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RESEARCH ARTICLE

Determination of Anthropometric Measurements and Nutritional Status of Wheelchair Basketball Players

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Abstract
The aim of this study was to determine the anthropometric measurements, nutritional habits, and nutritional knowledge levels of wheelchair basketball players. Anthropometric measurements and 24-hour food consumption records were taken from 29 wheelchair basketball players and a structured questionnaire about nutritional habits and knowledge levels **was** applied to 40 wheelchair basketball players by face-to-face interview. The median values of the anthropometric measurements of basketball players were within the reference range (21.6 kg/m^2 for female players, 22.7 kg/m^2 for male players). Fifty-two percent of basketball players find their nutritional knowledge level sufficient, 47.5% use media for the source of nutritional information, 45% skip lunch, and 12.5% drink water >2 L/day. The health complaints of basketball players were mostly frequent cramps (17.5%) and cold (17.5%). Nutrients that the majority of basketball players consumed below the estimated average requirements were found to be carbohydrate, fiber, thiamine, calcium, vitamin C, and vitamin D. It is concluded that not all basketball players have sufficient nutritional knowledge, and those who do, cannot reflect this knowledge very accurately on their nutritional habits. It will be better for wheelchair basketball players to receive nutritional education. More research is needed to make more accurate evaluations **of** the nutritional status of athletes with disabilities..

Keywords
Wheelchairs, Basketball, Anthropometry, Nutrition

INTRODUCTION

Adequate and balanced nutrition is very important for athletes to increase performance, prevent injuries, and recover quickly after competition and injuries. It is possible to meet the energy, carbohydrate, protein, fat requirement and fluid need of the athletes, which increase according to the sports branch, with adequate and balanced nutrition. While planning the optimal diet, the age, height, body weight, gender, sports branch, training frequency, training duration, and nutritional habits of the athlete should be taken into consideration. The main goal is to create a nutrition plan that will minimize the body deformations of amputee athletes. The energy requirements of disabled athletes are generally lower than those of other athletes (Krempien & Barr, 2011; Goosey-Tolfrey & Crosland, 2010). Considering the macro and micronutrient needs of athletes; since the training intensities between team athletes and their positions in the game will be different, there is a difference in carbohydrate requirements (Hawley, Dennis & Noakes, 1994). Compared to other athletes, although energy expenditure is lower, especially in wheelchairs, relative carbohydrate portions are similar (Price, 2010; Jung & Yamasaki, 2009). A diet rich in

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carbohydrates and fluid, recommended for athletes during recovery period, is also recommended for disabled athletes. An increase in protein requirement may occur among team athletes due to collisions and kicks during the competition, abrasions, and wounds in the body. It is argued that post-exercise protein use and requirement are similar to other athletes (Reddy, 2008; Lee et al., 2006). If the disabled athlete has a pressure wound, the need for protein may increase slightly and arginine is recommended for wound healing (Sherman & Barkley, 2011).

The recommended fat consumption level for team athletes is similar to the recommendation for all athletes (Fink, Burgoon & Mikesky, 2006). Dietary fiber intake is often insufficient in all persons with disabilities – whether they are athletes or not (Krempien & Barr, 2011; Goosey-Tolfrey & Crosland, 2010). Intestinal passage can take up to 80 hours in physically disabled individuals (Geders, Gaing, Bauman & Korsten, 1995); for this reason, a high fiber diet with adequate fluid intake is recommended to regulate bowel movements (Chung & Emmanuel, 2006). It is accepted that adequate and balanced nutrition alone does not guarantee the success of an athlete, but inadequate and unbalanced nutrition causes some health problems and poor performance (Özdemir, 2010). The aim of our study is to determine the anthropometric measurements, nutritional habits, and nutritional knowledge levels of wheelchair basketball players.

MATERIALS AND METHODS

Study Design

This cross-sectional study was planned and carried out with 40 basketball players from four professional wheelchair basketball teams in Wheelchair Super League between December 2021 and May 2022.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Marmara University Faculty of Health Sciences Non-Invasive Clinical Research Ethics Committee; 25.11.2021/97. Written informed consent was obtained from all participants.

Data Collection

The data of the study were collected through a structured questionnaire via face-to-face interview method. The questionnaire consisted of open-ended and multiple-choice questions prepared by the researchers as a result of the literature review. In the general information part of the questionnaire, the basketball players were asked about their ages, clubs, educational and marital status. In the continuation of the questionnaire, various questions measuring the level of nutrition knowledge and nutritional habits were asked.

Anthropometric measurements and 24-hour food consumption records were taken by the researchers on the training days of the teams. Body weight, demi-span, and mid-upper arm circumference (MUAC) measurements of the basketball players were taken. The heights of the players were calculated by using the demi-span lengths with the help of the formulas in Table 1. Then, Body Mass Indices (BMI) of the basketball players were calculated.

Table 1. Estimated height calculation via demi-span length (Width and Reinhard, 2021)

Gender	Estimated Height (cm)
Female	1.35 x demi-span (cm) + 60.1
Male	1.40 x demi-span (cm) + 57.8

The study was started with 40 basketball players (4 females and 36 males), and the number of athletes decreased to 29 as there were losses during anthropometric measurements and food records.

Data Analysis

The data were evaluated statistically using the SPSS (Statistical Package for the Social Sciences) 21.0 package program. The Kolmogorov-Smirnov test was used to determine the conformity of the data to the normal distribution. Since the data were normally distributed, the relationship between variables was determined by the Pearson correlation test. The significance level was accepted as $p<0.05$.

The daily total energy and nutrient intake of basketball players was calculated with the Nutrition Information System (BeBiS 7.2) by using 24-hour food consumption records. With this program, in detail; energy, carbohydrate, protein, fat, fiber, vitamin D, vitamin C, calcium, magnesium, iron, total cholesterol, sodium,

potassium, vitamin B12, folic acid, and thiamine values of basketball players were examined.

RESULTS

Distribution of the sports clubs of the basketball players participating in the study were: 32.5% from Beşiktaş HDI Sigorta Wheelchair Basketball Team, 25% from 1907 Fenerbahçe Disabled Stars Basketball Team, 22.5% from Bağcılar Municipality Wheelchair Basketball Team, and 20% from Galatasaray Wheelchair Basketball Team. Ninety percent of players were male, 40% were married and most of the players (65%) had high-school education (not shown in table). Anthropometric measurements of basketball players are shown in Table 2.

Table 2. Anthropometric measurements of basketball players (n=29)

Parameters	Females			Males		
	Median	Min.-Max. Values		Median	Min-Max Values	
Body Weight (kg)	54	52	75	71	50	85.5
Estimated Body Height (cm)	157.3	155.9	160	176.8	157.2	190.8
Mid-Upper Arm Circumference (cm)	35	30.5	35.5	34	28	42
Demi-span Length (cm)	72	71	74	85	71	95
Body Mass Index (kg/m^2)	21.6	21.1	30.4	22.7	16.5	31.4

The answers given by the basketball players participating in the study to the questions about measuring their nutritional knowledge levels and nutritional habits were shown in Table 3.

Table 3. Answers of basketball players about their nutritional knowledge and nutritional habits (n=40)

Questions	Answers	n	%
Source of nutritional information*	Coach	14	35
	Nutrition books	5	12.5
	Media	18	47.5
	Insufficient	9	22.5
	Dietitian	1	2.5
	Unanswered	1	2.5
Meals that are usually skipped*	Breakfast	13	32.5
	Lunch	18	45
	Dinner	3	7.5
	None	7	17.5
Problems seen when breakfast is skipped*	Tiredness	6	15
	Weakness	12	30
	Attention deficit	4	10
	Do not skip	20	50
	Unanswered	1	2.5
Amount of liquid consumed before competition	< 0.5 L	16	40
	0.5-1 L	12	30
	1-2 L	7	17.5
	> 2 L	5	12.5
Kinds of food consumed before competition*	Carbohydrates	15	62.5
	Proteins	22	55
	Fats	6	15
	Vitamins	5	12.5
Mostly consumed liquids/beverages (except meals)*	Fruit juice	4	10
	Water	27	67.5
	Tea-Coffee	21	52.5
	Carbonated beverage	5	12.5
	Mineral water	15	37.5
Mostly consumed foods (except meals)*	Chocolate	17	42.5

	Toast	7	17.5
	Fruit	19	47.5
	Nuts	19	47.5
	Candy	2	5
	Sweets/Desserts	8	20
	Pastry	4	10
	Other	1	2.5
	Unanswered	1	2.5
Hours stop eating before competition	< 1 h	0	0
	1-2 h	14	35
	3-4 h	24	60
	Unanswered	2	5
Numbers of meals per day	1-2	23	57.5
	3-4	17	42.5
	5 and above	0	0
Defecation frequency	Everyday	15	37.5
	Every other day	11	27.5
	Every 3-4 days	4	10
	More than once a day	10	25
Relation between nutrition and basketball	No relationship	1	2.5
	Very closely related	33	82.5
	No idea	6	15
Amount of carbohydrate in sports drinks	None	1	2.5
	%1-2	3	7.5
	%4-8	0	0
	No idea	36	36
Nutrient contents targeted for consumption during the competition	Liquid, fiber and fat	0	
	Liquid and protein	17	42.5
	Liquid and carbohydrate	14	35
	No idea	9	22.5
Nutrient contents targeted for consumption after the competition	Protein, carbohydrate and fat	12	30
	Only protein	3	7.5
	Only carbohydrate	2	5
	Carbohydrate and protein	18	45
	No idea	5	12.5
Has these health complaints*	Thin nails	2	5
	Stains on nails	2	4
	Frequent cramps	8	17.5
	Tingling in hands and feet	4	10
	Getting tired quickly	4	10
	Cracks on the corners of the mouth	1	2.5
	Cold	7	17.5
	None	21	52.5
	Unanswered	1	2.5

*more than one option is marked, ***Correct answers are indicated in bold.***

Of all, 52.5% of basketball players find their knowledge about sports nutrition sufficient, 77.5% skip meals, 35% use tobacco, 90% pay attention to fluid intake during training, 62.5% think that they have adequate nutrition intake, 57.5% eat late at night, 35% use nutritional supplements, 37.5% consume energy drinks. While 72.5% of basketball players believe that vitamin supplements improve performance, only 37.5% use vitamin supplements (not shown in the table).

As a result of the analysis of 24-hour food consumption records of the basketball players participating in the study, the daily energy, nutrient intakes, and estimated average requirement (EAR/AR) values are shown in Table 4.

Table 4. Energy, nutrient intakes, and EAR values of basketball players (n=29)

Parameters	Median	Min. Value	Max. Value	EAR/AR[1]
Energy (kcal)	1967.68±847.1	721	4097.9	-[2]
Carbohydrate (g)	198.77±94.75	63.9	389.3	-
Protein (g)	78.79±49.23	17.8	252.4	45.56[3]
Fat (g)	94.59±47.64	11	248	-
Fiber (g)	20.96±12.99	4.7	59.3	25
Vitamin D (mcg)	5.54±11.49	0.1	61.5	10
Vitamin C (mg)	91.07±71.83	2.9	289.8	90
Calcium (mg)	749.72±357.11	199.9	1403.3	750-860[4]
Magnesium (mg)	276.23±157.36	79.3	765.8	-
Iron (mg)	11.45±5.25	3.7	26.1	6[5]
Total Cholesterol (mg)	434.45±287.92	92.4	1320.4	-
Sodium (mg)	3827.82±1792	824.6	8130.7	-
Potassium (mg)	2351.08±1321	445.9	5641	-
Cobalamin / Vitamin B_{12} (mcg)	5.94±5.59	0.6	30.9	-
Folic Acid / Vitamin B_9 (mcg)	310.16±167.89	45.7	766.8	250
Thiamine / Vitamin B_1 (mg)	0.88±0.64	0.2	3.4	1.0

[1] Estimated Average Requirement; [2] No EAR Value; [3] EAR value for protein intake is 0.66 g/kg/day.; [4] 19-24 ages: 860 mg, 25-50 ages: 750 mg.; [5] Premenopausal stage of women: 7 mg, for men: 6 mg.

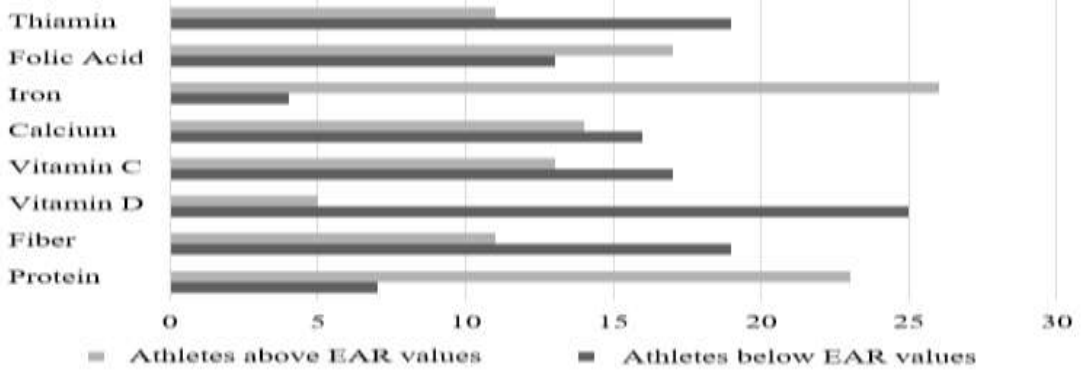

Figure 1. Figure 1. Comparison of the nutrient intakes of basketball players with the estimated average requirement (EAR/AR) values.

Figure 1 shows the comparison of the amount of nutrients taken by the athletes according to their food consumption records with the Estimated Average Requirement (EAR/AR) values (TÜBER, 2015). When the relationship between the MUAC and body weight of the basketball players and their energy and some nutrient intakes was examined, the relationship between body weight and MUAC was found to be statistically significant ($p<0.001$). The relationship between MUAC and energy, carbohydrate, protein, and fat intake were not significant ($p=0.444$, $p=0.438$, $p=0.925$, $p=0.437$, respectively).

DISCUSSION

Parameters such as body composition, ideal body weight, and BMI are important in every athlete group and are associated with performance. In a study, height and body weights were measured to calculate the BMI of 1,749 volunteer athletes participating in the paralympic games, and as a result, the prevalence of obesity was found to be

3.1 times higher than other athletes (Harris et al., 2003).

In a study of Latin American Special Olympics athletes, more than 40% of disabled athletes were found to be overweight and obese (Foley, Lloyd, Turner & Temple, 2017). The anthropometric measurements and the median values of BMI of the basketball players participating in our study were found to be within the normal range. In this context, they are not considered under the risk of obesity.

Inadequate and unbalanced nutrition is directly related to low performance in athletes (Ersoy, 2004). One of the aims of our study was to measure nutritional habits and nutritional knowledge levels of wheelchair basketball players. The numbers of basketball players who found their nutritional knowledge level sufficient and insufficient were found to be quite close to each other (52.5% and 42.5%, respectively). Although 82.5% of the basketball players in our study found sports and nutrition to be closely related, only 62.5% thought that they had adequate nutrition. This shows that there are shortcomings in the nutrition of the athletes. One of these shortcomings is that basketball players often skip meals that coincide with their training hours. For this reason, it was concluded that basketball players could not adjust their training times and meal times.

It has been determined that 40% of basketball players take less than 7 ml of fluid per kilogram before the competition. In order to prevent dehydration and regulate bowel movements in athletes, the recommended fluid intake is 5-7 ml/kg at least 4 hours before training and 3-5 ml/kg 2 hours before training (Chung & Emmanuel, 2006). Demirkan and colleagues emphasized that dehydration directly affects the performance of the athlete and that the habit of fluid intake should be gained by the athletes (Demirkan, Mitat & Kutlu, 2010). Sixty percent of the basketball players in our study answered as “3-4 hours ago”, 35% of them “1-2 hours ago” to the question “How many hours before the competition do you stop eating?”. The recommendation for athletes is to finish the main meal 3-4 hours before the competition. However, since the digestion is slower in wheelchair basketball players, it is recommended to extend this period (Schabort, Bosch, Weltan & Noakes, 1999).

It was determined that the content of the last food consumed by the majority of basketball players before the competition was carbohydrate (62.5%) and protein (55%). It is important for athletes to consume carbohydrate-rich foods before training. Wheelchair athletes have similar glycogen utilization as other athletes, but it has been reported that glycogen stores of disabled athletes are generally low at the beginning of exercise. For this reason, high carbohydrate intake before exercise is recommended for replenishing glycogen stores not to experience loss of performance (Goosey-Tolfrey & Crosland, 2010; Kreider et al., 2010). It was observed that basketball players in our study generally preferred foods with high simple carbohydrate content besides meals. A study has revealed that consumption of simple carbohydrates may cause movement restriction in wheelchair basketball players, as it causes fat accumulation around the waist (Grams, Garrido, Villacieros & Ferro, 2016). Although 35% of the basketball players gave the correct answer as "liquid and carbohydrate" to the question of what type of food the athletes aim to consume during the competition; no basketball player could give a correct answer to the question of how much carbohydrate the sports drinks contain. In a study examining the effect of sports drinks on performance; one group was given an 8% carbohydrate solution and the other group was given a placebo before the 20-minute arm-crank ergometer training. After all, the performance of the group that consumed 8% solution increased by 1 km (11.5 km vs. 12.5 km) (Spendiff & Campbell, 2002). When the athletes were asked which macronutrient(s) they aim to consume after the competition, 45% gave the correct answer by saying "carbohydrate and protein". Athletes need to consume a sufficient amount of carbohydrates in order to replenish glycogen stores and recover quickly after the competition. In addition, the protein consumed after the competition provides the amino acids necessary for the construction and repair of muscle tissue (Rodriguez, Di Marco & Langley, 2009).

The average energy intake of basketball players participating in the study was found to be 1967.68 kcal. The recommended intake for elite athletes with disabilities is 1500-2300 kcal on average (Krempien & Barr, 2011; Goosey-Tolfrey & Crosland, 2010). In this context, it is seen that the energy intake of the players participating in our

study is at a sufficient level. For muscle protein synthesis during the recovery period, if a sufficient amount of protein is not consumed, protein catabolism will overcome protein synthesis and this leads to loss of muscle mass and negative nitrogen balance (Wu, 2016). It is argued that post-exercise protein use and requirement are similar to those of non-disabled athletes. If the athlete has pressure wound, the need may increase a little more. The recommended amount of protein for elite athletes with disabilities is 1-1.5 g/kg/day (Lee et al., 2006). Twenty-three of the basketball players in our study have protein consumption above the recommended level. The recommended carbohydrate intake for disabled elite athletes is 3.4-4.4 g/kg/day (Price, 2010; Jung & Yamasaki, 2009). Similar to these recommendations, in a study investigating the nutritional status and supplement use of paralympic athletes, the average carbohydrate consumption of the participants was found to be 3.5 g/kg/day (Madden, Shearer & Parnell, 2017). Unlike the recommendations and similar studies, the average carbohydrate amount consumed by the basketball players participating in our study was determined as 2.87 g/kg/day. Adequate fiber intake is especially important for intestinal motility in wheelchair athletes because these athletes have a high incidence of constipation (Jeukendrup, 2017). The fiber intake of 19 basketball players in our study was found to be below the EAR value. It is recommended that the fat intake of disabled elite athletes should be between 28-37% of total energy (Krempien & Barr, 2011; Goosey-Tolfrey & Crosland, 2010). In a study investigating the nutritional status and nutritional knowledge levels of amputee wheelchair basketball players, it was determined that the athletes provided 44% of their daily energy needs from fat (Eskici & Ersoy, 2016). Similarly, the amount of fat consumed by the basketball players participating in our study was found to be 43% of the total energy. Considering the food records, it can be thought that the reasons for the high fat consumption may be the type of meat they consume was generally red meat, the consumption of nuts and oilseeds was high, and the carbohydrate deficit was completed from fat.

Athletes with disabilities cannot fully meet their vitamin and mineral needs with food. For this reason, the use of nutritional supplements is recommended for disabled athletes (Ersoy, 2004). Only 37.5% of the basketball players participating in our study use supplements. Appropriate intake and distribution of micronutrients in meals are very important to ensure the presence of substrates to regulate metabolic pathways and to modulate musculoskeletal adaptations caused by physical training (Close et al., 20016). For example, thiamine deficiency causes fatigue during exercise in athletes, while iron deficiency reduces hemoglobin level, leading to a decrease in performance capacity (Paker, 1996). For this reason, the health complaints (thin nails, frequent cramps, tingling in hands and feet, getting tired quickly, cracks on the corners of the mouth, cold, etc.) of the basketball players participating in our study made us think that the players may have had vitamin and mineral deficiencies. In Figure 1, the nutrient intakes of basketball players are compared with the estimated average requirement (EAR/AR). Among the reasons for the lack of various micronutrients in basketball players participating in the study; inadequate and/or unbalanced nutrition, incomplete use of supplements and especially low consumption of fresh vegetables and fruits can be shown.

In conclusion, it was determined that the median values of the anthropometric measurements of wheelchair basketball players were within the reference range. In addition, it has been observed that not all basketball players have sufficient nutritional knowledge and those who do cannot reflect this knowledge very accurately on their own nutritional habits. For this reason, it is recommended that it will be better for athletes to receive expert health support (such as nutrition education) in order to increase their nutritional knowledge, correct their unhealthy nutritional habits, enhance their performance, and minimize injuries. In addition, periodic health checks of the athletes (anthropometric and biochemical measurements) should be made and when a problem is detected, it should be solved with the help of experts before it worsens. There are very few comprehensive studies that determine the nutrient requirements of wheelchair basketball players, more research is needed to make more accurate evaluations for the athletes in this group.

Conflict of Interest

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

Ethics Statement

Ethical approval of the study was obtained from Marmara University Non-Interventional Clinical Research Ethics Committee at the board meeting dated 25.11.2021 (protocol number: 97). Written informed consent to participate in this study was provided by the participants.

Author Contributions

Study Design, AHİ; Data Collection, EÖ, TY, ZK; Statistical Analysis, AHİ, EÖ, TY, ZK; Data Interpretation, AHİ; Manuscript Preparation, AHİ, EÖ, TY, ZK; Literature Search, EÖ, TY, ZK. All authors have read and agreed to the published version of the manuscript.

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