ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

DOI: 10.5336/sportsci.2021-86032

Evaluation of Body Mass Index and Body Compositions of Elite and Non-Elite Korfball Athletes by Gender: Descriptive-Comparative Study

Elit ve Elit Olmayan Korfbol Sporcularının Beden Kitle İndeksi ve Vücut Kompozisyonlarının Cinsiyete Göre Değerlendirilmesi: Tanımlayıcı-Karşılaştırmalı Çalışma

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ABSTRACT Objective: The aim of the study was to compare the body mass index (BMI) and body compositions of elite and non- elite play- ers by gender in korfball, a mixed-gender team sport. **Material and Methods:** Thirty-nine athletes aged 17-30, 20 national athletes play- ing in international tournaments, and 19 playing only in national tour- naments voluntarily participated in the study. Body compositions of the participants were evaluated by using a Bluetooth-based device, BiodyXpert Bioimpedance. Fat%, fat weight, lean body weight (LBW), bone mineral content, total water, and basal metabolic rate were evaluated. **Results:** The BMI, %fat, LBW of the elite female and male players respectively is (21.00±2.73kg/m^2, 22.17±4.93, 47±4.31); (22.88±3.23 kg/m^2, %14.88±5.51, 64.13±6.2kg). The BMI, %fat, LBW of the non-elite female and male players respectively is (20.33±2.90 kg/m^2, %21.58±5.00, 44.5±4.1kg); (21±3.00 kg/m^2, %13.86±5.55, 62.71±1.16 kg). Height, weight, %fat, muscle mass and LBW values of elite athletes were found to be significantly higher than those of non- elite athletes ($p<0.05$). There was no significant difference in BMI and height values between the two groups ($p<0.05$). **Conclusion:** BMI and fat% of elite and non-elite female and male korfball players are within normal limits. LBW is higher in elite athletes than in non-elite athletes. As in other sports, fat % and fat weight are higher in female athletes than men, and LBW is higher in men. This difference is thought to be due to the physiological difference between men and women.

Keywords: Korfball; body composition; body mass index

ÖZET Amaç: Çalışmanın amacı; kadın ve erkek sporcuların aynı takımda eşit koşullarda oynadığı bir takım sporu olan korfbol de, elit ve elit olmayan korfbolculerin beden kütle indeksi ve vücut kompozisyonlarının cinsiyete göre karşılaştırılmasıdır. **Gereç ve Yöntemler:** Çalışmaya, uluslararası turnuvalarda oynayan 20 milli korfbolcu ve sadece ulusal turnuvalarda oynayan 19 korfbolcu olmak üzere toplam 39 sporcu gönüllü olarak katıldı. Korfbolcuların boy, vücut ağırlığı ölçümleri yapıldı, vücut kompozisyonlarının değerlendirmesi için BiodyXpert Bioimpedance cihazı kullanıldı. BKİ ve vücut bileşenlerinden % yağ, yağ ağırlığı, yağsız vücut ağırlığı, kemik mineral içeriği, toplam su ve bazal metabolizma hızı değerlendirildi. **Bulgular:** Elit kadın ve erkek korfbolcuların BKİ, %yağ ve yağsız vücut ağırlığı değerleri sırasıyla (21,00±2,73 kg/m^2; %22,17±4,93; 47±4,31kg); (22,88±3,23 kg/m^2, %yağ %14,88±5,5, 64,13±6,2 kg)'dır. Elit olmayan kadın ve erkek korfbolcuların BKİ, % yağ ve yağsız vücut ağırlığı değerleri sırasıyla (20,33±2,90 kg/m^2, % yağ %21,58±5,00,44,5±4,1kg); (21±3,00 kg/m^2, % yağ %13,86±5,55; 62,71±11,16 kg)'dır. Elit sporcuların boy, kilo, % yağ, yağsız vücut ağırlığı değerleri, elit olmayanlara göre anlamlı düzeyde yüksek bulundu ($p<0,05$). İki grup arasında BKİ ve boy değerlerinde anlamlı fark görülmedi ($p<0,05$). **Sonuç:** Elit ve elit olmayan kadın ve erkek korfbolcuların BKİ ve % yağları normal sınırlardadır. Yağsız beden ağırlığı elit sporcularda, elit olmayanlara göre daha yük- sektir. Diğer spor dallarında olduğu gibi % yağ, yağ ağırlığı kadın sporcularda, erkeklere göre daha yüksek, yağsız beden ağırlığı ise erkeklerde daha fazladır. Bu farklılığın, kadın ve erkekler arasındaki fizyolojik farklılıktan kaynaklandığı düşünülmektedir.

Anahtar Kelimeler: Korfbol; vücut kompozisyonu; beden kitle indeksi

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Peer review under responsibility of Turkiye Klinikleri Journal of Sports Sciences.

Received: 01 Sep 2021 ***Received in revised form:*** 03 Dec 2021 ***Accepted:*** 30 Dec 2021 ***Available online:*** 17 Jan 2022

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Researchers have shown that the training applied in team sports improves the physical and physiological performance of the athletes. That training has effects on physical performance is known. Studies have revealed adaptive changes in body weight, lean body weight, and fat percentage of individuals due to training.[1] It has been reported that the adaptations of different training programs and practices may differ and may show different results according to the athlete's needs, physiological demands, and sport type in some previous studies on team sports (soccer, basketball, handball, tennis).[2] Therefore, examining body composition, which is one of the performance criteria in team sports, is one of the basic needs in every sport.

Unlike other team sports, korfball is a team sport that requires all-round skills, cooperative play, controlled physical contact, and gender equality where men and women play together. In a team, 4 female and 4 male players are on the field at the same time. According to the rules, players directly defend only players of the same sex from the opposite team to reduce the effect of height, speed, or power advantages in the game, which ensures equality.[3,4] Therefore, there may be variability in the physical structures of the athletes, especially the body composition components. Numerous studies have revealed that the physical characteristics of elite and non-elite athletes in team sports, such as body weight, lean body weight, percent fat differ significantly in body components.[3,5] It has been stated that these differences may be due to firstly training and genetic equipment, nutrition, and sociocultural factors.[3]

Men's and women's leagues are different in team sports other than korfball. Therefore, in many sports branches, different physical characteristics and body composition are seen between the sexes.[6-8] However, since korfball is a sport in which both sexes play together, it is a matter of curiosity to what extent the answers differ in body composition in the game played at the same load intensity and duration.

In the literature, it is seen that there are a limited number of national and international scientific studies examining the body composition differences of men and women in korfball. In the study of Godinho et al. examining the body compositions of athletes playing elite korfball; it has been reported that korfball players have less % fat, more lean body mass, than other athletes, that their athletes are shorter and lighter than basketball and volleyball players, but heavier and taller than other team sports players.[3]

Although it is a sport discipline of European origin, korfball was played as a college sport in Turkey in the 1990s, and, naturally, the studies carried out on the teams at the national level remained fairly limited. There are no descriptive studies on athletes at the national team level, and there are no comparative studies, either. The study questions were: Are there differences in body mass index (BMI) and body components of elite and non-elite korfball players? Are there differences in body components of korfball players by gender?

In this direction, this study aims to compare the physical structure and body components of elite and non-elite korfball players by gender. It is thought that the study data will contribute to both national and international literature.

MATERIAL AND METHODS

PARTICIPANTS

The study is of descriptive type. The sample size calculation table was used to calculate the population and sample of the study, according to the "Survey Monkey" confidence level and acceptable error. The research universe is 200 korfball players playing in the universities, and clubs in the Marmara region. The sample with the acceptable error was accepted as 44 elite and non-elite athletes at ±18% and 99% confidence intervals. However, 39 people aged 17-35 were included in the study, and the "missing value" was not included because the data of 5 people were incorrect. In the current study, the athletes playing in national teams and international korfball club tournaments were considered elite athletes [n=20 (12 female-8 male)], and the athletes playing in korfball tournaments only in Turkey were considered non-elite athletes [n=19 (12 female-7 male)].

MEASUREMENTS

Height: The height of the participants in the study was measured with head in the Frankfort plane

and anatomical position and with bare feet (Heat & Carter) using the height scale (0.1 cm precision, Lafayette Instrument Company, USA).

Body Weight: While measuring the individuals, it has been paid attention to having minimum clothing. Body weight was measured to nearest +0.1 kg with a scale (SECA, Alpha 882, Hamburg).

BMI: BMI was calculated as body mass in kilograms divided by height in meters squared (kg/m^2).[9]

Body Composition: BiodyXpert branded (eBIODY, La Ciotat, France), wire- less, bioelectric impedance instrument was used to measure body composition in the study. BiodyXpert is a portable five-frequency bioimpedance meter op- erating via Bluetooth.[10]

In the measurement of body composition, while the athlete is in a sitting position, he places the electrodes of the bioelectric impedance device, which he holds with his/her hand, just below the ankle, malleoli, and holds the other electrodes with his/her hand and keeps the button pressed for 4-5 seconds with his thumb until the green light on the body flashes. The data were transferred to the relevant platform Biody (eBIODY,La Ciotat, France) manager software via Bluetooth as soon as the measurement was taken. With BiodyXpert (eBIODY,La Ciotat, France), fat%, fat free mass (kg), fat mass (kg), bone mineral content (kg), total water (L) and basal metabolic rate (BMR) (kcal) were evaluated. The research was conducted voluntarily and de- signed in accordance with the 2008 Helsinki Decla- ration criteria, and it was received from the Haliç University Non- interventional Clinical Research Ethics Committee to conduct the study (2020/124, September 24, 2020). Signed consents were obtained from all men and women participating in the study.

DATA ANALYSIS

IBM-SPSS (version 24.0; SPSS Inc., Chicago, IL, USA) program was used for the statistical evaluation of the data. The normality distribution of the data was assessed by Kolmogorov- Smirnov test, and it was found that they were not normally distributed. After calculating descriptive statistics, the Mann-Whitney U test was used to compare by gender and groups. The confidence interval was set at $p<0.05$.

RESULTS

Table 1 shows the descriptive statistics for physical parameters of korfball players. The mean values of the elite female players are as follows, respectively (age=24±3.91; height=170.25±6.05; weight=62.01± 8.51; BMI=21±2.73; BMR=1,454±73.2), while the mean values of the elite male players are as follows, respectively (age=25.13±3.98; height=186.25±8.54; weight=12.98±3.23; BMI=22.88±3.23; BMR= 1,899±130.66).

The mean values of non-elite female athletes are (age=18.58±3.2; height=166.50±3.75; weight= 58.21±7.09; BMI=20.33±2.90; BMR=1,450.25± 89.07), respectively. The mean values of non-elite male athletes are (age=22.14±4.14; height= 185.43±9.11; weight= 74.73±16.30; BMI=21.00±30; BMR=1,942.57± 177.9), respectively.

TABLE 1: Physical parameters of the players by levels and gender.

	Elite (n=20)			Non-elite (n=19)			
	Female (n=12)	Male (n=8)		Female (n=12)	Male (n=7)		Between groups
	Mean±SD	Mean±SD	p value	Mean±SD	Mean±SD	p value	p value
Age (year)	24±3.91	25.13±3.98	0.534	18.58±3.2	22.14±4.14	0.081	0.075
Height (cm)	170.25±6.05	186.25±8.54	0.002*	166.50±3.75	185.43±9.11	0.001*	0.000*
Weight (kg)	62.01±8.51	77.25±12.98	0.005*	58.21±7.09	74.73±16.3	0.042*	0.000*
BMI (kg/m^2)	21.00±2.73	22.88±3.23	0.116	20.33±2.9	21±3	0.417	0.126
BMR (kcal)	1,454±73.2	1,899±130.66	0.001*	1,450.25±89.07	1,942.57±177.9	0.000*	0.000*

*Significant difference between elite and non-elite groups ($p<0.05$); SD: Standard deviation; BMI: Body mass index; BMR: Basal metabolic rate.

The mean body height, weight, of the elite players was significantly higher than those of the non-elite players ($p<0.05$). In female elite athletes, BMR scores were found to be significantly higher than non-elite female athletes, and significantly lower in elite men than non-elite athletes ($p<0.05$). The BMI values of both elite and non-elite korfball players are within the normal limits (between 18.5 kg/m^2 and 24.9 kg/m^2).[9] There was no difference between the age and BMI values of the elite and non-elite athletes within the group and between the groups by gender ($p>0.05$).

Significant differences were observed when the height, weight and BMR values of elite athletes, and height, weight and BMR values of non-elite athletes were compared by gender ($p<0.05$).

Table 2 shows the mean values of body composition, standard deviation, comparisons between the elite and non-elite players by gender within the group, and the comparison between the groups by gender.

The averages of the elite female players are as follows, respectively (fat percent=22.17±4.93; fat mass=14.08±5.28; fat free mass=47.00±4.31; total water=43.92±3.12; bone mineral content=2±0), while the average values of the elite male players are as follows (fat percent=14.88±5.51; fat mass=12.25±7.09; fat free mass=64.13±6.2; total water=47.38±4; bone mineral content=2.5±0.53).

The averages of non-elite female players are respectively (fat percent=21.58±5; fat mass=12.5±4.06; fat free mass=44.50±4.10; total water=32.08±3.23; bone mineral content=1.83±0.39), while the averages of non-elite male players are respectively (fat percent=13.86±5.55; fat mass=11.14±6.39; fat free mass=62.71±11.16; total water=46±7.92; bone mineral content=2.71±0.49).

As a result of the statistical evaluation, it has been seen that there was a significant difference when fat percent, fat free mass, bone mineral content, total water of the elite athletes were compared by gender ($p<0.05$).

It has been observed that there was a significant difference when fat percent, total water, bone mineral content of the non-elite athletes were compared by gender ($p<0.05$). Only fat mass values of elite and non-elite athletes did not differ by gender ($p>0.05$). Fat percent, fat mass, fat-free mass, total water, the bone mineral content of the elite female and male players were significantly higher than those of non-elite female and male players ($p<0.05$).

In the study, fat percent, fat mass (kg), fat free mass (kg), total water (L), were significantly higher in elite athletes. Bone mineral density was measured significantly higher in male elite athletes than non-elite athletes ($p<0.05$).

DISCUSSION

In the current study, body components of elite and non-elite female korfball players were examined. While significant differences were observed in all components in the elite group, the only fat weight did not differ by gender. It was found that the % fat ratio was high in both groups and both in men and women. However, men and women of the elite group had higher lean body weight. BMI values were within the

TABLE 2: Different components of body composition of the korfball players by levels and gender.

	Elite (n=20)			Non-elite (n=19)			
	Female (n=12)	Male (n=8)		Female (n=12)	Male (n=7)		Between groups
	Mean±SD	Mean±SD	p value	Mean±SD	Mean±SD	p value	p value
Fat percent (%)	22.17±4.93	14.88±5.51	0.012*	21.58±5	13.86±5.55	0.012*	0.00*
Fat mass (kg)	14.08±5.28	12.25±7.09	0.229	12.5±4.06	11.14±6.39	0.348	0.012*
Fat-free mass (kg)	47±4.31	64.13±6.2	0.000*	44.5±4.1	62.71±11.16	0.002*	0.000*
Total water (L)	43.92±3.12	47.38±4	0.000*	32.08±3.23	46±7.92	0.001*	0.000*
Bone mineral content (kg)	2±0	2.5±0.53	0.008*	1.83±0.39	2.71±0.49	0.002*	0.000*

*Significant difference compared with elite and non-elite groups ($p<0.05$); SD: Standard deviation; BMI: Body mass index; BMR: Basal metabolic rate.

normal range, and there was no difference between men and women in both groups.[9]

Body compositions have been assessed with different measurement methods used in sports science and have been associated with sports performance. With anthropometric measurements, the suitability of body types for sports is determined and directed to appropriate sports at a young age, and training programs for body composition are organized for adult athletes.[6] The researchers investigated body composition relationships in different sports branches and different age groups. Body composition values in team sports, in footballers, basketball players, volleyball players, individual sports branches, and karate have been researched and contributed to the literature.[6-8,11-16] Some studies have been written on the body composition of players comparing their playing positions, but Korfball players perform every function and position during the game; therefore, they were not compared according to their playing positions in the current study.[17-19]

Korfball is played in many countries by players of different levels. It differs according to body composition, training level (elite-non-elite), and gender. In a compilation study comparing different countries and categories, it was seen that the fat ratios of handball players differ according to countries and cannot be classified according to their elite status. Studies have reported that body fat percentages of athletes vary depending on position and training status.[20]

Since korfball is played in all ages and categories, wide distribution in body composition components has been seen, and it is reported that studies on this sport are also limited. A significant difference was observed between elite and non-elite athletes in all parameters except BMI values in our study. The higher values of elite players, excluding fat percentage, can be explained by training. It is considered that the muscle ratio and the total body water increase depending on the athletes' training.[9] The fact that the fat percentage of the athletes is higher than that of non-elite athletes may be due to the nutritional habits of the athletes or the low quality of training.

Ergül and Günay evaluated the physical and physiological profiles of elite and non-elite female volleyball players and reported that female volleyball players playing in the premier league are heavier and taller than the 2nd league and other groups.[21] These findings are similar to our study. In the present study, it was observed that both groups were not in the ideal fat ratio, but the elite group was more massive. It is thought that this difference is due to elite athletes' regular training and nutrition.

In this study, the physical characteristics and body composition of the elite and non-elite players in korfball, which has different characteristics from other team sports, were revealed. The differences between male and female players playing on the same team equally with the same training characteristics were discussed. Due to the limited number of studies on korfball, comparisons were made with other team sports-volleyball, basketball, handball, soccer and softball.[6,8,13,22]

It is known that height and weight ratios are essential in sports. When the results of a study comparing the physical characteristics of professional and elite male players in basketball, which is a discipline similar to korfball sport, with the male korfball players in our study, it is seen that both the height and weight values of the basketball players are higher. Accordingly, their BMI values are higher than the korfball players.[23] Although the height and weight ratios of the female basketball players vary according to their positions, it is observed that they are heavier, taller, and more massive than female korfball players as in all other collective sports branches.[22,24,25]

When the physical characteristics and body composition values in male soccer players were compared with similar age averages as our research group, it was seen that korfball players were taller and had fatter bodies.[6,11] On the other hand, female korfball players were observed to be thinner than footballers evaluated the physical characteristics of volleyball and handball athletes playing in the young male premier league.[22,26,27]

It has been observed that volleyball players are seen to be taller, thinner, and have less fat %. It is seen that female volleyball players are taller and heavier than female korfball players. Female hand-

ball players are shorter but heavier and more massive.[22,25]

The fact that female volleyball players are thinner and have less fat than the korfball players may be due to the number of training sessions and diets of the athletes. In handball, the players defend one-on-one. On the other hand, in korfball, men and women play together equally, but players can only defend against players of the same sex from the opposite team. The reason why handball players are more massive may be the strength training required for defense. On the other hand, korfball is a sport with controlled physical contact based on skill rather than strength.[4] In korfball, training, which is based on skills, is more involved in training planning than strength training, so it can be expected that female athletes are thin.

According to the study conducted on male softball players of a similar age group (n=150) with our study by (Singh and Bedi), athletes' mean height and weight values were lower than the male korfball players.[28] Korfball players had lower percentage fat and higher lean body weight than softball players.[28] It is noteworthy that female korfball players had a similar height compared to female softball players but were thinner and had a lower fat ratio.[22,29]

Godinho et al., examined the body composition of male and female korfball players, and it has been found that the height and weight values of male korfball players were higher than the values of female players.[3] In terms of body fat percentage, it has been determined that female athletes have higher values than male athletes. These findings are in line with our study. However, when the male and female athletes in our study were compared with the study of Godinho et al. separately, it was determined that male athletes have similar weight and height, and female athletes have higher fat % in our study.[3] The difference is thought to be due to the age difference between athletes.

In the current study, it has been observed that the fat % of women is higher than men when age, height, BMI, and % fat values of the korfball players are compared by gender but body fatness is within normal limits for both sexes. It has been found that there were differences between the fat % values of men and women in different collective sports disciplines.[20,22,29] Examined 5 different sports disciplines (volleyball, softball, basketball, soccer, and handball), and the results of age, height, weight BMI and fat % ratio of elite female athletes of similar age group were similar to the values of Turkish female korfball players playing in the leagues.

In the literature, when the physical structure in similar branches is compared with the gender factor, it has been seen that men have less fat ratio, more body weight, and muscle mass, higher BMI value, and they are longer than female athletes.

In a study comparing volleyball women and sedentary athletes, the total bone density of the athletes was measured higher than the sedentary ones.[30] In this study, the bone mineral density of elite athletes was higher than that of non-elite athletes. These results reveal that women who do sports at the elite level have higher bone mineral density.

Bone mineral density varies according to the branch of the athletes. In a study comparing sixteen different branches, the bone mineral density of swimmers was lower than other sports branches, and basketball was the highest among the compared branches.[31] When compared with the results of this study, it was observed that the bone mineral density closest to the korfball players was in the football players.

Bone mineral density may vary depending on the sports. Compared to sports branches, the fact that the closest branch is in the football players suggests that the stimulus on the bone mineral density of the branches is similar.

CONCLUSION

As a result, studies conducted on other team athletes have revealed that it varies depending on gender and branch. In our study, it was observed that although both female and male athletes who play korfball are slim and their fat ratios are within normal limits, there are differences in physical characteristics and body composition by gender as in other sport branches. Structural and functional characteristics of athletes are essential to be successful in korfball as in other sports. The current study compared the similarities

between volleyball, basketball, football, handball, and softball with the korfball branch. It is noteworthy that the korfball players have different structural characteristics than the athletes in other team sports.

In the study, total water, lean body weight, height, weight, % fat and fat weight were found higher in elite athletes. This may be caused by elite athletes training more and their diet differences. BMR and bone mineral content were measured differently according to gender. While BMR values were measured higher in elite athletes in women, bone mineral density was measured higher in male elite athletes than in non-elite athletes. In the study, there were differences between the body components of elite and non-elite athletes, and elite athletes were more muscular and massive, which can be attributed to the fact that elite korfball players train more and their nutrition difference.

Future studies that discuss athletes' physical, physiological, psychological, and motor characteristics will provide a better understanding of the sport of korfball and contribute to the selection and evaluation of the players.

Acknowledgment

It is a study that is carried out in the Erasmus+ project conducted by the International Korfball Federation, in which Marmara University is a partner.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *lhan Odabaş;* ***Design:*** *lhan Odabaş, Lale Güler-Ali Günay;* ***Control/Supervision:*** *İlhan Odabaş;* ***Data Collection and/or Processing:*** *İlhan Odabaş, Ali Günay;* ***Analysis and/or Interpretation:*** *İlhan Odabaş, Ali Günay;* ***Literature Review:*** *Lale Güler, Ali Günay;* ***Writing the Article:*** *İlhan Odabaş, Lale Güler, Ali Günay;* ***Critical Review:*** *İlhan Odabaş, Lale Güler, Ali Günay;* ***References and Fundings:*** *Ali Günay.*

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