Int J Sport Stud Hlth. 2020 April; 3(1):e104103. doi: 10.5812/intjssh.104103.

Published online 2020 June 14. **Research Article**

Dietary Intake and Body Composition Characteristics of National Football League Players

Daniel Afrifa [1,*], Kwabena Nsiah [2], Collins Afriyie Appiah [2] and Omoniyi Monday Moses [1]

[1] Department of Physiotherapy and Sports Science, Faculty of Allied Health Science, College of Health Science, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[2] Department of Biochemistry and Biotechnology, College of Science, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

[*] *Corresponding author*: Department of Physiotherapy and Sports Science, Faculty of Allied Health Science, College of Health Science, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. Email: afrifadaniel88@yahoo.com

Received 2020 April 25; **Accepted** 2020 June 04.

Abstract

Background: It has been well documented that adequate body composition characteristics and good nutrition practices play significant roles in maintaining good health, proper immune functioning, muscle growth and repair, and delaying fatigue in continuously intense athletic performance. It would be incumbent, however, to support imported information with local data to enhance effective implementation.
Objectives: To examine dietary intake and body composition characteristics of National Football League Players in the Ashanti region of Ghana.
Methods: Cross-sectional study was used. 95 football players from the premier, 1st and 2nd divisions of the Ghana National Football League were recruited. A 24-hour dietary recall was used to assess the dietary intake of the players. Body composition characteristics of body mass index, percentage (%) body fat, visceral fat and percentage (%) muscle mass were measured.
Results: There were 8 (9.3%) goalkeepers, 29 (33.7%) defenders, 34 (39.5%) midfielders and 15 (17.4%) strikers. 42 (44.2%) of the players ate twice per day. Players within age group of 20 - 25 (49, 51.6%) had the highest mean total energy intake (2342.96 $\pm$ 848.18), carbohydrates (324.18 $\pm$ 106.35), proteins (75.54 $\pm$ 23.94) and fats (83.00 $\pm$ 50.76). Midfield players had the highest mean total energy intake (2216.26 $\pm$ 803.87), carbohydrates (315.74 $\pm$ 121.02), proteins (74.23 $\pm$ 26.35) and fats (71.59 $\pm$ 34.32). 82 (86.3%) had normal weight, 79 (83.2%) normal % body fat, 45 (47.4%) had very high % muscle mass.
Conclusions: The sample in this study has low total energy intake compared to other studies. Insufficient nutritional diets could suggest the reason for the low energy intake. If low energy intake persists, the players might be at high risk of chronic cardiovascular diseases and diabetes conditions.

Keywords: Body Composition, Fat, Football, Dietary Intake, Protein, Carbohydrates

1. Background

Football, also known in some countries as soccer or association football is the world's most popular sport with an estimated 250 million players across about 200 nations and their dependencies globally (1). It is played with a ball spherical in shape with the aim of scoring by moving the ball across the goal line (1). Football is a team sports characterized by an intermittent high intensity play which is intermingled with episodes of recovery (2). The general season for any professional football player is divided into 3 periods; pre-season, in-season and the off-season. During pre-season, the training demands for any professional football is so intense that they may be required to cover about 20 km combined with a modified training volume and match play during competition (2).

The high intensity nature of play and training for football players demand that they fuel appropriately through good nutrition and water. Among athletes especially football players, proper and adequate nutrition is essential for replacing and regenerating depleted hormones, energy reserves, nervous functions, dehydration and transfer of electrolytes (3), maintain lean muscle mass and promote optimal performance (4). Football players like any other athlete participating in team sports as a result of the extreme demand on the cardiovascular, metabolic and energy stores, have a special consideration when it comes to nutrition (5) as restrictive diet and their high requirements for certain nutrients and energy can result in high risk of suboptimal dietary intake among the players (6). Athletes, like football players need to continuously replen-

ished their energy stores especially during training and competition as their energy reserves may not be enough for a longer term.

Inadequate dietary intake and over-consumption among athletes may lead to body composition and body weight changes (5). The changes which may come as a result of the inadequate or overconsumption may have an adverse impact on the player's ability to perform and sustain activity during competition and in-season (7). Besides, the maintenance of energy balance through adequate energy consumption is necessary to accomplish right consumption of essential macro-and micro-nutrients for the athlete (7).

The main nutrients required for football players is carbohydrates and so it is recommended that they consume about 7 - 10 g/kg of body weight for carbohydrates (8) and 1.2 - 1.7 g/kg of body weight for protein since the contribution of proteins to the production of energy is low (7). It is also recommended that athletes consume about 20% - 35% of their total daily energy requirement from fat (7). The recommend intake of Carbohydrates is adequate to maintain plasma glucose levels and replenish muscle glycogen stores while the protein intake is also adequate to support nitrogen balance, spare amino acids for protein synthesis and to maintain optimum performance (7-9). Inadequate dietary intake will lead to low levels of cortisol and reduced activities of the antioxidant enzymes, high cell damage which may result in reduced performance and injuries (3, 10). Even though there has been so much research on the significance of nutrition among football players, little has been done concerning the intake of energy and nutrients among Ghanaian football players. Again, there is also lack of data regarding body composition and nutrition status among Ghanaian players.

2. Objectives

The main objective of this study was to assess the body composition and dietary intake among football players of some selected football clubs in the Ashanti Region of Ghana.

3. Methods

3.1. Study Design

The study followed a cross-sectional study design. The players were recruited from the premier, first and second divisions of the Ghana National Football League located in the Ashanti region of Ghana.

3.2. Sample Technique and Size

Non-probability convenience sampling technique was used to select the players. Ninety (95) football players from the premier (n = 35), first (n = 30) and second (30) divisions registered for Ghana National Football League for the 2018/2019 season with their respective clubs. Each of the clubs had commenced pre-season training. Permission of the club management, coaching crew and individual players were sought. Each player signed informed consent and ethical approval was given by the Committee on Human Research, Publication and Ethics (CHRPE) (CHRPE/AP/470/16) of the Kwame Nkrumah University of Science and Technology (KNUST).

3.3. Data Collection

Socio-demographic characteristics of the players were obtained.

3.4. Measurement

3.4.1. Body Composition

A stadiometer (Secca CE 0123) was used to measure standing height (centimeters) of the players. The weight (kilograms), body mass index (BMI), body fat percentage, visceral fat and muscle mass were assessed using the Omron body composition monitor (BF511). These instruments have been well used as standardized tools for measuring height and body composition (11-13).

3.4.2. Assessment of Dietary Intake

A 24-hour dietary recall was used to assess dietary intake of the players. The dietary intake was assessed on two week days and one weekend. The quantity of the foods eaten by the players were assess using handy measures of the various food items. The food weight (in grams) were then recorded. The nutrient analysis template (Tayie and Lartey, 1999; West African Food Composition tables, 2012) were used to analyzed the various nutrients in the food.

3.5. Data Analysis

The Statistical Package for Social Science (SPSS) (version 23.0, IBM Corporation) was used for data analysis. Mean and standard deviation were reported for the continuous variables while categorical variables were presented in percentages. ANOVA was used to compare the means of the players of particular teams and their dietary intake. A cross tabulation analysis was also done to assess the players and their teams against their respective dietary intake and body composition data.

4. Results

The total number of players recruited for the study were 86.; < 20 years (22, 25.6%), 20 - 25 years (49, 51.6%), 26 – 30 (15, 15.8%). Goalkeepers made about 9.3%, while Defenders, Midfielders, and Strikers were 33.7%, 39.5% and 17.4% respectively (Table 1). From Table 2, majority (86.3%) of the players were within normal weight, with 8.4% of the players being overweight. The players who dominated were those with normal body weight (83.2%). All the Players had normal visceral fat. The results also indicated that more than 80% of the players had either very high (47.4%) or high (45.3%) muscle mass percentage (Table 2). Again shown in Table 2 is the dietary pattern of participants. Only about a third of the players ate 3 times in a day. The remaining ate either once or two times in a day, with the majority (44.2%) eating two times.

Table 1. Age Profile, Playing Positions and Teams of Players[a]

Variable	Values
Age, y	
15 - 19	31 (32.6)
20 -25	49 (51.6)
26 - 30	15 (15.8)
Total	95 (100.0)
Playing position	
Goalkeepers	8 (8.4)
Defenders	30 (31.6)
Midfielders	38 (40.0)
Strikers	19 (20.0)
Total	95 (100)

[a] Values are expressed as No. (%).

Table 2. Distribution of Anthropometric Parameters and Dietary Pattern of Players[a]

Characteristics	Values
BMI	
Underweight	5 (5.3)
Normal	82 (86.3)
Overweight	8 (8.4)
Obese	0 (0)
Total	95 (100.0)
Body fat, %	
Low	10 (10.5)
Normal	79 (83.2)
High	5 (5.3)
Very high	1 (1.1)
Total	95 (100.0)
Muscle mass, %	
Normal	7 (7.4)
High	43 (45.3)
Very high	45 (47.4)
Total	95 (100.0)
Visceral fat	
Normal	95 (100.0)
High	0 (0)
Very high	0 (0)
Total	95 (100.0)
Dietary pattern	
3 meals a day	32 (33.7)
2 meals a day	42 (44.2)
1 meal a day	21 (22.1)
Total	95 (100.0)

[a] Values are expressed as No. (%).

From Table 3, all the body composition variables were dependent on age as the players who were between the ages of 26 - 30 years showed a significantly higher mean BMI (23.57 $\pm$ 2.26 kg/m^2), mean percentage body fat (17.00 $\pm$ 4.00%) and mean visceral fat (5.60 $\pm$ 2.35). Playing positions did not have any effect on the anthropometric variables of the players.

A cross tabulation of age, playing positions, and anthropometry was shown in Table 4. The BMI and muscle mass of the players were dependent on age. The 5 underweight players were found in the youngest year group, while the overweight were in the 20 - 25 and 26 - 30 year groups. The visceral fat was normal for all the year groups. On the other hand, percentage body fat of the players was dependent on age, and playing position. Players of the age group 20 - 25 years constituted the majority of those who had normal body fat. Midfielders predominated the players with normal body fat, followed by defenders.

Shown in Table 5 is the dietary intake by age, and playing positions of players. Players of age group 20 - 25 had the highest mean total energy intake, as well as highest mean intakes of carbohydrates, proteins and fats, except that these were not significantly different ($P > 0.05$) from the other age groups. According to playing positions, the goalkeepers had the highest mean total energy intake, as well as highest mean intakes of carbohydrates, proteins and fats even though they were not statistically significant.

Table 3. Anthropometric Distribution by Age, Playing Positions and Teams of Players[a]

	Number	BMI	P Value	BF, %	P Value	MM, %	P Value	VF	P Value
Age, y			0.000		0.000		0.002		0.000
15 - 19	31	20.03 ± 1.95[A]		10.71 ± 3.51[A]		43.60 ± 3.15[A]		2.90 ± 1.49[A]	
20 - 25	49	22.43 ± 2.01[B, C]		13.71 ± 4.05[B]		44.41 ± 2.56		4.26 ± 1.58[B]	
26 - 30	15	23.57 ± 2.26[B, C]		17.00 ± 4.00[C]		41.49 ± 2.52[C]		5.60 ± 2.35[C]	
Playing position			0.056		0.202		0.072		0.062
Goalkeepers	8	24.00 ± 2.91		16.35 ± 5.84		42.03 ± 3.92		5.75 ± 3.10	
Defenders	30	21.73 ± 2.27		13.04 ± 4.37		44.45 ± 2.70		3.90 ± 1.71	
Midfielders	38	21.47 ± 1.88		13.12 ± 3.49		43.90 ± 2.69		3.79 ± 1.54	
Strikers	19	21.81 ± 2.97		12.52 ± 5.14		42.73 ± 2.93		4.00 ± 2.05	

Abbreviations: BF, body fat; BMI, body mass index; MM, percentage muscle mass; VF, visceral fat.
[a] Values are expressed mean ± SD.

Table 4. Relationship Among Anthropometry and Age, Playing Positions and Teams of Players[a]

	Age				Playing Positions			
	15 - 19, %	20 - 25, %	26 - 30, %	P Value	GLKS, %	DFDS, %	MDFS, %	STRK, %	P VALUE
BMI				0.004					0.629
Underweight	5 (5.3)	0 (0.0)	0 (0.0)		0 (0)	2 (2.1)	2 (2.1)	1 (1.1)	
Normal	26 (27.4)	44 (46.3)	12 (12.6)		6 (6.3)	27 (28.4)	33 (34.7)	16 (16.8)	
Overweight	0 (0)	5 (5.3)	3 (3.2)		2 (2.1)	1 (1.1)	3 (3.2)	2 (2.1)	
Obese	0 (0)	0 (0)	0 (0.0)		0 (0)	0 (0.0)	0 (0)	0 (0.0)	
Body fat, %				0.022					0.048
Low	7 (7.4)	3 (3.2)	0 (0.0)		0 (0.0)	4 (4.2)	2 (2.1)	4 (4.2)	
Normal	24 (25.3)	42 (44.2)	13 (13.7)		6 (6.3)	24 (25.3)	35 (36.8)	14 (14.7)	
High	0 (0.0)	4 (4.2)	1 (1.1)		1 (1.1)	2 (2.1)	1 (1.1)	1 (1.1)	
Very high	0 (0.0)	1 (1.1)	1 (1.1)		2 (2.1)	1 (1.1)	0 (0.0)	0 (0.0)	
Visceral fat									
Normal	31 (32.6)	49 (51.6)	15 (15.8)		8 (8.4)	30 (31.6)	38 (40.0)	19 (20.0)	
High	0 (0.0)	0 (0.0)	0 (0.0)		0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Very high	0 (0.0)	0 (0.0)	0 (0.0)		0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
MM, %				0.017					0.298
Low	0 (0.0)	0 (0.0)	0 (0.0)		0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Normal	4 (4.2)	2 (2.1)	1 (1.1)		2 (2.1)	1 (1.1)	2 (2.1)	2 (2.1)	
High	13 (13.7)	18 (18.9)	12 (12.6)		3 (3.2)	12 (12.6)	17 (17.9)	11 (11.6)	
Very high	14 (14.7)	29 (30.5)	2 (2.1)		3 (3.2)	17 (17.9)	19 (20.0)	6 (6.3)	

Abbreviations: BF, body fat; BMI, body mass index; DFDS, defenders; GLKS, Goalkeepers; MDFS, midfielders; MM, percentage muscle mass; STRK, strikers; VF, visceral fat.
[a] Values are expressed as No. (%).

Table 5. Dietary Intake Distribution by Age, Playing Positions and Teams of Players[a]

	Number	TEI	P Value	CHO	P Value	Protein	P Value	FAT	P Value
Age, %			0.204		0.634		0.524		0.082
15-19	31	2107.16 ± 621.95		311.50 ± 109.95		70.62 ± 20.96		66.71 ± 21.08	
20-25	49	2342.96 ± 848.18		324.18 ± 106.35		75.54 ± 23.94		83.00 ± 50.76	
26-30	15	1999.89 ± 692.26		294.12 ± 119.96		70.63 ± 26.14		61.17 ± 22.89	
Playing position			0.437		0.788		0.814		0.184
Goalkeeper	8	2547.57 ± 1198		338.96 ± 134.52		79.27 ± 24.15		99.32 ± 80.01	
Defender	30	2070.64 ± 542.03		301.26 ± 94.16		71.81 ± 21.78		66.68 ± 22.49	
Midfielder	38	2216.26 ± 803.87		315.74 ± 121.02		74.23 ± 26.35		71.59 ± 34.32	
Striker	19	2284.61 ± 767.75		326.62 ± 99.87		70.58 ± 19.41		80.88 ± 48.02	

Abbreviations: CHO, carbohydrate; TEI, total energy intake.
[a] Values are expressed mean ± SD.

5. Discussion

From Table 2, majority of the players were having normal BMI. The occurrence of overweight and obesity among the football players was 8.4%. This finding contradicted that of Abdulai (14) who reported a 39% prevalence of overweight and obesity in division one players in Tamale, Ghana but similar to the findings of Stiefel et al. (15), which

reported a 19.8% of overweight and 10.1% obesity among student soccer players.

It was also shown that all the players had normal visceral fat and most of the players had a high and very high muscle mass. This is in agreement with similar studies where a high muscle mass was found among athletes (16-18). This also underscores the study by Davison et al. (19), which reported that a high muscle mass, correlates to a low total body fat. From Table 2, most of the players (66.6%) were eating either once or two times in a day and so could not meet their dietary goals. Good dietary intake is an important component of a soccer player's health and sporting future (20). Despite this, the soccer players are not meeting their dietary goals. This could be due to players having low financial status and so could not afford 3 meals a day.

From Table 3, it is observed that BMI, percentage body fat and visceral fat increased as age increased, with players between 26 - 30 years having the highest. This was similar to the work done by Meeuwsen et al. (21), who also reported a direct relationship between age and BMI and percentage body fat. This means that as one grows older, his or her BMI increases. As shown by Table 4, all the underweights (5, 5.3%) were found to between the ages of 15 - 19 years. Very high percentage body fat was more prevalent among the goalkeepers (2.1%), compared to other playing positions. According to playing positions, the goalkeepers had the highest mean total energy intake, as well as highest mean intakes of carbohydrates, proteins and fats, even though they were not statistically significant (Table 5). The energy and nutrient intakes in this study are in contradiction to the total energy intake reported by a study done by Iglesias-Gutiérrez et al., (22). They reported a total energy intake of 2600 $\pm$ 641, 2766 $\pm$ 452, 2855 $\pm$ 475 and 2779 $\pm$ 659 for Goalkeepers, Defenders, Midfielders and Strikers respectively. The dietary intakes observed in this study were lower as compared to studies done by Rico-Sanz (22), Leblanc et al. (23) and Iglesias-Gutiérrez et al. (24). This shows that the Ghanaian players were having low energy intake, compared to other soccer players in other countries. This could be due to sub-optimal dietary intake, as most of the players were eating either once or two meals in a day. Sub-optimal dietary intake could lead to poor performance in competitions (25).

Footnotes

Authors' Contribution: Daniel Afrifa did data collection and analysis, writing of main work, and review of article. Kwabena Nsiah did supervision of data collection and analysis and writing of main work. Collins Afriyie Appiah did data collection and analysis and review of article. Omoniyi Monday Moses reviewed of article and data analysis.

Conflict of Interests: There was no conflict of interest reported before, during and after the study.

Ethical Approval: The ethical code CHRPE/AP/470/16.

Funding/Support: The authors declare that we did not receive any financial supports from anyone or any organization.

Informed Consent: A consent form was signed by each of the players who participated in the study before they were recruited for the study.

References

1. Stolen T, Chamari K, Castagna C, Wisloff U. Physiology of soccer: An update. *Sports Med*. 2005;**35**(6):501–36. doi: 10.2165/00007256-200535060-00004. [PubMed: 15974635].
2. Faude O, Koch T, Meyer T. Straight sprinting is the most frequent action in goal situations in professional football. *J Sports Sci*. 2012;**30**(7):625–31. doi: 10.1080/02640414.2012.665940. [PubMed: 22394328].
3. Papadopoulou SK, Gouvianaki A, Grammatikopoulou MG, Maraki Z, Pagkalos IG, Malliaropoulos N, et al. Body composition and dietary intake of elite cross-country skiers members of the Greek National Team. *Asian J Sports Med*. 2012;**3**(4):257–66. doi: 10.5812/asjsm.34548. [PubMed: 23342224]. [PubMed Central: PMC3525822].
4. Devlin BL, Leveritt MD, Kingsley M, Belski R. Dietary intake, body composition, and nutrition knowledge of Australian football and soccer players: Implications for sports nutrition professionals in practice. *Int J Sport Nutr Exerc Metab*. 2017;**27**(2):130–8. doi: 10.1123/ijsnem.2016-0191. [PubMed: 27710165].
5. Nepocatych S, Balilionis G, O'Neal EK. Analysis of dietary intake and body composition of female athletes over a competitive season. *Montenegrin J Sports Sci Med*. 2017;**6**(2):57–65. doi: 10.26773/mjssm.2017.09.008.
6. Turocy PS, DePalma BF, Horswill CA, Laquale KM, Martin TJ, Perry AC, et al. National Athletic Trainers' Association position statement: Safe weight loss and maintenance practices in sport and exercise. *J Athl Train*. 2011;**46**(3):322–36. doi: 10.4085/1062-6050-46.3.322. [PubMed: 21669104]. [PubMed Central: PMC3419563].
7. Rodriguez NR, DiMarco NM, Langley S, American Dietetic A, Dietitians of C, American College of Sports Medicine N, et al. Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. *J Am Diet Assoc*. 2009;**109**(3):509–27. doi: 10.1016/j.jada.2009.01.005. [PubMed: 19278045].
8. Burke LM, Cox GR, Culmmings NK, Desbrow B. Guidelines for daily carbohydrate intake: Do athletes achieve them? *Sports Med*. 2001;**31**(4):267–99. doi: 10.2165/00007256-200131040-00003. [PubMed: 11310548].
9. Jager R, Kerksick CM, Campbell BI, Cribb PJ, Wells SD, Skwiat TM, et al. International Society of Sports Nutrition Position Stand: Protein and exercise. *J Int Soc Sports Nutr*. 2017;**14**:20. doi: 10.1186/s12970-017-0177-8. [PubMed: 28642676]. [PubMed Central: PMC5477153].
10. Diaz E, Ruiz F, Hoyos I, Zubero J, Gravina L, Gil J, et al. Cell damage, antioxidant status, and cortisol levels related to nutrition in ski mountaineering during a two-day race. *J Sports Sci Med*. 2010;**9**(2):338–46. [PubMed: 24149705]. [PubMed Central: PMC3761741].
11. Osei F, Moses MO, Pambo P, Baffour-Awuah B, Asamoah B, Afrifa D, et al. Changes in cardiovascular parameters of a-university football ath-

letes associated with short duration pre-tournament training. *Sci Afr*. 2020;**8**. doi: 10.1016/j.sciaf.2020.e00285.
12. Essaw E, Moses MO, Afrifa D, Acheampong IK, Mensah W, Owusu L. Physical activity patterns and dietary habits of undergraduate students. *Baltic J Health Physic Act*. 2019;**11**(1):115–23. doi: 10.29359/bjhpa.11.1.12.
13. Doku AO, Moses MO, Acheampong IK, Gyamfi I, Agbavor C, Akwa LG, et al. Physiological, anthropometric parameters, and balance skill response of healthy bankers to fitness training. *J Exerc Rehabil*. 2019;**15**(2):242–8. doi: 10.12965/jer.1836572.286. [PubMed: 31111007]. [PubMed Central: PMC6509456].
14. Abdulai K. *Assessment of nutritional status and dietary behaviour of division one league footballers in Tamale Metropolis*. Ghana: University of Ghana; 2015.
15. Stiefel EC, Field L, Replogle W, McIntyre L, Igboechi O, Savoie F3. The prevalence of obesity and elevated blood pressure in adolescent student athletes from the State of Mississippi. *Orthop J Sports Med*. 2016;**4**(2):2.3259671166294E+15. doi: 10.1177/2325967116629368. [PubMed: 26962540]. [PubMed Central: PMC4765822].
16. Prentice AM, Jebb SA. Beyond body mass index. *Obes Rev*. 2001;**2**(3):141–7. doi: 10.1046/j.1467-789x.2001.00031.x. [PubMed: 12120099].
17. Kreider RB, Almada AL, Antonio J, Broeder C, Earnest C, Greenwood M, et al. ISSN exercise & sport nutrition review: Research & recommendations. *J Int Soc Sports Nutr*. 2004;**1**(1):1. doi: 10.1186/1550-2783-1-1-1.
18. Kreider RB, Wilborn CD, Taylor LW, Campbell BI, Almada AL, Collins R, et al. ISSN exercise & sport nutrition review: Research & recommendations. *J Int Soc Sports Nutr*. 2010;**7**(1):7. doi: 10.1186/1550-2783-7-7.
19. Davison KK, Ford ES, Cogswell ME, Dietz WH. Percentage of body fat and body mass index are associated with mobility limitations in people aged 70 and older from NHANES III. *J Am Geriatr Soc*. 2002;**50**(11):1802–9. doi: 10.1046/j.1532-5415.2002.50508.x. [PubMed: 12410898].
20. Rogol AD, Clark PA, Roemmich JN. Growth and pubertal development in children and adolescents: Effects of diet and physical activity. *Am J Clin Nutr*. 2000;**72**(2 Suppl):521S–8S. doi: 10.1093/ajcn/72.2.521S. [PubMed: 10919954].
21. Meeuwsen S, Horgan GW, Elia M. The relationship between BMI and percent body fat, measured by bioelectrical impedance, in a large adult sample is curvilinear and influenced by age and sex. *Clin Nutr*. 2010;**29**(5):560–6. doi: 10.1016/j.clnu.2009.12.011. [PubMed: 20359792].
22. Rico-Sanz J. Body composition and nutritional assessments in soccer. *Int J Sport Nutr*. 1998;**8**(2):113–23. doi: 10.1123/ijsn.8.2.113. [PubMed: 9637191].
23. Leblanc J, Le Gall F, Grandjean V, Verger P. Nutritional intake of French soccer players at the clairefontaine training center. *Int J Sport Nutr Exerc Metab*. 2002;**12**(3):268–80. doi: 10.1123/ijsnem.12.3.268. [PubMed: 12432172].
24. Iglesias-Gutierrez E, Garcia A, Garcia-Zapico P, Perez-Landaluce J, Patterson AM, Garcia-Roves PM. Is there a relationship between the playing position of soccer players and their food and macronutrient intake? *Appl Physiol Nutr Metab*. 2012;**37**(2):225–32. doi: 10.1139/h11-152. [PubMed: 22380725].
25. Caccialanza R, Cameletti B, Cavallaro G. Nutritional intake of young italian high-level soccer players: Under-reporting is the essential outcome. *J Sports Sci Med*. 2007;**6**(4):538–42. [PubMed: 24149489]. [PubMed Central: PMC3794496].