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Pamukkale J Sport Sci, 15(2), 292-315, 2024 **Research Article**

Body Composition, Nutrition and Hydration Profile of Paralympic Athletes

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ABSTRACT

Paralympic athletes are separated from healthy athletes by having various diseases/disabilities and using auxiliary equipment. This study was planned to compare paralympic athletes' hydration, body composition, and nutritional status. For this purpose, a comparison of branches, sex, and nutritional habits on training day and non-training day were examined by 66 professional athletes from the Turkish Physically Disabled Sports Federation included in the research. Demographic characteristics, anthropometric measurements, nutritional habits, and physical activity data of individuals were collected. Dietary, physical activity, and water balance scale records were determined to evaluate the nutritional, physical activity, and hydration status of these athletes, respectively. Food consumption data were analyzed with the Nutrition Information System (BeBis) in detail; energy, carbohydrate, protein, fat, water, vitamin D, vitamin B12, calcium, magnesium, and iron were examined. Measuring mid-upper arm circumference (MUAC) is a good indicator of skeletal muscle protein mass. While women's MUAC was 28.9±3.8 cm and men's MUAC was 30.7±7.0 cm, respectively. When the reference values recommended for healthy athletes are met, it has been observed that protein, carbohydrate, iron, and calcium didn't meet the recommendations. Carbohydrate, dietary vitamin D, calcium and magnesium values were found to be higher on the training day than on the non-training day ($p<0.05$). There was no difference between spesific gravity, fluid intake during exercise or the amount of sweating of the athletes ($p>0.05$). The hydration status of the athletes was found to be inadequate in all conditions of gender, branch and the presence or absence of training.

INTRODUCTION

The word "Paralympic" was originally a combination of the words "Paraplegic" and "Olympic", but with the closer association of the Paralympic Movement with the Olympic Movement, it was formed from the combination of the Greek preposition "Para" (parallel) and "Olympic" (Tweedy & Howe, 2011). Paralympic athletes have less muscle tissue in energy expenditure during activity than healthy athletes (Goosey-Tolfrey et al., 2014). As there is reduced nutrient intake, nutrient-dense foods should be included in the athlete's diet to meet macro and micronutrient intake. Gastric emptying is slower in athletes with spinal cord injury than in healthy individuals. This should be considered when planning the number and frequency of meals. When planning the nutrition of Paralympic athletes, it is necessary to consider the time spent with the athlete and coaches, the energy spent by the athletes in training, and the health problems of the athlete (Goosey-Tolfrey et al., 2014).

Nutrition assessment is necessary to ensure adequate nutrition and hydration intake (Kesari & Noel, 2023). The primary purpose of nutritional assessment in Paralympic athletes is to define energy and nutrient intake, identify nutrition errors, and make the necessary changes to design the most appropriate nutrition plan. Hydration status, muscle fuel, and energy utilization should be considered when creating a nutritional strategy for Paralympic athletes (Das et al., 2019). The energy and nutrient needs of Paralympic athletes differ according to the region and type of physical disability (Crosland & Broad, 2011). In athletes with spinal cord injuries, changes in serum insulin and cholesterol levels as a result of overwork of the cardiovascular system and changes in nervous system responses can cause changes in the utilization of fats and carbohydrates (Das et al., 2019; Flueck & Perret, 2017). The importance of these two nutrients as fuel sources in disabled athletes is the same as in healthy athletes (Van de Vliet et al., 2011). An athlete's hydration status plays an important role in determining sports performance. Hydration status depends on factors such as the type of exercise, the athlete's muscle and fat mass, gender, age, and climatic factors such as temperature and humidity (Baysal, 2018). The hydration requirements of Paralympic athletes are similar to those of healthy athletes (Van de Vliet et al., 2011). When hydration is not provided, not only sports performance but also the life of the athlete can be jeopardized due to heat-related diseases (Ersoy, 2016; Özdemir & Ersoy, 2009). For example, in athletes with spinal cord injuries, hypothermia or hyperthermia can be seen in moderate body temperature changes. With appropriate hydration, athletes can be protected from this situation (Buchholz et al. et al., 2003).

Anthropometry is the measurement of weight, body size, and proportions, and it is a precious adjunct in assessing nutritional status (Çıtar Dazıroğlu & Köksal, 2023; Lee & Nieman, 2012). However, there are some difficulties in measuring the height and body weight within the scope of the evaluation of nutritional status in these individuals (Çıtar Dazıroğlu & Köksal, 2023). When it is impossible or difficult to take a patient's body weight directly, body weight can be estimated using various anthropometric measurements such as mid-upper arm circumference (MUAC), knee height, subscapular skinfold thickness, and calf circumference (Lee & Nieman, 2012). Waist circumference is also an indicator of visceral abdominal adiposity and is more related to the cardiovascular disease (CVD) risk than body mass index (BMI). It was stated that the relationship between CVD and waist circumference is higher in individuals with spinal cord injuries individuals compared to BMI (Buchholz & Bugaresti, 2005).

This study aimed to determine the body composition, nutritional status and hydration status of professional Paralympic athletes affiliated with the Turkish Sports Federation of the Physically Disabled and to evaluate the results obtained. For this purpose, a comparison of branches, sex, and nutritional habits on training day and non-training day was examined. In the literature, no study has been found that evaluates the body composition, nutritional, and hydration status of Turkish paralympic athletes together. The data obtained will be vital as it's the first study to be conducted on this subject.

METHODS

Participant

The professional athletes in Istanbul reached 25 swimmers, 4 archers, 20 amputee footballers, and 17 wheelchair basketballers due to the COVID-19 pandemic and the cancellation of the leagues. The sample of the study consisted of 66 participants. All participants were informed about the study and asked to sign a Voluntary Consent Form. Athletes over the age of 18 who agreed to volunteer with the consent form and who were not hearing impaired, licensed, or affiliated with the Turkish Sports Federation for the Physically Disabled were included in the study. Individuals who did not meet the inclusion criteria and had missing data in the food consumption record and physical activity record were excluded from the study.

Ethical approval for this study was obtained from the Marmara University Faculty of Medicine Clinical Research Ethics Committee on November 1, 2019, with protocol code 09.2019.956. Written informed consent to participate in this study was provided by the participants. The study was conducted in accordance with the Declaration of Helsinki.

Procedure

The study is a cross-sectional study planned to determine the nutrition and hydration status of Paralympic athletes. Study permission was obtained from the Turkish Physically Disabled Sports Federation for its execution. This study was conducted between November 2020 and June 2021 with licensed athletes affiliated with the Turkish Sports Federation for the Physically Disabled.

The study's data were collected through a structured questionnaire via the face-to-face interview method. The questionnaire consisted of open-ended and multiple-choice questions prepared by the researchers based on the literature review. In the general information part of the questionnaire, players were asked about their ages, clubs, educational level, and marital status.

Data Collection Tools

Determination of Nutritional Status

In the continuation of the questionnaire, various questions measuring the level of nutrition knowledge and nutritional habits were asked. Food consumption data were analyzed with the Nutrition Information System (BeBis version 8.1). This program examined energy, carbohydrate, protein, fat, water, vitamin D, vitamin B12, calcium, magnesium, and iron in detail.

Determination of Physical Activity

The researchers took physical activity and 24-hour food consumption records on the teams' training and non-training days. The participants' daily energy expenditure was calculated by multiplying the recorded activity times by the Physical Activity Ratio (PAR) values and basal metabolic rate-min (BMR) values determined for physical activity.

Determination of Hydration Status

To determine the hydration status, the Water Balance Scale (Şen & Aktaç, 2021) was applied and urine samples were collected. The Water Balance Scale has been used as a non-invasive screening tool to determine the amount of water lost through sweating, urine, and defecation and the amount of water intake through drinking water, beverages, and food (Malisova et al., 2012). It was aimed at evaluating the water balance, water intake, water loss, and fluid consumption habits of athletes with the Water Balance Scale, urine sample, and food consumption record. Urine samples were collected from the participants in disposable sterile urine containers before training. After sampling, the sample was allowed to reach room temperature (15-30 degrees). The results were evaluated according to the color scale indicated on the urine strip box. If the urine pH was seven or above, a value of 0.005 was added when reading the density.

Determination of Body Composition

Anthropometric measurements (knee height, MUAC, waist, and hip circumference) of the players were taken. Knee height was measured with the participant sitting on a stool suitable for his/her height, with his/her feet 25-30 cm apart and the knee in 90° flexion. The heights of the players were calculated by using the demi-span lengths with the help of the formulas in Table 1.

Table 1
Estimated Height and Weight Calculation via Knee Height and Mid-Upper Arm Circumference (Chumlea et al., 1994; Lee & Nieman, 2013)

Gender	Estimated Height (cm)
Male	(NH x 1.88) +70.85 (±7.9 cm)
Female	(NH x 1.87) - (Age x 0.06) + 70.25 (±7.2 cm)
Gender	**Estimated Weight (kg)**
Male	(NHx1.19)+(MUACx3.21)-86.82(±11.42 kg)
Female	(NHx1.01)+(MUACx2.81)-66.04 (±10.60 kg)

Note. NH: Knee Height, MUAC: Mid-upper arm circumference

Skinfold thickness measurement, which is an important method in determining body fat ratio, is performed using a caliper, and the accuracy and reliability of the results are negatively affected because of compliance issues in mentally disabled individuals (Casey, 2013). There are some errors in estimating body density when various anthropometric measurements are used, and these errors can be minimized when the equation that requires more variables (four instead of two) is used, and more attention is paid to measurement techniques (Lee & Niemann, 2012). Determination of the body density skinfold thickness measurements are taken from four regions (abdomen, triceps, suprailiac, and thigh) with a caliper, and the Siri equation (% Body Fat = (495 / Body Density) – 450) was used to determine body fat percentage.

Due to the COVID-19 outbreak, uniforms, gloves, masks, and visors were used while taking measurements, and the instruments to be measured were sprayed with disinfectant between measurements. The following conditions were observed during the measurements:

- Taking measurements before training
- The person being measured should be wearing as little clothing and no shoes as possible
- Flat surfaces to stand, support, and sit on during measurement
- Taking measurements from the same side of the body whenever possible
- Care was taken not to take measurements from the limb-deficient side.

Data Analysis

The data were evaluated statistically using the SPSS (Statistical Package for the Social Sciences) 22.0 package program. While evaluating the study data, the conformity of the parameters to normal distribution was evaluated by the Shapiro-Wilks test. In addition to descriptive statistical methods (mean, standard deviation, and frequency), the one-way ANOVA test was used for comparisons of parameters with a normal distribution between groups, and the Tukey HDS test was used to determine the group causing the difference. The Kruskal-Wallis test was used for intergroup comparisons of parameters that did not show a normal distribution, and Dunn's test was used to determine the group causing the difference. Significance was evaluated at the $p<0.05$ level.

RESULTS

The research involved 66 paralympic athletes, 50 of them (75.8%) men and 16 (24.2%) women, aged 18 to 54 (mean 27.5±9.4). The branch distribution of the athletes in the research is as follows: 37.9% (n = 25) to swimming, 30.3% (n=20) to amputee football, 25.7% (n = 17) to wheelchair basketball, and 6.1% (n = 4) archery. Limb deficiency in 48.5%, muscle strength, and coordination disorders in 18.2%, spinal cord paralysis in 16.7%, mental disability in 9.1%, spina bifida in 3%, ataxia, short stature, and mental disability in 1.5% of athletes are observed. Anthropometric measurements of athletes are shown in Table 2. Comparison of anthropometric measurements by branches of athletes are shown in Table 3.

Table 2
Anthropometric Measurements of Athletes by Gender (n = 66)

Parameters	Female			Male		
	Mean±SD	Min	Max	Mean±SD	Min	Max
Estimated Body Weight* (kg)	62.2±11.9	49.0	86.9	72.0±15.1	50.6	125.0
Fat Mass (kg)	13.5±3.7	6.0	20.8	12.6±9.4	1.5	61.4
Fat Free Mass (kg)	49.6±10.2	35.7	69.9	59.3±12.1	25.5	102.2
Fat Percentage (%)	21.7±5.6	9.4	29.4	16.7±9.9	2.8	70.6
Estimated Body Height (cm)	166.3±15.3	125	185	170.1±15.8	95	205
Knee Height (cm)	50.9±5.4	42	60	49.7±8.6	0	62
Waist Circumferance (cm)	77.6±11.0	62	99	86.3±12.70	64	121
Hip Circumferance (cm)	91.7±9.9	79	112	96.5±10.6	72	122
Waist/Hip Ratio	0.8±0.08	0.75	1.01	0.9±0.07	0.78	1.1
Mid-Upper Arm Circumference (cm)	28.9±3.8	23.0	35.0	30.7±7.0	0.0	42.0

Note. *Body weight calculation via knee height and mid-upper arm circumferance

Table 3
Comparison of Anthropometric Measurements by Branches (n = 66)

Parameters	Branch				p
	Swimming (n=25)	Wheelchair Basketball (n=17)	Archery (n=4)	Amputee Football (n=20)	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Estimated Body Height (cm)	148.3±34.2	178±10.8	174.3±7.8	164.7±17.1	**[1]0.000***
Waist Circumferance (cm)	76.6±9.2	94.5±12.2	101.3±2.9	81.5±9.3	**[2]0.000***
Hip Circumferance (cm)	89.6±7.6	102.4±9.9	106±6.1	94.6±10.2	**[2]0.000***
Waist/Hip Ratio	0.85±0.06	0.92±0.09	0.96±0.08	0.86±0.05	**[1]0.001***
Mid-upper arm circumferance (cm)	26.8±6.8	36.3±4.1	33.25±1.0	28.9±4.1	**[2]0.000***

Note. [1]Oneway Anova Test; [2]Kruskal Wallis Test; *p<0.05

The answers given by the athletes in the study to the questions about measuring their nutritional knowledge levels and nutritional habits are shown in Table 4.

Table 4
Nutritional Knowledge and Nutritional Habits of Athletes (n = 66)

Questions/Answers		Branch				p
		Swimming (n=25)	Wheelchair Basketball (n=17)	Archery (n=4)	Amputee Football (n=20)	
		Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Meal skipping situation	Not skipped	15 (%60)	11 (%64.7)	1 (%25)	15 (%75)	[1]0.309
	Skipped	10 (%40)	6 (%35.3)	3 (%75)	5 (%25)	
Meals usually skipped (n=24)	Breakfast	6 (%60)	1 (%16.7)	1 (%33.3)	2 (%40)	[2]0.565
	Lunch	2 (%20)	2 (%33.3)	1 (%33.3)	3 (%60)	
	Snack	2 (%20)	2 (%33.3)	1 (%33.3)	0 (%0)	
	Dinner	0 (%0)	1 (%16.7)	0 (%0)	0 (%0)	
Reason for skipping (n=24)	Lack of time	4 (%44.4)	3 (%50)	1 (%33.3)	2 (%40)	[3]0.825
	Be late	2 (%22.2)	1 (%16.7)	1 (%33.3)	2 (%40)	
	Other	1 (%11.2)	1 (%16.6)	1 (%33.3)	0 (%0)	
	Lack of habit	1 (%11.1)	0 (%0)	0 (%0)	1 (%20)	
	Anorexia	1 (%11.1)	1 (%16.7)	0 (%0)	0 (%0)	
Eating speed	Fast	14 (%56)	12 (%70.6)	2 (%50)	14 (%70)	[1]0.677
	Slow	11 (%44)	5 (%29.4)	2 (%50)	6 (%30)	
Macronutrient consumption status	Consume	24 (%96)	16 (%94.1)	2 (%50)	16 (%80)	**[1]0.043***
	Not consume	1 (%4)	1 (%5.9)	2 (%50)	4 (%20)	
Paying attention to nutrition status	Paying attention	17 (%68)	14 (%82.4)	1 (%25)	19 (%95)	**[1]0.012***
	Not paying attention	8 (%32)	3 (%17.6)	3 (%75)	1 (%5)	
Relationship between eating habits and success in sports	Very close relationship	16 (%64)	15 (%88.2)	4 (%100)	18 (%90)	[3]0.208

Note. Correct answers are indicated in bold. [1]*Fisher Freeman Halton Test,* [2]*Fisher's Exact Test,* [3]*Ki-Kare Test.* $^*p<0.05$

Table 4 (Continued)

Questions/Answers		Swimming (n=25)	Wheelchair Basketball (n=17)	Archery (n=4)	Amputee Football (n=20)	p
		Branch				
		Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Hours stop eating before competition	**No idea**	8 (%32)	2 (%11.8)	0 (%0)	1 (%5)	[3]**0.038***
	No relationship	1 (%4)	0 (%0)	0 (%0)	1 (%5)	
	1-2 hours	17 (%68)	4 (%23.5)	4 (%100)	10 (%50)	
	3-4 hours	6 (%24)	12 (%70.6)	0 (%0)	8 (%40)	
	Not paying attention	2 (%8)	1 (%5.9)	0 (%0)	2 (%10)	
Type of food consumed before training/competition	**Rich in carbohydrates**	8 (%32)	4 (%23.5)	0 (%0)	7 (%35)	[3]**0.015***
	Not paying attention	9 (%36)	4 (%23.5)	2 (%50)	3 (%15)	
	Rich in protein	5 (%20)	4 (%23.5)	0 (%0)	8 (%40)	
	Rich in carbohydrates and protein	0 (%0)	2 (%11.8)	1 (%25)	0 (%0)	
	Rich in carbohydrates and vitamins	1 (%4)	0 (%0)	0 (%0)	2 (%10)	
	Rich in carbohydrates, protein and vitamins	1 (%4)	1 (%5.9)	0 (%0)	0 (%0)	
	Rich in vitamins	0 (%0)	2 (%11.8)	0 (%0)	0 (%0)	
	Rich in protein and vitamins	1 (%4)	0 (%0)	0 (%0)	0 (%0)	
	Rich in carbohydrates, protein and fat	0 (%0)	0 (%0)	1 (%25)	0 (%0)	
Hours start eating after competition	**1-2 hours**	18 (%72)	8 (%47.1)	2 (%50)	8 (%40)	[3]**0.027***
	3-4 hours	5 (%20)	9 (%52.9)	2 (%50)	6 (%30)	
	Not paying attention	2 (%8)	0 (%0)	0 (%0)	6 (%30)	

Note. Correct answers are indicated in bold. [1]*Fisher Freeman Halton Test,* [2]*Fisher's Exact Test,* [3]*Ki-Kare Test.* *$p<0.05$

Table 4 (Continued)

Questions/Answers		Swimming (n=25)	Wheelchair Basketball (n=17)	Archery (n=4)	Amputee Football (n=20)	p
		Branch				
		Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Type of food consumed after training/competition	**Rich in protein**	13 (%52)	4 (%23.5)	1 (%25)	10 (%50)	[3]0.298
	Not paying attention	9 (%36)	3 (%17.6)	2 (%50)	4 (%20)	
	Rich in carbohydrates and protein	2 (%8)	3 (%17.6)	0 (%0)	2 (%10)	
	Rich in protein and vitamins	0 (%0)	2 (%11.8)	0 (%0)	2 (%10)	
	Rich in carbohydrates	1 (%4)	2 (%11.8)	0 (%0)	1 (%5)	
	Rich in carbohydrates, protein and fat	0 (%0)	1 (%5.9)	1 (%25)	0 (%0)	
	Rich in carbohydrates, protein and vitamins	0 (%0)	1 (%5.9)	0 (%0)	0 (%0)	
	Rich in vitamins	0 (%0)	1 (%5.9)	0 (%0)	0 (%0)	
	Rich in fat	0 (%0)	0 (%0)	0 (%0)	1 (%5)	

Note. Correct answers are indicated in bold. [1]*Fisher Freeman Halton Test,* [2]*Fisher's Exact Test,* [3]*Ki-Kare Test. *p<0.05*

While 21.2% of athletes use nutritional supplements, 78.8% do not use any product. 7.1% of athletes use supplements to build muscle, 28.6% to improve performance, and 64.3% to improve health. 71.4% of athletes who use supplements believe that the supplements are useful. (Not shown in the table.) The hydration status of athletes is shown in Table 5.

Table 5
Hydration Status of Athletes (n = 66)

Questions		Mean±SD	Min-Max
Sweat score when physically active		6.7±2.3	2-10
Sweat score when not physically active		4.2±2.6	1-10
Density (g/mL)		1016.9±6.7	1005-1030
Amount of water drink during training (mL)		892.8±539.4	180-3000
Amount of sports drink during training (mL) (n=11)		490.9±30.2	400-500
		n	**%**
Paying attention to fluid intake before and after training or competition	Paying attention	56	84.8
	Not paying attention	10	15.2
Fluid intake before training or competition (mL)	0-500	15	22.7
	501-1000	31	47.0
	>1001	20	30.3
Fluid intake after training or competition (mL)	0-500	10	15.2
	501-1000	34	51.5
	>1001	22	33.3

The amount of sweat excreted from the body, obtained from the Water Balance Scale, and fluid losses through urine output and fecal output were calculated. The sweat score lost with physical activity was 6.7 out of 10. The calculated sweat amount is 1666 ml. While the sweat score during the period when not physically active was 4.2 out of 10, the calculated sweat amount dropped to 501 ml. The amount of water lost through urine and feces was calculated as 925 ml and 150 ml, respectively. As a result of the analysis of the athletes' 24-hour food consumption records, the daily energy, nutrient intakes, and comparison with International Society of Sports Nutrition (ISSN) Recommendations are shown in Table 6.

Table 6
Energy and Nutrient Intakes Meet ISSN Recommendations by Gender (n = 66)

Parameters	Gender	Numbers analyzed on training day	ISSN[a] Recommendations	Percentage of meeting ISSN recommendations (%)	Numbers analyzed on non-training day	p
Energy (kcal)	Female	1395.5	-[b]	-	1302.7	[1]0.400
	Male	1579.5	-	-	1487.4	[1]0.380
Water (ml)	Female	2191.5	-	-	1605.4	[1]0.139
	Male	2759.6	-	-	1957.9	[1]0.566
Protein (g)	Female	73.5(1.15 g/bw[c])	1.4-2 g/bw	68	61.6	[2]0.110
	Male	71.4(1.02 g/bw)	1.4-2 g/bw	60	70.1	[2]0.544
Protein (%)	Female	%22	-	-	%19	[1]0.654
	Male	%19	-	-	%19	[1]0.602
Fat (g)	Female	66.9	-	-	63.9	[1]0.977
	Male	74.1	-	-	69.0	[1]0.227
Fat (%)	Female	%43	%20-35	125	%44	[2]0.373
	Male	%42	%20-35	117	%41	[2]0.525
CHO[d] (g)	Female	122.2 (2 g/bw)	8-12 g/bw	20	116.7	[2]0.637
	Male	153.1(2.13 g/bw)	8-12 g/bw	21	142.4	[2]0.164
CHO (%)	Female	%36	-	-	%37	[2]0.834
	Male	%40	-	-	%39	[2]0.554
Vitamin B12 (mcg)	Female	4.4	-	-	4.6	[2]0.940
	Male	5.2	-	-	4.8	[2]0.708
Vitamin D (mcg)	Female	5.1	-	-	2.1	[1]0.785
	Male	2.7	-	-	1.8	[1]0.554
Iron (mg)	Female	9.6	18	53	8.6	[1]0.397
	Male	9.8	8	122.5	9.4	[1]0.677
Calcium (mg)	Female	749.2	1500	50	677.0	[1]0.797
	Male	766.8	1500	51	637.5	[1]0.425
Magnesium (mg)	Female	224.5	-	-	207.5	[1]0.568
	Male	251.0	-	-	224.5	[1]0.960

Note. [a]ISSN: International Society of Sports Nutrition, [b]No ISSN value, [c]bw: body weight, [d]CHO: Carbohydrate. [1]Student t Test; [2]Mann Whitney U Test

Protein intakes on training days for both genders are lower than ISSN recommendations. Female athletes received 68% of the ISSN recommendations for protein, while male athletes received 60% of the protein. Fat intakes in both genders are approximately 1.2 times higher than ISSN recommendations. Carbohydrate intake on training days for both genders is lower than ISSN recommendations. Female athletes received 20% of the ISSN recommendations for carbohydrates, while male athletes received 21%. While the iron intake of female athletes is 53% of the ISSN recommendations, this increases to 122.5% for male athletes. Calcium intakes on training days for both genders are lower than ISSN recommendations. Female athletes received 50% of the ISSN recommendations for calcium, while male athletes received 51%. There is no statistically significant difference between men and women regarding food consumption record data values on training days and non-training days (p>0.05). While the athletes' PAL value was 2.3 on the training day, it was calculated as 1.5 on the non-training day. (not shown in the table) A comparison of energy, macro and micro nutrient intakes by branches and whether it is a training day is given in Table 7.

Table 7

Comparison of Energy, Macro, and Micro Nutrient Intakes by Branches (n = 66)

Parameters		Branch				p
		Swimming (n=25)	Wheelchair Basketball (n=17)	Archery (n=4)	Amputee Football (n=20)	
		Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Energy (kcal)	Training	1611.0±566.3	1399.6±573.6	1489.3±418.1	1600.3±493.7	[1]0.606
	Not training	1489.6±389.7	1400.0±616.5	1261.7±502.2	1517.1±509.6	[1]0.747
Protein (g)	Training	74.4±23.1	77.4±34.8	63.5±39.9	67.8±24.8	[1]0.652
	Not training	68.3±18.7	77.4±32.0	70.9±3	65.4±22.0	[1]0.507
Protein (%)	Training	19.6±4.1	22.1±7.23	25.3±8.7	17.3±4.2	[2]0.091
	Not training	19.2±4.6	24.8±12.8	23±5.4	18.0±4.5	[2]0.089
Fat (g)	Training	80.2±36.2	60.0±27.8	71.5±21.6	68.6±25.2	[1]0.212
	Not training	74.6±22.6	59.7±27.3	60.9±23.6	63.4±22.8	[1]0.199
Fat (%)	Training	43.2±8.5	38.7±9.2	42.8±3.4	41.2±6.8	[1]0.368
	Not training	45.2±9.1	41.2±9.4	43±2.9	40.1±7.7	[1]0.230
CHO[3] (g)	Training	144.4±57.8	136.8±87.5	118.6±50.8	164.1±64.5	[2]0.273
	Not training	132.7±60.3	128.2±93.4	103.4±45.9	152.8±71.5	[2]0.275
CHO (%)	Training	37.3±8.2	42.0±15.5	32±7.4	41.8±7.5	[2]0.125
	Not training	35.7±10.8	39.52±16.94	33.75±5.5	41.95±8.64	[2]0.210
Liquids (ml)	Training	2621.5±1235.5	2556.0±1512.4	3084±1168.6	2287.2±572.2	[2]0.650
	Not training	2053.5±838.9	1649.8±1306.0	1934.5±717	1664.7±739.9	[2]0.156
Vitamin D (mcg)	Training	5.0±7.5	2.3±1.9	1.5±1.0	1.7±1.3	[2]0.425
	Not training	1.8±1.2	2.4±1.6	1.5±1.0	1.5±1.4	[2]0.262
Iron (mg)	Training	9.9±3.1	9.2±3.2	11.0±3.9	9.8±3.0	[1]0.768
	Not training	8.7±3.0	9.6±3.4	9.9±4.4	9.5±3.5	[1]0.752
Vitamin B12 (mcg)	Training	5.9±2.9	4.3±2.4	5.8±2.3	4.5±2.8	[1]0.193
	Not training	5.0±2.2	4.9±2.6	5.8±2.3	4.1±2.3	[1]0.479
Ca (mg)	Training	826.4±421.2	686±262.3	706.1±172.7	762.2±373.8	[1]0.652
	Not training	690.3±294.8	625.8±299.4	657.9±184.7	620.8±302.2	[1]0.852
Mg (mg)	Training	253.9±83.8	222.8±76.7	249.1±64.4	253.8±63.5	[1]0.555
	Not training	221.6±70.8	216.6±68.8	222.9±83.4	233.6±87.6	[1]0.918

Note. [1]Oneway Anova Test, [2]Kruskal Wallis Test, [3]CHO: Carbonhydrate

DISCUSSION

Body Composition

Paralympic athletes differ from healthy athletes by having various diseases/disabilities, the auxiliary equipment (crutches, wheelchairs, etc.), the muscle groups used in the sport, and the prolongation of muscle glycogen regeneration (recovery) time. This study aimed to determine the nutritional status, hydration status, and some anthropometric measurements of professional-level disabled athletes affiliated with the Physically Disabled Sports Federation and to evaluate the results obtained. When BMI was calculated by adjusting for limb losses using the Amputees Coalition calculator, it was found to be inconsistent for lean and muscular lower limb amputees, and the ratio of the body segments is different from Osterkamp (Frost et al., 2017; Osterkamp, 1995). While BMI underestimates body weight in individuals with unilateral amputations, it overestimates it in individuals with bilateral amputations due to low height (Meyer & Edwards, 2014). In this study, the BMI of the athletes was calculated at 23.9±4.1. Since the number of athletes with unilateral limb deficiency was high and the number of athletes with bilateral amputation was low in the study, the average BMI may have been underestimated.

In athletes with disabilities, 23.5-32 cm MUAC is classified as usual, MUAC >32 cm is classified as overweight (Bhurosy & Jeewon, 2013). In this study, the participants' MUAC value found was 30.3±6.4 cm, and according to classification, the athletes were normal. Wheelchair basketball athletes had higher MUAC values than swimming and amputee soccer athletes. This may occur when these athletes perform exercises such as pull-ups to increase arm muscle strength. It is known that although stroke length does not change with age, it is closely related to height (Yaraşır et al., 2011). The results of the study support this relationship between height and stroke range. Swimming athletes had a lower stroke range than wheelchair basketballers.

While 27.3% of the athletes did not pay attention to the food consumed before training or competition, 28.8% consumed carbohydrate-rich foods, and 25.8% consumed protein-rich foods. In the literature, 300-400 grams of carbohydrate intake (ACSM, 2016) or 1-2 g/kg/day carbohydrate intake (Kreider et al., 2010) approximately 3-4 hours before training/competition is recommended for healthy athletes. While no protein-rich foods are consumed before training or competition at the archers, this rate is 40% in amputee footballers. It was observed that the athletes' level of knowledge about how to eat before training or competition was low.

The rate of paying attention to nutrition in amputee footballers (95%) was higher than the swimmers (68%) and archers (25%). There is no statistically significant difference between other branches in terms of paying attention to nutrition. It can be thought that football is more prominent in the Turkish sports culture, and athletes are more careful about their nutrition to meet the expectations of the public and maintain their success.

Energy and Macronutrients

Wheelchair athletes have reduced muscle mass and sympathetic nervous system compared to healthy athletes. Therefore, they are expected to have lower energy requirements (Price, 2010). In this study, training day energy intakes by branch were 1399.6±573.6 kcal for wheelchair basketball and 1489.3±418.1 kcal for archery. Compared to other studies in the literature, the energy intake of wheelchair basketball athletes in this study was found to be low 4284 kcal (Bescos-Garcia & Rodriguez-Guisado, 2011), 2497±362 kcal (Ferro et al., 2017), 2060 kcal (Goosey-Tolfrey & Crosland, 2010). Egger and Flueck (2020) found that the energy intake of female wheelchair athletes was 1377±337 kcal/day. Therefore, they suggested that wheelchair athletes and possibly other para-athletes may be at risk for low energy availability. In this study, the daily energy intake of men on training day (1577.6±549.8 kcal) was higher than that of women (1447.1±492.5 kcal). On a non-training day, the energy intake of men was 1491.3±523.6 kcal, and that of women was 1366.3±374.3 kcal, and the energy intake of men was higher than that of women. The findings suggest that female athletes are in a more risky position regarding low energy availability as in the literature.

The mean energy intake of the athletes on training day was 1545.9±535.7 kcal, and the non-training day was 1461.0±491.8 kcal. Energy intake on the training day was found to be higher compared to the non-training day, but it was lower than the literature (Madden et al., 2017: 2092 kcal; Penggalih et al., 2019: 1627 kcal; Sasaki & Da-Costa, 2021: 2128 kcal). In the literature, energy expenditure of 1500-2900 kcal/day was higher (3990.9±1247.7 kcal) than all other studies involving wheelchair athletes (Eskici & Ersoy, 2016; Grams et al., 2016; Innocencio da Silva Gomes et al., 2006). However, it should be interpreted by considering the calculation errors that may occur if the energy expenditure of Paralympic athletes is calculated from formulas. Shaw et al. (2021) compared the energy intake of disabled athletes before (male 2819 kcal, female 2034 kcal) and during (male 2878 kcal, female 1760 kcal) the COVID-19 pandemic. When the data taken during the COVID-19 pandemic were compared with the research findings, the energy intake of the athletes in this study (male 1579 kcal, female 1395.5 kcal) was lower than the literature.

An optimal carbohydrate intake maintains body weight, replenishes glycogen stores, repairs muscle tissue through protein synthesis, and provides fat, essential fatty acids, and fat-soluble vitamins (Kreider et al., 2010; Rodriguez et al., 2009; Thomas et al., 2016). Inadequate carbohydrate intake decreases oxygen transport and concentration, resulting in negative effects such as muscle cramps, fatigue, and an increased risk of injury (Skolnik & Chernus, 2010). In this study, carbohydrate intake on training day in all branches was found to be higher than on non-training day but lower than in the literature (Shaw et al., 2021: men: 387 g, women: 247 g men; Madden et al., 2017: 252 g, women: 209 g). A higher carbohydrate intake on the training day may positively affect the replenishment of muscle glycogen stores and recovery time. The carbohydrate intake of men on training day (152.6±71.3 g) was higher than that of women (128.9±54.6 g). When the training day carbohydrate intake data obtained from food consumption records were compared with the ISSN recommendations, men met 21% of the recommendations, while this rate decreased to 20% in women.

Standardization of nutrient recommendations for athletes with physical disabilities is difficult as the athlete's nutritional needs vary depending on their disability. Carbohydrate recommendations for healthy athletes suggest that nutrient intake should be based on body weight and is typically recommended between 3-12 g/kg/day depending on exercise type, volume, etc. (Burke et al., 2011). In the study, the carbohydrate intake of women (2 g/kg/day) was lower than that of men (2.1 g/kg/day). Carbohydrate intake in both genders was lower than the recommendations for healthy athletes.

Protein intake is important to produce enzymes and hormones, repair damaged tissue and compensate for protein breakdown due to increased protein catabolism during exercise (Knuiman et al., 2018). In both genders, protein intake on the non-training day (man: 69.6±24.6 g, women: 66.8±25.5 g) was lower than on the training day (man: 70.9±25.4 g, women: 81.5±35.1 g) and protein intakes in both genders were lower than the literature (man: 121 g, women: 81.7 g Madden et al., 2017; man: 136 g, woman: 86 g Shaw et al., 2021). When training day protein intake from food consumption records is compared with ISSN recommendations, men meet 60% of the recommended level, while women meet 68%. Protein recommendations for healthy athletes range from 1.2-2.0 g/kg/day depending on the type, duration, and intensity of physical activity (Thomas et al., 2016). In the present study, the protein intake of women (1.2 g/kg/day) was higher than that of men (1 g/kg/day). Protein intake in both genders was lower than the recommendations for healthy athletes. When the data taken from Shaw et al. during the COVID-19 pandemic were compared with the research findings, the protein intake of the athletes in this study (man 71.4 g, woman 73.5 g) was lower than the literature (man 136 g, women 86 g, Shaw et al., 2021).

Dietary fats are important for health and athletics as they provide the body with energy, aid in the absorption of fat-soluble vitamins, and are a component of cell membranes (Thomas et al.,2016). Fat recommendations for healthy athletes are that 20-35% of daily energy intake and less than 10% should come from saturated fats (IOM, 2017; Thomas et al., 2016). In this study, the daily energy coming from fats was 42%, which is above the recommendations for healthy athletes. Men's fat intake was higher on the training day (71.9±31.13 g) than on the non-training day (65.6±25.1 g), while it was the opposite for women (67.9±30.5 g on training day, 69.3±22.2 g on non-training day). When the results of the study were compared with the literature, it was found that men's fat intake was lower than the literature while women's fat intake was higher than the literature (Men: 75.7 g women: 57.4 g Madden et al., 2017). When training day fat intake from food consumption records is compared with ISSN recommendations, men meet 117% of the recommended, while women meet 125%. When the data taken from Shaw et al. during the COVID-19 pandemic were compared with the research findings, men's fat intake (71.9 g) was lower than the literature, while women's fat intake (67.9 g) remained higher than the literature (man 89 g, women 52 g, Shaw et al., 2021). Lower fat intake was found in the literature than in the study results (51g, Penggalih et al., 2019). According to the ISSN, 10-20% of the daily energy requirement of healthy athletes should come from proteins, 20-35% from fats and 45-60% from carbohydrates (Kreider et al., 2010). In the study, 19% of the daily energy requirement on the non-training day came from proteins, 43% from fats, and 38% from carbohydrates.

Micronutrients

Iron indirectly plays a role in antioxidant activity and oxidative metabolism (Sasaki & Da-costa, 2021). Iron intake of men on training day (9.7±3.2 mg) was lower than that of women (9.9±3.0 mg). Iron intake of men and women on the training day was higher compared to the non-training day. When the training day iron intake obtained from food consumption records was compared with the ISSN recommendations, men met 122.5% of the recommended rate, while the rate decreased to 53% in women. When the data taken from Shaw et al. during the COVID-19 pandemic were compared with the research findings, the iron intake of the athletes (man 9.4 mg, women 8.6 mg) in this study was low (Shaw et al., 2021: man 28 mg, women 18 mg). Athletes have lower iron intakes than other studies in the literature (Eskici & Ersoy, 2016: 15.7 ± 4.2 mg; Krempien & Barr, 2011: man: 14.5 ± 4.2 mg, women: 15.2 ± 7.1 mg). Iron deficiency can increase anemia, which can cause weakness, fatigue, poor concentration, and limit physical performance (Longo & Camaschella, 2015; Rowland, 2012). In this study, women were more prone to anemia than men. Female athletes have a higher risk of iron deficiency than men due to losses from menstruation and lower energy intake (Parnell et al., 2015; Sasaki & Da-costa, 2021; Sandström et al., 2012).

Vitamin D deficiency can decrease neuromuscular function (Flueck & Perret, 2017). Furthermore, individuals with spinal cord injuries are at increased risk for sublesional osteoporosis, characterized by excessive bone resorption and reduced bone formation (Doubelt et al., 2015). The vitamin D intake of men on training day (2.8±4.4 mcg) was lower than that of women (4.2±6.6 mcg). Although men's and women's vitamin D intakes on training day were higher than on non-training day, they are lower than in the literature (Madden et al., 2017; Shaw et al., 2021). Similar to the study results, women had lower intakes of vitamin B12, vitamin D, and iron compared to men in the literature (Shaw et al., 2021).

Vitamin D deficiency causes a decrease in calcium (Ca) absorption (Rakıcıoğlu, 2008). Disabled athletes are at higher risk of stress fractures when they train intensely and experience loss of bone mineral density (Blauvet et al., 2017). On the training day, the calcium intake of men (770.0±379.8 mg) was higher than that of women (743.2±287.4 mg). When the training day Ca intake obtained from food consumption records is compared with the ISSN recommendations, men meet 51% of the recommended rate, while the rate decreases to 50% in women. When the data taken from Shaw et al. (2021) during the COVID-19 pandemic were compared with the research findings, the Ca intake of the athletes in this study (man 749.2 mg, women 766.8 mg) was lower than the literatüre (man 1447 mg, women 1081 mg, Shaw et al., 2021). Increasing dietary Ca intake may not replace the deficiency, as 30-40% of dietary calcium can be absorbed (Rakıcıoğlu, 2008; Sasaki & Da-costa, 2021). Low levels of micronutrients involved in bone health, such as calcium, magnesium, and vitamin D, may negatively affect wheelchair athletes susceptible to osteoporosis (Calvo & Tucker, 2013; Miyahara et al., 2008). It is important to note that these values only come from dietary sources, and supplement use can improve them.

Pre-exercise dehydration and vigorous post-exercise fluid replacement are vital to ensuring timely recovery (Jepson et al., 2012). In the study, 84.8% of the athletes paid attention to fluid intake before/after training or competition. It was observed that the participants generally had 500-1000 ml of fluid intake before and after training. While 51.5% of them used bottles, 48.5% used glasses. In amputee athletes, the skin surface area is reduced to dissipate the heat released due to limb deficiency. Additional heat may be released by contact of the prosthesis or prosthetic liners with the skin surface (Andrews et al., 2016). Such conditions are important to ensure proper hydration for the athlete (Shirreffs & Sawka 2011).

Skinfold thickness measurement is a simple and easy tool that can be used to determine body fat. BIA and LCD measurements can be used interchangeably (Kaner et al., 2015). Since the disability status of the athletes made it difficult to determine their body composition by BIA, body fat was determined in the study by taking skinfold thickness measurements. Innocencio da Silva Gomes et al. (2006) used the equation of Jackson and Pollock (1978) by taking skinfold thickness measurements from three different regions for body fat percentage determination. In the present study, for the determination of body fat percentage, skinfold thickness measurements were taken from four different regions. Body fat weight and fat percentage were determined by Jackson and Pollock (1978) and Siri (1961) equations. Since Jackson and Pollock (1978) did not develop this formula based on a sample of amputated athletes, it is questionable whether the equation is appropriate for this population (Meyer & Edwards, 2014).

There are no published MET values for people with disabilities that can estimate energy expenditure during daily activities and exercise. There are also no guidelines that can be used to adapt the MET values of healthy individuals to an athlete with an amputation, significantly lower body amputations (Ainsworth et al., 2011). There is no gold standard method for determining energy expenditure in Paralympic athletes. Due to the COVID-19 pandemic during the study period, we could not reach a sufficient number of athletes for profiling in the wheelchair basketball branch.

Limitations

The findings of this study should be interpreted with caution because of several limitations. First, the participants were young soccer players with amateur backgrounds. Therefore, the findings may not be generalizable to other age groups, skill levels, and competitive contexts. Second, the study only used psychological and technical responses in 2-a-side and 4-a-side game formats. These results may not fully represent the effects of physiological and kinematic parameters. Third, this study only assessed immediate responses during and shortly after game sessions. However, the long-term implications of these observed differences have not yet been explored.

CONCLUSION

As a result, it was determined that the energy, carbohydrate, vitamin B12, Ca, Mg, and fluid intakes of Paralympic athletes in swimming, archery, amputee football, and wheelchair basketball branches were below the recommended levels, while daily protein, fat, and vitamin D intakes were above the recommended levels. It was found that dietary iron intake was above the recommended intake in men and below the recommended intake in women. In the study, it was determined that the rate of attention paid to the eating time of athletes was low. The hydration status of the athletes was found to be inadequate in all conditions of genderand branch, as well as in the presence or absence of training.

PRACTICAL IMPLICATIONS

In this study, it was observed that the hydration status of the athletes was inadequate in all conditions, such as gender, branch, and training. This result suggests that all coaches should be careful with athletes' hydration monitoring. Special modules should be created for coaches and athletes on nutrition, hydration, and supplement use, considering the special needs of paralympic athletes. These findings suggest that female athletes can prevent iron deficiency if they monitor regularly. Future research should identify barriers to good nutrition in athletes and determine how they relate to their body composition and daily energy intake and expenditure. Considering the disabilities and special needs of Paralympic athletes, a guideline should be established. For disabled athletes participating in sports, professional sports nutrition counseling should be applied by a dietitian specializing in the effect of nutrition on performance and the importance of fluid intake.

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Authors' contribution

The study's design was contributed to by the first and second authors, while the first author managed the data collection. The data analysis and interpretation were completed by the first and second authors, while the drafting or critical revisions of article's was done by the first author. The article's final version has been approved of both authors.

Declaration of conflict interest

No conflict of interest is declared by the authors. In addition, no financial support was received.

Ethics Stament

Ethical approal for this study was obtained from Marmara University Faculty of Medicine Clinical Research Ethics Committee on 01.11.2019 with protocol code 09.2019.956. Written informed consent to participate in this study was provided by the participants.

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