Rev Esp Nutr Hum Diet. 2021; 25 (Supl. 1): e1398
Nutrition for Physical Activity and Sports

Freely available online - OPEN ACCESS

Revista Española de Nutrición Humana y Dietética
Spanish Journal of Human Nutrition and Dietetics

RESEARCH ARTICLE

Food intake, body composition and physical assessments in young male and female soccer players

Consumo de alimentos, composición corporal y rendimiento físico en hombres y mujeres jóvenes judadores de fútbol

María Soto-Célix[a], Silvia S nchez-Díaz[a,*], Daniel Castillo[a], Javier Raya-Gonz lez[a], Marta Domínguez-Díez[a], Ángel Lago-Rodríguez[a], Tara Rendo-Urteaga[b]

[a] Facultad de Ciencias de la Salud, Universidad Isabel I, Burgos, Espa a.
[b] Elikos group, Institute for Innovation and Sustainable Development in Food Chain (IS-FOOD), Department of Health Sciences, Public University of Navarra, Pamplona, Navarra, Spain.

* silvia.sanchez2467@ui1.es

Assigned Editor: José Miguel Martínez Sanz. Universidad de Alicante, San Vicente del Raspeig, Espa a.

Recibido: 06/28/2021; Aceptado: 07/29/2021; Publicado: 08/29/2021

CITA: Soto-Célix M, S nchez-Díaz S, Castillo D, Raya-Gonz lez J, Domínguez-Díez M, Lago-Rodríguez A, Rendo-Urteaga T. Food intake, body composition and physical assessments in young male and female soccer players. Rev Esp Nutr Hum Diet. 2021; 25 (Supl. 1): e1398. doi: 10.14306/renhyd.25.S1.1398.

ABSTRACT

Introduction: Few studies have analysed the nutritional habits, body composition and physical condition of young soccer players among different categories and further differentiating between males and females. Therefore, the aim was to analyze differences in food consumption habits, body composition parameters and physical performance among young soccer players.

Material and Methods: A cross-sectional study was performed during the 2019-2020 competitive season. Forty-eight soccer players (16-18 years) were classified by age and sex into three groups: under 16 and under 18 years males (U16 and U18), and under 16 years females (U16 female). Food habits, anthropometry, body composition and physical performance variables were collected. A one-way analysis of variance (ANOVA) with least significant difference post hoc comparison (Bonferroni correction) was used.

Results: We found that U16 females consumed lower pork and bread and higher mollusk and shellfish than males ($p<0.05$). U16 males consumed less fruits ($p<0.05$) and more olive oil ($p<0.05$) than U16 females and had lower muscle mass in lower limbs than U18 male ($p<0.05$, ES=0.80-0.96); males showed higher muscle mass in lower limbs ($p<0.01$, ES=1.80-2.59) and lower %fat than females ($p<0.01$, ES=1.73); and U18 males presented higher weight than females ($p<0.01$, ES=1.64). U18 males showed better performances ($p<0.05$-0.01, ES=0.90-1.38) in maximal sprint trials (40-m length), counter movements jumps (CMJ) and CMJ with dominant leg, maximal bilateral horizontal jumps (HJ), HJ with dominant and non-dominant leg than U16 males. Males showed better results in linear straight sprint test (LSST, $p<0.05$; ES=1.66-5.16), change of direction ability (CODA, $p<0.05$; ES=2.82-5.46) and jumping ($p<0.05$; ES=1.60-4.12) performances.

Conclusion: In conclusion, sex- and age- specific differences were detected in the healthier dietary practices and body composition parameter in youth of soccer players. Also, better physical performances were found as age increases, except for CODA, and males exhibited higher performances in LSST, CODA and jumping than females.

Keywords: Feeding Behavior; Body Composition; Nutrition Assessment; Exercise; Soccer; Sex Characteristics.

RESUMEN

Introducci n: Pocos estudios han sido encontrados donde se analicen los hábitos nutricionales, la composición corporal y la condición física de jóvenes futbolistas entre diferentes categorías y diferenciando entre chicos y chicas. Por tanto, el objetivo fue analizar las diferencias en los hábitos de consumo de alimentos, los parámetros de composición corporal y el rendimiento físico en jóvenes futbolistas.

Material y métodos: Se realizó un estudio transversal durante la temporada competitiva 2019-2020. Cuarenta y ocho futbolistas (16-18 a os) fueron clasificados por edad y sexo en tres grupos: menores de 16 y menores de 18 a os masculinos (U16 y U18), y menores de 16 a os féminas (U16 femenino). Se recogieron variables de hábitos alimentarios, antropometría, composición corporal y rendimiento físico. Se utilizó un análisis de varianza de (ANOVA) de un factor con *post hoc* de Bonferroni.

Resultados: Observamos que las chicas U16 consumieron menos carne de cerdo y pan y más moluscos y mariscos que los chicos (p<0,05). Los chicos U16 consumieron menos frutas (p<0,05) y más aceite de oliva (p<0,05) que las chicas U16 y tuvieron menor masa muscular en miembros inferiores que los chicos U18 (p <0,05, ES=0,80-0,96); los chicos mostraron mayor masa muscular en miembros inferiores (p <0,01, ES=1,80-2,59) y menor porcentaje de grasa que las chicas (p<0,01, ES=1,73); y los chicos U18 presentaron mayor peso que las chicas (p<0,01, ES=1,64). Los chicos U18 mostraron mejores rendimientos (p<0,05-0,01, ES=0,90-1,38) en pruebas de sprint máximo (40 m de longitud), salto en contramovimiento (CMJ) y CMJ con pierna dominante, saltos horizontales bilaterales máximos (HJ), HJ con pierna dominante y no dominante que los chicos U16. Los chicos mostraron mejores resultados en los esprints (LSST, p<0,05; ES=1,66-5,16), el cambio de dirección (CODA, p<0,05; ES = 2,82-5,46) y los saltos (p<0,05; ES=1,60-4,12).

Conclusi n: En conclusión, se observaron diferencias por sexo y edad en las prácticas dietéticas y los parámetros de composición corporal en los jóvenes futbolistas. Además, mejor rendimiento físico a medida que aumentaba la edad, excepto para el CODA. Los chicos exhibieron mejores rendimientos en LSST, CODA y saltos que las chicas.

Palabras clave: Conducta Alimentaria; Composición Corporal; Evaluación Nutricional; Ejercicio Físico; Fútbol; Caracteres Sexuales.

KEY MESSAGES

- Research question: Are there any differences in food consumption habits, body composition parameters and physical performance among youth categories and sex in soccer?
- Key findings: Soccer players who belonged to the same academy reported differences in food intake patterns, body composition and physical performance according to age and sex groups.

INTRODUCTION

Soccer is one of the most popular sport around the world in which an estimated 270 million people participate in the sport, in which male and female players need to exhibit an optimal physical conditioning[1], which is affected by the invisible training (i.e., other strategies than training plans) in the pursuit of optimizing athlete health and performance[2]. It is well known that eating habits[3] as well as body composition[4] are associated with physical performance among young athletes. In this sense, a proper diet optimizes not only sports performance and training-arising benefits, but also reduces the injury risk[5], improves the recovery[6] and optimizes growth and development[7]. Therefore, an adequate physical training together with optimal nutrition help to achieve an adequate body composition and consequently improves sports performance[8]. Accordingly, it is essential to know the eating habits in young athletes.

Previous research has determined the relevance of anthropometric profiles and body composition parameters as one of the factors that influence the identification, selection, and promotion of young talent players in soccer[9], which could partially determine soccer player's future sporting career[10]. In addition, other authors have also observed that a better level of physical condition in young players, such as vertical jump, agility, sprint time or anticipation skill, allows them to increase the possibilities of being selected for a professional youth team[11,12]. Thus, in addition to increasing the nutrition knowledge of athletes, it would be interesting for coach staffs to analyze the anthropometric profile, body composition and physical fitness in young soccer players.

Up to date few studies have analyzed the nutritional habits, body composition and physical condition of young soccer players among different categories and further differentiating between males and females. Although it is known that well eating habits can meet the high physical demands of players and could be determinant for their future sporting success[13], teams do not have specialized nutrition staff who accompany and adapt the young players' nutrition to achieve better performance and avoid injury. Knowing players' nutritional habits could be of great interest for nutrition specialist to improve possible unhealthy dietary habits as well as give players more personalized nutritional education, with individualized tips for each player according to their nutritional requirements. This could translate into healthier dietary practices, a more optimal body composition, and thus lead to improved performance[8,14].

Considering the relevance of analyzing those aspects related with the nutrition, body composition and physical performance parameters to help players to improve their in-game soccer competence, the main aim of this study was to analyze the differences in food consumption habits, body composition parameters and physical performance among young soccer players by different age and sex groups. Our hypotheses were as follows: (1) there are differences in healthier dietary practices between males and females, (2) better body composition and physical performance is exhibited by males and (3) older players demonstrate better physical performances.

MATERIAL AND METHODS

Study design

A cross-sectional study was performed. Testing sessions were carried out in two separate sessions during the 2019-2020 competitive season. During the first session, players performed linear sprinting straight tests (LSST) and change of direction ability (CODA) tests interspersed with 5 min of passive rest on a natural soccer pitch (i.e., 17-22ºC, 60-70% humidity), for which the players used soccer boots. During the second session, each player performed a food frequency questionnaire (FFQ), anthropometry assessment, body composition measurements from dual-energy X-ray absorptiometry (DXA) and jumping performances on laboratory conditions (i.e., 17-22ºC, 60-70% humidity). Prior to the testing sessions, researchers provided participants with graphic and direct instructions about how to successfully perform each test. All participants were familiarized with tests on at least one occasion before the test session during the week before the investigation and wore the normal soccer equipment. Participants had not reported any injuries throughout the two months prior to the test session and had been available in all training sessions during the previous four weeks. Players were advised not to perform any type of physical exercise during 48 h before the test session, and the participants were given advice to ensure they were fully hydrated and energized. Always before testing, a warm-up consisting of 5 min self-paced low intensity running, skipping exercises, strides, two 30 m sprints with and without changes of direction, and two vertical and horizontal jumps.

Participants

Forty-eight youth soccer players aged 16 to 18 years were enrolled in the study. Participants were split up into three groups based on their age group and category: under 16 years males (U16 male), under 18 years males (U18 male), and under 16 years females (U16 female). All players trained at least three times a week and were involved in an official match every weekend. Participants belonged to the same soccer academy whose teams competed at national competitive level for each age category. Participants and parent -or tutors- were informed of the procedures, methods, benefits, and possible risks involved in the study before giving parent's or tutor's written consent. They were also informed of their right to voluntarily withdraw from the study at any given time. This investigation was performed in accordance with the Declaration of Helsinki (2013) and was approved by the Institutional Ethics Committee.

Food consumption Measurement

A semiquantitative FFQ with 136 food-items was used[15]. The questionnaire allowed participants to choose among the following frequency categories of intake: "never or less than one time per month", "one to three times per month", "one time per week", "two to four times per week", "five to six times per week", "one time per day", "two to three times per day", "four to five times per day" and "six or more times per day". The FFQ was designed to assess dietary intake over the past year. Players answered the questionnaire under the supervision of a registered dietitian. The common portion size for each food item was obtained from the values in grams published elsewhere[16] and the participants were asked how often they had consumed that unit on average over the previous year. Daily food consumption was estimated as frequency × portion size for each consumed food item. This FFQ was previously validated in youth people[17,18].

Anthropometric Measurements

Measures were carried out by trained personnel following standardized procedures[19] where all participants were barefoot and wearing light clothes. Weight was measured to the nearest 0.1 kg using a digital balance (SECA, Hamburg, Germany) and height was measured to the nearest 0.1 cm using a stadiometer (SECA, Hamburg, Germany). Body mass index (BMI) was calculated as weight (in kg) divided by squared height (in m).

Body composition with DXA

Whole body %Fat and muscle mass (kg) of lower limbs were obtained via DXA (Lunar Prodigy Primo, HE Healthcare, USA). The age-, gender- and ethnicity-specific reference data provided by the National Health and Nutrition Examination Survey (NHANES)[20] were used. Calibration tests with a spine phantom were daily performed before taking any measurements. Participants were asked to avoid eating anything at least 2-hours before testing and to refrain from training. They were measured with minimum clothes and without jewelry and placed in a supine position in the center of the scanning area. Velcro straps were used to hold their feet in place with their toes pointed upwards. Their hands were placed flat on the table next to the hips. Both arms and hands were separated to the torso and hips respectively. All DXA scans were done during the afternoon and the evening (between 17:00-20:00 hours) and were conducted and analyzed by the same technician who had been fully trained in the operation of the scanner, the positioning of participants and the analysis of results according to the manufacturer´s guidelines.

Physical performance

Linear straight sprinting test (LSST): The LSST consisted of 2 maximal sprint trials of 40-m length (SPR40), interspersed with a 90-s rest period between sprints. Participants' starting position was 0.5 m behind the first timing gate (MicrogateTM Polifemo Radio Light, Bolzano, Italy). Soccer players were asked to run as fast as possible from the start line. They started when ready, thus eliminating reaction time[21]. The time was automatically activated as participants passed the first gate, that is, at the 0-m line. Split times were recorded at 5 m (SPR5) and 10 m (SPR10). The software Witty Manager (Microgate) was used to download the sprint test data. The three timing gates were placed 0.4 m above the ground. The fastest trial was used for statistical analysis. Coefficient of variation (CV) for the LSST tests was calculated (SPR5: 2.74 ± 2.43 %, SPR10: 1.59 ± 1.44 % and SPR40: 0.73 ± 0.54 %).

Change Of Direction Ability (CODA): The 505-test consisted of sprinting forward to a line 5 m ahead and pivoted 180º with right leg (505-Right) and with left leg (505-Left) before returning to the start position[22]. A photocell (Microgate™ Polifemo, Bolzano, Italy) located over the start/finish line was used to record the time. Time measurement started and finished when the player crossed the line between the tripods. The fastest trial was used for further analysis, and CV for CODA tests was calculated (505-Right: 2.21 ± 2.25 % and 505-Left: 2.30 ± 2.25 %).

Jumping: Two maximal bilateral counter movements jumps (CMJ) with dominant leg (CMJd) and non-dominant leg (CMJnd) were performed by each participant through an Optojump photocell system (Microgate, Bolzano, Italy). Each jump were separated by a 30 s rest, following the procedures of previous research[23]. In addition, players performed two maximal bilateral horizontal jumps (HJs), with dominant leg (HJd) and non-dominant leg (HJnd), starting from a standing position, swinging their arms and bending their knees to provide maximal forward drive. Using a metric tape measure, the jump-length measurement was determined from the take-offline to the nearest point of landing contact (i.e., back of the heels)[24]. The highest vertical and horizontal jump results were used for statistical analysis. CV for jumping tests was calculated (CMJ: 3.57 ± 2.64 %, CMJd: 5.18 ± 4.42 %, CMJnd: 5.81 ± 4.93 %, HJ: 2.61 ± 1.84 %, HJd: 3.20 ± 3.26 % and HJnd: 1.90 ± 1.45 %)

Statistical analysis

Results are presented as means ± standard deviations (SD). The Kolmogorov–Smirnov and Levene tests were applied to evaluate the normal distribution of data and homogeneity of variances, respectively. For those variables with normal distribution, parametric statistics were used. A one-way analysis of variance (ANOVA) with least significant difference post hoc comparison (Bonferroni correction) was used to examine the mean differences among the three age and sex groups (i.e., U16 male, U18 male and U16 female) in the food consumption, anthropometric variables, body composition parameters, and physical performances. Pairwise comparisons were performed when a p-value ≤0,05 for the comparison between age groups was observed. Practical significance was assessed by calculating Cohen's effect size (ES)[25]. ES of above 0.8, between 0.8 and 0.5, between 0.5 and 0.2, and lower than 0.2 were considered large, moderate, small, and trivial, respectively. Data analysis was performed using the Statistical Package for the Social Sciences (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). Statistical significance was set at $p < 0.05$.

RESULTS

The mean age for the forty-eight soccer players enrolled in the study was 16.48 ± 1.57 years, mean weight and mean height were 60.34 ± 9.04 kg and 1.69 ± 0.10 cm, respectively, and mean BMI was 21.14 ± 2.06 kg/m^2.

Food intake, in grams per day, among the three age and sex groups is shown in table 1. U16 females recorded lower pork intake and higher mollusk and shellfish intake than U16 (p<0.01) and U18 male players (p<0.05). Moreover, U16 females consumed less bread than U16 and U18males (p<0.01). In addition, U16 males consumed less fruits (p<0.05) and more olive oil (p<0.05) in comparison to U16 females. Regarding beverages intakes, U18 males presented higher consumption of water than U16 females (p<0.01), U16 males the consumed higher natural fruit juice in comparison to U18 males (p<0.01) and U18 males recorded higher consumption of soft drinks in comparison to U16 males (p<0.05) and U16 females (p<0.05)

Differences in the anthropometric variables and body composition parameters among age and sex groups are shown in table 2. U16 males had lower height, weight and muscle mass in lower limbs in comparison to U18 male players (p < 0.05, ES: 0.80 - 0.96). Moreover, U16 and U18 males showed higher height and muscle mass in lower limbs (p < 0.01, ES: 1.80 - 2.59) and lower %fat than U16 females (p < 0.01, ES: 1.73). Additionally, U18 males also presented significant higher weight in comparison to females (p < 0.01, ES: 1.64).

Table 1. Differences in the food consumption (in grams per day) among age and sex groups.

	U16 Male (n = 16) Mean ± SD	U18 Male (n = 20 Mean ± SD	U16 Female (n = 12) Mean ± SD	CV	ES interpretation	p-value[1]	*P*-value[2] (U16 Male vs. U18 Male)	*P*-value[3] (U16 Male vs. U16 Female)	*P*-value[4] (U18 Male vs. U16 Female)
Milk and dairy products									
Milk (all types)	431.10 ± 261.62	301.73 ± 173.52	467.50 ± 432.75	1.56	1.90, large	0.224			
Yogurt (all types)	127.22 ± 163.01	97.31 ± 105.02	76.36 ± 40.56	0.63	1.21, large	0.763			
Cheese low-fat	0.52 ± 0.80	1.79 ± 3.93	3.58 ± 6.54	1.87	0.37, small	0.726			
Cheese medium-high-fat	5.42 ± 6.05	10.70 ± 12.16	7.45 ± 9.42	1.32	0.76, moderate	0.502			
Meat, fish and eggs									
Beef	54.29 ± 26.39	41.83 ± 23.57	34.62 ± 22.26	2.42	2.36, large	0.101			
Chicken or turkey	50.86 ± 22.36	89.53 ± 82.06	66.75 ± 30.64	2.09	1.67, large	0.068			
Pork	43.53 ± 24.97	35.82 ± 36.42	19.09 ± 6.33	2.49	1.55, large	0.006*	0.205	0.001**	0.039*
Hamburger	9.55 ± 9.81	13.74 ± 10.64	17.08 ± 26.33	0.80	0.93, large	0.061			
Sausages and cold meat	27.24 ± 18.13	35.70 ± 23.72	40.00 ± 30.09	1.04	1.87, large	0.364			
Fish	91.24 ± 42.36	62.86 ± 47.64	82.33 ± 49.04	1.76	2.26, large	0.184			
Mollusk and shellfish	5.71 ± 4.23	6.69 ± 7.37	39.46 ± 101.46	1.95	0.32, small	0.043*	0.935	0.026*	0.023*
Eggs	20.89 ± 9.16	57.94 ± 66.43	19.30 ± 14.03	4.29	1.00, large	0.089			
Legumes									
Beans	7.98 ± 5.45	6.15 ± 3.30	8.45 ± 6.39	1.00	1.27, large	0.419			
Lentils	10.15 ± 6.28	10.04 ± 8.64	8.80 ± 5.67	0.14	1.37, large	0.866			
Chickpeas	7.47 ± 2.52	5.52 ± 3.73	10.25 ± 7.49	3.87	1.27, large	0.222			
Cereals									
Rice (cooked)	14.66 ± 13.01	16.23 ± 13.40	14.47 ± 9.53	0.10	1.44, large	0.901			
Pasta (cooked)	20.94 ± 10.72	27.02 ± 13.42	22.72 ± 10.24	1.25	2.52, large	0.298			
Bread (all types)	127.33 ± 71.57	140.14 ± 61.26	40.91 ± 29.46	10.55	2.21, large	0.001*	0.892	0.003**	0.001**
Cookies	26.30 ± 32.87	36.49 ± 35.05	23.07 ± 19.32	0.84	1.24, large	0.439			
Bakery products	10.38 ± 9.84	24.20 ± 29.42	22.05 ± 24.61	1.68	0.97, large	0.286			
Breakfast cereals	16.86 ± 43.24	24.11 ± 34.54	21.90 ± 23.65	0.19	0.75, moderate	0.829			
Pizza	6.59 ± 3.81	13.62 ± 11.12	15.13 ± 17.09	2.46	1.07, large	0.051			
Tubers, vegetables and fruits									
Fried potatoes	38.00 ± 27.63	43.97 ± 26.48	33.00 ± 36.65	0.53	1.77, large	0.589			
Potatoes	17.26 ± 15.19	22.39 ± 19.74	26.62 ± 33.04	0.61	1.20, large	0.747			
Vegetables (all)	251.98 ± 187.96	290.05 ± 215.16	234.14 ± 260.57	0.27	1.74, large	0.764			
Fruits (all)	207.81 ± 159.82	223.51 ± 151.36	376.8 ± 209.61	3.60	2.00, large	0.036*	1.000	0.049*	0.069
Oils									
Butter	1.07 ± 2.62	1.21 ± 2.45	0.71 ± 1.22	0.18	1.13, large	0.757			

Table 2. Differences in age, anthropometric measures and body composition parameters among age and sex groups.

	U16 Male (n = 15)		U18 Male (n = 16)		U16 Female (n = 17)		Pair comparisons (Δ %; ES, interpretation)		
	Mean ± SD	CV	Mean ± SD	CV	Mean ± SD	CV	U16 Male vs. U18 Male	U16 Male vs. U16 Female	U18 Male vs. U16 Female
Age (years)	15.67 ± 0.49	3.11	18.19 ± 0.75	4.12	15.59 ± 1.46	9.37	-13.85; 4.07, large**	0.51; 0.08, trivial	16.68; 2.35, large**
Height (m)	1.71 ± 0.06	3.64	1.77 ± 0.07	4.04	1.59 ± 0.07	4.39	-3.11; 0.82, large*	7.47; 1.80, large**	10.93; 2.46, large**
Weight (kg)	59.86 ± 7.69	12.85	66.90 ± 7.01	10.48	54.59 ± 8.00	14.66	-10.52; 0.96, large*	9.65; 0.67, moderate	22.54; 1.64, large**
BMI (kg/m^{-2})	20.39 ± 1.73	8.47	21.46 ± 1.98	9.24	21.49 ± 2.33	10.84	-4.98; 0.58, moderate	-5.14; 0.54, moderate	-0.17; 0.03, trivial
%Fat	15.95 ± 3.03	19.01	15.03 ± 3.48	23.15	27.85 ± 6.16	22.13	6.13; 0.28, trivial	-42.71; 2.59, large**	-46.02; 2.66, large**
Muscle mass (kg)	17.02 ± 2.81	16.54	18.80 ± 1.66	8.85	12.93 ± 1.91	14.76	-9,49; 0,80, large*	31.58; 1.73, large**	45.38; 3.28, large**

Note: SD: standard deviation; CV: coefficient of variation (%); ES: effect size; BMI: body mass index.
* Significant level set at *P*<0.05; ** Significant level set at *P*<0.01

Table 3 presents the differences in the physical performances among age and sex groups. U18 males showed better performances ($p < 0.05$-0.01, ES = 0.90 - 1.38) in SPR40, CMJ, CMJd, HJ, HJd and HJnd in comparison with U16 males. However, no significant differences ($p > 0.05$, ES = 0.36 - 2.45) were observed in SPR5, SPR10, CODA test and CMJd between U18 males and U16 males. In addition, both males' groups showed better performances in LSST ($p < 0.05$; ES = 1.66 - 5.16), CODA ($p < 0.05$; ES = 2.82 - 5.46) and jumping ($p < 0.05$; ES = 1.60 - 4.12) performances in comparison with U16 females.

Table 3. Differences in the players' physical performances among age and sex groups.

	U16 Male (n = 15)		U18 Male (n = 16)		U16 Female (n = 17)		Pair comparisons (Δ %; ES, interpretation)		
	Mean ± SD	CV	Mean ± SD	CV	Mean ± SD	CV	U16 Male vs. U18 Male	U16 Male vs. U16 Female	U18 Male vs. U16 Female
LSST									
SPR5 (s)	1.06 ± 0.08	7.13	1.04 ± 0.07	6.38	1.16 ± 0.04	3.76	2.49; 0.36, small	-8.53; 1.66, large**	-10.75; 2.27, large**
SPR10 (s)	1.78 ± 0.10	5.65	1.73 ± 0.09	5.19	2.04 ± 0.07	3.57	2.71; 0.49, small	-12.64; 2.97, large**	-14.94; 3.74, large**
SPR40 (s)	5.53 ± 0.23	4.22	5.25 ± 0.21	3.91	6.47 ± 0.27	4.14	5.50; 1.32, large**	-14.39; 3.71, large**	-18.85; 5.16, large**
CODA									
505-Right (s)	2.28 ± 0.05	2.27	2.13 ± 0.07	3.05	2.59 ± 0.10	3.80	7.01; 2.45, large	-11.99; 4.14, large*	-17.76, 5.46, large**
505-Left (s)	2.30 ± 0.06	2.42	2.25 ± 0.06	2.86	2.59 ± 0.15	5.72	2.39; 0.90, large	-11.10; 2.82, large*	-13.17; 3.21, large**
Jumping									
CMJ (cm)	31.99 ± 6.12	19.12	38.01 ± 5.65	14.86	23.12 ± 3.77	16.31	-15.82; 1.02, large**	38.39; 1.80, large**	64.40; 3.16, large**
CMJd (cm)	17.87 ± 3.77	21.13	20.19 ± 2.44	12.08	12.63 ± 2.59	20.51	-11.50; 0.75, moderate	41.47; 1.78, large**	59.85; 3.01, large**
CMJnd (cm)	15.32 ± 4.10	26.75	18.52 ± 3.03	16.37	10.66 ± 1.71	16.08	-17.27; 0.90, large*	43.65; 1.60, large**	73.65; 3.31, large**
HJ (m)	2.00 ± 0.16	8.20	2.16 ± 0.16	7.21	1.57 ± 0.13	8.47	-7.54; 1.02, large**	27.53; 2.91, large**	37.94; 4.12, large**
HJd (m)	1.74 ± 0.12	7.15	1.88 ± 0.15	7.73	1.39 ± 0.11	7.84	-7.06; 0.98, large*	25.48; 3.03, large**	35.01; 3.83, large**
HJnd (m)	1.60 ± 0.14	8.80	1.79 ± 0.13	7.30	1.33 ± 0.15	11.06	-10.48; 1.38, large**	20.49; 1.89, large**	34.59; 3.31, large**

Note: SD: standard deviation; ES: effect size; CV: coefficient of variation (%); LSST: linear straight sprinting tests; SPR5: sprint in 5 m; SPR10: sprint in 10 m; SPR40: sprint in 40 m; RSA: repeated sprint ability; CODA; change of direction ability; CMJ: countermovement jump; CMJd: countermovement jump with dominant leg; CMJnd: countermovement jump with non-dominant leg; HJ: horizontal jump; HJd: horizontal jump with dominant leg; HJnd: horizontal jump with non-dominant leg. * Significant level set at $P<0.05$; ** Significant level set at $P<0.05$

DISCUSSION

The aim of this study was to analyze the differences in food consumption habits, anthropometric profile, body composition parameters and physical performances among young soccer players by different age and sex groups. This is the first study analyzing these characteristics in young players from different categories and differentiating males and females. The main results showed different food intake patterns, body composition and physical performance among age and sex groups, and gender and age specific differences in the ability of soccer players.

An adequate nutrition has been shown to improve performance in athletes6. In our study, female showed a significantly lower consumption of pork, bread, olive oil and soft drinks in comparison with male, and a significantly higher consumption of seafood, natural fruit juice and fruits what may indicate a trend to control the diet more than boys and follow patterns that they consider healthier26. This pattern could be due to the combination of several factors as the idea of reaching or maintaining a specific weight, an ideal body image or wanting to eat a healthy diet26. In our study, the main food groups consumed by boys (U16 and U18) are milk, meat, cereals, vegetables, and fruit. Between the two categories of males (U16 and U18), the main difference was that the older males reported a higher intake of soft drinks than the younger ones. In the same way, U16 males reported a higher intake of packed fruit juice than U18 males. These differences may be due to age10. Older boys choose their own eating pattern usually basis on a poor nutritional knowledge, while the younger ones depend to a greater extent on family or school purchases, which may suppose a better dietary habit27. Moreover, an optimal hydration also plays an important role of sport performance of athletes. Without counting on hydration during sports practice, soccer players should drink at least 2.5 liters throughout the day28. In our study, male of both age groups met this recommendation, but not female, in whom low water consumption stood out. To assess food groups intake rather than macro/micronutrients individually may be the best strategy to study the role of diet in young population29. More studies analysing food groups intake in young soccer players are necessary, which would also allow to analyze food intake composition not only quantitatively, as usual, but qualitatively. More studies analysing food groups or macro and micronutrient intake in young soccer players are necessary.

Our results, regarding food intake habits, showed that food consumption correspond to what is expected for this population30,31. However, it does not mean that these patterns were adequate. As reported by Ruiz et al.14 nutritional intake in soccer players was not optimal and was poorer among the adult players than among the adolescents. A deficient intake has been documented in both male and female soccer players, and in fact, there is a unanimous agreement on the inadequate consumption32. This fact is repeated in young professional players who neither follow the most appropriate diet to optimize their performance28.

In young soccer players it is particularly necessary to ensure an optimal growth and muscle development as well as to achieve optimal body composition7,33. Therefore, an optimal food consumption and hydration is essential to maximize training adaptations. In this sense, since body composition is one of the main factors which can determine the likelihood of success, strength and conditioning specialists could plan changes in body composition, measured as a lower fat mass and a higher muscle mass, to improve players' physical performances. In our study, U16 and U18 males showed higher height and muscle mass in lower limbs and lower %fat than U16 females. These differences could be explained by physiological, biological, and hormonal mechanisms according to age34, such as a higher effect of estradiol on leptin and a low level of testosterone which contributes to an increase in adiposity35. In fact, boys seem to be relatively protected against fat mass gain than girls36. Likewise, pubertal stage could determine changes in body composition parameters in adolescents, mainly in girls, determining in part their %fat. In fact, girls with the same chronological age but with later maturation are still experiencing an increase in %fat36. On the other side, our results revealed no differences in %fat between U18 and U16 male players, which coincide with results obtained by other authors showing a significant %fat difference between age groups, but an inverse association with age37. On the other hand, muscle mass showed significant differences between U18 and U16, being lower in younger players, so the higher BMI was mainly due to the increase in fat-free mass. This situation, which coincides with that found by other authors37, could be due, in part, to growth and maturation38.

From a practical point of view, data collection related to %fat absolute values could be attended by strength and conditioning and nutrition specialists as reference values. As such, in our study, females obtained 27.85 ±6.2% of fat, that were like other studies carried out in female soccer, in which adolescents reported 26.8 ± 3.4% of fat39, mid-level adults registered 24.35 ± 7.3% of fat40 and top-level senior showed similar values [24.1 ± 0.8% of fat41, 24.5 ± 3.7%34]. Regarding to males' %fat, values of 15.95 ± 3.03 % for U16 players and 15.03 ± 3.48% for U18 players were observed, being like those found in other European teams (16.5 ±3. % for U16 and 15.8 ±3.51% for U18)37, and similar to other players belonging to the third team Europa League professional football (16.5 ± 2.1% for U17)42. However, Bernal-Orozco et al.43 found a higher adipose mass in Mexican players reporting 21.8 ± 2.9% for U-20 division and 22.3 ± 2.5 for U17 players. Not all studies were carried out with DXA (gold standard) as our study, but rather used the ISAK anthropometric profile with or without a complete profile, which may lead to differences.

Regarding physical performance, previous literature has shown the importance of neuromuscular parameters, such as sprints, changes of directions and jumps, in the early stages in the development of players being able to determine the specific competence of top soccer players12,44. In our study, U18 males showed better performances in SPR40, CMJ, CMJd, HJ, HJd and HJnd in comparison with U16 males. These results coincide with those reported by other authors who found that U16 players presented worst performance in the SPR40 and the best run in a repeated sprint ability test compared to U18 players45. In this line, previous research has shown that older youth players achieved higher peak velocity over 40 m distance than younger ones46. Regarding to the differences in vertical and horizontal jumps, previous research also found that older players presented higher CMJ performances than younger ones in Italian National players47. This difference seems to be due to the increase in power and FFM of the leg muscles, which occurs during adolescence and which reaches its maximum upon with maturity48. On the other side, our results showed no significant differences for acceleration capacity (i.e., SPR5, SPR10) and CODA test between U18 males and U16 males. Likewise, Loturco et al.49 reported similar CODA throughout U15 and U17 age-categories in top-level players. Also, while no differences in sprint performances coincide with those reported by some authors45,50, Mendez-Villanueva et al.51 found higher 10 and 20 m sprint results in U18 players than in U16 male soccer players which could be due to the variability in maturation in the different biomechanical and physiological factors involved. Considering the differences further research would be necessary to be able to discriminate the physical performance among U16 and U18 age-categories.

On the other side, both male groups showed better performances in LSST, CODA and jumping performances in comparison with U16 females. These results agree with results reported by Papaiakovou et al.52 who found differences between gender regarding sprint performance especially after the age of 15 years, when males had a greater and faster improvement. Respect to CODA test, previous studies have shown a difference of 9-12% between young men and women51,54, but no studies have been found analyzing this difference between gender in U16 and U18 players. In addition, CMJ results were consistent with findings by Castagna and Castellini47 in Italian players who recorded a difference of 29% in U17 and by Helgerud et al.55 in elite Norwegian players who presented a 20 % difference in CMJ values. These differences between male and female players could be explained by several physical and biomechanical factors. Males present greater lean body mass, and are significantly taller, factors which were implicated in a greater performance, as sprinting which could be conditioned by the height and therefore by the stride length52. Sprint could also be affected by neuromuscular characteristics as muscle contraction velocity which are related to sex-specific factors like electro-mechanical characteristics or fiber type distribution56. Sex hormones are also implicated in these differences, influencing muscle size and skeletal muscle growth, encouraging slower type-I and -IIA fibers in females57. On the other hand, both biomechanics and body structure are gender specific which could influence performance. For example, sex differences in tendon viscoelastic properties have been noted, being more flexible and with less hysteresis for women, which could explain differences in muscle function between male and female, and even affect jumping and sprinting58. Furthermore, puberty produces musculoskeletal changes, also in knee joint mechanics, with greater presence of genu valgus in women. It could result in a declined neuromuscular control of the knee in female which could affect coordination and strength59. Previous research also suggest that males are better able to control their CODA technique due to their hip abduction angle, which favours greater speed60. Certainly, it should be noted that both age, as well as the level of development and maturation involve morphological and neuromuscular characteristics which influence the performance of these tests60. The female group is U16 and could be at a different point in the development stage which could interfere with the results of the physical tests. Therefore, sprint, CODA and CMJ performances are sex-, age- and maturity-level dependent so coaches should consider specific trainings adapted to players' characteristics.

The main limitation of this study was the small sample size in each category and the heterogeneity between sex groups. Because of that, future studies must cover a greater number of participants per categories or levels of play and must evaluate equal number of boys and girls. It would also be of interest to evaluate if differences are found for endurance tests as well as to relate a more exhaustive dietary profile with performance. Another limitation of the present study was that eating habits, body composition and physical performance were analyzed only at one point in the season. It would be interesting to analyze the evolution throughout the season in order to implement specific strategies for each period across the competitive season.

CONCLUSION

In conclusion, our results have demonstrated sex- and age- specific differences in the healthier dietary practices in youth of soccer players. Likewise, body composition parameters were influenced by sex and age. Finally, better physical performances were found as age increases, except for CODA, and males exhibited higher performances in LSST, CODA and jumping than females.

AUTHORS' CONTRIBUTIONS

MSC, SSD, DC, MDD, JRG and TRU collected the data. MSC, SSD and TRU wrote the first draft with contributions from DC. All authors reviewed and commented on subsequent drafts of the manuscript

FUNDING

The project leading to these results has received funding from "La Caixa" Foundation (ID 100010434) and La Caja de Burgos, under agreement LCF/PR/PR18/51130008.

CONFLICT OF INTEREST

The authors state that there are no conflicts of interest in preparing the manuscript.

REFERENCIAS

[1] Reilly T, Bangsbo J, Franks A. Anthropometric and physiological predispositions for elite soccer. J Sports Sci. 2000;18(9):669-83, doi: 10.1080/02640410050120050.

[2] Mujika I, Halson S, Burke LM, Balagué G, Farrow D. An Integrated, Multifactorial Approach to Periodization for Optimal Performance in Individual and Team Sports. Int J Sports Physiol Perform. 2018;13(5):538-61, doi: 10.1123/ijspp.2018-0093.

[3] Kirkendall DT. Effects of nutrition on performance in soccer. Med Sci Sports Exerc. 1993;25(12):1370-4.

[4] H gstr m GM, Pietil T, Nordstr m P, Nordstr m A. Body composition and performance: influence of sport and gender among adolescents. J Strength Cond Res. 2012;26(7):1799-804, doi: 10.1519/JSC.0b013e318237e8da.

[5] Close GL, Sale C, Baar K, Bermon S. Nutrition for the Prevention and Treatment of Injuries in Track and Field Athletes. Int J Sport Nutr Exerc Metab. 2019;29(2):189-97, doi: 10.1123/ijsnem.2018-0290.

[6] Beck KL, Thomson JS, Swift RJ, von Hurst PR. Role of nutrition in performance enhancement and postexercise recovery. Open Access J Sports Med. 2015;6:259-67, doi: 10.2147/OAJSM.S33605.

[7] Purcell LK, Canadian Paediatric Society, Paediatric Sports and Exercise Medicine Section. Sport nutrition for young athletes. Paediatr Child Health. 2013;18(4):200-5, doi: 10.1093/pch/18.4.200.

[8] 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.

[9] Gil S, Ruiz F, Irazusta A, Gil J, Irazusta J. Selection of young soccer players in terms of anthropometric and physiological factors. J Sports Med Phys Fitness. 2007;47(1):25-32.

[10] Hidalgo y Ter n Elizondo R, Martín Bermudo FM, Pe aloza Méndez R, Bern Amor s G, Lara Padilla E, Berral de la Rosa FJ. Nutritional intake and nutritional status in elite Mexican teenagers soccer players of different ages. Nutrici n Hospitalaria. 2015;32(4):1735-43, doi: 10.3305/nh.2015.32.4.8788.

[11] Reilly T, Williams AM, Nevill A, Franks A. A multidisciplinary approach to talent identification in soccer. J Sports Sci. 2000;18(9):695-702, doi: 10.1080/02640410050120078.

[12] le Gall F, Carling C, Williams M, Reilly T. Anthropometric and fitness characteristics of international, professional and amateur male graduate soccer players from an elite youth academy. J Sci Med Sport. 2010;13(1):90-5, doi: 10.1016/j.jsams.2008.07.004.

[13] Keen R. Nutrition-Related Considerations in Soccer: A Review. Am J Orthop (Belle Mead NJ). 2018;47(12), doi: 10.12788/ajo.2018.0100.

[14] Ruiz F, Irazusta A, Gil S, Irazusta J, Casis L, Gil J. Nutritional intake in soccer players of different ages. J Sports Sci. 2005;23(3):235-42, doi: 10.1080/02640410410001730160.

[15] de la Fuente-Arrillaga C, Ruiz ZV, Bes-Rastrollo M, Sampson L, Martinez-Gonz lez MA. Reproducibility of an FFQ validated in Spain. Public Health Nutr. 2010;13(9):1364-72, doi: 10.1017/S1368980009993065.

[16] Trinidad Rodríguez I, Fern ndez Ballart J, Cuc Pastor G, Biarnés Jord E, Arija Val V. Validaci n de un cuestionario de frecuencia de consumo alimentario corto: reproducibilidad y validez. Nutrici n Hospitalaria. 2008;23(3):242-52.

[17] Martin-Moreno JM, Boyle P, Gorgojo L, Maisonneuve P, Fernandez-Rodriguez JC, Salvini S, et al. Development and validation of a food frequency questionnaire in Spain. Int J Epidemiol. 1993;22(3):512-9, doi: 10.1093/ije/22.3.512.

[18] Ochoa MC, Moreno-Aliaga MJ, Martínez-Gonz lez MA, Martínez JA, Marti A, GENOI Members. Predictor factors for childhood obesity in a Spanish case-control study. Nutrition. 2007;23(5):379-84, doi: 10.1016/j.nut.2007.02.004.

[19] Ruiz De Eguilaz MH, Martínez de Morentín B, Pérez-Diez S, et al. Comparative study of body composition measures by dual X-ray absortiometry, bioimpedance and skinfolds in women. *An R Acad Nac Farm*. 2010;76:209-222.

[20] Fan B, Shepherd JA, Levine MA, Steinberg D, Wacker W, Barden HS, et al. National Health and Nutrition Examination Survey whole-body dual-energy X-ray absorptiometry reference data for GE Lunar systems. J Clin Densitom. 2014;17(3):344-77, doi: 10.1016/j.jocd.2013.08.019.

[21] Castillo D, Raya-Gonz lez J, Manuel Clemente F, Yanci J. The influence of youth soccer players' sprint performance on the different sided games' external load using GPS devices. Res Sports Med. 2020;28(2):194-205, doi: 10.1080/15438627.2019.1643726.

[22] Sheppard JM, Young WB. Agility literature review: classifications, training and testing. J Sports Sci. 2006;24(9):919-32, doi: 10.1080/02640410500457109.

[23] Ramírez-Campillo R, Burgos CH, Henríquez-Olguín C, Andrade DC, Martínez C, Álvarez C, et al. Effect of unilateral, bilateral, and combined plyometric training on explosive and endurance performance of young soccer players. J Strength Cond Res. 2015;29(5):1317-28, doi: 10.1519/JSC.0000000000000762.

[24] Gonzalo-Skok O, Tous-Fajardo J, Arjol-Serrano JL, Suarez-Arrones L, Casajús JA, Mendez-Villanueva A. Improvement of Repeated-Sprint Ability and Horizontal-Jumping Performance in Elite Young Basketball Players With Low-Volume Repeated-Maximal-Power Training. Int J Sports Physiol Perform. 2016;11(4):464-73, doi: 10.1123/ijspp.2014-0612.

[25] Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences (2nd ed.). Routledge. https://doi.org/10.4324/9780203771587

[26] Bibiloni M del M, Pich J, Pons A, Tur JA. Body image and eating patterns among adolescents. BMC Public Health. 2013;13:1104, doi: 10.1186/1471-2458-13-1104.

[27] Nattiv A, Puffer JC, Green GA. Lifestyles and health risks of collegiate athletes: a multi-center study. Clin J Sport Med. 1997;7(4):262-72, doi: 10.1097/00042752-199710000-00004.

[28] Russell M, Pennock A. Dietary analysis of young professional soccer players for 1 week during the competitive season. J Strength Cond Res. 2011;25(7):1816-23, doi: 10.1519/JSC.0b013e3181e7fbdd.

[29] Neuhouser ML, Patterson RE, Thornquist MD, Omenn GS, King IB, Goodman GE. Fruits and vegetables are associated with lower lung cancer risk only in the placebo arm of the beta-carotene and retinol efficacy trial (CARET). Cancer Epidemiol Biomarkers Prev. 2003;12(4):350-8.

[30] Iglesias-Gutiérrez E, García A, García-Zapico P, Pérez-Landaluce J, Patterson AM, García-Rovés 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.

[31] Livingstone MB, Robson PJ. Measurement of dietary intake in children. Proc Nutr Soc. 2000;59(2):279-93, doi: 10.1017/s0029665100000318.

[32] García-Rovés PM, García-Zapico P, Patterson AM, Iglesias-Gutiérrez E. Nutrient intake and food habits of soccer players: analyzing the correlates of eating practice. Nutrients. 2014;6(7):2697-717, doi: 10.3390/nu6072697.

[33] 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.

[34] Sanfilippo J, Krueger D, Heiderscheit B, Binkley N. Dual-Energy X-Ray Absorptiometry Body Composition in NCAA Division I Athletes: Exploration of Mass Distribution. Sports Health. 2019;11(5):453-60, doi: 10.1177/1941738119861572.

[35] Demerath EW, Towne B, Wisemandle W, Blangero J, Chumlea WC, Siervogel RM. Serum leptin concentration, body composition, and gonadal hormones during puberty. Int J Obes Relat Metab Disord. 1999;23(7):678-85, doi: 10.1038/sj.ijo.0800902.

[36] Araújo J, Barros H, Severo M, Lopes C, Ramos E. Longitudinal changes in adiposity during adolescence: a population-based cohort. BMJ Open. 2014;4(6):e004380, doi: 10.1136/bmjopen-2013-004380.

[37] Nikolaidis PT, Vassilios Karydis N. Physique and body composition in soccer players across adolescence. Asian J Sports Med. 2011;2(2):75-82, doi: 10.5812/asjsm.34782.

[38] Gouvea M, Cyrino ES, Ribeiro AS, da Silva DRP, Ohara D, Valente-Dos-Santos J, et al. Influence of Skeletal Maturity on Size, Function and Sport-specific Technical Skills in Youth Soccer Players. Int J Sports Med. 2016;37(6):464-9, doi: 10.1055/s-0035-1569370.

[39] Pettersson U, Nordstr m P, Alfredson H, Henriksson-Larsén K, Lorentzon R. Effect of high impact activity on bone mass and size in adolescent females: A comparative study between two different types of sports. Calcif Tissue Int. 2000;67(3):207-14, doi: 10.1007/s002230001131.

[40] Pilis K, Stec K, Pilis A, Mroczek A, Michalski C, Pilis W. Body composition and nutrition of female athletes. Rocz Panstw Zakl Hig. 2019;70(3):243-51, doi: 10.32394/rpzh.2019.0074.

[41] Stanforth PR, Crim BN, Stanforth D, Stults-Kolehmainen MA. Body composition changes among female NCAA division 1 athletes across the competitive season and over a multiyear time frame. J Strength Cond Res. 2014;28(2):300-7, doi: 10.1519/JSC.0b013e3182a20f06.

[42] Suarez-Arrones L, Lara-Lopez P, Torreno N, Saez de Villarreal E, Di Salvo V, Mendez-Villanueva A. Effects of Strength Training on Body Composition in Young Male Professional Soccer Players. Sports (Basel). 2019;7(5):E104, doi: 10.3390/sports7050104.

[43] Bernal-Orozco MF, Posada-Falomir M, Qui nez-Gastélum CM, Plascencia-Aguilera LP, Arana-Nu o JR, Badillo-Camacho N, et al. Anthropometric and Body Composition Profile of Young Professional Soccer Players. J Strength Cond Res. 2020;34(7):1911-23, doi: 10.1519/JSC.0000000000003416.

[44] Baron J, Bieniec A, Swinarew AS, Gabryś T, Stanula A. Effect of 12-Week Functional Training Intervention on the Speed of Young Footballers. Int J Environ Res Public Health. 2019;17(1):E160, doi: 10.3390/ijerph17010160.

[45] Castillo D, Lago-Rodríguez A, Domínguez-Díez M, S nchez-Díaz S, Rendo-Urteaga T, Soto-Célix M, et al. Relationships between Players' Physical Performance and Small-Sided Game External Responses in a Youth Soccer Training Context. Sustainability. 2020;12(11):4482, doi: 10.3390/su12114482.

[46] Buchheit M, Simpson BM, Peltola E, Mendez-Villanueva A. Assessing maximal sprinting speed in highly trained young soccer players. Int J Sports Physiol Perform. 2012;7(1):76-8, doi: 10.1123/ijspp.7.1.76.

[47] Castagna C, Castellini E. Vertical jump performance in Italian male and female national team soccer players. J Strength Cond Res. 2013;27(4):1156-61, doi: 10.1519/JSC.0b013e3182610999.

[48] Nikolaidis P. Age-related Differences in Countermovement Vertical Jump in Soccer Players 8-31 Years Old: the Role of Fat-free Mass. American Journal of Sports Science and Medicine. 2014;2:60-4, doi: 10.12691/ajssm-2-2-1.

[49] Loturco I, Jeffreys I, Abad CCC, Kobal R, Zanetti V, Pereira LA, et al. Change-of-direction, speed and jump performance in soccer players: a comparison across different age-categories. J Sports Sci. 2020;38(11-12):1279-85, doi: 10.1080/02640414.2019.1574276.

[50] Loturco I, Jeffreys I, Kobal R, Cal Abad CC, Ramirez-Campillo R, Zanetti V, et al. Acceleration and Speed Performance of Brazilian Elite Soccer Players of Different Age-Categories. J Hum Kinet. 2018;64:205-18, doi: 10.1515/hukin-2017-0195.

[51] Mendez-Villanueva A, Buchheit M, Kuitunen S, Douglas A, Peltola E, Bourdon P. Age-related differences in acceleration, maximum running speed, and repeated-sprint performance in young soccer players. J Sports Sci. 2011;29(5):477-84, doi: 10.1080/02640414.2010.536248.

[52] Papaiakovou G, Giannakos A, Michailidis C, Patikas D, Bassa E, Kalopisis V, et al. The effect of chronological age and gender on the development of sprint performance during childhood and puberty. J Strength Cond Res. 2009;23(9):2568-73, doi: 10.1519/JSC.0b013e3181c0d8ec.

[53] Sekulic D, Spasic M, Mirkov D, Cavar M, Sattler T. Gender-specific influences of balance, speed, and power on agility performance. J Strength Cond Res. 2013;27(3):802-11, doi: 10.1519/JSC.0b013e31825c2cb0.

[54] Ramírez-Campillo R, Vergara-Pedreros M, Henríquez-Olguín C, Martínez-Salazar C, Alvarez C, Nakamura FY, et al. Effects of plyometric training on maximal-intensity exercise and endurance in male and female soccer players. J Sports Sci. 2016;34(8):687-93, doi: 10.1080/02640414.2015.1068439.

[55] Helgerud J, Engen LC, Wisloff U, Hoff J Aerobic endurance training improves soccer performance. Med Sci Sports Exerc. 2001;33(11):1925-31, doi: 10.1097/00005768-200111000-00019.

[56] Meylan CMP, Cronin JB, Oliver JL, Rumpf MC Sex-related differences in explosive actions during late childhood. J Strength Cond Res. 2014;28(8):2097-104, doi: 10.1519/JSC.0000000000000377.

[57] Haizlip KM, Harrison BC, Leinwand LA. Sex-based differences in skeletal muscle kinetics and fiber-type composition. Physiology (Bethesda). 2015;30(1):30-9, doi: 10.1152/physiol.00024.2014.

[58] Kubo K, Kanehisa H, Fukunaga T. Gender differences in the viscoelastic properties of tendon structures. Eur J Appl Physiol. 2003;88(6):520-6, doi: 10.1007/s00421-002-0744-8.

[59] Hewett TE, Myer GD, Ford KR. Decrease in neuromuscular control about the knee with maturation in female athletes. J Bone Joint Surg Am. 2004;86(8):1601-8, doi: 10.2106/00004623-200408000-00001.

[60] Thomas C, Dos'Santos T, Comfort P, Jones PA Male and female soccer players exhibit different knee joint mechanics during pre-planned change of direction. Sports Biomechanics. 2020;0(0):1-14, doi: 10.1080/14763141.2020.1830160.