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Examination of Speed, Jumping, Balance and Postural Sway Values in Athletes of Different Sports

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Abstract

This study aims to examine the speed, jumping, balance, and postural sway values of athletes from different sports. A total of 30 male athletes, including 12 football players,10 futsal players and 8 volleyball players, who were actively engaged in sports, participated in the study. The gender, age, height, body weight(kg), dynamic balance (Y balance), squat jump (Optojump), postural sway (Kistler© brand Body Sway Module), and speed(30m) parameters of the athletes included in the study were collected. Differences among the disciplines was examined using One-Way Analysis of Variance(ANOVA).There was a significant difference (p<0.05) in squat jump and dynamic balance (post-medial-left foot) values between football, futsal and volleyball players, while no difference was found in anthropometric measurements such as body weight (kg),height (cm),body fat percentage (%BF),body mass index (BMI),and leg length, as well as dynamic balance tests (right and left foot / anterior-posterior-lateral).There was also no difference found in postural sway (double foot/eyes open and closed/anterior-posterior-medial-lateral-total sway) and speed test performance parameters(p>0.05).The differences observed between the branches can be attributed to the different physical characteristics and training programs required by the related sports branches.

Keywords: Balance, Postural sway, Speed, Jumping, Kistler

Introduction

Football has an intermittent nature, including short periods of high-intensity running and longer periods of low-intensity exercise (Rampinini et al.,2007). While aerobic energy production dominates the energy supply in football, elite-level players perform short periods of high-intensity actions during a match, resulting in high anaerobic demands during intense playing periods (Bangsbo, 1994). In addition, speed plays an important role in the foundation of endurance in football (Aytekin et al., 1998). The factors that make up physical fitness in football can be listed as aerobic capacity, anaerobic power, strength, speed, flexibility, agility, balance, and coordination (Açıkada et al., 1999; İşleğen, 1987).

Futsal, also known as indoor soccer, is an officially recognized indoor football by the Federation Internationale de Football Association (FIFA) (Alvurdu et al.,2016), which has its own unique rules despite its general resemblance to traditional football (Barbero et al., 2015). Futsal is played for fun, amateur, and professional levels all over the world (Barbero et al., 2008). The game is played on a rectangular court that measures 40 x 20 meters and consists of two halves of 20 minutes each, with the clock stopping during dead-ball situations, which can result in a total playing time of 75-90 minutes (Álvarez et al., 2002). Futsal is played at a high intensity with numerous repetitions of sudden accelerations and decelerations, quick changes of direction, and battles (Arı & Tunçel, 2020). Therefore, well-developed aerobic endurance, anaerobic power, and speed performance are important in athletes due to the high aerobic-anaerobic requirements of futsal (Colantonio et al., 2020).

Furthermore, anaerobic power and capacity performance are determining factors in futsal, where they are heavily utilized. The anaerobic system is important in futsal players' success and high performance. It is known that movements related to anaerobic endurance mostly consist of sudden accelerations, changes of direction, shots, jumps, sprints at various distances, and the relationship between speed, distance, and time (Erdem & Yazar, 2019).

Studies on the physiological demands of futsal have shown that tasks such as acceleration, deceleration, sprints, and changes of direction are necessary physical abilities to achieve high performance during a game as it is an intermittent sport (Torres et al., 2017).

Although volleyball is considered a sport that requires technical and tactical skills with low-intensity activity periods and recovery times between high-intensity activities, it also requires high-level endurance (aerobic, anaerobic, respiratory functions), strength, flexibility, speed, agility, balance, reaction, and control. As the game lasts for about 90 minutes and includes high-intensity activity periods during the match, players need to use their aerobic and anaerobic energy systems well (Gabbett & Georgieff, 2004). Additionally, sprints jump (blocks and sudden rises), and repeated high-intensity movements during the match increase the importance of the neuromuscular system. Therefore, volleyball players need to have a good physical structure and highly developed conditioning characteristics, and many studies have been conducted to determine their positional differences (Marques et al., 2009).

Like every motor skill, balance is also one of the motor skills that determine performance in the sports field, and weakness in balance skill is a risk factor for ankle segment injuries during sports activities (Brown et al., 2008). Balance is evaluated in two categories: a static and dynamic balance. The support surface is not fixed in dynamic balance measurement, whereas in static balance evaluation, the support surface is fixed (Bressel et al., 2007).

Balance is the ability of an individual to maintain their center of mass within a supporting surface. Posture (static balance) is a continuation of individual static positions. Postural performance (dynamic balance) is the active control of the body's posture and position to maintain sufficient and effective movement without falling in different environments and situations, either at rest or during movement (Shumway & Horak, 1986). Maintaining balance and a stable posture are integral to most movement applications (Carr & Shepherd, 1998).

Posture is defined as the proper alignment of body parts and is an important indicator of health and a motor habit that accompanies daily activities (Kendall, McCreary & Provance, 2005). Posture serves two important functions in the body. The first is to provide mechanical antigravity and balance to create optimal posture. It accomplishes this function through the muscle tone of extensor antigravity muscles, providing joint stiffness and resisting the reaction force against the ground. The other function is to act as a reference frame for perception and action of a few extremities in relation to the external world. The position and orientation of body segments such as the head, trunk, and extremities not only determine the target location in the external environment but also organize movements toward these targets (Massion, 1994).

Postural control is a necessary skill for all physical activities. Flexor and extensor muscles play an important role in maintaining postural control by working synergistically in opposite directions (Trew & Everett, 2010).

It has been noted that elite athletes exhibit balance control that develops in line with the requirements of each discipline. Learning and training a sport over a long period of time improves the effectiveness of dynamic and static postural control in daily life activities (Perrin et al., 2002). In sports such as football, volleyball, etc., athletes use their muscles intensively against gravity during training and competition.

In football, unlike other individual and team sports, movements in the form of single-leg actions, such as keeping the ball away from the opponent with one foot while simultaneously struggling with a sudden shot/pass, are used. In these movements, it has been observed that players achieve better results than dancers who use intense single-leg stances in terms of some postural performance characteristics (Gerbino et al., 2007). The proper control of postural stability is essential for most actions performed by volleyball players (Agostini et al., 2013).

Therefore, this study was conducted to examine the relationship between the speed, jumping, balance, and postural sway performance of athletes in different sports.

Materials And Methods

The study included 30 male athletes who were currently actively participating in sports and voluntarily agreed to participate in the research. The research group consisted of 12 football players, 10 futsal players, and 8 volleyball players. Football players had an average age of 22.25±0.68 years, an average height of 1.80±0.01 cm, and an average weight of 73.30±2.17 kg. Futsal players had an average age of 22.80±1.04 years, an average height of 1.77±0.01

cm, and an average weight of 72.90±2.18 kg. Volleyball players had an average age of 19.88±0.51 years, an average height of 1.86±0.02 cm, and an average weight of 73.50±2.11 kg. The athletes selected had not experienced a significant lower extremity injury in the past year.

Study Ethics

The research group was informed about the research, and to athletes who participated in the study signed a consent form containing information about the purpose and methods of the study. Ethical approval for this study was obtained from the Ankara Yildirim Beyazit University Health Sciences Ethics Committee on 03.01.2023 with decision number 23-1304.

Data Collection Tools

The height of the research group was measured using a stadiometer (Holtain brand) and their body weights were measured using a digital scale (Tanita BC 480). The athletes' body mass indexes (BMI) were calculated using the formula body weight (kg/m^2). Additionally, the athletes' balance was measured using the Y Balance test, their speed

performance was measured using the 30 m speed test, their squat jump heights were measured using the Microgate optojump® (Microgate, Bolzano, Italy) device, and their postural sway values were evaluated using a protocol created with the Body Sway (Switzerland) module of Kistler® brand.

Study Design

Athletes were instructed to refrain from any activity that could cause physical fatigue one day before the test. Additionally, athletes were instructed to wear comfortable sports clothing on the day of the test and to stop eating and consuming caffeine at least 2-3 hours before the test. Before the start of the test, each athlete was given sufficient trial time before beginning the test.

The 30 athletes were divided into groups according to their respective sports, and with sufficient rest time between tests, they participated in the height-weight-postural sway (Kistler)-dynamic balance (Y balance)-speed (30 m) and squat jump (Opto Jump) tests in order.

Height Measurement: The height of the participants in the study was measured using a Holtain brand stadiometer with a precision of 0.1 cm. To determine the height, the stadiometer was brought to the top of the head after taking a deep breath with the head upright and eyes looking straight ahead. (Özer, 2009).

Body Weight Measurement: The body weight of the participants was measured using the Tanita BC 480 with shorts and bare feet.

Balance Measurement: The "Y Balance Test" was performed barefoot on a platform. The athletes started on their right foot behind the starting line and stood in balance on one foot while reaching with the tip of the other foot in 3 directions (anterior, posteromedial, and posterolateral). The test was repeated 3 times for each direction with 15 seconds of rest intervals, and the best score was recorded in centimeters. The best degree for each leg in three different directions was evaluated.

Squat Jump: The OptoJump device was used for the squat jump tests, which are widely used in squat jump tests and have been subjected to validity and reliability studies (Gür et al., 2018). In this test, athletes were asked to jump vertically without bouncing their hands on their hips and to wait for 1-2 seconds in a 90° squat position. Bending the knees in the 90° squat position, bouncing hands off the hips in the air phase of the jump, and retracting the knees were considered incorrect movements. (Santos et al., 2014).

30 m Speed Measurement: The athletes' 30 m sprint times were measured using a photosensor in the gym. Each participant performed two fast-running tests with a 3-minute rest period between them. The best performance between the two repeated speed tests was recorded.

Postural Sway Measurement: Postural Sway Measurement: For the postural sway analysis of the athletes, a protocol was created and evaluated in the Kistler® brand Body Sway (Switzerland) module. Postural control measurements included static balance test. Static balance test was performed in double foot stance positions with eyes open and closed.

Each participant was allowed to practice on the Kistler® brand Body Sway module for 2 to 3 minutes before the test in order to get used to the measurement tool and to reduce the learning effect. The research group was first taken to the test after 5 minutes of low-paced running in a light sportswear and a dynamic stretch. Before starting the test, the athletes were instructed to focus on a fixed point on the wall 1 m in front of them and to remain as still as possible during the test with their arms relaxed at their sides.

The athletes stepped on the center of the force platform and placed their feet anterior-posterior (A-P) (along the Y-axis of the force plate) and medial-lateral (M-L) (along the X-axis of the force plate) with the toes pointing forward (+Y). After the body position was stabilized, the test was started with the countdown "3, 2, 1". The athletes performed 3 tests for 30 seconds double foot eyes open and 30 seconds double foot eyes closed respectively. In addition, rest intervals of 2 minutes were given between each test to prevent fatigue from negatively affecting the test result.

Data Analysis

SPSS 25 software was used to perform statistical analysis of the collected data. Descriptive statistics such as mean, standard deviation, and minimum and maximum values were used to present the data. The normality of the anthropometric and performance parameters was examined using the Kolmogorov-Smirnov test, and it was found that they were normally distributed. One-way analysis of variance (ANOVA) was used to examine whether the data showed significant differences between sports, and if significant differences were found, Gabriel post hoc test was conducted to determine which group(s) showed the differences.

Findings

Table 1 shows the descriptive statistics for the athletes who participated in the study, including mean, standard deviation, and minimum and maximum values.

Table 1. Descriptive statistics for football, futsal, and volleyball players.

		n	x̄	Ss	Min	Max
	Football	12	22,25	2,37	19	28
Age/Year	Futsal	10	22,80	3,29	20	30
	Volleyball	8	19,88	1,45	18	22
	Total	30	21,80	2,73	18	30
	Football	12	73,30	7,52	64	83
Body Weight (kg)	Futsal	10	72,90	6,91	59	80
	Volleyball	8	73,50	5,97	65	84
	Total	30	73,22	6,70	59	84
	Football	12	1,80	0,05	1,74	1,94
Height (cm)	Futsal	10	1,77	0,04	1,71	1,83
	Volleyball	8	1,86	0,08	1,75	2,00
	Total	30	1,81	0,06	1,71	2,00
	Football	12	22,55	1,37	21,10	25,10
Body Mass Index (BMI)	Futsal	10	22,98	1,50	20,31	24,80
	Volleyball	8	21,25	1,61	19,00	24,30
	Total	30	22,34	1,59	19,00	25,10
	Football	12	9,28	3,85	3,60	16,20
	Futsal	10	12,40	3,39	5,10	17,00
Body Fat Percentage (%BFP)	Volleyball	8	9,19	3,16	5,20	13,50
	Total	30	10,29	3,73	3,60	17,00
	Football	12	97,25	5,95	91	114
Leg Length (cm)	Futsal	10	96,40	2,95	93	103
	Volleyball	8	101,25	5,20	93	107
	Total	30	98,03	5,16	91	114

Thirty athletes with a mean age of 21.80±2.73 years, a mean body weight of 73.22±6.70 kg, and a mean height of 1.81±0.06 cm participated in the study. Additionally, the mean BMI values for the athletes were determined as 22.34±1.59, the mean %BF values as 10.29±3.73, and the mean leg lengths as 98.03±5.16.

Table 2. Comparison of Speed and Squat Jump Values According to Groups.

Variable		n	x̄	Ss	F	p
	Football	12	4,39	0,23		
Speed	Futsal	10	4,30	0,18	,463	,634
	Volleyball	8	4,42	0,39		
	Total	30	4,37	0,26		
	Football	12	29,65	4,61		
Squat jump	Futsal	10	31,06	4,09	4,375	,023
	Volleyball	8	35,35	3,98		
	Total	30	31,64	4,76		

Table 2 shows that there was a significant difference in squat jump values among athletes from different sports ($p<0.05$). However, no significant difference was found in speed performance values ($p>0.05$).

Table 3. Comparison of Dynamic Balance (Right and Left Foot) Values According to Groups.

In Table 3, there is a significant difference in the Dynamic Balance (Left Foot/Posterior Medial) values between athletes from different sports (p<0.05). However, there is no significant difference in the Dynamic Balance (Right and Left Foot/Anterior-Posterior Lateral) parameters (p>0.05).

Table 4. Comparison of Postural Sway (Double Leg/ Eyes open and closed) Values between Groups.

The table 4 shows that there is no significant difference in the performance parameters of Postural Oscillation (Double Feet / Eyes Open and Closed / Anterior-Posterior, Medial-Lateral, Total Oscillation) among different sport branches (p>0.05).

Variable		n	x̄	Ss	F	p
Sway_area_Ant_Post_mm_s_ closed eyes, two feet	Football	12	152,55	73,36	1,567	,227
	Futsal	10	132,64	63,19		
	Volleyball	8	99,91	52,82		
	Total	30	131,87	66,43		
Sway_area_Med_Lat_mm_s_ closed eyes, two feet	Football	12	52,11	20,86	3,294	,052
	Futsal	10	80,04	53,37		
	Volleyball	8	38,81	21,54		
	Total	30	57,87	38,00		
Sway_area_Total_mm_s_ closed eyes, two feet	Football	12	1337,29	1706,93	1,474	,247
	Futsal	10	832,75	808,69		
	Volleyball	8	404,76	440,27		
	Total	30	920,43	1225,89		
Sway_area_Ant_Post_mm_s_ Open eyes, two feet.	Football	12	106,40	55,58	,351	,707
	Futsal	10	113,23	55,45		
	Volleyball	8	93,15	35,01		
	Total	30	105,14	49,84		
Sway_area_Med_Lat_mm_s Open eyes, two feet.	Football	12	45,28	27,09	1,077	,355
	Futsal	10	69,84	53,22		
	Volleyball	8	40,57	20,95		
	Total	30	52,21	37,78		
Sway_area_Total_mm_s_ Open eyes, two feet.	Football	12	852,91	1260,26	,701	,505
	Futsal	10	612,28	750,16		
	Volleyball	8	355,73	281,68		
	Total	30	640,11	915,16		

Variable		n	x̄	Ss	F	p
Y_Anterior_ Right foot	Football	12	103,83	28,15	,035	,966
	Futsal	10	105,40	22,30		
	Volleyball	8	106,87	24,46		
	Total	30	105,16	24,51		
Y_Post_Medial_ [Right foot]	Football	12	105,08	17,98	2,459	,104
	Futsal	10	95,40	9,84		
	Volleyball	8	110,37	14,17		
	Total	30	103,26	15,42		
Y_Post_Lateral_ Right foot	Football	12	100,58	20,43	1,012	,377
	Futsal	10	96,60	14,98		
	Volleyball	8	108,00	13,11		
	Total	30	101,23	17,02		
Y_Anterior_ [Left] foot	Football	12	106,50	23,94	1,757	,192
	Futsal	10	97,60	19,06		
	Volleyball	8	114,37	29,95		
	Total	30	105,63	24,80		
Y_Post_Medial_ [Left foot]	Football	12	110,00	17,61	3,927	**,032**
	Futsal	10	97,10	14,88		
	Volleyball	8	119,62	19,09		
	Total	30	108,26	18,82		
Y_Post_Lateral_ Left foot	Football	12	101,66	18,50	1,084	,353
	Futsal	10	101,30	14,92		
	Volleyball	8	112,25	19,57		
	Total	30	104,36	17,74		

Discussion and Conclusion

This study aimed to examine the speed, jumping, balance, and postural sway values of athletes from different sports branches. When the data obtained in this study were examined, a significant difference was observed between groups in squat jump and dynamic balance (post-medial-left foot) values ($p<0.05$), while there was no significant difference in 30 m speed, dynamic balance (right and left foot / anterior-posterior-lateral) and postural sway (both feet/eyes open and closed / anterior-posterior-medial-lateral-total sway) performance parameters ($p>0.05$).

In sports such as football, the athlete's important achievements depend on speed. A football player must be fast while running during a match, attacking, and defending (Günay & Yüce, 2008). Especially in sports that require speed and explosiveness, strength is an important element (Muratlı et al., 2007). Jumping, sprinting, throwing shot put and javelin, or running at a high pace are examples of converting energy into strength for the athlete. Power is expressed as the unit of work (performance) over time. Explosive power is related to anaerobic metabolism, and it measures it (Günay et al., 2006).

Although there is much domestic and foreign literature evaluating the different features of professional and amateur football players, studies evaluating the characteristics of futsal players are quite limited.

When 30 m sprint performance values were analyzed in our study, no significant difference was found between the groups. When we examine the performance values between branches, it is seen that soccer players run at 4.39 m/s, futsal players run at 4.30 m/s, and volleyball players run at 4.42 m/s.

MendezVillanueva, Buchheit, Kuitunen, et al. reported the sprint speed values of football players as 4.39±0.12 s, Rodríguez and Andújar found the sprint speed values of Spanish football players to be 4.26±0.014 s, Silva-Junior, Palma, Costa, et al. reported a value of 4.147±0.122 s for Brazilian footballers, Sander, Keiner, Schlumberger, et al. found a value of 4.455±0.278 s for German footballers, Wong, Chamari, Chaouachi et al. reported a value of 4.36±0.17 s for Chinese footballers, Aguiar, Abrantes, Maçãs, et al. found a value of 4.23±0.25 s for Portuguese footballers, and Cerrah, Polat, and Erkan reported the values of 4.31±0.22 s for goalkeepers, 4.17±0.19 s for defenders, 4.25±0.17 s for midfielders, and 4.15±0.20 s for forwards playing in the top amateur league. In futsal, high-intensity actions such as transitioning from defense to attack and attack to defense describe physiological characteristics (Burns, 2003).

The ability of players to perform at maximum performance in high-intensity activities is related to the development of their endurance, sprint, agility, and other attributes. In addition, while sprint ability is an important factor for high-level player performance in matches, good agility is also necessary to gain an advantage over the opponent. Agility can be influenced by many factors such as speed, strength, decision-making, and quickness (Eroğlu, 2018). Therefore, the development of all these mentioned motor skills together is a criterion for successful performance from a high-level performance perspective. Sampaio, Maçãs, Abrantes, and Ibáñez reported that semi-professional futsal players had a speed of 4.88±0.10 seconds, which varies depending on the type of fiber in the body (Sevim, 2006; Loturco et al., 2015). In the study conducted by Eren, Erdoğan and Tel (2020) on male volleyball players, 30-meter sprint speed values were reported as 4.80±0.37 s. It is thought that the speed difference between athletes is due to the type of fiber.It is believed that the difference in speed between athletes is due to the type of fiber.

When squat jump (cm) performance values were analyzed in our study, there was a statistically significant difference between the groups ($p<0.05$). When we examine the performance values between the branches, it is seen that soccer players run at a speed of 4.39 m/s, futsal players run at a speed of 4.30 m/s, and volleyball players run at a speed of 4.42 m/s. Loturco et al. reported squat jump values of 40.08 ± 3.68, Keiner et al. 36.0±5.5 cm in young soccer players, G.Coratella et al. 38.8±3.3 cm, L. Dragula et al. reported squat jump values of 36.23±4.75 cm in young soccer players.

I.Tamara et al. reported squat jump values as 26.94±3.83 cm in a study on amateur volleyball players, G.Giatsis et al.reported squat jump values as 28.8±4.5 in elite volleyball players, Ciccarone et al.reported squat jump values as 40.3±3.1 in volleyball players, L.Stanganelli et al. reported squat jump values as 40.5±6 1.2 in volleyball players. M.Lopez et al.reported squat jump values as 37.0±0.5 in a study on amateur futsal players.

In our study, it was determined that the branch with the highest mean difference between squat jump values among the branches was volleyball. This result can be attributed to the fact that for a successful performance in sports branches based on jumping, it is important to practice training to improve jumping strength in order to jump faster and higher and to jump in movements specific to the sports branch (block, smash).

When our study was examined, a significant difference was observed between the groups in dynamic balance (post-medial-left foot) values ($p<0.05$), while no significant difference was found in dynamic balance (right and left foot/anterior-posterior-lateral) performance parameters ($p>0.05$).According to Altay, Jastrejevskaya reported that balance is a factor in distinguishing between those who perform well and those who do not in sports skills and that it positively contributes to physical development where motor skills are exhibited. In our study, while dynamic balance values were found to be similar among football, futsal, and volleyball disciplines, Troop et al.emphasized in their studies with footballers that weak balance can be defined as a risk factor for ankle injuries, which makes us think that this risk factor may also exist in other disciplines, not just in football, for the value observed only significantly between disciplines (post-medial-left foot). If the balance status of a healthy athlete can be determined in advance, some preventive measures can be taken to prevent various injuries. Balance is important in athletes because balance disorders can have negative effects on some sport skills (Panjan & Sarabon, 2010). In other words, an effective postural balance is considered important to reduce both injury risk and physical negativity (McKeon & Hertel, 2008; Myer et al., 2006; Plisky et al., 2006; Zemková, 2014).

In our study, no significant difference was found between the groups when the postural swing (double foot/eyes open and closed/anterior posterior-medial lateral-total swing) performance values were examined). Similarly to our study, Gribble et al.reported that there was no significant difference in the swing distance between the right and left extremities in healthy research groups.

Andreeva et al. (2021), in a study conducted by bringing together 936 athletes aged 6-47 years from 13 different sports branches, revealed that in every sport branch they examined, athletes provided swing values better in the eyes open state compared to the eyes closed state. As a result of the study, they emphasized that all kinds of sports improve postural stability. In our study, there was no significant difference between the groups in postural oscillation (biped/eyes open and closed/anterior posterior-medial lateral-total oscillation) values, but similar to the study, it was observed that the mean values of postural oscillation in the group with eyes open were better than those with eyes closed.

Cofre Lizama et al. (2016) found that the absence of visual information had no effect on sway, while the presence of visual information reduced postural sway.

Unlike this information in the literature, Asseman et al. (2005), in their study, stated that the absence and presence of visual information did not differ in bipedal stance. This information is consistent with the fact that visual information does not cause any difference in the direction of postural sway bipedal/eyes open and closed/anterior-posterior-medial lateral-total sway.

In addition, in the first case, a more pronounced shift of postural sway was observed in the antero-posterior direction than in the medio-lateral direction. The fact that the ability to maintain balance in sport-specific positions may differ significantly from upright posture (Zemková & Hamar, 2004; Zemková, Hamar, & Böhmerová, 2005; Zemková, Hamar, Pelikánová, & Schickhofer, 2006; Zemková & Hamar, 2008; Zemková, Kyselovičová, & Hamar, 2010) should be taken into account during balance assessment.

Upon examining the obtained data, a significant difference was observed between the groups in squat jump and dynamic balance (post-medial-left foot) values ($p<0.05$), while there was no significant difference between the performance parameters of 30m speed, dynamic balance (right and left foot/anterior-posterior lateral), and postural sway oscillation (double foot/eyes open and closed/anterior posterior-medial lateral-total oscillation) ($p>0.05$). We can assume that the differences in our study arise from different physical characteristics and training programs required by the sports branches.

Furthermore, by increasing the number of athletes and types of sports, performance parameter values can be determined according to sports branches.

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