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Relationship Between Nutritional Status, Anthropometric Measurements and Dietary Inflammatory Index in Professional Football Players

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ABSTRACT

Objective: This study was carried out to evaluate the relationship between the nutritional status, anthropometric measurements and dietary inflammatory index (DII) of professional football players exposed to long-term intense exercise.

Method: Twenty-one professional male football players with a mean age of 26.00±5.69 years playing in the same club participated in the study. The nutritional status of the football players was evaluated with 3-day food consumption record (2 days of training and 1 match day). DII scores were calculated using data on 34 nutrient/nutritional ingredients obtained from the food consumption records. Body fat percentage in the anthropometric evaluations were determined by caliper and skinfold thicknesses.

Results: The median DII scores of the football players were found as – 3.42 (-9.95 – 0.95), and their nutritional intake were found to be anti-inflammatory. When the relationship between the DII scores of the football players and their anthropometric measurements was examined, a positive and significant correlation (R: .476; p: .029) was found between their DII score and their abdominal adiposity. However, there was no significant correlation (p> .05) between the DII scores and the other anthropometric measurements. In addition, there was a significant negative correlation (R: – .468; p: .032) between fiber consumption and abdominal adiposity, and a significant positive correlation between carbohydrate and fat consumption and body weight (respectively R= .730 p= .000; R= .526 p= .014).

Conclusion: It has been revealed that the football players participating in our study generally have an anti-inflammatory diet. It was also found that abdominal adiposity was higher in the football players with high DII scores.
Keywords: Football player, dietary inflammatory index, anthropometry

1. INTRODUCTION

Football is a challenging game that includes irregular changes in speed and anaerobic activities, as well as long-term moderate-intensity exercise in which various physiological systems are combined, and it includes non-cyclical and intermittent, high-intensity activities (1). In football, which is the most popular sport in the world, it is of crucial importance to maintain and improve performance and prevent injuries. Nutrition is considered to be a vital part of performance and recovery in both young and elite athletes (2). It also has a very important effect on the general health of athletes. It is emphasized that optimal nutrition for athletes includes adequate intake of energy, macro and micronutrients, and fluid during training and competition periods (2,3). However, it is stated that the immune system is at risk in football, which is an endurance sport. (4). Long-term and intense exercises are associated with psychological, metabolic and physiological stress, immune dysfunction, inflammation, oxidative stress and muscle damage (5). In addition, it is stated that there is an increase in inflammation biomarkers, especially after high-intensity exercises (6).

Nutrition affects inflammation positively or negatively (7). Cavicchia et al. created a special scoring system called the dietary inflammatory index (DII) by measuring the nutrients or nutritional ingredients thought to affect inflammation (8). In the study by Shivappa et al. (2014), the validity of DII was achieved (9). DII has been used in many studies on nutrition and inflammation (10,11). The aim of the study is to evaluate the relationship between the nutritional status, anthropometric measurements and DII scores of professional football players exposed to long-term intense exercise.

2. METHODS

The sample of this cross-sectional study consisted of male football players of a professional club based in Istanbul that plays in the Turkish Football Federation Second League.

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After necessary permissions were obtained from the club, the players meeting the inclusion criteria were made to sign voluntary consent forms. Those who did not have any chronic diseases and were not receiving any medication or nutritional support were included in the study. Having been prepared in accordance with the ethical standards of the Declaration of Helsinki, the present study received ethical approval from the clinical research ethics committee of Marmara University (16.09.2020 no: 09.2020.952).

Anthropometric variables include body height (BH), body weight (BW), body mass index (BMI), and body fat percentage (BF%). The measurements were performed according to the anthropometric measurement standards recommended by the International Society for the Advancement of Kinanthropometry (ISAK) (12). BH was measured with an accuracy of 0.1 cm using a Harpenden anthropometer (Holtain Ltd, Croswell, UK). BW was evaluated using an electronic scale (Sinbo^{R}) with an accuracy of 0.1 kg. Skinfold thickness was measured with a caliper (Holtain Ltd, Croswell, UK). Skinfold thicknesses were taken from four areas (anterior thigh, abdominal, triceps and medial calf sites) suggested for football players, and were calculated using the following formula to estimate BF% (13). BMI was calculated by dividing the body weight by the square of the height in meters. However, it is stated that the use of BMI parameter in athletes causes problematic results (14). For this reason, BMI was not included when examining the relationship between nutrient intake and anthropometric measurements of football players.

BF%= 5.174 + (0.124 × thigh) + (0.147 × abdominal) + (0.196 × triceps) + (0.130 × calf)

The food consumption records of the football players were obtained by interviewing them face to face and showing them the food atlas (15). The food consumption of the football players was determined by taking the average of their 3-day diet records (2 days of training and 1 match day). The food consumption data were analyzed using Nutrition Information Systems (Beslenme Bilgi Sistemleri – BeBiS) version 8.1 (Pasific Ltd. Şti., Istanbul, Turkey). The results obtained based on the food consumption records were evaluated by using the DII scoring that Shivappa et al. developed and revised (8,9).

The obtained data were evaluated with SPSS software package program version 21.0 (IBM Inc., Chicago). Statistical significance was accepted as $p<0.05$ in all analyzes. Numbers, percentages, medians and minimum-maximum values were included in descriptive statistics. The relationship between the DII scores and anthropometric measurements was determined using Spearman's correlation.

3. RESULTS

A total of 21 volunteer professional football players with a mean age of 26.00±5.69 years were included in the study. While 76.2% of the football players were high school graduates, 23.8% were university graduates. When their dietary intakes were examined, all of the participants (100%) were found to consume 3 main meals, while 57.1% had only 1 snack. On the training days, all of them (100%) had their meals 3-4 hours before the training. They had meals within the first 2 hours following the training (Table 1).

Table 1. *Demographic characteristics and dietary habits of football players*

	n	%
Characteristics		
Education		
High school	16	76.2
Bachelor's degree	5	23.8
Marital status		
Married	8	38.1
Single	13	61.9
Nutrition habits		
Number of main meals		
2	0	0.0
3	21	100.0
Number of snacks		
1	12	57.1
2	9	42.9
Pre-workout meal timing (hours)		
≤2 hours	0	0.0
3-4 hours	21	100.0
>4 hours	0	0.0
Post-workout meal timing (hours)		
≤2 hours	21	100.0
>2 hours	0	0.0

When the anthropometric measurements of the football players were evaluated, the median BW was found to be 72.00 kg (61.20-88.50), while the median BMI to be 23.07 kg/m^2 (19.32-26.05). The median body fat percentage of football players whose skinfold thickness was measured with caliper was 9.66% (7.71-11.25) (Table 2).

Table 2*. Anthropometric measurements of football players*

Anthropometric measurements	Median	Minimum	Maximum
Height (cm)	178.0	164.0	189.0
Body weight (kg)	72.0	61.2	88.5
Body mass index (kg/ m^2)	23.0	19.3	26.0
Thigh (mm)	8.3	4.8	15.0
Abdominal (mm)	9.4	4.9	16.2
Triceps (mm)	6.8	3.4	11.0
Calf (mm)	4.0	2.4	5.3
Total fat (%)	9.6	7.7	11.2

**cm:centimeters, kg: kilograms, m: meters, mm: milimeters, %: percentage*
** statistical significance level p<0.05*

When the nutritional intakes of the football players was analyzed, the median energy was found 3053.79 kcal (2820.23-3197.05), and the median rates of carbohydrate, protein and fat consumption were 50% (46.0-52.0), 20%

(18.0-21.0) and 30% (28.0-33.0), respectively. The median DII scores of the football players were found to be – 3.42 (-9.95-0.95) (Table 3).

Table 3. *Nutritional intakes and dietary inflammatory index scores of football players*

	Median	Minimum	Maximum
Energy (kcal)	3053.7	2820.2	3197.0
Protein (g)	143.8	132.7	157.7
Protein (%)	20.0	18.0	21.0
Fat (g)	103.9	87.2	116.3
Fat (%)	30.0	28.0	33.0
Saturated fatty acids (g)	43.3	36.7	48.2
Monounsaturated fatty acids (g)	36.7	31.6	42.2
Polyunsaturated fatty acids (g)	15.2	12.3	22.3
Omega 3 (g)	2.1	1.8	4.0
Omega 6 (g)	12.3	9.4	17.5
Cholesterol (mg)	882.3	606.4	925.2
Carbohydrate (g)	374.7	331.3	398.0
Carbohydrate(%)	50.0	46.0	52.0
Fiber (g)	31.9	24.0	39.9
Caffeine (mg)	32.0	29.0	36.0
Vitamin A (mcg)	2126.9	2011.0	2465.3
Carotene (mcg)	5930.0	5260.0	8430.0
Vitamin D (mcg)	5.2	3.2	5.4
Vitamin E (mg)	15.2	12.7	21.9
Vitamin B1 (mg)	1.3	1.0	1.7
Vitamin B2 (mg)	2.4	2.0	2.8
Vitamin B6 (mg)	2.6	2.0	3.4
Niacin (mg)	28.5	25.9	34.0
Folate (mcg)	482.9	386.2	545.8
Vitamin B12 (mcg)	12.3	11.0	13.8
Vitamin C (mg)	219.7	141.8	345.6
Iron (mg)	17.8	14.8	26.0
Magnesium (mg)	426.7	348.0	495.1
Zinc (mg)	50.0	46.0	52.0
Selenium (mcg)	22.0	20.0	26.0
Alcohol (g)	0.0	0.0	0.0
Total DII score	-3.4	-9.9	0.9

**kcal: kilocalories, g: grams, mg:miligrams, mcg: micrograms, %: percentage DII: Dietary inflammatory index*
** statistical significance level p<0.05*

The relationship between the nutritional intakes of the football players and their anthropometric measurements is given in Table 4. A significant positive correlation was found between the energy, carbohydrate and fat consumption of the football players and their body weights (p< .05). In addition, there was a significant negative correlation (R: – .468; p: .032) between fiber consumption and abdominal adiposity, and a significant positive correlation between carbohydrate and fat consumption and body weight (respectively R= .730 p= .000; R= .526 p= .014). However, no significant correlation was observed between the consumption of protein, saturated fatty acids and other micronutrients and the anthropometric measurements.

Table 4. *The relationship between the nutritional intakes of football players and their anthropometric measurements*

	Body weight (kg)	Thigh (mm)	Abdominal (mm)	Triceps (mm)	Calf (mm)	Total fat (%)
Energy (kcal)	R=0.729 **p=0,000**	R=-0.125 p=0.589	R= – 0.087 p= 0.709	R=-0.195 p= 0.397	R=0.152 p=0.511	R= – 0.135 p=0.559
Protein (g)	R=0.379 p=0,090	R= – 0.122 p= 0.598	R= – 0.241 p= 0.292	R= – 0.171 p= 0.460	R= 0.082 p= 0.725	R= – 0.188 p= 0.415
Protein (%)	R=-0.242 p=0,291	R= – 0.011 p= 0.963	R= – 0.057 p= 0.806	R= 0.087 p= 0.708	R= 0.088 p= 0.703	R= 0.019 p= 0.934
Fat (g)	R=.526 **p=0.014**	R= – 0.272 p= 0.233	R= – 0.105 p= 0.651	R= – 0.260 p= 0.255	R= 0.165 p= 0.475	R= – 0.246 p= 0.282
Fat (%)	R=-0.059 p= 0.799	R= – 0.249 p= 0.277	R= – 0.032 p= 0.889	R= – 0.139 p= 0.548	R= 0.052 p= 0.823	R= – 0.155 p= 0.502
Monounsaturated fatty acids (g)	R= 0.184 p= 0.424	R= – 0.068 p= 0.771	R= 0.334 p= 0.139	R= 0.015 p= 0.949	R= – 0.014 p= 0.951	R= 0.099 p= 0.670
Carbohydrate (g)	R=.730 **p= 0,000**	R= 0.165 p= 0.474	R= 0.115 p= 0.621	R= – 0.006 p= 0.980	R= 0.095 p= 0.683	R= 0.105 p= 0.650
Carbohydrate (%)	R= 0.307 p= 0.176	R= 0.397 p= 0.075	R= 0.238 p= 0,299	R= 0.193 p= 0.402	R= 0.064 p= 0.782	R= 0.304 p= 0.180
Fiber (g)	R= 0.314 p= 0.165	R= – 0.279 p= 0.220	R= – .468 p= **0.032**	R= – 0.347 p= 0.123	R= 0.107 p= 0.644	R= – 0.412 p= 0.064

**kcal: kilocalories; g: grams; %: percentage; * statistical significance level p<0.05*

When the relationship between the DII scores of the football players and their anthropometric measurements was examined, a moderate positive correlation (R: .476; p: .029) was found between the DII score and abdominal adiposity. No significant correlation (p> .05) was found between the DII scores and the other anthropometric measurements (Table 5).

Table 5. *The relationship between the football players' dietary inflammatory index scores and anthropometric measurements*

	Dietary inflammatory index score	
	R	p
Anthropometric measurements		
Body weight (kg)	-0.276	0.226
Body mass index (kg/m^2)	-0.339	0.133
Thigh (mm)	0.233	0.309
Abdominal (mm)	0.476	**0.029**
Triceps (mm)	0.194	0.400
Calf (mm)	-0.083	0.721
Total fat (%)	0.337	0.135

** kg: kilograms, m: meters, mm: milimeters, %: percentage; * statistical significance level p<0.05*

4. DISCUSSION

The relationship between the nutritional status of professional football players, their anthropometric measurements and their DII scores was investigated in this study. The nutritional status of football players is of great importance as it positively affects performance parameters and reduces the risk of injury (16).

When the participants' nutritional intakes before training were examined, it was found that all of them consumed a meal 2-4 hours before training. Considering the intensity of training in football players, they need to receive nutrition before training in order to prevent fatigue, increase performance and muscle strength. However, it is stated that they should consume meals 3-4 hours before training due to gastrointestinal problems that may occur during training (17). The football players participating in our study ate in accordance with this statement. When the football players' nutritional intakes after training were examined, all of them were found to consume meals during the first 2 hours following training. Nutrition is essential in recovery after training in football. The main goal in post-training nutrition is to replenish glycogen stores and repair muscle damage for the next match or training. It is stated that the timing of eating is very important at this point so as to ensure rapid recovery (18). It is also stated that a meal containing sufficient carbohydrates (1-1.5 g/kg) and protein (0.4 g/kg) should be consumed within the first 2 hours after training/exercise for optimal muscle glycogen and protein synthesis (19).

Body composition is of significance for optimal performance and protection from injuries in football (20). The fat percentage of the football players participating in our study was found as 9.66% (7.71-11.25). In a study conducted on elite Australian football players, their average fat percentage was found as 12.8±1.9% (21). When the body compositions of professional football players playing in different leagues in Turkey were examined, it was found that the average body fat percentage of those playing in the 2nd league was 16.5±3.26%, which is in accordance with our study (22). It has been revealed that an increase in body fat percentage decreases football players' performance (23) and causes an increase in the risk of injury (24).

The nutritional intakes of football players are stated to be of great importance for their performance and health. In the study Anderson et al. conducted with football players, the average energy intake was 2956±374 kcal (25), and this result is similar to ours [median 3053.79 kcal (2820.23 – 3197.05)]. The distribution of energy to macronutrients is as important as the total energy intake in the diet. Carbohydrate consumption is crucial for the optimal performance of team sports athletes (26). The carbohydrate consumption of the football players participating in the study was found as 50% of the energy (46.0-52.0). It has been shown in studies conducted with football players that carbohydrate consumption is 38±12% (19) and 43.9±4.8% of energy (22). However, a positive correlation was found between carbohydrate consumption and body weight, which is in accordance with the literature (27). It is stated that an increase in carbohydrate consumption above the recommended levels has negative effects on body composition (28). In addition, a negative significant correlation was found between fiber consumption and abdominal skinfold thickness in this study. In a cohort study, a negative correlation was determined between increased fiber consumption and abdominal adiposity (29). It is stated that fiber consumption should be encouraged in athletes due to its positive effects on health (30).

Proteins increase muscle protein synthesis and endothelial regeneration, especially after exercise, and reduce muscle damage (31). It was found that the protein consumption of the football players participating in the study corresponded to 20% of the energy (18.00-21.00). Although there are studies in the literature indicating that the daily protein consumption of football players is in accordance with this study (32,33), there are also those reporting lower protein consumption (34,35). It is stated that the total amount of daily protein intake should be between 1.4-2.0 g/kg/day in football players, although it varies according to training/match frequency (36). The protein consumption of the football players participating in the study met the recommendations.

Although the benefits of fat for exercise performance are not clear, fat consumption is essential in maintaining health (37). The fat consumption of the football players participating in the study was found to correspond to 30% (28.0-33.0) of the energy. In the study Brinkmans et al. conducted with a group of professional football players, it was revealed that their fat consumption was 30.8±4.9% on average, which is similar to our study (38). Furthermore, a positive correlation was observed between fat consumption and body weight in the present study. In another study examining its effects on athletes' nutrition intakes and body composition, a positive correlation was found between fat consumption and body weight (27). Although carbohydrate and fat consumption are positively correlated with body weight, body fat mass/percentage is not correlated. It is believed that carbohydrate and fat consumption do not have a negative effect on body composition. For football players, fat consumption is recommended to be between 20-35% of the daily energy intake. That fat consumption exceeds the recommended level is stated to have negative effects on performance and body composition (39).

It has been stated that inflammation and oxidative damage in football players can negatively affect their performance and increase the risk of diseases such as upper respiratory tract infections (40). DII score has been found to be associated with inflammation parameters. In this study, the median DII scores of the football players were found to be low (-3.42). A study indicated that soldiers with low DII scores had higher maximum VO_2 levels, which is very important in sportive performance (41). Another study reported that the maximum VO_2 levels of individuals with pro-inflammatory (high DII score) eating habits were 7% less (42).

In our study, a moderate positive correlation was found between DII score and abdominal adiposity. A study with a large sample size revealed that individuals with low DII scores (anti-inflammatory) had lower waist circumferences (43). Another study conducted with soldiers reported that individuals with high DII scores had higher fat percentages. It is stated that an increase especially in abdominal adiposity increases inflammation and health risks (44). In addition, it has been shown that abdominal adiposity increases the risk of

injury in athletes (45) and decreases endurance performance (46). Considering these effects, it can be recommended that football players gain anti-inflammatory (low DII score) eating habits.

When the literature is reviewed, this study is the first to evaluate the nutritional status of professional football players through DII, and it is of significance to obtain detailed food consumption records through face-to-face interviews and using the food atlas (15). On the other hand, since only one professional football team was studied, the number of samples was limited and the DII scores could not be compared with the biochemical findings because the football players did not want to undergo an invasive procedure during the season.

5. CONCLUSION

In conclusion, it was found that the football players participating in the study had an anti-inflammatory diet. Besides, individuals with high DII scores were found to have more abdominal adiposity. In addition, a negative correlation was determined between fiber consumption and abdominal adiposity, and a positive correlation between carbohydrate and fat consumption and body weight. Considering the risks posed by the training loads of professional athletes, it is thought that more studies should be carried out on the relationship between inflammation and nutritional intakes. Further studies are needed to determine the relationship between biochemical measurements and inflammatory status, in addition to sex, which is one of the main contributors to inflammatory status.

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