference between them in these indicators. Perhaps it can be said that gender factor is one of the main factors in the difference of anthropometric indicators between male and female shooters rather than shooting type. Comparing the performance of static balance among different sports is also a subject addressed in some studies. For example, the results of a study on female athletes showed that the gymnasts and football players have the same static and dynamic balance while the basketball players have a lower static balance compared to the gymnasts and a lower dynamic balance

compared to football players (3). By examining the texts according to the present study, there was a statistically significant difference in this regard among different sports, due to different challenges in the various sports which have been encountered in each sport. For example, the gymnasts usually have the ability of static balance on a balance beam (such as the BESS static test). Thus, the gymnasts are likely to focus more on the changing signs of balance function, such as slight changes in joints position and speed. Basketball players, on the other hand, rarely have a static balance on one leg, and their attention is usually on the signs of the ball and success of players. As a result, static balance may be less advanced in team rather than in the gymnasts (3).

As the results, the gender factor affects both types of balance tests and despite the fact that, according to past research, women have a better balance than men; the results of this study have showed the opposite that the male rifle and pistol shooters had a higher balance than the females in these sports (25).

It was indicated that the male pistol shooters had a higher balance than the other three groups which may be due to the effect of the used exercises and positions in the sport of pistol shooting than rifle because exercises had an effect on kinetic responses as well as an increase in proprioception and visual perception and changes in sensation and kinetic system also affected the performance of balance.

The results of this study indicated a significant relationship between the mean score of Sharpened Romberg and the main anthropometric indicators of weight and the BMI of the female rifle shooters as well as the sitting height, the length of two hands, the length of lower limbs, and the height of male rifle shooters. In addition, there was a significant relationship between the mean score of stork test and knee width index among the male rifle shooters. The existence of these significant relationships for example, with height means that a taller person will have less static balance which is consistent with the findings of Chirri *et al.* (25). Furthermore, a significant relationship between the weight and static balance among female rifle shooters has indicated that the higher the weight, the greater the force for the same distribution of static balance. Therefore a more stable person has a higher static balance. The muscle circumference is an indicator of higher muscle mass and higher BMI with less fat, which can produce more strength and stability in lower limb joints leading to a better static balance in athletes (26, 27). Hills (1991) stated that a 20 percent increase in body mass decreases the body's ability to control body posture in response to external disturbances which leading to the reduction of postural stability. The individuals with a BMI greater than 30 are less likely to remain in a state of balance

than those who are not obese (BMI below 30), so a high body mass index (obesity) can affect the range of postural stability control (28). Hills reported that the high body mass index even affects the selection of various strategies by the body to control the balance (28-30). Several other studies emphasized the relationship between increasing body mass index and decreasing postural stability (23, 31). Alonso *et al.*, (17, 32) showed that body anthropometric indicators such as weight and height, could affect the body's stability. Among the anthropometric indicators, height is known as the most important indicator regardless of gender; Alonso *et al.* indicated that anthropometric indicators affect more the postural balance in the male group than in the female group (33). The studies of Molikonara *et al.* as well as Chirri *et al.* showed that an increase in body mass index could be related to postural balance which is more common in men than in women. They stated that the differences which have been observed in the postural balance in men and women groups are related to the early differences in anthropometric indicators such as differences in height and weight in men and women (25, 34). Based on the findings of the present study, the postural balance in men and women are related to early differences in anthropometric indicators such as age, weight, BMI, standing height, sitting height, the length of two hands and feet.

Conclusion

Male pistol shooters have a higher balance than female pistol shooters and male and female rifle and pistol shooters. In addition, the postural balance in male and female rifle and pistol shooters are related to the main anthropometric indicators of weight, BMI, sitting height, standing height, length of two hands, length of the lower limbs, and knee width.

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