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Athletic Performance in Sports and Nutrition

Guest Editor: Ozkan Isik

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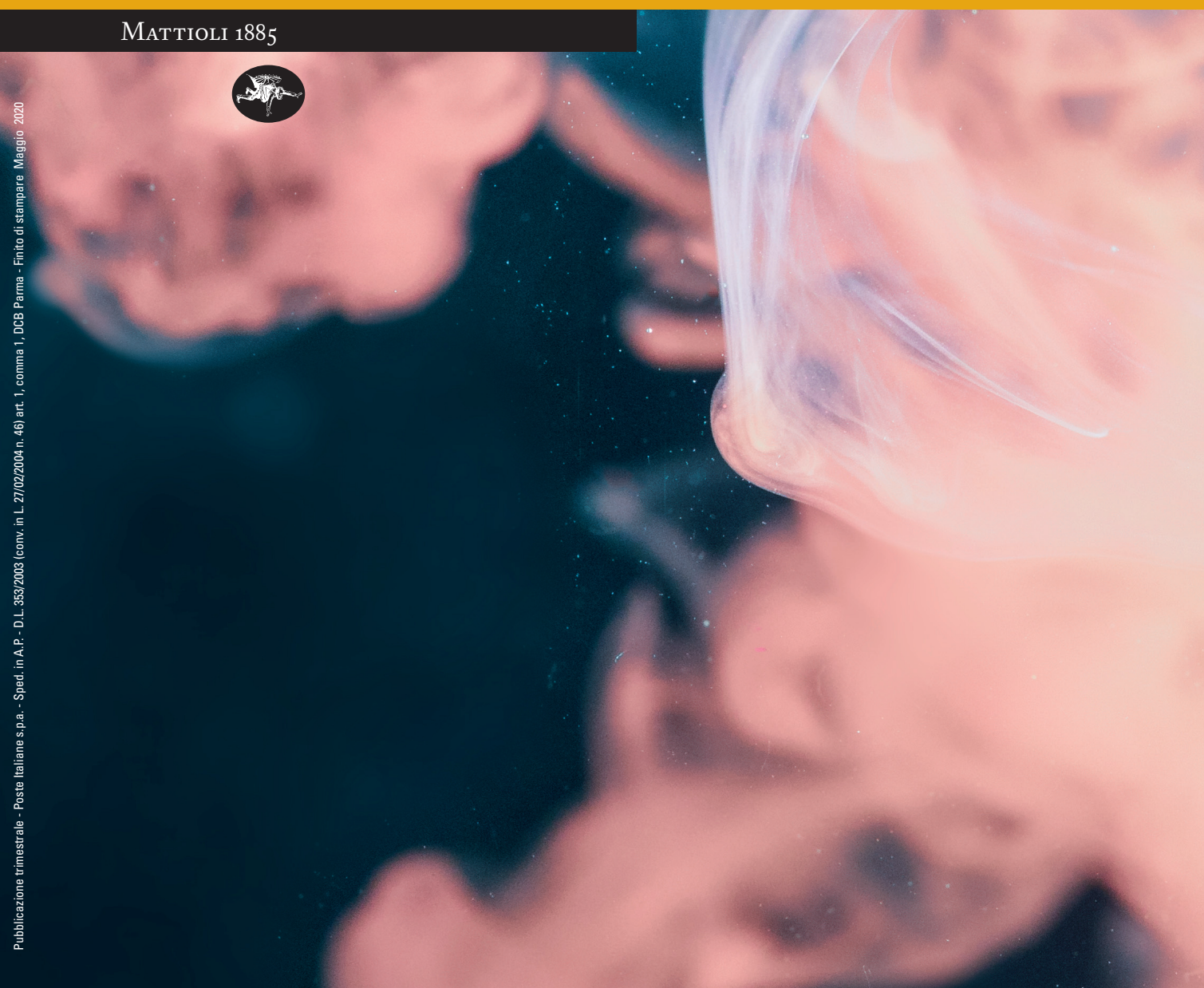

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Athletic Performance in Sports and Nutrition

Original articles

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Original article

Investigation of the relationship between basal metabolic rate and body composition in young adults using CHAID analysis

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Summary. *Study Objectives:* Basal metabolic rate (BMR) is the most important component of the individual's daily energy-consuming. Personal and environmental factors make a difference in BMR. Body composition is the most important variable for BMR, from these factors. In this context, the aim of this study was to examine the relationship between BMR and body components in young adults and to determine the most effective body component on BMR. *Methods:* The sample of this study consisted of 229 women and 123 men, a total of 349 young adult individuals. All measurements of the participants were carried out in the physiology laboratory of the School of Physical Education and Sports, Afyon Kocatepe University. Participants' height measurements were measured using Seca 213 (Germany) 1 mm precision portable stadiometer, body compositions (Body weight, Fat Mass, Free-Fat Mass, and Total Body Water) and BMR using a bioelectrical impedance analyzer. In the analysis of the obtained data, CHAID analysis was applied using the SPSS package program to explain the relationship between basal metabolic rate and body composition as well as descriptive statistics. *Results:* It was determined that the BMR of men and women differed statistically. It was determined that the most important body component affecting BMR in young adult women and men is free-fat mass. *Conclusion:* The BMR was predicted by 83.91% in young adult women and 70.39% in men by free-fat mass. Moreover, it was determined that BMR increased as the free-fat mass increased.

Key words: Basal Metabolic Rate, Obesity, Body Composition, CHAID Analysis

Introduction

Obesity is defined as the accumulation of fat in adipose tissues to the extent that it can impair human health. Obesity is a chronic health problem called the epidemic of our age, and its prevalence is gradually increasing. Many genetic, personal and environmental factors that play a role in the development of obesity cause degradation of the energy balance (1-4). The energy balance is the total received energy in a day is equal to the total consumed energy. The fact that the total received energy in a day is less than the total consumed energy is called the negative energy balance, and the total received energy in a day is more than the total consumed energy is called the positive energy balance. Degradation of the energy balance, and its transformation into chronic form change in body composition. While long-term negative energy balance creates body weight loss, positive energy balance causes body weight increase, and obesity (5,6). The

total received energy in a day is consumed under the thermal effect of foods (10%), physical activity (15-30%), and BMR (60-65%). Basal metabolism is the lowest amount of energy required to maintain an individual's vital functions (7). BMR is the most important component of the individual's daily energy-consuming. However, some personal and environmental factors create a difference in BMR and affect the amount of energy-consuming per unit of time (5,8-13). Previous studies show that BMR is related to diet, physical activity, gender, age, height, body weight, body temperature, climate, some hormones, pregnancy, disease, etc. (8,14,15). Moreover, it is stated that the most important factors in BMR changes are body size and body composition (14,16). Body composition consists of the relative ratios of muscle, bone, fat, and other components to body weight (17-19). It is stated that lean mass (FFM), fat mass (FM) and total body water (TBW) in body composition are effective on the BMR (14,16-19). However, we think that they have a different effects on BMR. For this reason, it is important to identify the most effective body component in BMR.

In the literature, it has been observed that there are studies examining BMR changes in different populations and the components that are effective in BMR changes (6,20-23). However, studies examining the body composition components that are effective in BMR using the CHAID analysis technique in young adult individuals have not been encountered. In this context, the aim of this study was to examine the relationship between BMR and body components in young adults and to determine the most effective body component on the BMR using the CHAID analysis.

Material and Method

Participants

A total of 349 (226 women and 123 men) young adults participated in this study. Before the measurements, the participants were informed about the purpose of the study and the "Informed Volunteer Consent Forms" were obtained from participants. The participants were selected from healthy individuals between the ages of 18-30. However, disease, pregnancy, breastfeeding, and menstrual periods in women were determined as exclusion criteria.

Data Collection

All measurements were performed in the physiology laboratory of the School of Physical Education and Sports, Afyon Kocatepe University.

Height Measurements

Height measurements of the participants were measured with a portable stadiometer with Seca 213 (Germany) brand 1 mm precision. Length measurements were measured with barefoot in the anatomical position with a thin rod parallel to the floor that touched the head during deep inspiration with a sensitivity of 1 mm as the distance between the sole of the foot and the top of the head.

Body composition and BMR Measurements

Body composition and BMR were measured in sedentary mode with the TANITA BC-418 (Tanita Corp., Tokyo, Japan) brand bioelectric impedance analyzer. All participants were informed about measurement protocols 72 hours before body composition measurements. They were informed about not drinking alcohol up to 48 hours before the measurements, not eating 4 hours in advance, not consuming tea, coffee and cola 12 hours before the measurement and not exercising. Body composition measurements were performed with light clothes, barefoot, without any metal objects on them, in the case of an empty stomach and an empty bladder.

Statistical Analysis

CHAID (Chi-Squared Automatic Interaction Detection) analysis is a method that can achieve similar results with regression analysis but does not take into account the assumptions of regression analysis. CHAID analysis is a method that determines statistically significant groups, can give results with clear and easily readable tree diagrams, classifies, or estimates observations. CHAID analysis examines the factors

that significantly affect the change in estimated variables, and tries to identify the interactions and common level combinations of variables in the research model. CHAID analysis is a statistical method that divides the categorical dataset into detailed homogeneous sub-groups to describe the best dependent variable (24,25). In the analysis of the obtained data, CHAID analysis was applied using the SPSS program to explain the relationship between BMR and body composition, as well as descriptive statistics. Significance was determined as $p < .05$.

Results

In Table 1 some descriptive statistics related to body components for women was given. It was determined that the most important body component that affects BMR in women was FFM (Figure 1). FFM components for women were divided into 5 groups. When the FFM groups in Figure 1 were examined, ≤ 39.20 (n = 46), 39.20 < FFM ≤ 42.50 (n = 66), 42.50 < FFM ≤ 43.60 (n = 25), 43.60 < FFM ≤ 46.40 (n = 44), and BMR means for women in the FFM > 46.40 (n = 45) groups were 1189.67 Kcal, 1283.24 Kcal, 1348.88 Kcal, 1391.43 Kcal, and 1529.20 Kcal, respectively. As the FFM ratio increases for women, the BMR also increases. In addition, the determination coefficient of this model for women was determined as $R^2 = 83.91\%$. In other words, approximately 84% of the change in BMR can be explained by FFM.

In Table 2 some descriptive statistics related to body components for men was given. It was determined that the most important body component that affects BMR in men was FFM (Figure 2). FFM components for men were divided into 3 groups. When the FFM groups in Figure 2 were examined, ≤54.00 (n = 26), 54.00<FFM≤60.50 (n = 35), and BMR means for men in the FFM >60.50 (n = 62) groups were 1493.92 Kcal, 1722.63 Kcal, and 1981.40 Kcal, respectively. As the FFM ratio increases for men, the BMR also increases. In addition, the determination coefficient of this model for men was determined as $R^2 = 70.39\%$. In other words, approximately 70% of the change in BMR can be explained by FFM.

Discussion and Conclusion

In order to maintain the energy balance, all of the total received energy in a day must be spent. The most important component of energy-consuming is BMR. Because approximately 60-65% of the individual's daily energy consumption is spent on basal metabolism. However, the BMR varies individually (5,6,8-12,15). Body size and body composition are the most important factors estimating individual differences and changes in the BMR (10,11,14,16). In this context, in this study, the effects of body components on the BMR were investigated.

In the literature, it is stated that gender creates a difference in BMR, and women have a BMR of about

Table 1. Descriptive Statistics of Women Participants

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age (Year)	226	18.00	29.00	20.88	1.77
Height (cm)	226	146.00	178.0	162.23	5.29
Body Weight (kg)	226	39.6	104.2	61.42	11.57
Body Mass Index (kg/m^2)	226	15.5	39.2	23.35	4.34
BMR (Kcal)	226	1070.0	1774.0	1341.50	125.89
Percentage of FM (%)	226	9.2	45.4	28.77	7.68
FM (kg)	226	3.6	47.2	18.45	8.11
FFM (kg)	226	32.9	57.5	42.99	4.29
TBW (kg)	226	24.1	42.1	31.47	3.14

Table 2. Descriptive Statistics of Men Participants

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age (Year)	123	18.00	27.00	20.48	1.83
Height (cm)	123	156.00	194.00	176.02	6.36
Body Weight (kg)	123	45.90	117.80	71.39	13.49
Body Mass Index (kg/m^2)	123	16.10	36.10	22.99	3.78
BMR (Kcal)	123	1290.00	2578.00	1804.72	233.38
Percentage of FM (%)	123	2.80	32.70	14.07	7,.44
FM (kg)	123	1.90	34.60	10.76	7.46
FFM (kg)	123	43.00	83.20	60.48	7.63
TBW (kg)	123	31.50	60.90	44.17	5.77

10-15% lower than men (8,15). The results of this study showed that men's BMR was higher than women. It can be said that the difference between BMR of women and men is due to the ratio of body components. Therefore, BMR of women and men according to their body composition were evaluated separately in the CHAID analysis.

When the literature was examined, it was reported that the percentage of FM, FM, and FFM was effective in BMR (14,16,20-22). While Lührmann et al. (2001) stated that the resting metabolic rate (RMR) is not only dependent on FFM, and also is affected by FM and FM distribution in the body (21), Molnar and Schutz (1997) reported that the main determinant of RMR is FFM (22). In studies conducted at different ages and groups in the literature, it was seen that there was no consensus regarding the effect of body compositions on BMR. In this study, according to the results of CHAID analysis using FFM, FM, percentage of FM, and TBW, it was determined that the most important component estimating BMR for women (figure 1) and men (figure 2) was FFM. It was seen that the FFM component was divided into 5 groups in women and 3 groups in men. For both women and men, BMR increased as FFM increased. Approximately 60% of human body weight consists of water. Water is 78% in muscle mass and 18% in FM. According to these ratios, as the muscle mass increases in the body increases the water ratio and decreases the fat ratio. This study was planned considering that per unit changes in the body composition of FFM, FM, and TBW components would change the effective rates on BMR. As a matter of fact, according to our hypothesis, FFM has been found to be the most important component affecting BMR. We also estimated that the BMR difference between men and women was due to body compositions. This situation may be due to the lower TBW and FFM ratios of women and higher FM than men.

In this study, changes in BMR can be explained by approximately 83.91% for women (figure 1) and 70.39% (figure 2) for men by the FFM. In the current study, considering the most important change in BMR may be due to body composition, only FFM, FM, TBW, and FM percentage were included in the CHAID analysis model. However, it is stated in the literature that BMR is affected as well as body composition and gender by many factors such as age, hormones, current general health status, stress, diet, disease, environmental temperature, pregnancy, etc. Stress, post-workout, pregnancy, breastfeeding, growth era, increased muscle mass in the body, febrile diseases, cancer-derived diseases, low environmental temperature, excess protein in the diet, and excess of thyroid hormone increase the BMR. Depending on age, the BMR decreases in low thyroid hormone (8,15). In this study, women and men were evaluated separately, the participants were selected from healthy individuals, and it was paid attention not to have women participants during pregnancy, breastfeeding, and menstrual periods. In addition, BMR changes in young adults were examined, paying attention that the participants

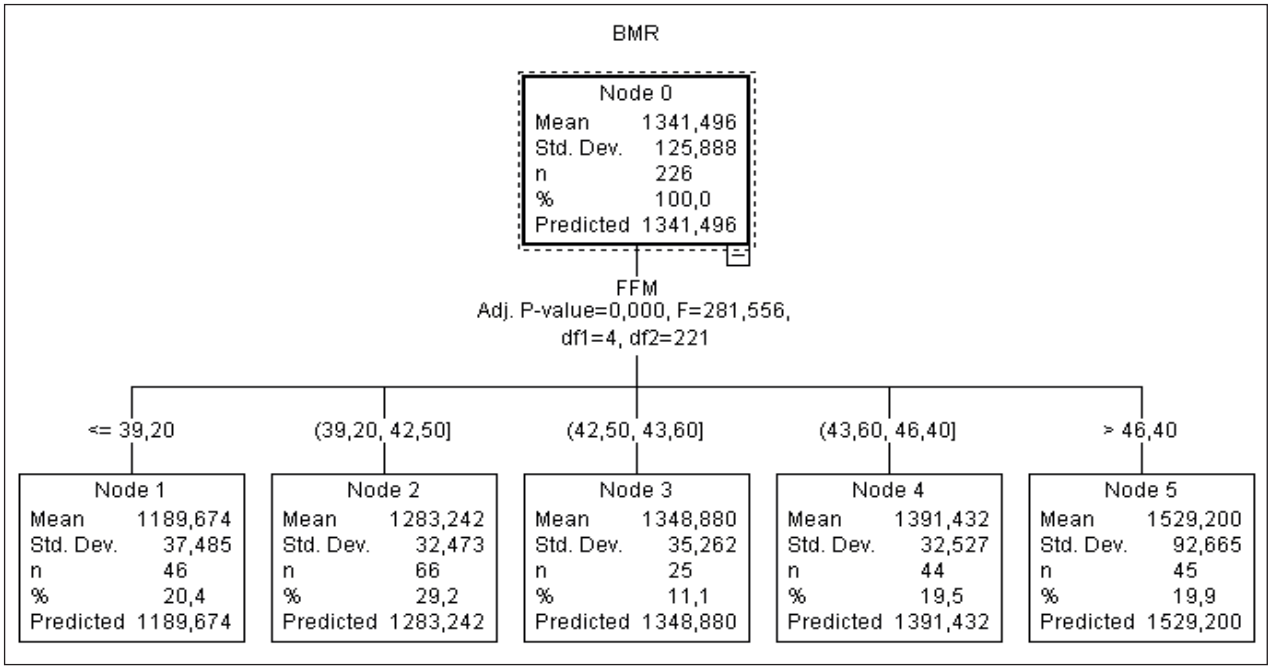

Figure 1. CHAID analysis results for women

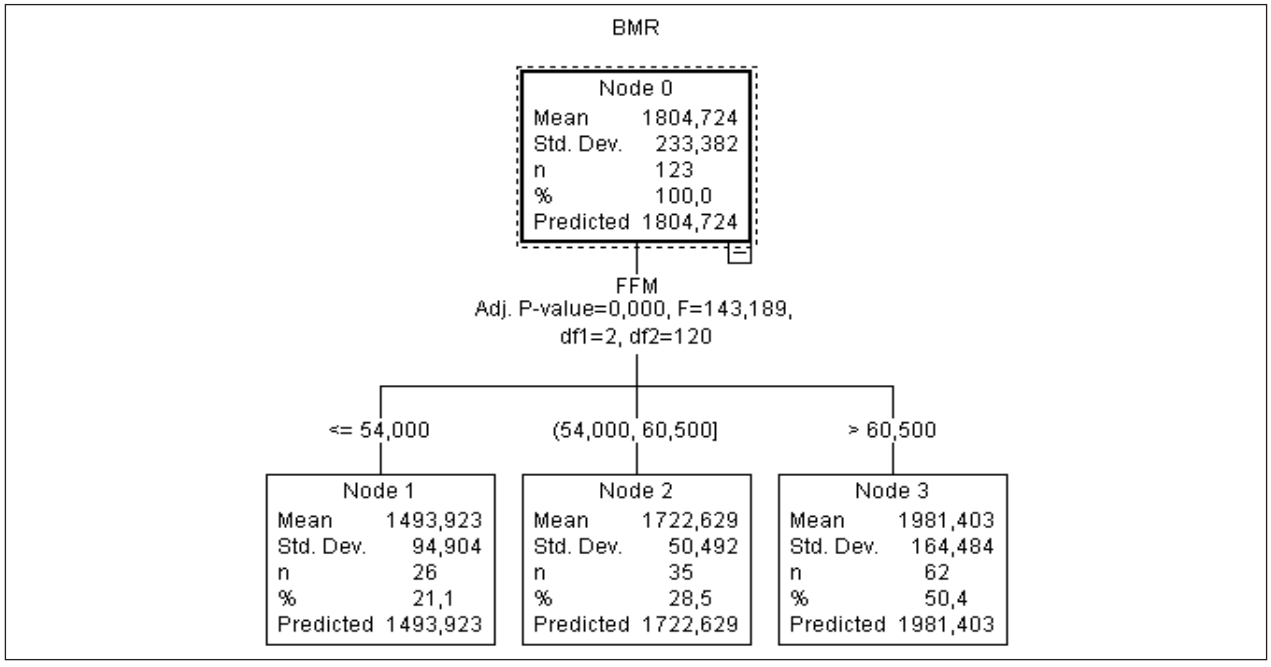

Figure 2. CHAID analysis results for men

were between the ages of 18-30. Thus, individual and environmental factors that may affect the BMR were brought under control. However, the stress, diet, and thyroid hormones that we cannot control can also cause changes in the BMR of the participants. Therefore, it can be said that the unexplained percentages of BMR changes in the model are caused by stress, diet, and thyroid hormone levels.

As a result, it was determined that the most important component affecting BMR in young adult women and men was FFM. It was determined that the BMR increased as the FFM ratio in the body increased. 83.91% of BMR changes in women and 70.39% of men were explained through FFM. In future researches, the examination of the levels of stress, diet, and thyroid hormones and the effect of body components on the BMR using CHAID analysis will contribute to the sports and health field.

Conflict of interest

The authors declare that there is no conflict of interest in this manuscript.

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Original article

Effect of Alkaline Diet with 8-week Step Aerobic Exercise on Body Composition and Aerobic Exercise Performance of Sedentary Women

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Summary. *Study Objectives:* The aim of this study was to investigate the effect of an alkaline diet with step aerobic exercises for 8-week in sedentary women on their body composition and aerobic exercise performances. *Methods:* 22 sedentary women (age = 49.18 ± 6.28) voluntarily participated in the study (n = 11 alkaline diet group; n = 11 acidic diet group). Alkaline diet and acidic diet programs were applied to the sedentary women together with step aerobic exercises for 8 weeks. This research was designed as a randomized controlled trial model. Body composition (total body weight, fat mass, and free-fat mass), aerobic exercise performance indicators (Bruce treadmill test, lactate accumulation, estimated VO_{2Max}, and rating of perceived exertion) were measured before and after diet and exercise programs. *Results:* The results of the body weight, fat mass, lactate accumulation, and rating of perceived exertion levels of the group consuming an alkaline diet together with the eight-week step aerobic exercises showed a higher decrease and aerobic exercise performance duration and VO_{2Max} levels indicated a higher increase than acidic diet group. *Conclusion:* The alkaline diet with reduced acid value together with 8-week step aerobic exercises in sedentary women, has a high rate of positive effects on body composition and aerobic exercise performances.

Key words: Alkaline Diet, Aerobic Exercise performance, Body Composition, Lactate accumulation, Rating of Perceived Exertion

Introduction

In order for organisms and cells to survive in the world for a long time, the pH value of the environment they live in must be appropriate. This value should be at pH 7.4 (7.35-7.45) alkaline level in human serum (1). With the development of industrialization in the last 100 years, the amount of CO_2 in the universe has increased and the pH level in the oceans has decreased from 8.2 to 8.1 (2). This drop in the pH of the oceans results in the disappearing of coral reefs and negatively affecting the mineral content of the plants grown in the soil (3). The pH value in the human body consists of numerical values between 1 (most acidic) and 14 (most basic); While pH 7 is neutral, the optimal pH in the blood is slightly alkaline in the range of 7.2-7.4. Even if the pH range in the blood drops in a very low rate of 0.2 units towards the acidic level, the pH takes minerals from the blood to reach the neutralized level (4). While diet types and exercises positively affect the body's acid-base balance, this interaction also increases the efficiency of exercise (5). Today's modern western diets have an acidic diet feature (6), and mostly consist of animal foods with high protein, high fat, high

cholesterol content and fall into a diet type including fewer vegetables and fruits are consumed (7). Disruption of the acid-base balance of the body is directly related to universal diseases such as metabolic acidosis, obesity, diabetes, cardiovascular diseases (8,9).

The basic nutrients are divided into two as acidic and alkaline (basic). Alkali foods contain potassium (K), magnesium (Mg), iron (Fe), and manganese (Mn), while acidic foods mostly contain sulfur (S), phosphorus (P) and copper (Cu) (10). Alkaline foods are balanced with acidic foods, but most people do not prefer alkaline foods and not participate in activities such as exercises to cope with stress and to reduce acidosis (8). Apart from exercise, the alkalinity of the body is provided by electrons, and the important sources that provide these electrons are seeds, spices, vegetable oils, vegetables, fruits, and fish containing healthy oils, alkaline water and clean oxygen (11). Vegetable proteins are richer than animal proteins in terms of glutamate and neutralize hydrogen ions, while animal proteins and grains increase the body's acidic ratio due to the amino acids such as methionine, homocysteine, and cysteine (6). In general, the alkaline diet aims to increase consumption of whole grains, fruits, and vegetables, which are accepted as basic foods and reduce fried and processed foods (animal and dairy products, eggs), which are accepted as acidic foods (4). By increasing the alkaline (basic) environment with an alkaline diet, it contributes to the reduction of protons in the acidic environment and the reduction of acidosis occurring in the muscles throughout the exercise and thus contributing to the development of aerobic exercise performance (5). In addition, aerobic exercises increase the blood circulation of the muscles and remove acids from our cells and benefit the alkalization of the body (9).

Although acid-base balance plays a major role in nutrition and exercise, there are limited studies in the literature that investigate the effect of diets containing alkaline or acidic foods on performance components (2,4,12). Ball et al. (13) reported that a diet containing high acid (high-PRAL), low carbohydrate, high fat, and high protein decreased performance capacity in exercises. The acute study of Limmer et al. (2018) stated that the 4-day alkaline diet decreases 400-m sprint times in individuals who do active sports for moderate recreational purposes (14). Rios Enriquez et al. (2010) stated that the alkaline diet in combination with anaerobic exercises provides an improvement on exhaustion time (from 60 sec to 2 mins) in extreme anaerobic stress test to exhaustion (15). In a cross-study about High-PRAL (High-Potential Renal Acid Load) and Low-PRAL (Low-Potential Renal Acid Load) diets, Caciano et al. (2015) report that Low-PRAL diet increases anaerobic exercise performance by 21% (16).

When the experimental and review studies conducted in the literature are examined, it is seen that the Low-PRAL diets increase aerobic and anaerobic performances and also have positive effects on physiological parameters. However, they are mostly acute experimental studies and less chronic. Additionally, short-term diet programs have been applied in most of the previous researches. To strengthen the generalizations on this subject, further studies are required that investigate the chronic effects of the exercises with the long-term alkaline diet program. In this context, this study aimed to examine the effects of the 8-week alkaline diet together with the step-aerobic exercise on body composition and aerobic exercise performances.

Material and Method

Participants

The sample of the study initially consisted of 24 volunteer sedentary women. The study was completed with 22 sedentary women (age = 49.18±6.28) since 2 participants did not participate in post-test measurements during the research. All participants passed medical control before starting the research. Sedentary women who have not received any medication, skeletal-muscle system injuries, and moderately healthy women in the last six months have been included in the study. Also, it was questioned that the participants did not apply a personal diet program prepared by experts in the last six months. All participants were given detailed information about the content and purpose of the study by the researchers and an informed voluntary consent form was signed. Ethics committee approval was received for this research from Sakarya University of Applied Sciences with the number 26428519/044.

Experimental Design

A randomized controlled trial model was used to comparing the effect of two different diet types. The sedentary women were randomly divided into two as Low-PRAL (alkaline) and High-PRAL (acidic) diet groups. All participants were informed about diets but not hypotheses. At the beginning of the study, the body weight, fat mass, and free-fat mass of the sedentary women were measured with bioelectrical impedance analyzer and their aerobic exercise performances were determined using the Bruce treadmill test. During treadmill tests, lactate accumulation and Rating of Perceived Exertion (RPE) were measured for each session. After the first measurements, the participants performed to the step-aerobic exercises 3 times a week for 8 weeks. During the exercises, the subject groups applied their alkaline and acidic diets. At the end of the 8-week exercise and diet period, the tests applied in the first measurement week of the study were repeated as a post-test. During the tests, individuals were kept under control without much intervention to their normal diet and were warned not to consume any alcohol or energy drinks on the test days.

Collection of Data

Measurement of Body Composition

Body composition (body weight, fat mass, and free-fat mass) of the participants were measured with the bioelectric impedance analyzer TANITA BC-418 (Tanita Corp., Tokyo, Japan) when they hungry at the morning. All sedentary women were wearing only shorts and T-shirts during body composition measurements. From the body weights obtained, 250 g tare was removed for accurate estimation of body weight.

Sub-maximal Bruce Treadmill Test

Sub-maximal Bruce treadmill test was used to determine the aerobic exercise performances of the sedentary women. Because the participants were sedentary and their high average age a submaximal test was preferred. The test was performed on the treadmill in three-minute steps up to 85% of the participants' estimated age-based Maximum Heart Rate (HR_{Max}). Submaximal Bruce treadmill test starts at 2.7 km/h with a 10% incline after a general warm-up and increases speed and slope every 3 minutes. Bruce's treadmill test was finished when the heart rate of the participants' was reached 85% of the estimated HR_{Max}. The duration of the test was recorded and the estimated VO_2max was calculated by a formula using the test ending time (17). The sub-maximal heart rate (85% HR_{Max}) of the participants was calculated using the formula [208-(0.7 × Age) × 85%] (18). In the calculation of estimated VO_{2Max} (For women: Estimated VO_{2Max} = 4.38 x (Test duration) - 3.90) formula was used (19).

Calculation of Lactate Accumulation

To determine the blood lactate accumulation of the participants during the Bruce treadmill test, blood samples taken from the participants' fingers 1 min. before and after the test. Lactate accumulation level was calculated by subtracting before and after the lactate levels of the participants. In the last tests, lactate measurement was taken again at the same ending time of the participants as the first test. The lactate accumulation differences between the two measurements were analyzed. Blood lactate measurements were measured with Lactate Scout (LS, SensLab GmbH, Germany) brand lactate analyzer.

Determination of RPE

To determine the Session RPE (sRPE) scores of the participants during the Bruce treadmill test, the CR10 scale was used, developed by Foster, (1998). At the end of each minute of the test, participants were asked about the level of exertion on the scale, which depicts the perception of exertion between 0-10. The sRPE is calculated as the arbitrary unit by multiplying the RPE scores and the exercise duration (min) (20). In the pre and post-tests, sRPE scores were obtained for the two tests using the same method.

Dietary Intervention

The PRAL is a value that indicates the acid-base status of the nutrients we take by mouth after passing into the stomach (12,17). The protein content of

the PRAL formula is based on Cl^-, PO43–, SO42–, Na +, K +, Ca 2+, and Mg 2+ (21). The PRAL value of foods (mEq / 100 g) is calculated as: 0.49 × protein (g / 100 g) + 0.037 × phosphorus (mg / 100 g) - 0.021 × potassium (mg / 100 g) - 0.026 × magnesium (mg / 100 g) - 0.013 × calcium (mg / 100 g) (22). A German PRAL list published by the Institute for Prevention and Nutrition, Ismaning, Germany, was distributed to the participants (23). In the PRAL list, participants are given advice on how to make food alkaline or acidic.

The participants in the alkaline diet group consumed animal proteins like fish, chicken, and turkey meat for eight weeks in their main menu only three days a week (exercise days). They consumed animal proteins for breakfast seven days a week as curd cheese and powder egg white. For eight weeks, animal proteins were reduced and mostly vegetable proteins (soyabeans, lentils, beans, peas, chickpeas, etc.) were emphasized. The alkaline diet group, which is considered to be acidic drinks during the research, was not allowed to consume coffee, cola, milk, instant juices, and black tea for eight weeks, but herbal teas were allowed (green tea, white tea, fennel, mint-lemon tea, and rosehip). As a result, individuals in the experimental group kept animal proteins limited for eight weeks (fish, chicken and turkey meat, curd cheese, egg whites), mostly vegetable-fruit, starchy vegetables (sweet potatoes) vegetable oils (almonds, avocados, walnuts, nuts), dried fruits (black raisins, dried apricots, dried figs, dried dates).

Animal proteins were included in the diet programs of the acidic diet group for eight weeks every day of the week [only red meat, eggs, milk, yogurt, and cheese (cheddar, cream, and parmesan)]. In addition to consuming cereals (oats, bread, pasta, and rice), they were also allowed to drink black tea, coffee, milk, acidic drinks (e.g. cola), ready-made juices. High-sugar fruits and dried fruits were also included, and eight-week diet programs were completed for both groups.

Exercise Plan

In the study, the sedentary women participated in 90-min. step aerobic exercise programs for three weeks a week (Monday, Wednesday, Friday), between 10:00 and 12:00 a.m for 8 weeks. An exercise consisted of 4 phases. In the first phase of the exercise, subjects performed low-rhythm exercises without using a step board, and warm-up exercises involving aerobic movements along with heart rate controls with music for about 20 minutes (120-125 BPM). In the second phase, 10-minute dynamic stretching exercises were performed for the basic muscle groups. In the third phase, which is the main phase of the exercise, the basic movements (Basic step, Wide Step, Tap Up, Tap Down, Knee Up, Leg Curl, Leg Lif, Kick, Across The Top, Over The Top, Straddle Up-Down, Turn Step, Turn Travel Tip, A Step, L Step, T Step, Z Step, Corner To Corner, Reverse Step, Lunge, and Turn Mambo) of step aerobic exercise were performed at the speed of 130-135 BPM using a step board with a height of 70 cm, a width of 30 cm and a height of 10 cm. In the last phase of the exercise, 10 minutes of static flexibility exercises were applied for recovery and cool-down.

Statistical Analysis

IBM SPSS Statistics 24 package program was used to analyze the obtained data. Descriptive statistics of the obtained data were given as mean and standard deviation. Besides, a two-way repeated analysis of variance was used to determine the difference between the body composition, athletic performance, and biochemical parameters according to the time points (Pre-test and Post-test) of alkaline (Low-PRAL) and acidic (High-PRAL) diet types. Moreover, percentage differences of time points according to diet types were calculated with the formula "% Δ = (Post-test - Pre-test) / Pre-test *100". The confidence interval was chosen as 95% and values below $p < 0.05$ were considered statistically significant.

Results

When table 1 was examined, it was found that the pre-test and post-test averages of the body weight ($F=75.606$), fat mass ($F=58.935$), and free-fat mass ($F=9.285$) of sedentary women were statistically different according to the measurement times ($p < 0.01$). These results show that the decrease in body weight and the fat mass of sedentary women who consume

an alkaline diet with an eight-week step aerobic exercise was higher than women who consume an acidic diet. In addition, body weight, fat mass, and free-fat mass were not statistically different according to diet types (p> 0.05). Moreover, the interaction between diet types and measurement times for body weight (F = 10.514) and fat mass (F = 14.435) ratio was found to be statistically significant (p <0.01), whereas the interaction for the free-fat mass was not significant (p > 0.05). According to these results, it was seen that sedentary women who consume an alkaline diet have higher body weight (5.22%) and fat mass (10.90%) reduction than women who consume an acidic diet.

When Table 2 was examined, it was found that the pre-test and post-test averages of the Bruce treadmill test duration (F= 177.397), blood lactate level (F= 67.606), VO_{2Max} (F= 31.587), and sRPE (F= 80.234) of sedentary women were statistically different according to the measurement times (p <0.01). These results show that the increase in Bruce treadmill test duration and VO_{2Max} levels and the decrease in blood lactate level and sRPE of sedentary women who consume an alkaline diet with an eight-week step aerobic exercise was higher than women who consume an acidic diet. In addition, it was found that Bruce treadmill test duration, blood lactate, and VO_{2Max} levels were not statistically different according to diet types (p> 0.05), whereas the sRPE was statistically different (p <0.05). In addition, the interaction between diet types and measurement times for Bruce treadmill test duration (F = 51.747), blood lactate level (F = 43.667) and VO_{2Max} levels (F = 22.199), was statistically significant (p <0.01), whereas the interaction for sRPE (F = .180) was not significant (p> 0.05). According to these results, Bruce treadmill test duration (33.66%) and VO_{2Max} levels (35.67%) of sedentary women who consume an alkaline diet with eight-week step aerobic exercise increased, and blood lactate levels (81.71%) decreased.

Discussion

In this study, the effects of an alkaline diet with 8-week step aerobic exercises on body composition and aerobic exercise performances of sedentary women were investigated. According to the findings of the

Table 1. Comparison of variables related to body composition according to diet type and measurement times of sedentary women

Variables	Diet Type	N	Pre-test	Post-test	Total	%Δ	F	p
			$\bar{X}$± S.D.	$\bar{X}$± S.D.	$\bar{X}$± S.D.			
Body Weight kg	Alkaline (Low-PRAL)	11	78.48±14.32	74.38±12.93	76.43±13.63	-5.22	1.079	.311
	Acidic (High-PRAL)	11	84.39±17.99	82.52±17.67	83.46±17.83	-2.22		
	Total	22	81.44±16.15	78.45±15.67		Interaction		
			F= 75.606; p= .001**			F= 10.514; p= .004**		
Fat Mass kg	Alkaline (Low-PRAL)	11	30.55±8.98	27.22±8.52	28.89±8.75	-10.90	2.015	.171
	Acidic (High-PRAL)	11	36.00±12.68	34.87±12.49	35.44±12.58	-3.14		
	Total	22	33.28±11.08	31.05±11.15		Interaction		
			F= 58.935; p= .001**			F= 14.435; p= .001**		
Free-Fat Mass kg	Alkaline (Low-PRAL)	11	47.95±6.07	47.16±5.32	47.56±5.70	-	.001	.975
	Acidic (High-PRAL)	11	47.76±7.26	47.17±7.18	47.47±7.22	-		
	Total	22	47.85±6.53	47.17±6.17		Interaction		
			F= 9.285; p= .006**			F= .180; p= .676		

**p<0.01; $\bar{X}$: Mean; S.D.: Standard Deviation; PRAL: Potential Renal Acid Load

Table 2. Comparison of variables related to performance outputs according to diet type and measurement times of sedentary women

Variables	Diet Type	N	Pre-test	Post-test	Total	%Δ	F	p
			$\bar{X}$± S.D.	$\bar{X}$± S.D.	$\bar{X}$± S.D.			
Bruce Treadmill Test Duration min.	Alkaline (Low-PRAL)	11	9.21±1.29	12.31± .85	10.76±1.07	33.66	.030	.865
	Acidic (High-PRAL)	11	10.40±1.71	11.33±1.73	10.86±1.72	8.94		
	Total	22	9.81±1.60	11.82±1.42		Interaction		
			F= 177.397; p= .001**			F= 51.747; p= .001**		
Blood Lactate μL	Alkaline (Low-PRAL)	11	1.64± .64	.30± .25	.97± .45	-81.71	3.481	.077
	Acidic (High-PRAL)	11	1.54± .86	1.39± .85	1.46± .86	-9.74		
	Total	22	1.59± .68	.85± .83		Interaction		
			F= 67.606; p= .001**			F= 43.667; p= .001**		
VO_{2Max} ml.kg^{-1}.dk^{-1}	Alkaline (Low-PRAL)	11	37.34±5.75	50.66±3.48	44.00±4.62	35.67	.715	.408
	Acidic (High-PRAL)	11	45.12±7.15	46.29±5.43	45.71±6.29	2.52		
	Total	22	41.23±7.48	48.48±4.98		Interaction		
			F= 31.587; p= .001**			F= 22.199; p= .001**		
sRPE	Alkaline (Low-PRAL)	11	15.35±4.99	3.44±3.12	9.39±4.06	-	8.051	.010*
	Acidic (High-PRAL)	11	17.32±3.23	9.26±4.87	13.29±4.05	-		
	Total	22	16.34±4.23	6.35±4.98		Interaction		
			F= 80.234; p= .001**			F= 2.983; p= .100		

*p<0.05; **p<0.01; $\bar{X}$: Mean; S.D.: Standard Deviation; PRAL: Potential Renal Acid Load

study, it was found that the alkaline diet with step aerobic exercise provides a greater reduction in body weight and fat mass and less lactate accumulation as well as higher aerobic exercise time, the level of VO_{2Max} and reduction in the sRPE compared to the acidic diet.

In our study, it is observed that the alkaline diet with step-aerobic exercises provides a higher rate of decrease in total body weight and fat mass compared to the acidic diet in women (total body weight = 5.22%, fat mass = 10.90%). In the free-fat mass of sedentary women, no significant difference was found between diet types. Massiera et al. (2010) report that the Western-type diet causes a gradual increase in fat mass and thus the spread of obesity in humans (24). In contrast, the meta-analysis study of Ballor and Keesey (1991) states that aerobic exercises are effective on body mass, fat mass, and free fat mass values, and the numbers of the week and duration of exercise sessions can be important predictors especially in women (25). In the present study, the free-fat mass data which did not differ significantly (p> 0.05) could be accepted as an indicator that lean muscle mass is preserved. However, researchers state that physical activity, age, and protein intake, as well as long-term nutritional habits, are effective in preserving muscle mass (26, 27). In the literature, no longitudinal study investigating the effect of an alkaline diet with exercise on body composition parameters and comparing it with other diet programs has been encountered. Therefore, our findings indicated that the alkaline diet together with the aerobic exercise program was more effective than the acidic diet in reducing the total body mass and fat mass ratio.

When the physiological and psychological responses to Bruce treadmill test were analyzed, participants who were on an alkaline diet had a higher increase in test termination durations and estimated

VO_{2Max} data (test duration = 33.66% and VO_{2Max} = 35.67%), and a higher decrease in the level of lactate accumulation (blood lactate accumulation = 81.71%) than an acidic diet. A significant difference was found in the sRPE in terms of diet types ($p < 0.05$). In studies investigating the effect of diet-related acid load on performance during exercise, they assume that reducing the acid load of the diet and creating a more alkaline environment can increase the cleansing of protons and inhibitor molecules that affect muscles that perform during acid-induced acidosis, thereby improving aerobic and anaerobic exercise performance. However, the benefit of diets with a reduced acid load on performance has not been demonstrated (28). In the literature, different results have been reached in the studies investigating the effect of diets with the low acid load on performance. Greenhaff, Gleeson, and Maughan (1987) report that individuals who performed a 4-day low-protein and high-carbohydrate diet exhibit higher exhaustion times in their cycling test compared to those who applied high-protein and low-carbohydrate-acid diet (29). However, the study of Ball et al. (1996) state that the alkaline high carbohydrate diet does not increase the cycling test performance acutely compared to other diet types (13). Limmer et al. (2018) investigate the effect of short-term (4 days) alkaline and acidic diet on 400-meter sprint performance, blood lactate, blood gas parameters, and urine pH in adults with moderate exercise. They demonstrate that the alkaline diet improves 400 m sprint performance and increases the blood level of lactate concentration (14). When the studies examining the relationship between VO_{2Max} and alkaline diet are examined, the respiratory exchange ratio used in the correct determination of VO_{2max} is higher in Low-PRAL diets in treadmill tests (30,31).

Our findings indicated that the sRPE during exercise varied according to diet types, and the sRPE after the diet program was less in the applied test to the alkaline diet group. No study examined the sRPE, which is a valid subjective marker of internal load during exercise. Moreover, it is seen that the alkaline diet processes applied are short in the previous studies according to the relationship between alkaline diet and performance. The use of short-term diet programs and measurements on mainly anaerobic performance restricts the generalizations about the subject. Applegate et al. (2017) emphasize the lack of studies involving a long diet intervention program in the studies on the alkaline diet and suggest that further studies are required for investigating the efficacy of long diet programs (5). In this context, our findings will contribute to the literature by revealing the longitudinal results of the alkaline diet that includes a long diet program.

Conclusion

The results of this study reveal that the alkaline diet with aerobic exercises has a positive effect on the body composition and aerobic exercise performance of sedentary women. To increase the quality of life, it should be considered to choose alkali-derived diets instead of western diets that are high in acid density a diet with regular physical activities. Furthermore, more longitudinal studies involving long diet and exercise programs are needed to generalize the effects of low acid density alkaline diets on physical and physiological parameters.

Conflicts of interest

The authors declare that there is no conflict of interest in this manuscript.

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Original article

Investigating BMI, fatphobia and dietary habits of individuals going to the gym

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Abstract. *Study Objective:* The purpose of this study was to investigate BMI, fatphobia, and dietary habits of individuals going to the gyms. *Methods:* Samples of this study consisted of individuals who go to the gyms in Siirt province. The sample size consisted of 514 individuals (190 female, 324 male) who participated voluntarily in the study. A survey method was used as a data collection method in the study. To determining the fatphobia levels of participants, a 14 item scale developed by Scheltema and Robinson (2001) was conducted. Questions from the survey prepared by Ceylan (2017) were used for determining demographic attributes and dietary habits of participants. In the comparison of continuous data between two independent groups t-test was used and one way ANOVA test was used for comparison of continuous data between independent groups which are more than two. Scheffe test was used as a post-hoc analysis for determining the differences after the test Anova. Pearson correlation analysis was conducted between the continuous variables of the study. *Result:* As a result of the study, there was no significant relationship between BMI and fatphobia. However, when the differentiation status of BMI and fatphobia values according to their nutritional habits were observed, it was found that there was a significant difference in favor of those who exercise for weight loss ($p < 0.05$).

Key words: Sports, Body Mass Index(BMI), Fat Phobia, Diet, Dietary Habits.

Introduction

As a result of the developments in technology, machines have taken the place of the labor force and for this reason, people were exposed to an immobilized and sedentary lifestyle. With increasing age, many people with these sedentary lifestyles have come down with several diseases (1). Furthermore, developing technology affects the dietary habits of people in a negative way (2,3). For this reason, changing dietary habits made people gain a lot of weight. Particularly in developed and developing countries, obesity-caused physical and social problems have become a social issue. Today, excessive weight or obesity is known as one of the most important health issues. While an individual who has to maintain his/her life struggling with problems in the presence of obesity, he/she is obliged to cope with the psychological attitudes which society exhibits (4). An individual categorized as "obese" by society with an excessive weight gain find him/herself in a guilt feeling and each abstracted from society feel him/herself unhappy and drop psycho-socially, communicationally, physically, and culturally behind (5). Obese individuals are usually exposed to discrimination in various places, in many countries (6,7).

There are many factors in the etiology of obesity. Malnutrition and overnutrition, consuming high-calory meals, sedentary life-style, personality, age, genetics, hormonal imbalance, and factors like environmental, physiological, psychological, biochemical, socio-cultural, neurologic exist in the etiology obesity (4,8). This negative attitude exhibited towards those who have much bodyweight or obese is defined as fatphobia (9) and also it means fearing from being overweight pathologically, feeling antipathy against being overweight, and disliking being overweight (4).

Therefore obese individuals will have to tackle fatphobia. Almost in every study, it can be seen that obesity is directly associated with physical activity and diets. Once again emphasized the relationship between nutrition and physical activity, saying that physical performance can be improved with a balanced diet and that it may be adversely affected by malnutrition (10).

On the other hand, the World Health Organization (WHO); recommends the use of Body Mass Index in weight classification (11). Body Mass Index is used as a method to explore weight-height balance, fatness, leanness, malnutrition (12). Body Mass Index is a value calculated by dividing body weight to height square (kg/m^2) (13).

People feed themselves to supply the energy they need for their bodies and by taking all nutritional elements as body needs, i.e. if people spend all the energy they daily intake, and if energy taken is equal to energy spent there is no weight gain (14). Following that it is thought that people who regularly exercise spend the energy they took from their nutrition. Therefore, in this study, it was aimed to investigate BMI, fatphobia, and dietary habits of people who go to the gyms.

Material and Methods

Research Model

This research was a descriptive study aimed to reveal whether fatphobia and dietary habits change according to BMI, demographic characteristics of individuals who go to the gym in Siirt province. The research model was a causal-comparative model. The survey method is a general survey model mentioned in the literature and general survey model from case models. Also, it is a relational screening model among general survey models. Relational screening models aim to determine the presence of change or changing levels through correlation and comparison methods.

Table 1. Classification of the Body Mass Index (kg/m^2)

Lean	< 18,5
Normal	18,5-24,9
Overweight	25,0-29,9
Obese	≥ 30
Class 1	30,0 - 34,9
Class 2	35,0 - 39,9
Class 3 (morbid)	≥ 40

Reference: Ceylan, C. (2017) Master Thesis, Selcuk University

Participants

The research group consisted of 514 participants (190 female, 324 male) who go to the gym in Siirt province.

Data Collection

Fatphobia Scale and Dietary Habits questionnaire were used as data collection tools in research.

Dietary Habits Questionnaire

Nutrition questionnaire used in the research Dr. It was taken from the thesis titled "Determination of Nutritional Habits in Women Attending Sports Halls" prepared by Canan Ceylan (2017) (15). The questionnaire used contains 29 questions to determine the nutritional habits of the participants.

Fatphobia

The Fatphobia scale was used to determine the fatphobia of participants. The fatphobia scale first developed by Robinson, Bacon, and O'Reilly in 1993 with 50 items. Bacon, Scheltema, and Robinson developed a 14 item short version of this scale in 2001. Turkish adaptation was done in 2005 by Koçak, Saraç and Hürmeriç. The scale was given as a list and consisted of 14 items to determine the fat people item rating and the items were made according to the fivefold rating system. Numbers close to "5" represent a high-fat phobic attitude, and numbers close to 1 represents low fatphobic attitudes. Assessment in the fatphobia scale is made by dividing the total score obtained from 14 items to 14.

Statistical Analysis

The obtained data were analyzed by SPSS (Statistical Package for Social Sciences) for Windows 22.0 program. In this study, number, percent, mean and standard deviation were used for descriptive statistical methods. In the comparison of continuous data between two independent groups t-test was used and the One Way Anova test was used for comparison of continuous data between independent groups which are more than two. Scheffe test was used as a post-hoc analysis for determining the differences after the test Anova. Pearson correlation analysis was conducted between the continuous variables of the study.

Results

When we look at the age distribution of the participants, 269 (52.3%) are 21 and below, 245 (47.7%) are 22 and above. According to Body Mass Index values 31 (6,05%) of participants were lean, 296 (57,6%) were normal, 135 (26,3%) overweight, 40 (7,8%) Level 1 obese, 12 (2,3%) Level 2 obese. According to educational status, 15 (2,9%) of participants graduated from primary school, 76 (14,8%) graduated from high school, 308 (59,9%) bachelors, 115 (22,4%) graduated from graduate programs. According to monthly income 20 (3,9%) of participants earn 1000 Turkish Lira and below, 117 (22,8%) earn 1001-2000 Turkish Lira, 140 (27,2%) earn 2001-3000 TL, 237 (46,1%) earn 3001 TL and above. According to days in a weekly going to gym 181 (35,2%) participants went to the gym 1 day, 228 (44,4%) 2 days, 105 (20,4%) 3 days. According to membership duration to the gym were as 121 (23,5%) 0-2 month, 144 (28,0%) 3-5 months, 177 (34,4%) 6-7 months, 72 (14,0%) 8 months and above (Table 2).

Participants "body mass index" and "fat phobia" were determined as $\bar{x}$ = 24,27±5,02 (Min = 15,57; Max = 72,00), $\bar{x}$ = 3,33±0,67 (Min = 1,57; Max = 5,00), respectively (Table 3). When correlation analysis was investigated between BMI and fat phobia no relation was found (p>0,05, r=-0,018).

Table 2. Frequency and Percent Distributions Related to Demographic Properties of Participants

Groups	Frequency (f)	Percent (%)
Age		
21 and below	269	52,3
22 and above	245	47,7
Gender		
Female	190	37,0
Male	324	63,0
Body Mass Index		
Lean	31	6,0
Normal	296	57,6
Overweight	135	26,3
Level 1 Obese	40	7,8
Level 2 Obese	12	2,3
Educational Status		
Primary	15	2,9
High School	76	14,8
Bachelors/University	308	59,9
Graduate	115	22,4
Monthly Income		
1000 TL and below	20	3,9
1001-2000 TL	117	22,8
2001-3000 TL	140	27,2
3001 TL and above	237	46,1
How Many Days They Go to the Gym in a Week		
1 Day	181	35,2
2 Days	228	44,4
3 Days	105	20,4
Gym membership duration		
0-2 Month	121	23,5
3-5 Month	144	28,0
6-7 Month	177	34,4
8 Month and above	72	14,0

Table 3. Body Mass Index, Fat Phobia Levels, Mean and Correlation

	N	Mean	Sd	Min	Max	r	p
BMI	514	24,27	5,02	15,57	72,00	-0,02	0,68
Fat Phobia	514	3,33	0,67	1,57	5,00		

Table 4. Changing Status of BMI and Fat Phobia Values According to Dietary Habits

Demographic info	n	Body Mass Index	Fat Phobia
Dietary Style		**Mean ± Sd**	**Mean ± Sd**
Family	343	24,45 ± 5,44	3,35 ± 0,69
Diet Books	19	23,41 ± 5,04	3,35 ± 0,76
Visual and Written Media	81	24,32 ± 3,93	3,31 ± 0,56
Doctor and Dietitian	71	23,57 ± 3,90	3,27 ± 0,64
F =		0,78	0,32
p =		0,50	0,81
Morning Breakfast Preference		**Mean ± Sd**	**Mean ± Sd**
Tea, Cheese, Olive, Egg Etc.	425	24,32 ± 5,09	3,34 ± 0,69
Tea, Pastry, Toast, Bagel, etc.	39	25,02 ± 5,01	3,333 ± 0,55
Only Beverage	7	22,57 ± 3,09	3,265 ± 0,48
Cereal with Milk	32	23,87 ± 5,07	3,35 ± 0,56
Other	11	21,90 ± 2,50	2,96 ± 0,43
F =		1,08	0,91
p =		0,37	0,46
Regular Lunch Eating Status		**Mean ± Sd**	**Mean ± Sd**
Yes	228	23,90 ± 4,32	3,33 ± 0,70
No	286	24,56 ± 5,50	3,33 ± 0,64
t =		-1,48	0,02
p =		0,14	0,99
Lunch Preference		**Mean ± Sd**	**Mean ± Sd**
Meals Contrainin Red Meat	100	23,77 ± 4,12	3,29 ± 0,57
Table D'hote (Legume Family, Chickpea, Bean, Lentil)	220	24,42 ± 4,89	3,36 ± 0,70
Fast Food (Hamburger, Pizza, Döner Kebab Sandwich, Meatball Sandwich, etc.)	116	24,74 ± 6,16	3,313 ± 0,73
Fries, Sandwich, etc.	37	23,35 ± 4,76	3,409 ± 0,58
Salads	41	24,12 ± 4,34	3,303 ± 0,61
F =		0,88	0,32
p =		0,48	0,87
Dinner Preference		**Mean ± Sd**	**Mean ± Sd**
Meat (Boiled Beef, Saute, Grill, etc.)	310	24,62 ± 5,31	3,34 ± 0,63
Fast Food (Hamburger, Fries, Döner Kebab Sandwich, Meatball Sandwich, Bagel etc.)	29	23,93 ± 4,53	3,44 ± 0,86
Vegetable Dish	161	23,69 ± 4,61	3,31 ± 0,69
Pastry	14	23,89 ± 3,14	3,21 ± 0,63
F =		1,29	0,49
p =		0,28	0,69
Family Attitudes Towards Red Meat		**Mean ± Sd**	**Mean ± Sd**
Good	390	24,24 ± 5,25	3,36 ± 0,66
Less is Good	100	24,35 ± 4,35	3,24 ± 0,69
Must eat every day	24	24,36 ± 3,73	3,37 ± 0,71
F =		0,02	1,21
p =		0,98	0,30

View on Red Meat		**Mean ± Sd**	**Mean ± Sd**
Good	372	24,03 ± 4,16	3,35 ± 0,66
Less is good	125	25,01 ± 7,07	3,30 ± 0,68
Must eat every day	17	24,07 ± 3,68	3,09 ± 0,68
F =		1,80	1,44
p =		0,17	0,24
Daily Meat Consumption		**Mean ± Sd**	**Mean ± Sd**
25 Gr	187	24,15 ± 5,65	3,28 ± 0,69
50 Gr	155	24,23 ± 4,38	3,34 ± 0,66
100 Gr	113	24,46 ± 5,26	3,44 ± 0,67
100 Gr and above	59	24,38 ± 4,02	3,27 ± 0,53
F =		0,11	1,48
p =		0,96	0,22
Red Meat Consumption Whole Family		**Mean ± Sd**	**Mean ± Sd**
1-2 Kg	111	23,35 ± 4,29	3,34 ± 0,72
3-5 Kg	160	24,23 ± 4,36	3,29 ± 0,62
6-8 Kg	157	24,27 ± 5,08	3,39 ± 0,71
10 Kg and above	86	25,53 ± 6,51	3,29 ± 0,58
F =		3,09	0,72
p =		**0,03**	0,54
PostHoc=		4 > 1 (p<0.05)	
Number of Family Members		**Mean ± Sd**	**Mean ± Sd**
3	115	24,64 ± 4,66	3,32 ± 0,64
4	138	23,85 ± 4,00	3,36 ± 0,72
5	151	24,79 ± 6,44	3,38 ± 0,67
6 and above	110	23,68 ± 4,18	3,25 ± 0,61
F =		1,58	0,85
p =		0,19	0,47
Night Eating Habit		**Mean ± Sd**	**Mean ± Sd**
I often eat at night	77	25,13 ± 6,94	3,26 ± 0,67
Sometimes I eat at night	224	24,06 ± 4,28	3,39 ± 0,67
I don't eat at night	213	24,17 ± 4,90	3,30 ± 0,66
F =		1,37	1,48
p =		0,26	0,23
Daily Water Drunk Per Glass		**Mean ± Sd**	**Mean ± Sd**
1-5	126	24,32 ± 6,04	3,29 ± 0,64
6-10	254	23,99 ± 4,85	3,36 ± 0,67
10 above	134	24,74 ± 4,22	3,33 ± 0,69
F =		0,97	0,44
p =		0,38	0,65

Previous Diet Status		**Mean ± Sd**	**Mean ± Sd**
Yes	258	24,53 ± 4,03	3,34 ± 0,65
No	256	24,00 ± 5,84	3,32 ± 0,68
t =		1,18	0,32
p =		0,24	0,75
Exercise Participation Status		**Mean ± Sd**	**Mean ± Sd**
I do exercise regularly	233	24,22 ± 4,83	3,32 ± 0,65
Sometimes I do Exercise	269	24,40 ± 5,25	3,34 ± 0,68
I never do exercise	12	22,18 ± 2,73	3,39 ± 0,66
F =		1,15	0,10
p =		0,32	0,91
Purpose of Doing Exercise		**Mean ± Sd**	**Mean ± Sd**
For Weight Gain	14	22,05 ± 2,96	3,35 ± 0,58
For Losing Weight	248	24,99 ± 4,84	3,34 ± 0,69
For Keeping it Fit	182	23,63 ± 5,45	3,33 ± 0,64
For Health Issues	37	24,38 ± 4,92	3,34 ± 0,64
Other	33	23,09 ± 3,78	3,23 ± 0,66
F =		3,24	0,20
p =		**0,01**	0,94
PostHoc =		2 > 1, 2 > 3, 2 > 5 (p<0.05)	
Regular Physical Activity Participation Status		**Mean ± Sd**	**Mean ± Sd**
Yes	325	24,22 ± 5,29	3,33 ± 0,66
No	189	24,33 ± 4,52	3,32 ± 0,67
t =		-0,23	0,18
p =		0,82	0,86
Physical Activity Frequency		**Mean ± Sd**	**Mean ± Sd**
Everyday	57	22,69 ± 3,37	3,26 ± 0,68
3-4 Days in A Week	117	24,27 ± 5,63	3,32 ± 0,66
2-3 Days in A Week	122	24,77 ± 5,81	3,37 ± 0,63
1-2 Days in A Week	29	24,75 ± 4,25	3,40 ± 0,76
F =		2,14	0,45
p =		0,10	0,72
Minimum 30 Min. in A Week Physical Activity Status		**Mean ± Sd**	**Mean ± Sd**
Yes	313	24,13 ± 5,34	3,30 ± 0,66
No	64	23,64 ± 3,81	3,37 ± 0,73
Sometimes	137	24,86 ± 4,72	3,38 ± 0,63
F =		1,57	0,88
p =		0,21	0,42
Reason For Going to The Gym		**Mean ± Sd**	**Mean ± Sd**
For Losing Weight and Maintaining My Weight	141	24,26 ± 4,15	3,38 ± 0,75
Other Reasons	373	24,26 ± 5,31	3,31 ± 0,63
t =		-0,02	1,15
p =		0,99	0,29

Seeing Him/Herself Very Fat Status		**Mean ± Sd**	**Mean ± Sd**
Yes	207	24,92 ± 4,23	3,34 ± 0,70
No	307	23,82 ± 5,44	3,32 ± 0,64
t =		2,44	0,40
p =		**0,02**	0,69
Desire For Losing Weight		**Mean ± Sd**	**Mean ± Sd**
Yes	361	24,67 ± 4,80	3,33 ± 0,68
No	153	23,31 ± 5,38	3,33 ± 0,61
t =		2,82	-0,11
p =		**0,01**	0,91
Diet Status Last One Month		**Mean ± Sd**	**Mean ± Sd**
Yes	207	24,72 ± 5,05	3,38 ± 0,69
No	307	23,95 ± 4,97	3,30 ± 0,64
t =		1,70	1,40
p =		0,09	0,16

BMI, fatphobia scores of participants were not statistically significant differences according to dietary style variable, morning breakfast preferences, dietary style, morning breakfast preference, regular lunch eating status, lunch preference, dinner preference, family attitudes towards red meat, view on red meat, daily meat consumption, number of family members, night eating habit, daily water drunk per glass, previous diet status, exercise participation status, regular physical activity participation status, physical activity frequency, minimum 30 min. in a week physical activity status, the reason for going to the gym, diet status last one month ($p > 0.05$).

On the other hand, BMI of the participants, in the scores of fatphobia; As a family, in the consumption of RED meat; BMI scores of the participants differ significantly as a family of red meat consumption variable ($F = 3,09$; $p = 0.03 < 0.05$). The reason for the difference is that the BMI scores of those who consume red meat as a family of 10 kg and above are higher than the BMI scores of those who consume red meat as a family as 1-2 kg ($p < 0.05$). The scores of the participants did not differ significantly according to the red meat consumption variable as a family ($p > 0.05$).

BMI scores of the participants differ significantly according to the purpose of sports ($F = 3,24$; $p = 0.01 < 0.05$). The reason for the difference is that the BMI scores of those who aim to lose weight are higher than the BMI scores of those who aim to lose weight ($p < 0.05$). Besides, the purpose of doing sports is to keep my BMI scores for those who lose weight and maintaining my fitness form and other ones are higher than the BMI ($p < 0.05$).

BMI scores of the participants differ significantly according to the variable of finding themselves overweight. BMI scores ($\bar{x} = 24,92$) of those who found themselves overweight were found higher than BMI scores ($\bar{x} = 23,82$) of those who did not find themselves overweight ($t = 2,44$; $p = 0.015 < 0.05$).

BMI scores of the participants differ significantly according to the desire to lose weight variable. BMI scores (= 24,67) of those who want to lose weight were higher than those who did not want to lose weight ($\bar{x} = 23,31$) ($t = 2,82$; $p = 0.005 < 0.05$).

Discussion and Conclusion

When looking at the results of this study, it can be seen that there is no relation between BMI and fatphobia. Besides when changing status of values of BMI, fatphobia according to dietary habits; while there was no statistically significant difference in dietary style, morning breakfast preference, regular lunch, and dinner eating, family individual number, eating at night habit, water amount took a day, previous diet status, exercise

participation status, frequency of regular physical activity, the reason of going to the gym and desire for losing weight variables ($p>0.05$), there were statistically significant differences in 10 kg and above meat consumption of all family and those who do exercise for losing weight ($p<0.05$). It is possible to discuss these findings in two ways. First is the status of individuals who had low BMI which fatphobia levels of lean individuals were high, this may show that lean individuals may have negative attitudes towards fat people. The second one is the status of individuals who had high BMI having low or high fatphobia levels; in this case, fat individuals may have negative attitudes towards both lean and other fat individuals. In either case, mentioned, the characteristics of these individuals will play an important role. When viewed from this aspect BMI was expected to associate with fatphobia. Negative attitudes towards overweight people create a discussion platform almost in the country in the world (4). Although an association determined in literature parallel with that in this study having seen no association between BMI and fatphobia can be suggested as a contradicting result to other research in literature. It is possible to say that this situation may arise from the socio-economic and sociocultural status of the sample and population. Today, it is a fact that sedentary individuals have a higher BMI, in other words, they become overweight and obese. However in this study participants distributed as 6.0% lean, 57% normal, 26.3% overweight, and 10.1% obese. Therefore it can be suggested that because there were a lot of normal individuals in research can be shown as a cause of not being able to find such an association. As mentioned above, when we look at BMI, fatphobia, and dietary habits of participants, there were statistically significant differences in red meat consumption in all families and doing exercise variables. When we look at these dietary habits of participants they show protein-based diet habits and this shows that they intend to lose weight. Also, determining a significant difference in who had the desire to lose weight in doing exercise purpose variable supports this idea. When we look at literature; Harrisi Sandoval and Cortese (1998) they found that participants had negative attitudes towards both individuals who had mid-level weight and their weight levels (16). Besides, Poon and Tarrant (2009) in their study, the attitudes of student nurses and serving nurses towards individuals who had been taking obesity treatment were examined. According to this research reveals a mid-level fatphobia, and nurses were seen to have neutral attitudes towards obese individuals (17). On the other hand, Chambliss, Finley and Blair (2004) made a research on attitudes of students working in the exercise field towards overweight individuals. And their study revealed that determined that these participants had very negative attitudes towards overweight individuals (18).Consequently, as can be seen, fatphobia levels of individuals or social groups or having negative attitudes towards overweight people show the difference. That means their attitudes may change. However in this study, as can be understood from research; finding, and literature, individuals who had the idea of losing weight had significant differences in their fatphobia levels. There were no significant differences with other variables in the study. Also, there was no significant relationship between BMI, fatphobia, and dietary habits.

Conflicts of interest: The authors declare that there is no conflict of interest in this manuscript.

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Original article

Monitoring the skeletal ,muscle damage marker levels of elite mountain bikers during official mountain marathon

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Abstract. *Study Objectives:* The purpose of the present study was to monitor the levels of skeletal muscle damage of elite mountain bikers during the official mountain marathon. *Methods:* The study group consisted of 12 male elite mountain bikers. The implementation of the study was performed during the official 6th International Manavgat Mountain Biking competition on 01.04.2018 in the Manavgat District of Antalya. The blood samples of the athletes were taken before the competition, immediately after the competition, 24 hours, 48 hours, and 72 hours after the competition, The descriptive statistics were given as mean, standard deviation, and minimum and maximum values. The normality test of the data was checked with the Shapiro-Wilk Test. The Friedman Test was preferred among non-parametric tests for repeated measurements in the analysis of the data that did not have normal distribution. The Dunn' Post-Hoc Test was used to determine the source of the differences between measurement times. *Results;* According to the results, it was determined that there were statistically significant difference between skeletal muscle damage markers according to measurement times. *Conclusion:* As a result, it may be speculated that the competition setting is a marker of skeletal muscle damage in elite mountain bikers. Among the bio-motoric characteristics, endurance is important in elite mountain bikers, as a characteristic of their branches, long-term exercise cause that they use heart beat at a maximum level; and therefore, it can be argued that this prepares the ground for skeletal muscle damage marker.

Key words: Mountain Bicycle, Competition Setting, Skeletal Muscle Damage

Introduction

Today, the post-exercise muscle damage marker attracts the attention of many scientists, and many studies are being conducted on this. As a result of these studies, several pharmacological agents are recommended to avoid muscle damage. The post-exercise muscle damage marker also attracts the attention of those who receive physical therapy due to various diseases, those who do sports due to cardiovascular diseases, in other words, those who do sports for health purposes, and trainers who prepare exercise programs. Studies in the literature, it was seen that a muscle damage marker occurs in the structure of the muscle because of the type and nature of the exercise, and the myocardial muscle causes similar wear and tear to infarction (1-3).

In the literature, many studies have been conducted and techniques have been determined for the detection of skeletal muscle damage. The first method is imaging techniques (Magnetic Resonance Imaging (MRI), Micrography, Electron Microscope, Ultrasonography), and structural changes in the histological appearance of myofibrils can be used

as indicators of muscle damage, but these methods are both expensive and difficult to apply to the area. At the same time, the biopsy technique is used as the second method for the detection of muscle damage. However, differences arising from biopsy techniques may affect the results. The third method is based on the determination of serum-specific enzyme activities in serum levels (4).

The damage to the muscle after exercise is also called "Adaptive Microtrauma" in the sports sciences field and is investigated a lot in exercise physiology studies (5). Although skeletal muscle damage marker is related to the intensity and volume of exercise, it is more pronounced after an unusual exercise. It was determined that even a single exercise protocol plays protective roles against muscle damage that would occur after exercise in the same severity or after a heavier exercise. Considering the effective renewal process and the protection of exercise after muscle damage marker caused by exercise, it may be considered that muscle damage is inevitable in terms of adaptation to training (6).

Contraction, in which muscle damage is observed more severely, is the eccentric contractions. The damage mechanism after unconventional eccentric muscle contraction is triggered by mechanical and chemical factors. Eccentric muscle contractions are those with negative character (i.e. climbing stairs, running down a hill, etc.) where muscle size grows. The first signs of damage immediately after eccentric exercises are reduction in strength and loss of function. The pain peaks at the 24-48th hours after exercise. Concrete muscle damage findings in humans were determined as a result of the biopsy on the soleus muscle on the 2nd and 7th days after exercise (7). In this context, the purpose of the present study was to monitor the skeletal muscle damage marker levels of elite mountain bikers during official mountain marathons.

Material and Method

Participants

A total of 12 licensed male mountain bikers were included in the study; however, since the Creatine Kinase (CK) level was over 1000 U/L (hyper-responder) in one individual, the relevant data were not included in the study and were accepted as lost data, and the study was continued with 11 mountain bikers (8).

Competition Protocol

The implementation of the study was performed during the official 6th International Manavgat Mountain Biking competition on 01.04.2018 in the Manavgat District of Antalya. The competition track consisted of 90 km, which was completed by the athletes between 3.30 and 4.00 hours. Two of the competitors who were included in the study showed high performance at the marathon and ranked among the first 3.

Body Weight and Height Measurement

A SECA-brand electronic scale with a sensitivity of 0.5 kg was used to weigh the participants with barefoot when there were only shorts and t-shirts on them. The heights were measured with a SECA-brand height scale with a sensitivity of 0.1 m.

Muscle Damage Measurement

The blood samples of the athletes who were included in the study group were taken before the competition, immediately after the competition, 24 hours, 48 hours, and 72 hours after the competition, as 10 ml blood from the forearm vein by a specialist nurse, and were kept at biochemistry tubes containing sodium fluoride. The blood samples were left to rest for 30 minutes, centrifuged in cooled centrifuge device for 5 min at 4000 rpm, and the serums obtained were divided into 3 Eppendorf Tubes for analysis of biochemistry profiles. The samples were stored at -80^{o}C until analyses.

All parameters (Creatine Kinase (CK), Creatine Kinase -Miyokardiyal Band (CK-MB), Lactate Dehydrogenase (LDH), Myoglobin (MYB), Blood Lactate (LA)) were analyzed at the Medical Biochemistry laboratory of Suleyman Demirel University Faculty of Medicine. CK, CK-MB, LDH, LA enzymes were analyzed with the Spectrophotometric Method (Beckmann Coulter AU 5800) in biochemistry autoanalyzer, and the Electrochemiluminescence Method (ECLIA) Method was used in MYB Hormone Autoanalyzer

(Roche Cobas, 660). Approval was obtained for the study from the Ethics Board of Suleyman Demirel University, Faculty of Medicine.

Statistical Analysis

The descriptive statistics were given as mean, standard deviation, minimum, and maximum values. The normality test of the data was checked with the Shapiro-Wilk Test ($p < 0,05$). The Friedman Test was preferred among non-parametric tests for repeated measurements in the analysis of the data that did not have normal distribution. The Dunn' Post-Hoc Test was used to determine the source of the differences between measurement times. The significance level was taken as $p < 0.05$.

Results

The demographical characteristics of the elite mountain bikers who participated in the study are given in Table 1. In this respect, mean height value was 1.72 ± .07 m, mean body weight was 64.90 ± 6.84 kg, mean age was 22.36 ± 2.57 years, and mean sports age was 7.27 ± 2.37 years.

Table 1. Demographic characteristics of the athletes

Variables	N	Minimum	Maximum	$\bar{X}$ ± SD
Height (cm)	11	1.60	1.84	1.72 ± .07
Body weight (kg)		56.00	78.00	64.90 ± 6.84
Age (years)		19.00	28.00	22.36 ± 2.57
Sports Age (years)		4.00	11.00	7.27 ± 2.37

The differences in the measurement times of CK, CK-MB, LDH, MYB, LA levels of the elite mountain bikers who participated in the study are given in Table 2. In this respect, it was determined that although there were differences between the CK levels 24 hours after the competition and the values before the competition and 72 hours after the competition ($p < 0.05$), there were no differences among other times ($p > 0.05$). Significant differences were detected among CK-MB levels immediately after the competition and the values 72 hours after the competition ($p < 0.05$); however, there was no difference among other times ($p > 0.05$). Although there was a significant difference among the values measured immediately after the competition and the values at the 24th, 48th, and 72nd hours after the competition ($p < 0.05$), it was determined that there was no difference among other times ($p > 0.05$). Although it was determined that there was a difference between the MYB levels immediately after the competition and at the 24th and 72nd hours after the competition ($p < 0.05$), it was found that there was no difference among other times ($p > 0.05$). There was a significant difference between the LA values measured immediately after the competition and the values at the 24th and 72nd hours after the competition ($p < 0.05$); however, it was determined that there was no difference among other times ($p > 0.05$).

Table 2. Descriptive statistics of the biochemical parameters of the athletes by measurement times

Measurement Times	CK $\bar{X}$ ± SD	CK-MB $\bar{X}$ ± SD	LDH $\bar{X}$ ± SD	MYB $\bar{X}$ ± SD	LA $\bar{X}$ ± SD
Before competition	160,12 ± 90,72^{b}	9,62 ± 4,05^{b}	183,85 ± 28,00^{ab}	24,23 ± 5,57^{b}	33,99 ± 11,26^{ab}
Immediately after competition	214,28 ± 92,47^{ab}	17,08 ± 5,56^{a}	292,50 ± 76,33^{a}	145,69 ± 154,06^{a}	63,40 ± 21,93^{a}
24 hours after competition	326,69 ± 215,72^{a}	13,51 ± 10,60^{ab}	182,80 ± 32,99^{b}	27,07 ± 8,09^{b}	24,96 ± 5,66^{b}
48 hours after competition	221,36 ± 102,33^{ab}	11,87 ± 7,85^{ab}	183,26 ± 28,14^{b}	32,70 ± 14,15^{ab}	38,10 ± 34,71^{ab}
72 hours after competition	156,57 ± 62,16^{b}	9,37 ± 8,78^{b}	168,60 ± 14,05^{b}	25,27 ± 8,24^{b}	20,81 ± 4,88^{b}
N (11)	< 190 (U/L)	< 24 (U/L)	< 248 (U/L)	28-72 (ng-ml)	4,5-19,8 (mg-dl)
X^2	19,127	16,727	19.127	20,143	22,327
p	0,001**	0,002**	0,001**	0,001**	0,001**

**p < 0,01; ab: Different letters represent the differences between the groups.

Discussion and Conclusion

Based on the results of the differences in skeletal muscle damage marker CK level measurements, it was found that there were differences between the CK levels 24 hours after the competition, and the values before the competition and 72 hours after the competition ($p < 0.05$); and there were no differences among the measurements made at other times ($p > 0.05$). As a result of the study, it was determined that the competition effected on CK levels. It is considered that the reason why CK levels returned to normal 72 hours after the competition was the recovery of the competitors.

Studies in the literature, it was reported that CK amounts reach the highest level 1-5 days after exercise. In a study conducted by Vincent (1997), the elevation in CK levels after leg resistance exercise reached the highest levels in days 3 and 4 (9). In the study of Schneider et al. (1995), it was found that the serum CK amount was twice higher in marathoners than before the marathon, and returned to normal 4 days after the marathon (10). In another study conducted by Clarkson et al. (1992), it was determined that serum CK values increased as a result of long-term exercise, and peaked after 24th and 48th hours (5). In a similar study, the same results were reported by Noakes (1987) (11). In the study conducted by Howaton (2009) that included repeated sprints, the time effects of muscle damage was examined, and it was reported that the differences in CK values were significant in subjects after 48 hours. Although the differences were not as high as exercise protocols with high density, no significant differences were detected in subsequent measurements 72 hours after the exercises (12).

According to the results regarding the differences in the measurement times of muscle damage marker MYB levels, it was determined that there were differences among the MYB levels immediately after the competition and the MYB levels at 24th and 72nd hours after the competition ($p < 0.05$), and there were no differences among other times ($p > 0.05$). Baker et al. (2005) conducted exercise protocol that included concentric-eccentric contractions held at bicycle ergometer and found that the MYB level was 53 ± 22.1 before the exercises, and was 54.5 ± 25.4 immediately after the exercises (13).

According to the results of differences in skeletal muscle damage marker CK-MB level measurements, although there was a significant difference among the values after the competition and other values ($p > 0.05$); however, there was no significant difference among other values ($p > 0.05$). In a study conducted by Hazar (2004), it was determined that trainings that involved maximal force and continuity in force did not cause significant damage to myocardial values, and reported that the elevation in CK-MB was not of cardiac origin, but was caused by skeletal muscle damage. The results of the present study of ours are similar to the literature data (14).

According to the results of the differences in the levels of skeletal muscle damage marker LA measurements, it was found that there was a significant difference among LA values immediately after the competition and at 24th, 48th, and 72nd hours after the competition ($p < 0.05$); however, there were no differences among the values before the competition and all the values after the competition ($p > 0.05$). Cetinkaya (2014) conducted a study on footballers, and determined that the LA level before the strain and the training program was 42.56 ± 1.77 mg/dl; 97.32 ± 6.95 mg/dl immediately after the strain, 16.60 ± 0.81 mg/dl 48 hours after the strain; and after the training program was applied, 25.89 ± 1.50 mg/dl before the strain, 93.83 ± 6.89 mg/dl immediately after the strain, and 21.91 ± 3.04 mg/dl 48 hours after the strain (15).

Nose et al. (1991) conducted a study and reported that the blood lactate level increased at a significant level after exercises applied at 95% VO_{2max} level (16). Bouhlel et al. recorded the mean blood lactate level as 12.81 ± 1 mmol/l after 20-meter shuttle run test in their study conducted with 8 elite taekwondo athletes with a mean age of 20 ± 1 years, and it was measured as $10,2 \pm 1,2$ mmol/l after the competition (17). The studies in the literature support the present study with similar results. A different point is that the elevated LA level 48 hours after the competition may be due to the characteristic of the branch regeneration training.

According to the results of the differences in skeletal muscle damage marker LDH level measurements, although it was found that there were significant differences among the values immediately after the competition and the values at 24th, 48th, and

72nd hours after the competition ($p > 0.05$), there were no differences among other times ($p > 0.05$). endil (2008) conducted a study and reported that the LDH level of the subjects who participated in the study was 146.7 ± 19.43 u/l before exercise, 167.8 ± 19.52 u/l after exercise, 189.7 ± 17.69 u/l at the 24th hour after exercise, 201.4 ± 12.68 u/l at the 48th hour after exercise, and 191.8 ± 8.17 u/l at the 72nd hour after exercise (18).

As a result of the present study, it can be speculated that the competition setting is a marker of skeletal muscle damage because of exercise in elite mountain bikers. Among the bio-motoric characteristics, endurance is important in elite mountain bikers. As a characteristic of the branches of elite mountain bikers, long-term exercises cause that they use heart beat at a maximum level; and therefore, it can be argued that this prepares the ground for skeletal muscle damage marker.

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Original article

Examination of the eating behaviours and depression states of the university students who stay at home during the coronavirus pandemic in terms of different variables

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Abstract. *Study Objective:* This study aims to examine the eating behaviors and depression states of the university students who stay at home during the coronavirus pandemic in terms of different variables. *Methods:* The study group consists of 1064 participants in total (440 men and 624 women). In addition to the personal information form, The Dutch eating behavior questionnaire (DEBQ), and the CES-Depression scale (CES-D) were used in the study. The normality test of the data was checked with the Shapiro-Wilk Test. The Mann Whitney-U test was used to compare continuous data between two independent groups, and the Kruskal Wallis-H test was used to compare continuous data between more than two independent groups. In addition, Spearman Correlation Analysis was used to determine the relationship between dependent variables. *Results:* As a result, a significant difference was found in all variables including age, gender, self-isolation, regular physical activity at home during the Covid-19, and before the Covid-19 Outbreak. In addition, in the correlation between eating behaviour scale sub-dimension scores and depression scale scores, no significant relationship was found between depression and external eating. *Conclusion:* It can be said that nutrition and mental health are as important issues as viruses in the process of (covid-19) pandemic.

Key words: Covid-19, university students, eating behaviours, depression

Introduction

The New Type of Coronavirus pandemic, which has shaken the world recently and has been described as a worldwide pandemic, causes death, and seriously threatens all humanity (1). As in the whole world, serious measures are taken in all areas in Turkey. As the number of people who contract the disease increases, the authorities increase the calls to 'Stay Home', and people take it seriously. In addition to all these precautions, they also try to eat healthily and keep themselves psychologically strong. Well, do our students eat healthy on corona days? Do they have mental problems? The whole world is having this problem and this is the first time we have faced it. Perhaps none of us has had such an experience before. But during this period, we have to stay at home. At this point, we must be strong both physically and spiritually. In this context, nutrition and staying positive are of great importance. University students are in the first period after childhood and school-age that reach adulthood (2). Especially the first periods of university years coincide with the adolescent period (3). Wrong nutritional attitudes acquired during the university education period, which coincides with the adolescence stage when important changes take place, become even more important as they can negatively affect other stages of life if they proceed to the period after university education. Young people constitute almost one-quarter of the Turkish population. Based on the young population, nutrition is of great importance for the youth in this period to be healthy for the next generations (4). University years refer to a transition period in which the late stages of adolescence and the first period of

adulthood begin. In this period, young people leave the family atmosphere which they are accustomed to, their stress levels increase, and thus they become more open to external influences and begin to make their own free choices. Eating out habits, especially consumption of fast-food products outside the home, are increasing and malnutrition are being observed along with changes in students' eating attitudes and behaviours (5). The prevalence and frequency of eating disorders among young people and especially among women is a public health problem defined by the World Health Organization (WHO) as 'an important medical condition' that requires 'medical attention' (6,7). Eating disorders, including anorexia nervosa, bulimia nervosa, binge eating syndrome, and night eating syndrome, occur as a result of impaired eating attitude. It is stated that the majority of eating disorders occur before the age of 25 and the prevalence of eating disorders is high during university years (8,9). The incidence of eating disorders in Turkey has increased in the last 25 years and is generally defined as abnormal and harmful eating habits developed to maintain weight loss and lost body weight. The main features of eating disorders include physical appearance-related disorders such as self-perception of fat, uncontrollable emotional disturbances accompanied by eating much, fear of gaining weight and fatness, and excessive desire to lose weight (10). It is stated that eating behavior is the tendency of people's nutrition-related thoughts, knowledge, emotions, and behaviors. This behavior can be affected by physiological, social, geographical, demographic, cultural, and material conditions, as well as the perception of the person, their previous experience with nutrition, and their nutritional attitudes. It is known that emotions are important and effective in eating activity (11). The effect of emotional states on eating behaviors is one of the most important factors related to emotional eating (12,13). It is known that individuals eat foods they love to suppress their emotions and that emotional correction has two positive effects on eating behaviours (13). Emotional eating is expressed as one of the eating problems and is an eating disorder that indicates the tendency to overeat against negative emotions. Those who are in danger in terms of emotional eating behavior are obese, adolescents, and children, etc. Emotional eating can trigger emotional states such as stress/anxiety, depression, modelling of mother and father, anger, anxiety, and joy (14). Nutritional behaviour begins to take shape with the cultural characteristics of the society in which the person lives, and it can turn into negative eating habits such as unconscious eating according to the living conditions, unbalanced eating, fast eating, or eating pass because of the shortage of time. These habits can lead to eating disorders revealing the need for a multidimensional approach that includes physical, spiritual, and social components (15,16). During the period of youth, it is common to experience social and mental problems as well as physical problems. Given that about 30% of Turkey's population is comprised of the 12-25 age groups, it is observed that socio-cultural changes and cultural conflict increase the prevalence of eating disorders and appear to affect a large audience. A large part of this audience consists of university students. It is known that eating disorders are highly prevalent in this group and especially among women (15,17). Many factors in life can create depression, anxiety, and stress. Disasters such as fire, flood, long-term or severe illness, incompatibility in the family, problems at work, economic problems, fear of being dismissed, and some traffic disruptions while driving in traffic are possible situations in daily life that can cause depression, anxiety, and stress (18). It is known that eating disorders and long-term mental and social problems such as depression, anxiety, substance abuse, and suicide are interrelated. Due to eating disorders, personal health costs for problems such as decreased quality of life, loss of reproductive ability, severe medical problems, and death are also high (15,19). Based on psychological theories, Van Strien et al. define three different eating behaviors: restricted eating, emotional eating, and external eating. According to the restricted eating theory, individuals restricting their food intake consciously suppress their feelings of hunger and reduce their food intake (20). However, when their auto-control abilities are weakened, these individuals can abandon their diets completely, and the probability of overeating increases compared to those who do not. The psychosomatic theory focuses on "emotional eating" behavior that results in eating in response to emotional arousal or stress. These individuals use eating as a method of dealing with negative emotions. The third

theory, the external eating theory, suggests that some people have an increased tendency to eat without feeling hungry by being affected by external food stimuli such as taste, smell, and appearance (21). In light of all this information this study aimed to examine the eating behaviors of university students who stay at home during the coronavirus (Covid-19) pandemic and their depression states in terms of different variables.

Material Method

Study group

University students constitute the population of the study. The sampling of the study consists of 1064 people, 440 men, and 624 women, who stay at home during the coronavirus pandemic (Covid-19), which was selected via the convenience sampling method. Also, the data was obtained through the google form. Convenience sampling is the inclusion of only easily accessible people who are planned to be selected for the sample (22). This study has been designed according to the descriptive method and relational screening model. The data were collected without making any changes to the existing characteristics of the subjects, and the opinions of the subjects about the existing situation were obtained.

Data collection

In addition to the personal information form, the Dutch eating behavior questionnaire (DEBQ) and the CES-Depression Scale (CES-D) were used as data collection tools.

The dutch eating behaviour questionnaire (DEBQ)

DEBQ was developed by Van Strein et al. (1986) The questionnaire consisting of 33 items includes 3 sub-dimensions that evaluate emotional eating behaviors (for example, do you eat dessert when you are unhappy?), external eating behaviors (if the smell of what you eat is very nice, would you eat more than you normally eat) and restricted eating behaviors (would you eat less than you want to eat to avoid getting fat?). The first 1-10 items of the scale measure external eating behaviors, 11-23 items measure emotional behaviors, and 24-33 items measure restricted eating behaviors. In the scale answered with the 5-point Likert, "1 refers to Never", and "5 refers to Often". The 31st item in the scale was asked in reverse with the necessary corrections made before proceeding with the analysis.

The validity and reliability study of the scale in Turkey was conducted by Bozan et al. (23). The Cronbach alpha values for sub-dimensions range between 0.90 (external eating) and 0.97 (emotional eating). The internal consistency coefficient of the entire scale was found to be 0.94.

CES-Depression scale (CES-D)

CES-Depression Scale (24) is a short self-report scale developed by the American National Institute of Mental Health for use in scientific studies to evaluate the depressive symptoms of the general population. It is a scale consisting of 20 items with a 4-point Likert-type answer option (0 = Never-Rarely, 3 = Most of the Time). A total score between 0 and 60 is obtained from the scale, and a high score indicates a high level of depression. The scale was adapted into Turkish by Tatar and Saltukoğlu (25). It was reported that the Cronbach Alfa internal consistency reliability coefficient was calculated as 0.84 in the original application and 0.88 in the retest application. In addition, it was stated that there was a 0.69 level relationship between the two applications (26).

Statistical analysis

SPSS 22 program was used in the analysis of the data revealing whether there were differences in the mean scores between the eating behaviour scale and the depression scale and the variables. The normality test of the data was checked with the Shapiro-Wilk Test ($p < 0,05$). The Mann Whitney-U test was used for comparing continuous data between two independent groups. The Kruskal Wallis-H test was used for comparing continuous data between more than two independent groups. Moreover, Pairwise Multiple Comparison Test was used to determine the source of the difference in comparing more than two groups. In

addition, Spearman correlation analysis was used to determine the relationship between dependent variables. Confidence interval was 95% (significance level 0.05 $p < 0.05$). In this study, the cronbach alpha correlation coefficient of the eating behaviour scale was 0.87 and the cronbach alpha correlation coefficient of the depression scale was 0.76.

Results

Table 1 shows that external eating scores and emotional eating scores of participants differ significantly in favor of female ($p < 0.05$). However, restricted eating scores do not differ significantly according to the gender variable ($p > 0.05$). Depression scale scores of the participants differ significantly in favor of female according to the gender variable ($p < 0.05$).

Table 2 shows that the scores of external eating of the participants differ in favor of 24 and over years of age, emotional eating in favor of 21-23 years of age, and restricted eating scores in favor of 18-20 years of age according to the age variable ($p < 0.05$). In addition, it is seen that those with depression scores of 18-20 years of age have higher median than others ($p < 0.05$).

Table 3 highlights that according to the self-isolation variable of the participants during the Covid-19, the external eating scores differ significantly in favor of those who say yes and the restricted eating scores differ in favor of those who say no ($p < 0.05$). However, emotional eating scores do not differ significantly according to self-isolation during the Covid-19 variable ($p < 0.05$). It was observed that depression scores do not differ significantly according to self-isolation during the Covid-19 variable ($p > 0.05$).

Table 4 shows that the external eating scores differ significantly in favor of those who do physical ac-

Table 1. Comparing the eating behaviour scale sub-dimensions and the depression scale scores according to the gender

Variables	Gender	N	Median (Q_1-Q_3)	p
External Eating	Female	624	26,50 (21,00-31,00)	0,01*
	Male	440	25,00 (19,00-30,00)	
Emotional Eating	Female	624	32,50 (22,00-40,00)	0,01*
	Male	440	27,00 (19,00-36,00)	
Restricted Eating	Female	624	30,00 (25,00-34,00)	0,19
	Male	440	29,00 (25,00-34,00)	
Depression	Female	624	47,00 (42,00-54,00)	0,01*
	Male	440	45,00 (40,00-51,00)	

*p < .05

Table 2. Comparing eating behaviour scale sub-dimensions and depression scale scores according to the age

Variables	Age	N	Median (Q_1-Q_3)	p
External Eating	18-20	254	24,50 (17,00-31,00) [b]	0,01*
	21-23	567	26,00 (20,00-31,00) [ab]	
	24 and over	243	27,00 (22,00-31,00) [a]	
Emotional Eating	18-20	254	28,00 (21,00-38,00) [ab]	0,01*
	21-23	567	31,00 (21,00-40,00) [a]	
	24 and over	243	30,00 (18,00-37,00) [b]	
Restricted Eating	18-20	254	30,00 (25,00-34,00) [a]	0,01*
	21-23	567	29,00 (24,00-32,00) [ab]	
	24 and over	243	29,00 (23,00-33,00) [b]	
Depression	18-20	254	49,00 (42,00-55,00) [a]	0,01*
	21-23	567	46,00 (41,00-52,00) [b]	
	24 and over	243	45,00 (40,00-52,00) [b]	

*p < .05; ab: Different letters represent the differences between the groups.

Table 3. Comparing eating behaviour scale sub-dimensions and depression scale scores according to the self-isolation during the Covid-19 Outbreak

Variables	Did you self-isolate?	N	Median (Q_1-Q_3)	p
External Eating	Yes	1007	26,00 (20,00-31,00)	0,01*
	No	57	23,00 (15,00-28,50)	
Emotional Eating	Yes	1007	30,00 (26,00-38,00)	0,54
	No	57	31,00 (18,00-45,00)	
Restricted Eating	Yes	1007	29,00 (25,00-34,00)	0,23
	No	57	32,00 (23,50-36,00)	
Depression	Yes	1007	46,00 (41,00-53,00)	0,10
	No	57	44,00 (39,50-49,50)	

*p < .05

tivity and the restricted eating scores differ in favor of those who do not perform physical activity, according to the variable of regular physical activity before the Covid-19 process ($p < 0.05$). However, there was no significant difference in emotional eating scores according to the variable of regular physical activity before the Covid-19 process ($p > 0.05$). It was observed that depression scores do not differ significantly according to the variable of regular physical activity before the Covid-19 process ($p > 0.05$).

Table 5 shows that the external eating scores differ significantly in favor of those who do an activity and the restricted eating scores differ in favor of those who do not according to the variable of regular physical activity at home during the Covid-19 process ($p < 0.05$). However, it is seen that emotional eating scores do not differ significantly according to the variable of regular physical activity at home during the Covid-19 process ($p > 0.05$). Depression scores also do not differ significantly according to the variable of regular physical activity at home during the Covid-19 process ($p > 0.05$).

Table 6 shows that the emotional eating scores of the participants differ in favor of those who eat according to the variable of nutrition management during the Covid-19 process ($p < 0.05$). However, it was found that the scores of external eating and restricted eating do not differ significantly according to the variable of nutrition management during the Covid-19 process ($p > 0.05$). It was observed that there was no significant difference in depression scores according to the variable of nutrition management during the Covid-19 process ($p > 0.05$).

Table 7 shows that the emotional eating scores of the participants differ significantly in favor of those with weight gain and the restricted eating scores differ in favor of those with weight gain according to the variable of change in body weight ($p < 0.05$). However, it was seen that there were no significant differences in external eating scores according to the change in body weight during the Covid-19 process ($p > 0.05$). Depression scores were also found to be significantly different in favor of those with a weight loss according to the variable of change in body weight during the Covid-19 process ($p < 0.05$).

In the correlation between eating behaviour scale sub-dimension scores and depression scale scores shown in Table 8, no significant correlation was found between depression and external eating ($p > 0,05$). There is a low-level positive correlation between depression and emotional eating ($r = 0,250$; $p < 0,05$). There is also a low positive correlation between depression and restricted eating ($r = 0,184$; $p < 0,05$).

Table 4. Comparing eating behaviour scale sub-dimensions and depression scale scores according to the regular physical activity before the Covid-19

Variables	Doing Regular Physical Activity	N	Median (Q_1-Q_3)	p
External Eating	Yes	688	27,00 (21,25-31,00)	0,01*
	No	376	24,00 (17,00-30,00)	
Emotional Eating	Yes	688	31,00 (21,00-39,00)	0,89
	No	376	29,00 (20,00-39,00)	
Restricted Eating	Yes	688	29,00 (24,00-33,00)	0,01*
	No	376	31,00 (26,00-36,00)	
Depression	Yes	688	47,00 (41,00-53,00)	0,05*
	No	376	45,00 (40,00-53,00)	

*p < .05

Table 5. Comparing eating behaviour scale sub-dimensions and depression scale scores according to the regular physical activity at home during the Covid-19

Variables	Doing Regular Physical Activity	N	Median (Q_1-Q_3)	p
External Eating	Yes	556	28,00 (23,00-33,00)	0,01*
	No	508	24,00 (17,00-29,00)	
Emotional Eating	Yes	556	31,00 (21,00-38,00)	0,22
	No	508	30,00 (21,00-39,00)	
Restricted Eating	Yes	556	29,00 (24,00-33,00)	0,01*
	No	508	30,00 (26,00-35,00)	
Depression	Yes	556	47,00 (42,00-53,00)	0,21
	No	508	46,00 (40,00-53,00)	

*p < .05

Discussion and Conclusion

This study has been designed to examine the eating behaviors and depression states of the university students who stay at home during the Coronavirus (Covid-19) pandemic that has affected all humanity.

Table 6. Comparing eating behaviour scale sub-dimensions and depression scale scores according to nutrition management during the Covid-19

Variables	Nutrition	N	Mean Rank	Median (Q_1-Q_3)	p
External Eating	Home	1000	531,34	26,00 (20,00-31,00)	0,63
	Out	64	550,60	27,00 (23,00-30,00)	
Emotional Eating	Home	1000	521,07	30,00 (20,00-38,00)	0,01*
	Out	64	711,06	37,00 (30,25-41,00)	
Restricted Eating	Home	1000	528,51	29,00 (25,00-34,00)	0,09
	Out	64	594,86	30,00 (27,00-35,00)	
Depression	Home	1000	527,91	46,00 (41,00-53,00)	0,05
	Out	64	604,20	49,00 (42,00-54,75)	

*p < .05

Table 7. Comparing eating attitude scale sub-dimensions and depression scale scores according to the change in body weight during the Covid-19

Variables	Body Weight	N	Median (Q_1-Q_3)	p
External Eating	Gain	557	26,00 (22,00-31,00)	0,05
	Loss	157	27,00 (21,00-31,50)	
	No Change	350	24,00 (17,00-30,00)	
Emotional Eating	Gain	557	33,00 (24,00-40,00) [a]	0,01*
	Loss	157	32,00 (21,50-40,00) [a]	
	No Change	350	25,00 (16,75-34,00) [b]	
Restricted Eating	Gain	557	30,00 (26,00-34,00) [a]	0,01*
	Loss	157	29,00 (25,00-33,00) [ab]	
	No Change	350	28,50 (23,75-34,00) [b]	
Depression	Gain	557	48,00 (42,00-53,00) [a]	0,01*
	Loss	157	48,00 (42,00-54,00) [a]	
	No Change	350	44,00 (38,00-50,00) [b]	

*p < .05: ab: Different letters represent the differences between the groups.

Emotional eating behaviour is a tendency to eat that manifests in response to some emotional states and closely related to situations such as anxiety, depression, and problems in social relationships (28). Individuals with restricted eating behaviors are constantly trying to restrict their eating behavior to control their weight due to the anxiety they feel with the thought they eat a lot. However, individuals without restricted eating behavior do not worry about the consequences of eating behaviour (29). The most important difference that distinguishes the external eating theory from the psychosomatic theory is that the eating event is the reason for restarting. Eating perception of individuals who have an external eating attitude occurs when they are only in the same environment with food. Because they are affected by the features of the food such as its smell or appearance, they eat too much, and in other cases, they do not have a food-oriented perception (30). The population that suffers most from problematic eating attitudes and eating disorders is the women especially in adolescence and young adulthood and in addition, these disorders are known to be chronic and recurrent (31). Furthermore,

Table 8. Correlation analysis results between eating behaviour scale sub-dimensions and depression scale scores

		Depression (X)	External Eating (Y1)	Emotional Eating (Y2)	Restricted Eating (Y3)
Depression (X)	r	1	0,033	0,250	0,184
	p		0,284	0,001**	0,001**

problematic eating patterns have effects not only in the group with clinical disorder level eating behaviour but also in the general population. As an example, Neumark-Sztainer et al. (32) reported longitudinal eating behaviors with adolescents in 61% of women and 28% of men. Studies have shown that women are more sensitive to these conditions than men, and accordingly, the prevalence of depression in women is higher than men (33,34). It is known that approximately 95% of eating disorder cases are of women and dissatisfaction with the body and restricted eating attitudes are much more common in women than in men (35,36). The data obtained from our study coincide with the literature information. In our study, external eating scores and emotional eating scores in women differ significantly in favor of women compared to men, and Depression scale scores of participants differ significantly in favor of women according to the gender (Table 2). Depression can be the cause or result of social, psychological, and biological factors such as age and gender (37,38). In another study regarding female university students (n: 377) with similar characteristics to our study, cognitive and behavioural components of eating were questioned, and it was found that 73% of students had anxiety, 44.8% were sad, 45.1% were alone, 43.6% were happy and 27.4% were tired, 14.6% were angry respectively when they were eating in response. As a result, the vast majority of female students with normal weight stated that they had more eating attacks in response to emotional states such as anxiety (39,40). The data of this study are similar to our study. In a study the eating attitudes of individuals between the ages of 18-24 were examined and it was determined that 7.1% in the 18-19 age group of individuals are at risk for eating disorders; 10.9% in the 20-21 age group; 17.6%. in the 22-24 age group. Considering this study, the scores of external eating of the participants differ in favor of 24 and over, emotional eating scores in favor of 21-23 years, and restricted eating scores in favor of 18-20 years according to the age variable. The reason for the change between age groups shows that many factors (socio-economic, cultural, educational field, etc.) play a role in the aetiology of the disorders among groups; therefore it is not known which age group is riskier in eating disorders. Emotional eating behavior is closely related to anxiety, depression, and problems in social relationships (28,41). In addition, in our study, it was seen that those with depression scores of 18-20 years have higher rank averages than others. Depression can be the cause or result of social, psychological, and biological factors such as age and gender. Considering the relationship between age and depression, studies report that the prevalence of depression decreases with increasing age (37,38). In another study, the issue of whether stress and emotional eating caused eating disorders in 345 young adults (mean age: 19.5 years), mostly composed of healthy women (n: 227) was investigated. Eating disorders were determined to be accompanied by stress and emotional eating, and it was reported that girls experience more stress mainly related to emotional eating (42). In another study, Czaja, Rief, and Hilbert (43) stated that loss of control is particularly difficult in children between 7-12 years of age who have binge eating or overeating behavior. The results of a study with undergraduate students showed that as the difficulty in defining emotion and understanding the emotional state increased and the access to emotion regulation strategies was restricted, binge eating increased (44). While expanding the scope of the measures taken to protect the Coronavirus pandemic, attention is paid to the issue of social isolation from state elders. One of the most critical measures to prevent the spread of coronavirus cases is to follow the social distance rule and to self-isolate outside of essential situations. In our study, according to the variables of self-isolation in the Covid-19 process of the participants, the external eating scores differ significantly in favor of those who said yes, and the restricted eating scores in favor of those who said no. However, emotional eating scores do not differ significantly according to the Covid-19 self-isolation variable. According to the results of the study, it can be thought that individuals who are isolated and who stay at home have increased their consumption and fondness for food smells and appearance. It was also observed that depression scores did not differ significantly according to the Covid-19 self-isolation variable. According to the results of our study, there is a situation in favor of those who self-isolate in their eating attitudes and behaviors, and this may be due to

the sense of trust arising from self-isolation. Again, negative consequences should not be expected in the depression of those who self-isolate. Again the reason for this may be that thought that the individual has secured him/herself. However, it has been proven by studies that after a while social isolation creates depression and stress. According to the World Health Organization, nutrition is food intake, which is considered to be related to the nutritional needs of the body. Good nutrition is the cornerstone of health with an adequate and balanced diet with regular physical activity. Adequate and balanced nutrition provides a healthy life, efficiency, vitality, and physical activity to combat human problems. In addition, the health and well-being of future generations is provided. Nutrition is accepted as a basic principle in developed countries. In our study, according to the variable of doing a regular physical activity before the Covid-19 process, it was seen that the external eating scores differ significantly in favor of those who do physical activity and the restricted eating scores differ in favor of those who do not perform physical activity. However, it was concluded that emotional eating scores do not differ significantly according to the variable of regular physical activity before the Covid-19 process. The main factors for healthy aging and minimizing health risks related to age are to increase healthy nutrition and physical activity. Daily regular physical activity is the most important element in the prevention of chronic diseases along with healthy nutrition (45). Again, according to the variable of performing regular physical activity before the Covid-19 process, it was observed that depression scores do not differ significantly. However, studies done have shown that physical activity reduces anxiety and depression and facilitates stress coping by improving positive thinking (46). The effect of physical activity and nutritional intake on health is often explored separately. Physical inactivity is one of the main causes of most chronic diseases (47, 48). Malnutrition is an important risk factor for non-communicable diseases such as cardiovascular diseases, diabetes, and some types of cancer (47, 49). Table 6 of this study shows that the external eating scores differ significantly in favor of those who do the activity and the restricted eating scores differ in favor of those who do not according to the variable of regular physical activity at home during the Covid-19 process. Many studies have shown that nutrition and physical activity are among the most important effects in terms of human health. In the study of Cavadini et al. (50), it was stated that 60-80% of them consumed the morning snacks and 80-90% of the afternoon consumed snacks in the adolescent period, that adolescents doing physical activities are more healthy, that the frequency of consumption of cereals, fruit, juices, and salads was higher so that individuals doing physical activity during the adolescent period had higher micronutrient consumption than non-sports individuals. Depression scores do not differ significantly during the Covid-19 process according to the variable of regular physical activity at home. The reason for getting these results from the study is that the pandemic is very new, frightening and unknown, and people cannot show enough interest in physical activity in such a period due to different flurries. But it should be known that participating in regular physical activity is good for human health physically, physiologically, and psychologically. In a systematic review by Mammen and Faulkner (51), it was emphasized that increasing physical activity is a valuable strategy in improving mental health and reducing the risk of developing depression. It is known that many discourses have emerged about how nutrition will be during the COVİD-19 pandemic. Many clues such as strong immunity, regular, balanced diet, vitamin D supplements, abundant fluid intake, etc. are given and people are confused along with a very rapid change. Although this situation changes people's eating habits, it is thought to create some uneasiness. According to a result obtained from our study, the emotional eating scores of the participants differ in favor of those who eat out according to the variable of how nutrition was managed during the Covid-19 process. It may be thought that this situation may be due to the uneasiness of those who have to eat out in such a period. Emotional eating is defined as the use of nutrients to avoid negative emotions. Among the negative situations that reveal emotional hunger are many factors such as sadness, frustration, anger, daily troubles, discouragement, ego threats, depression, and stress. To eliminate these situations, there is a tendency toward emotional eating behavior. Another important factor is the overeating behavior of the individual as a result of

the difficulties in expressing and perceiving his feelings (52). Therefore, considering these situations and results, it is thought that they will guide and shed light on new studies. It has been determined that stress and other emotions affect body weight and food intake. In some emotional situations, obese people are predicted to eat more than individuals of normal weight. It seems that eating like this has the effect of reducing negative emotions, especially loneliness, boredom, anger, and depression (39). According to the results obtained from our study, the emotional eating scores differ significantly in favor of those who gain weight and the restricted eating scores differ in favor of those who gain weight according to the variable of body weight change in the Covid-19 process of the participants. The abovementioned information that supports our study reveals that eating reduces the psychological states. In our study, it is thought that obtaining results in favor of those who gain weight in their eating subdimensions is indicative of the deterioration of their eating attitude behaviors in those who experience the pandemic and those who gain weight. Insomnia, loss of weight, anorexia, and fatigue can sometimes be early somatic signs of depression (53). In our study, it was observed that depression scores differ significantly in favor of those with weight loss according to the variable of body weight change in the Covid-19 process. Literature studies explain that depression is affected by many different factors. Irregular weight gains may be the cause of depression, and it has been determined by studies that individuals with depression have weight loss. Although a regular loss in weight is known to be healthy by humans, if it is in the same group as in our study with irregular weight loss and accompanying irregular eating attitudes and behaviors, even insomnia, anorexia, etc., it is necessary to investigate whether there are symptoms of physical or psychological diseases. In the relationship between eating attitude scale sub-scale scores and depression scale scores, no significant relationship was found between depression and external eating. There is a low-level positive relationship between depression and emotional eating (r = ,250). There is also a low positive correlation between depression and restricted eating (r = ,184). It is known that depressive symptoms are often associated with obesity and emotional eating plays an important role in weight gain (39, 54). In a study, the relationship between a sample of 298 fathers and 294 mothers and three-factor eating behaviors (emotional eating, external eating, and restricted eating), depression, and body weight gain were examined. It was observed that there is a causal relationship between body weight gain, emotional eating, and depression in women, and depressive symptoms are highly associated with emotional eating (39,55). In a study with a total of 1453 students at a university in Mexico (mean age: 20.6 years, 664 girls and 789 boys), the relationship between BMI, depressive symptoms, and emotional eating was examined. As a result, it was found that BMI and depressive symptoms in both genders were associated with emotional eating ($p < 0.05$) (39,54). The results obtained from these studies support our work in all aspects. Some psychological terms and definitions are also included in the definitions of emotional eating and restricted eating sub-dimensions. In our study, a low positive relationship was found. It has been reported that depression is a central feature of eating disorder, and it appears as exaggerated symptoms due to hunger and weight loss (15,56). Literature sources tell us that the fact that hunger and/or protein malnutrition and corticotrophin-releasing hormone increase or decrease serotonin function increases depressive symptoms in eating disorders (15,57).

As a result, external eating and emotional eating scores of university students are significantly different in favor of women according to the gender variable; external eating scores differ in favor of 24 and over, emotional eating scores differ in favor of 21-23 age group and restricted eating scores differ in favor of the 18-20 age group according to the age variable there are significant differences in favor of those who say yes, and the restricted eating scores in favor of those who say no according to the variable of self-isolation during the Covid-19 process. According to the variable of doing regular physical activity at home during the Covid-19 process, external eating scores differ in favor of those who do the activity and restricted eating points differ in favor of those who do not. Emotional eating scores differ significantly in favor of those who eat out according to the variable of how nutrition was managed during the Covid-19 process, emotional eating scores differ in favor of those who gain weight

and the restricted eating scores differ in favor of those with gains in weight according to the variable of body weight change during the Covid-19 process. Depression scale scores of university students were found to differ significantly in favor of women according to the gender variable, sum of the ranks of those who were 18-20 years old were higher than others, and differed significantly in favor of those who lost weight during the Covid-19 process. There was no significant relationship between depression and external eating. There was a low-level positive relationship between depression and emotional eating (r = 0,250). A low positive correlation was found between depressions and restricted eating. It can be said that nutrition and mental health are as important issues as viruses in the process of (covid-19) pandemic.

Conflicts of interest: The authors declare that there is no conflict of interest about this manuscript.

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Original article

Acute effects of carbohydrate gel and isotonic usage on power, heart rate and glucose levels in elite cyclists

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Abstract. *Study Objective:* This study aimed to compare the acute effects of carbohydrate gel and isotonic usage on power, heart rate (HR), and glucose levels of elite cyclists. *Method:* Twenty licensed cyclists participated in the study voluntarily. Cyclists are randomly divided into two groups (The first group: carbohydrate gel receiving group; second group: isotonic drink receiving group). Cyclists performed about one hour of velodrome training. The first group continued to operate using one energy carbohydrate gel in the fifth minute of the training. The second group used a 2 scale (27 g) electrolyte and carbohydrate mixture in 500 ml water and added powder product during the training. Athletes' mean HR values were recorded with the Garmin brand watch. The mean power (watt) values of the athletes were also obtained with the Garmin Power meter. Heart rate and power values were compared as the mean values after the training that the athletes applied after carbohydrate gel and isotonic drink intake. OKmeter Optima OK-10H (Taiwan) sugar meter was used in the measurement of blood glucose values of cyclists. Glucose measurement was taken pre- and post-test. The analysis of data was made in the statistical package program by using "Descriptive statistics", "Independent samples-t Test" and "Repeated Measures Analysis of Variance (ANOVA)" for comparison. *Results:* There were no significant differences in the mean HR, mean power, and glucose pre-and post-test values of the cyclists who took carbohydrate gel and isotonic drink before and after the training ($p > 0.05$). *Conclusion: As a* result, carbohydrate gel or isotonic usage during cyclists' sports activity didn't effect on performance and physiological properties.

Key words: Cyclist, Carbohydrate Gel, Isotonic Drink

Introduction

Cycling has become a branch of sport that is growing in popularity in the world and subject to scientific studies. Cycling is now within the scope of the Olympic sports and is considered as one of the most difficult sports branches of it. Races organized at the national and international levels are held in different disciplines (1).

Training intensely to maximize and maintain their performances in the cycling branch which requires endurance, elite cycling athletes prefer to use supplementary nutrients (gel and isotonic) they require for their body during training. Carbohydrates should be taken as a supplement during exercise to renew limited glycogen stores, discharge as late as possible, and maintain muscle strength by maintaining blood glucose concentration. It is recommended to use sports drinks and gels designed especially for athletes during exercise. The use of sports drinks helps the recovery of both carbohydrate needs and fluid and electrolytes lost through exercise (2).

Carbohydrates, which can also be used as a nutritional supplement, are the most important component of energy metabolism in exercise and play an important role in exercise performance (3). Additional

carbohydrate intake is important as the fuel cost of metabolism exceeds endogenous carbohydrate stores during sub-maximal and high-intensity intermittent exercises and races (4). Carbohydrate (CHO) intake during exercise has been reported to increase exercise performance, especially in long-term exercises where endogenous carbohydrates are limited (5). Athletes frequently consume carbohydrate-electrolyte solutions during exercises to increase blood glucose concentration (6).

Sports drinks are products designed to balance blood glucose concentration before, during, and after exercise, and while carbohydrates in them contribute to energy balance, electrolytes affect the performance positively by reducing the risk of dehydration and hypothermia (7).

In this context, the information obtained from the literature, this study aimed to compare the acute effects of carbohydrate gel and isotonic usage on power, heart rate (HR), and glucose levels of elite cyclists.

Material and Method

Twenty licensed cyclists voluntarily participated in the study. The "Informed Volunteer Consent Forms" were obtained from the cyclists to make them about the importance of the study, and to increase their desires and motivation levels to participate in the study. Cyclists were randomly divided into two equal groups. The first group is the carbohydrate gel receiving group (n: 10) and the second group is isotonic drink receiving group (n: 10). Cyclists practiced in the velodrome, which lasted about an hour (nearly its sizes is 400 m). Cyclists applied the velodrome training at 110-120 cadence, 35-40 km/h. The first group continued the activity using one energy gel in the fifth minute of the training. The second group used 2 scale (27 g) electrolyte and carbohydrate mixture powder product in 500 ml of water and used it throughout the training. We applied the principles outlined in the Declaration of Helsinki.

Heart Rate and Power Measurements

Using a "Garmin" brand watch, the mean Heart Rate values of the athletes were recorded. Mean power values of the athletes were taken with the Garmin Power meter measurement device. Heart rate and power values were compared as the mean values after the training that the athletes applied after carbohydrate gel and isotonic drink intake.

Glucose Measurement

OKmeter Optima brand, OK-10H model (Taiwan) glucose meter was used to measure cyclists' blood glucose values. Blood Glucose measurements were taken from the fingertip using the OK meter Optima Brand (OK-10H-Taiwan) and dropped on the "Glucose Test Strip". Blood glucose values were measured as "pre-test" before carbohydrate gel and isotonic drink intake while cyclists were at rest, and as "post-test" immediately after the end training that the athletes applied after carbohydrate gel and isotonic drink intake.

Statistical Analysis

In this study, SPSS 24.0 was used to obtain statistical results. The demographic data of the cyclists were evaluated by summarizing and using the Descriptive Statistics $\bar{x}$ (Arithmetic Mean) and Sd (Standard Deviation) values. "Shapiro-Wilk" test was used to determine whether data have normal distribution or not ($p>0.05$). Comparisons among the groups were performed using the Independent Sample t test for HR and power variables. Differences in glucose levels were analyzed using a 2X2 (treatment X time) repeated measures ANOVA. The results were evaluated according to "0.05" significance level.

Results

When Table 1 is examined, carbohydrate gel receiving groups' mean age was 24.3 ± .9 year, mean length was 175.8 ± 4.8 cm, mean weight was 70.7 ± 7.5 kg, mean sport age was 8.3 ± 1.1 years; of the isotonic drink receiving groups' mean age was 25.4 ± 3.3 year, mean length was 176.6 ± 3.8 cm, mean weight was 65.1 ± 3.7 kg, mean sport age was 7.2 ± 1.4 year.

Table 2 shows the mean HR and mean power values. There were no statistically significant differences for mean HR and mean power values ($p>0.05$).

Table 1. Demographic Features of Cyclists

	Groups	N	Minimum	Maximum	$\bar{x} \pm Sd$
Age (year)	Carbohydrate gel receiving group	10	23	26	24.3 ± .9
	Isotonic drink receiving group	10	20	29	25.4 ± 3.3
Length (cm)	Carbohydrate gel receiving group	10	168	182	175.8 ± 4.8
	Isotonic drink receiving group	10	172	182	176.6 ± 3.8
Body Weight (kg)	Carbohydrate gel receiving group	10	61	82	70.7 ± 7.5
	Isotonic drink receiving group	10	60	71	65.1 ± 3.7
Sport Age (year)	Carbohydrate gel receiving group	10	6	10	8.3 ± 1.1
	Isotonic drink receiving group	10	5	9	7.2 ± 1.4

Table 2. Comparing Mean HR and Mean Power Values of Cyclists Using Carbohydrate Gel and Isotonic Drink

Parameters	Groups	$\bar{x} \pm Sd$	t	p
Mean HR (beats/min)	Carbohydrate gel receiving group	148.3 ± 7.3	–1.191	.249
	Isotonic drink receiving group	152.9 ± 9.7		
Mean Power (watt)	Carbohydrate gel receiving group	170.1 ± 17.8	–.167	.869
	Isotonic drink receiving group	168.9 ± 13.9		

Table 3. Comparing the pre- and post-test Glucose Levels of Cyclists

Parameters	Groups	Pre-test	Post-test	Total	F	P
		$\bar{x} \pm Sd$	$\bar{x} \pm Sd$	$\bar{x} \pm Sd$		
Glucose (mg/dl)	Carbohydrate gel receiving group	96.3 ± 3.5	98.6 ± 11.7	97.4 ± 1.1	**.079**	**.782**
	Isotonic drink receiving group	99 ± 2.1	98 ± 2.6	98.5 ± 1.1		
	Total	97.6 ± 3.1	98.3 ± 8.2	Trial x Time		
			F = .401; p = .534	**F = .509; p = .485**		

According to Table 3, there were no statistically significant differences in the means by time, means of groups, and interaction between measurement times of glucose values pre- and post-test of cyclists receiving carbohydrate gel and isotonic drink (p>0.05).

Discussion

In the study, it was found that there was no significant difference in the comparison of the values of mean heart rate and the mean power of cyclists (p>0.05), We think that the reason for the difference in these values is not because of the similarly applied load intensity in the training. However, we can say that the group that received the gel had better performance values.

In scientific studies conducted in the literature, it was stated in this discipline that athletes spent a mean of 140–150 beats/min during the race and 80% of their M_{ax}HR was exerted (8).

In the study where Patlar (1999) examined the effect of the game form on durability and breathing parameters with continuous running in players, the pulse post-test measurement values were 145.6 ± 12.26 beats/min in group 1 and 141.14 ± 9.72 beats/min in group 2 / It has been determined as min (9). Suna and Alp (2019) defined the mean HR values in pre- and post-test competition as 157 ± 12.06 beats/min

146.88 ± 11.99 beats/min (10). In Pündük and Öztürk (2019) study, the $M_{ax}HR$ of the cyclists decreased even if the end of season value was not significant, and they found that there was a significant improvement in mean watt (11). In their study, Müniroğlu et al. (2000) obtained a statistically significant difference at the 0.05 level in aerobic power means ($p<0.05$) (12). When we look at similar studies in the literature, it is seen that the power and mean muscle values in our study are in line with other studies. Alp and Görür (2020) found differences between branches in mean power values in their study (13). The researchers have suggested that the reasons for the difference depending on the training differences and physical needs according to the branches. We believe that the reason for this study's incompatibility with our study is due to the application of different training intensities arising from the characteristics of the branches.

Considering the Repeated Measures ANOVA Test's results of glucose values before and after the training of cyclists who took carbohydrate gel and isotonic drinks, there was no significant difference in the means by time, means of groups and interaction between measurement times ($p>0.05$). However, while glucose levels increased in the group taking the carbohydrate gel, a decrease occurred in the group taking the isotonic drinks. According to these results, we can comment that carbohydrate gel intake has more effect in terms of performance and providing energy during sports activities.

Current research findings indicate that carbohydrate intake is important in maintaining the blood glycogen concentration before and during long-term exercises in cyclists and this is one of the most important factors affecting performance (14). When the data obtained are evaluated on the increase of blood glycogen concentration, it shows that it shares similarities with the previous research data, but the increase rates are negotiable. In the study of Khoo et al. (2010) examining the effects of exercise application on glucose, insulin, and glucagon in healthy individuals, they reported that insulin levels decreased after cycling exercise (15). Aydın et al. (2000) conducted the study of insulin and blood glucose levels after aerobic and anaerobic exercise on 9 male football players and reported that the mean insulin values decreased after aerobic exercise (16). In the studies of Moghadasi et al. (2013), in which they examined the effect of intense aerobic exercise applied to athletes on insulin levels, they reported that insulin levels decreased after aerobic exercise athletes (17). Our study is similar to other study findings on the subject. In their study, Brooks et al. (2002) reported a high increase in blood glucose levels in the experimental group athletes who received carbohydrate gel compared to the control group who only drank water and did not take carbohydrates (18). Campbell et al. (2008) stated in their research, where they examined different carbohydrate supplements, that athletes using supplements had significantly different blood glucose concentrations for all products compared to those who did not use them (19).

It is said that footballers' consumption of isotonic drinks containing 4–8% carbohydrates can help maintain exercise performance by delaying fatigue which may occur. According to the suggestion of NATA, 200–250 ml of water or sports drink should be consumed every 10–15 minutes during exercise to ensure hydration (20). In the study conducted by Harper et al. (2016) on football players, the effects of the use of carbohydrate gels on psychological status and performance in prolonged football competitions were examined and it was observed that the physical performances and hydration status of football players who consumed carbohydrate-electrolyte-containing gel (0.7 g/kg body weight) were preserved in extra time (21). Demiriz et al. (2015). In the study in which they examined the effects of anaerobic interval training on different resting intervals on aerobic capacity, anaerobic threshold and blood parameters, as a result of the training performed by the intensive interval training group, an increase in the level of blood glucose ($z=-2.19$) before and after the training was found at $p<0.05$ level (22). In another study, Phillips et al. (2012) reported that the time spent in the game for athletes using carbohydrate gel was 21% longer than the placebo group in their study they performed on adolescent young athletes (23).

Beyleroğlu (2019), found that cyclists' use of carbohydrate gels was higher after the aerobic exercise and that the mountain cyclist exhaustion times were higher than those who did not use carbohydrate gel. Studies examining CHO gel intake show that

exhaustion times of athletes, when they consume CHO gel may be higher than when they do not consume carbohydrate gel (24). Patterson and Gray (2007) reported in their study, they examined the effects of the addition of carbohydrate gel on the intermittent high-density shuttle run, and they found that using carbohydrate gel, the group's exhaustion time was 45% higher than the placebo group (25). When the literature is examined, it is observed that the performance of athletes increased after the use of carbohydrate gel. However, there is insufficient information about the effects of the use of isotonic drinks on athletes. In this context, we think that the information we obtained after isotonic consumption will contribute to future studies.

Conclusion

In conclusion, in the study we performed, the values of performance and physiological properties of the group receiving carbohydrate gel were higher than the isotonic drinking group. According to this result, it can be said that the carbohydrate gel used before and during the exercises positively affects athletic performance by increasing the blood glucose level and fatigue time and reducing the use of carbohydrates. Furthermore, we think that our research is very important in terms of making a detailed analysis of the characteristics and field performance of elite cyclists in our country. It is thought that increasing the number of samples in the future will be important in terms of determining the differences between them and that this is important in terms of the maturity of our research and its contribution to sports science.

Conflict of interest

The authors declare that there is no conflict of interest in this manuscript.

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Original article

Comparison of the effect of the mat and reformer pilates exercises on the waist-hips ratio and body compositions of the middle-aged sedentary women

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Abstract. *Study Objectives:* The aim of this study was to compare the effects of the 8-week mat and reformer pilates exercises on body composition and waist-hip ratios of middle-aged sedentary women. *Methods:* Fifty-eight volunteer women participated in the study. Body compositions of women were measured by bioelectrical impedance analyzer, and waist and hip circumference were measured a using tape measure. In the analysis of the obtained data, two-way repeated-measures ANOVA was used. In addition, Bonferroni post-hoc test was used to determine the source of the difference between the groups. In addition, the changes in waist-hip ratios and body compositions of adult women for eight-week exercises were determined using the formula %Δ = [(Post-test - Pre-test) / Pre-test * 100]. *Results:* Body mass index, body fat mass, fat-free mass, and waist-hip ratios of the exercise groups were found to be statistically different from the control group ($p < 0.01$). According to these results, the highest body mass index (-1.87%) and body fat mass reduction (-5.35%) were found in the reformer exercise group. In contrast, the highest waist-hip ratio reduction (-1.20%) was in the mat exercise group. Moreover, the highest fat-free mass increase (0.39%) was found to be in the mat exercise group. *Conclusion:* As a result, 8-week mat and reformer pilates exercises were found to have positive effects on waist-hip ratios and body compositions of middle-age sedentary women.

Key words: Mat pilates, Reformer pilates, Body composition, Waist-hip ratio

Introduction

Lack of physical activity causes adverse effects on the body as well as an increase in body weight. Societies that walk less distance and start to participate less in activities outside the home, while reducing the amount of energy they spend during the day, also live a life away from healthy eating (1).

In addition to adequate and balanced nutrition, a lifestyle maintained with a regular habit of physical activity is needed in maintaining body composition. Both underweight and obesity rates, which are outside the normal body weight limits, differ greatly in developed and developing countries. In countries with food shortages, underweight is seen as a major health problem, while in developed or developing countries, obesity is the first major health problem. Obesity is a global public health problem and also an economic problem. The prevalence of obesity is increasing all over the world and women are affecting this more (2). Body mass index (BMI) is a widely used method in calculating the prevalence of obesity. Although BMI is a practical method, it cannot report the fat mass (FM) in the body and its distribution in the organism. When BMI is classified according to the World Health Organization, it is defined as ≤18.5 kg/m^2 underweight, 18.6–24.9 kg/m^2 normal, 25.0-29.9 kg/m^2 overweight, and ≥30.0 kg/m^2 obese (3).

Waist-hip ratio (WHR) is the first anthropometric method developed from epidemiological research as an indicator of body fat distribution (2). WHR should not exceed 1.0 in men and 0.8 in women (4). Otherwise, an increase in abdominal adipose tissue, and thus an increase in WHR negatively affect health. Because the risk for diabetes has increased 3.7 times in obese women, while it has increased 10.3 times in obese women (5).

Physical activity regulates the body's energy balance, provides control in body weight, and determines the body composition (6). Recent research shows that pilates exercises spend calories as fast walking (7). Also, it is seen that pilates exercises decrease BMI and WHR measurements (8). However, pilates exercises have started to contain diversity with advances in technology. Individuals can perform pilates exercises with their body weights, or they can perform pilates exercises against resistance with the help of tools. In this context, in this study, we aimed to compare the effect of reformer and mat pilates exercises on the body composition and WHR of middle-age sedentary women to prevent a health problem such as obesity. Thus, the differences between two different pilates exercises will be revealed.

Material and Method

Participants

Sixty-six volunteers who have been working at Bursa Technical University between the ages of 25-50 and who have been sedentary for at least 2 years participated in the study. The modified physical activity readiness questionnaire was used as the criterion for inclusion in the research. However, eight participants could not complete the research for various reasons (pregnancy, health problem, etc.), so they were excluded from the research and the research was completed with a total of 58 middle-aged sedentary women. At the beginning of the research, the participants were informed about the purpose, importance, method, and achievements of the research, informed volunteer consent forms were filled and their signed approvals were obtained. In addition, the ethics committee approval was obtained from the Ethics Committee of Gazi University for this study (Approval number: 77082166-604.01.02).

Experimental Design

The experimental design model was used in the research. In the study, all measurements were measured twice, before and after the eight-week pilates exercise program. Middle-age sedentary women were divided into three groups. The first group did not participate in any exercise program as a control group (n: 17). Exercise groups were divided into two groups as a mat (n: 21) and reformer (n: 20) exercise groups. During the research, no diet program was applied and the participants continued their routine lives. All exercise programs were designed by the researcher 3 times a week for eight weeks and 60–75 minutes per exercise.

Exercise Protocols

Mat Pilates Exercise

Mat pilates exercises were carried out by pilates instructor as two sessions to groups of ten and eleven people. Before the main phase of each exercise, the warm-up was performed for 10 minutes with pre-pilates exercises (Breathing, Imprinting, Iso-Abs, Rib Cage Arms, Head Nods, Neck Curl, Knee Folds, Flight, Seated Tracking, and Goal Post Arms). Level 1 mat pilates exercises were applied for 45 minutes in the main phase of the exercise and daily exercise program was completed after 5 minutes of stretching.

Reformer Pilates Exercise

Reformer exercises were applied to the participants one-to-one by the pilates instructor in the reformer tool. During the warm-up phase of the exercise, pre-pilates exercises (Breathing, Imprinting, Iso-Abs, Rib Cage Arms, Head Nods, Neck Curl, Knee Folds, Flight, Seated Tracking, and Goal Post Arms) were performed on the mat for 10 minutes. Level 1 reformer pilates exercises were applied for

45 minutes in the main phase of the exercise and daily exercise program was completed after 5 minutes of stretching.

Repeat numbers for mat and reformer pilates exercises were as in Table 1 for the first four weeks of study. In the last four weeks of the study, the number of repetitions for each week in mat pilates exercises was increased by two for each movement except a hundred and in reformer pilates exercises were increased by one for each movement except a hundred.

Table 1. Contents of mat and reformer exercises (9,10).

Mat Pilates Exercises		Reformer Pilates Exercise	
Movements	Number of Repetition	Movements	Number of Repetition
Hundred	5+5 (10 Breathing) x 10	Pilates V –Toes	10 Rep
Roll up	10 Rep	Plantar Flexed –Arches	10 Rep
One leg circle	10 Rep (for both Legs)	Heels	10 Rep
Rolling Like a Ball	8 Rep	Calf Raise -Tendon Stretch	10 Rep
Single Leg Stretch	8 Rep	Slow Running	10 Rep
Double Leg Stretch	10 Rep	Hundred	5+5 (10 Breathing) × 10
Single Straight Leg Stretch	10 Rep	Arm Straight - Reach and Pull	10 Rep
Double Straight Leg Lower Lift	10 Rep	Triceps Press	10 Rep
Crisscross	10 Rep	Winning	10 Rep
Spine Stretch Forward	6 Rep	Arm Circle	8 Rep
Saw	6 Rep	Parallel-Hamstring Pull	10 Rep
Swan	6 Rep	Laterally Rotated –Frog	10 Rep
Seal	6 Rep	Leg Circle	10 Rep
Abduction	12 Rep (for both Legs)	Straight Back -Straight Arm Row	10 Rep
Leg Circle	8 Rep (for both Legs)	Biceps Curl	10 Rep
Side Kick	10 Rep (for both Legs)	Rowing 1	10 Rep
Swimming Prep.	8 Rep	T Position	10 Rep
Mermaid	4 Rep (for both Directions)	RollBack	10 Rep
Push up series	4 Rep	Long Stretch	8 Rep
		Round Back -Elephant	8 Rep
		Neutral Back	10 Rep
		Round Back	10 Rep
		Knee Pull	10 Rep
		Prone Pull	8 Rep
		Swan Dive Prep.	8 Rep
		Mermaid	4 Rep
		Adductor stretch	5 Rep × 10 sec.
		Thigh Stretch - Scooter	5 Rep × 10 sec.

Measurements of BMI and Body Composition

The body heights of the participants were measured with the Seca 213 (Germany) brand 1 mm precision portable stadiometer according to the protocols (11). In addition, BMI and body compositions were measured in a sedentary mode according to protocols of the TANITA MC 780 brand Bioelectric Impedance Analyzer (12).

Measurement of WHR

Waist and hip circumference of the participants were measured with a tape measure. Waist circumference measurements were measured from the umbilicus level, while hip circumference measurement was measured from the widest part of the hips. The WHR of the participants was calculated by dividing the measured values with each other (13).

Statistical Analysis

IBM SPSS Statistic 24 package program was used to analyze the obtained data. Two-Way repeated-measures ANOVA was used in the analysis of variables measured repeatedly (pre and post-test) between groups. In addition, Bonferroni post-hoc test was used to determine the source of the difference between the groups. Moreover, the percentage changes between the measurement times of the measured variables were calculated with the formula % Δ = [(Post-test - Pre-test) / Pre-test * 100] (14). The significance level was determined as $p < 0.05$ and $p < 0.01$.

Results

The effects of eight-week pilates exercises on BMI, FM, fat-free mass (FFM), and the WHR of the participants were explained in the result section.

When table 2 was examined, there was a statistically significant difference between pre- and post-test measurement times for BMI of participants ($F = 15{,}308$; $p < 0{,}01$). In addition, it was determined that there was a statistically different between exercise groups' BMI ($F = 19{,}582$; $p < 0{,}01$). According to this result, it was determined that there was a difference between the control group and the BMI values of the mat and reformer pilates groups ($p < 0{,}01$), while there was no difference between the mat and reformer pilates exercise groups ($p > 0{,}05$). In addition, the highest BMI reduction (−1,87 %) was in the reformer pilates exercise group.

In table 3, there was a statistically significant difference between pre- and post-test measurement times for the body FM of participants ($F = 8{,}608$; $p < 0{,}01$). In addition, it was determined that there was a statistically different between exercise groups' body FM ($F = 12{,}255$; $p < 0{,}01$). According to this result, it was determined that there was a difference between the control group and the body FM values of the mat and reformer pilates groups ($p < 0{,}01$), while there was no difference between the mat and reformer pilates exercise groups ($p > 0{,}05$). In addition, the highest body FM reduction (−5,38 %) was in the reformer pilates exercise group.

When table 4 was examined, there was no statistically significant difference between pre- and post-test measurement times for the body FFM of participants

Table 2. Comparison of BMI according to exercise groups and measurement times

Groups/ Times	N	Pre-test	Post-test	Total	F	P
		± S.D.	± S.D.	%Δ		
Control	17	29,16 ± 5,42	28,74 ± 5,55	−1,38[b]		
Mat	21	22,39 ± 3,44	22,08 ± 3,13	−1,44[a]	19,582	0,001**
Reformer	20	21,93 ± 2,70	21,52 ± 2,57	−1,87[a]		
Total	58	24,22 ± 5,02	23,84 ± 4,95	−1,57	Interaction	
F=15,308; p=0,001**					F = 0,141; p = 0,869	

**p < 0,01; a,b: Different letters represent the difference between groups.

Table 3. Comparison of body FM according to exercise groups and measurement times

Groups/ Times	N	Pre-test	Post-test	Total	F	P
		± S.D.	± S.D.	%Δ		
Control	17	26,40±10,40	26,09±10,68	1,17[a]		
Mat	21	15,90±6,98	15,10±6,35	-5,03[b]	12,255	0,001**
Reformer	20	16,35±4,36	15,47±4,42	-5,38[b]		
Total	58	19,13±8,73	18,45±8,79	-3,55	Interaction	
		F = 8,608; p = 0,005**			F = 0,723; p = 0,490	

**p < 0,01; a,b: Different letters represent the difference between groups.

Table 4. Comparison of body FFM according to exercise groups and measurement times

Groups/ Times	N	Pre-test	Post-test	Total	F	P
		± S.D.	± S.D.	%Δ		
Control	17	48,64±4,20	47,86±4,51	-1,60[a]		
Mat	21	43,79±4,72	43,96±4,07	0,39[b]	8,499	0,001**
Reformer	20	43,23±3,24	43,39±2,82	0,37[b]		
Total	58	45,02±4,68	44,91±4,23	0,24	Interaction	
		F = 1,052; p = 0,309			F = 4,432; p = 0,016*	

*p < 0,05; **p < 0,01; a,b: Different letters represent the difference between groups.

Table 5. Comparison of WHR according to exercise groups and measurement times

Groups/ Times	N	Pre-test	Post-test	Total	F	P
		± S.D.	± S.D.	%Δ		
Control	17	0,89±0,07	0,91±0,07	2,25[a]		
Mat	21	0,83±0,06	0,82±0,07	-1,20[b]	10,540	0,001**
Reformer	2	0,83±0,04	0,84±0,04	1,20[b]		
Total	58	0,85±0,06	0,85±0,07	-	Interaction	
		F = 1,435; p = 0,236			F=3,402; p = 0,040*	

*p < 0,05; **p < 0,01; a,b: Different letters represent the difference between groups.

(F = 1,052; p > 0,05). In addition, it was determined that there was a statistically different between exercise groups' body FFM (F = 8,499; p < 0,01). According to this result, it was determined that there was a difference between the control group and the body FFM values of the mat and reformer pilates groups (p < 0,01), while there was no difference between the mat and reformer pilates exercise groups (p > 0,05). In addition, the highest body FFM increase (0,39 %) was in the mat pilates exercise group.

When table 5 was examined, there was no statistically significant difference between pre- and post-test measurement times for WHR of participants (F = 1,453; p > 0,05). In addition, it was determined that there was a statistically different between WHR of the exercise groups (F = 10,540; p < 0,01). According to this result, it was determined that there was a difference between the control group and the WHR of the mat and reformer pilates groups (p < 0,01), while there was no difference between the mat and reformer pilates exercise groups (p > 0,05). In addition, the high-

est WHR reduction (-1,20%) was in the mat pilates exercise group.

Discussion

According to the main findings of this study, BMI, FM, and WHR values of the exercise groups decreased more than the control group, whereas FFM values increased higher. However, there was no statistically significant difference between the mat and reformer pilates exercises.

In general, it can be thought that BMI values will not decrease since pilates exercises are not based on the cardiovascular training method. However, pilates exercises also differ from each other. For example, mat exercises include movements performed by using one's body weight, whereas reformer exercises include exercises against resistance. It is known as the movements against resistance will cause us to spend more effort. Indeed, when the literature was examined, it was found that the effects of pilates exercises on BMI show contradictory results. While some studies reported that pilates exercise did not have a positive effect on BMI (15, 16, 17), other studies reported that it had a positive effect (18, 7, 19, 20, 21, 22). According to the results of this study, it was determined that exercise groups had higher BMI decrease compared to the sedentary group. In exercise groups, the highest BMI decrease was observed in the reformer exercise group as −1,87 %. This result shows that reformer pilates exercises cause more effective in reducing BMI than mat pilates exercises.

When body FM changes were examined, it has been reported by many studies that pilates exercises cause changes in individuals' body FM. (16, 17, 20, 23). According to the results of the current research, it was determined that there was a higher FM decreased in the exercise groups compared to the sedentary group. In exercise groups, the highest FM decrease was observed in the reformer exercise group as −5.38 %. This result shows that reformer pilates exercises will cause more effective results than mat pilates exercises in FM decrease. Moreover, it suggests that reformer exercises may cause more body fat burning in the individual because they are performed against resistance.

The results of the researches about the effects of pilates exercises on body FFM differ from each other. Çakmakçı (2011) reported that pilates exercises have no effect on FFM in obese women (24). Similarly, Wong et al. (2020) reported that 12-week pilates exercises in obese women did not make a significant difference to their FFM (25). In contrast, Vaquero-Cristóbal et al. (2015) and Marilia et al. (2015) reported that pilates exercises significantly reduced body FFM (21, 26). The reason for the contradiction can be the fact that the research groups are in different BMI classes or the pilates exercises are continued regularly for a longer period. When the current research results were examined, it was determined that there was a higher FFM increase in exercise groups compared to the sedentary group. In exercise groups, the highest FFM increase was observed in the mat exercise group as 0.39 % kg.

The distribution of adipose tissue in the body regions is as important as the amount of adipose tissue in the body (27), and it has been reported by the World Health Organization that the WHR can be used to evaluate the risk associated with obesity (28). When the effect of pilates exercises on WHR was examined, it was found that the results of the studies in the literature differ from each other. avkın (2014) observed that pilates exercises do not cause a significant change in WHR in middle-aged women (29). Similarly, Baylan (2008) formed a mat and control group and made pilates exercises among people between the ages of 18–25 and 40–50. They reported that there was no significant difference between the pre- and post-test results of the WHR of the exercise and control groups in both age ranges (30). Despite the results of these studies, Junges et al. (2012) found that pilates exercises caused a significant decrease in WHR (31). In another study, Eroğlu (2011) and Katasıfçı et al. (2014) found that 6-week mat pilates exercises significantly reduced WHR in sedentary women (32, 33). According to the results of this study, the highest WHR decrease was observed in the mat exercise group as −1.20 %.

Conclusion

As a result, it was observed that reformer exercises decrease the body FM of women and decrease

BMI values due to the decrease in body FM. On the other hand, it was found that women who performed mat exercises caused a lower decrease in their FFM values, although they caused a lower decrease in BMI. In this context, because of the muscle mass increases, it can be said that the mat group has a lower decrease in BMI than the reformer group. The fact that the most decrease in WHR is in favor of the mat pilates exercise group supports these results. These results suggest that women who want to decrease their body mass index should do reformer exercise and women who want to increase muscle mass should do mat exercise.

Aladro-Gonzalvo et al. (2012) reported that one of the main deficiencies of the groups performing pilates exercise was not controlling the nutritional status. They stated in their research that changes in body composition would increase energy expenditure (eg, exercise) and reduced energy intake (eg, diet) to achieve more effective results (34). For this reason, individuals who do pilates exercises should check their nutritional status during the exercise period to obtain a change in body composition. Nutrition and diet are some of the limitations of this research. With pilates exercises, more effective results can be obtained by applying diet. In addition, individuals may be advised to design pilates exercises as combined exercises, including mat and reformer exercises, so that parameters in body compositions can be developed in many ways.

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Original article

Determination of running performance in young soccer players

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Abstract. *Study Objectives:* This study aimed to determine the relationship between running performances in young soccer players and various parameters. *Methods:* The study was conducted with 20 male athletes from the U-14 youth setup soccer team of a sports club playing in the Turkish Football Super League. Various measurements were made to determine athletes' height, body weight, leg, lower leg and upper leg length, leg force, active and squat jump heights, sprint times in 15, 20, 25, 30, 35, and 40 meters. The videos, on which athletes' two full stride lengths where they reached maximal speed were recorded, were analyzed on Ariel Performance Analysis System (APAS) package program the with below-waist analysis method, and their stride lengths on maximal speed were found. Thus, athletes' step frequencies were found by dividing their running times into their stride lengths. Data were evaluated on SPSS 22.0 package program with descriptive statistics and Spearman's rank correlation coefficient to determine the correlation between stride length and step frequency, and other parameters. *Results*: The results of statistical analyses showed that there was a negative medium level correlation between stride length and sprint time in 15m (r = -.484) while there was a negative strong correlation between stride length and step frequency (r = -.880). There was a positive strong correlation between step frequency and sprint time in 15m (r = .751), 20m (r = .691), 25m (r = .632) and 40m (r = .635) while a positive medium level correlation with sprint time in 35m (r = .460). *Conclusion:* Stride length is more determinative than step frequency especially in short distance races in terms of running performance in young soccer players.

Key words: soccer, running performance, stride length, step frequency, sprint

Introduction

Soccer is a universal game loved by people almost everywhere regardless of their sex, age, height, level of skill, race, or beliefs (1). A professional sports branch, soccer became a sector due to its large budget possibilities, and teams make thousands of their fans expect sportive success (2). Developing world conditions require being able to control and manage all possible uncertainty in their favor to be successful in soccer. Therefore, success can be achieved with high-level techniques, tactics, and physical skills (3, 4). Because game performance in soccer is the interaction of different techniques, tactics, mental and physical factors (5), high game speed in modern soccer generally requires soccer players to perceive various situations at the same time, evaluate them quickly, make decisions quickly, and apply them quickly. During a game, players do 2 or 4 seconds long sprints every 90 seconds, thus, they do short-term activities for 1000 or 1400 times in total (6). Previous studies have shown that the number of sprints that players display during a game increased at the rate of 37%. This is a solid proof that soccer requires increased physical performance (7). Speed in general is one of the most important components of soccer-specific efficiency ability. Best soccer players not only display high-level technical-tactical features but also have very advanced speed capabilities. Speed

in both offense and defense can mostly be significant for the win (8).

Knowing the physiological needs of young soccer players during the matches will make the training plans to be made more efficient (9). Previous studies have shown that soccer players are exposed to high game intensity during games, therefore, young players should also participate in training processes similar to adult players (10). Studies have shown that the most significant performance-related superiority of professional young setup players aged between 15 and 16 superior over same-aged amateur players appeared in agility and sprint tests (11). Maly, Zahalka, Hrasky, et al. (12) stated that sprint ability develops between the ages of 12 and 18, and sprints trainings conducted during this period are quite significant.

Brown (13) defines speed as the multiplication of stride length with step frequency while defining agility as swing speed. To increase speed, one must improve their stride length and frequency, and to increase agility, they must improve the speed of acceleration, deceleration, and swing. The number of studies on the relationship between athletes' sprint performances and anaerobic power is insufficient, and the acceleration capacities of athletes and covering longer distances in shorter times may be affected by power output (14, 15). Sprint is a type of recurring human movement and composed of running steps at maximum speed. Studies on determining which parameters affect sprint performance have been conducted for years. When evaluated biomechanically, stride length and step frequency of an athlete are the most effective parameters of sprint performance (16). During running, speed is determined by stride length and stride frequency and desired running performance is revealed by the optimal ratio between stride length and stride frequency. (17, 18). Stride length and step frequency increase according to a linear increasing of speed at certain speeds (19). Speed changes in every stage of performance based on the interaction between stride length and step frequency. Because stride length and step frequency are two parameters having a negative correlation in between both parameters are associated with one's morphological features, physiological properties, motor abilities, and energy capacities. Studies have stated that stride length is generally related to the height or leg length of an athlete while step frequency is based primarily on the central nervous system functioning on cortical and subcortical levels (16, 20–22).

Which of stride length and step frequency is more important for reaching maximal running speed and what affects these are discussed (17). The development of these two important parameters of sprint running with different training methods has always been a study subject (16). Knowing which parameter prominent as well as what the two parameters are affected from and related to be important to plan the content of sprint training of sports branches like soccer for which sprint performance is quite effective. Therefore, this study aimed to determine the relationship between running performance in young soccer players, and physical and performance parameters.

Material and Methods

Participants

The study was conducted with 20 voluntary male athletes (age: 13.75 ± 0.44 years, height: 159.92 ± 10.60 cm, body mass: 47.94 ± 9.55 kg) from U-14 youth setup soccer team of a sports club playing in the Turkish Football Super League. Measurements were made at the same training day and time for all athletes.

Anthropometric Measurements

Necessary calculations were made by measuring height, body weight, lower and upper leg lengths, and whole leg length. Measurements were taken place in the dressing room at the sports facilities of the team before the training. Athletes were asked to take off their shoes and shirts and only wear shorts for the measurements. Athletes' height was measured using a stadiometer with ±0.1 mm precision. For measuring body weight, Japanese-brand Tanita TBF 401 A weighing machine was used. For leg length measurements, the length between an athlete's hip joint and floor while standing was measured with a tape. The upper leg length was measured as the length between the proximal patella and midpoint of the inguinal ligament while in sitting position. Lastly, the lower leg length

was measured as the length between tibial point and medial malleolus point while in cross legged position.

Leg force measurements were made with ±1 pound error using a Lafayette brand strain gauge, and a leg dynamometer consisting of a dynamometer with crystal and sitting panel. Video recordings were made using the Panasonic NV-MS2B camera that can shoot 50 fields per second. The videos were analyzed using the APAS package program. Jumping tests were conducted with a Bosco test device consisting of a microprocessor with a data bank that can measure with a 1 cm error margin and a line connected to it. Sprint times were recorded using a seven-door telemetric timer and a scoreboard system (Prosport, Ankara, Turkey) located at the start, 15m, 20m, 25m, 30m, 35m, and finish (40m) lines.

Testing Procedures

Measurements were conducted on two days. On the first day, height, leg force, jumps, and anthropometric measurements were made, and familiarization practices were conducted. On the second day, sprint measurements were made, and running videos during sprint were recorded. Forty-meters speed test was carried out with the athletes as a pre-study and the photocell doors were placed at the start, 15m, 20m, 25m, 30m, 35m, and finish lines (40m) to determine the five-meters long gap where they reach maximum speed. The sprint values of the athletes were recorded, the periods athletes finished 5-meter long distances after the 15th meter were analyzed, and these periods were checked to determine which gap they reached maximum speed. This process was carried out for every athlete and the gap to reach maximal speed was found. The study found that athletes reached maximal speed between 20 and 25 meters. The athletes one again undergone 40m speed test on another day. The researchers placed the Panasonic NV-MS2B camera that can shoot 50 fields per second between the 20th and 25th meters to record the five-meter gap where they reach maximal speed during this run. The athletes' two full stride lengths where they reached maximal speed were analyzed on the APAS package program with the below-waist analysis method, and their stride lengths on maximal speed were found. Thus, athletes' step frequencies were found by dividing their running times into their stride lengths.

Leg Force Measurements

These measurements were made using 1-sec preparation and 3-sec test method at 90^0 with Strain Gauge leg dynamometer, and the athletes' relative force indexes were calculated by converting pound values into kilograms and dividing to body weights.

$$\text{Leg Force Index} = (\text{Measured Value} * 0{,}454) / \text{Body Weight}$$

Jump tests

Countermovement jump (CMJ): The athletes were made to perform CMJ by making a quick downward movement starting from an upright hands-at-waist standing position, then immediately jumping vertically with maximum force.

Squat jump (SJ): The athletes' stood hands at the waist, the knees at an angle of 90 degrees and without any downward movement, then they jumped upward with maximum force.

Statistical analysis

The data were analyzed on the IBM SPSS 22 package program using descriptive statistics and Spearman's rank correlation coefficient. The study used mean and standard deviation among descriptive statistics because all of the variables were continuous. Since the sample size was smaller than 30, the researchers used Spearman's rank correlation coefficient which is a non-parametric analysis method to determine the correlation between variables. The correlation coefficient (r) can be between −1 and +1, and the minus sign (–) shows a negative correlation while plus sign (+) shows a positive correlation. The correlation coefficient between variables was regarded as very weak when lower than 0.20, as weak when between 0.20 and 0.39, as medium level when between 0.40 and 0.59, as strong when between 0.60 and 0.79, and as very strong when at and above 0.80. The statistical significance level was $p<0.05$.

Table 1. Descriptive Statistics Results of the Participants from the Measurements.

	Descriptive Statistics			
	Minimum	Maximum	Mean	SD
Age (year)	13,00	14,00	13,75	0,44
Height (cm)	138,20	177,90	159,92	10,60
Body Weight(kg)	31,00	62,40	47,94	9,55
15m Sprint (s)	2.31	2.83	2.51	0.14
20m Sprint (s)	2.97	3.53	3.22	0.16
25m Sprint (s)	3.56	4.23	3.89	0.20
30m Sprint (s)	4.19	5.04	4.66	0.26
35m Sprint (s)	5.06	5.82	5.45	0.22
40m Sprint (s)	5.76	6.64	6.21	0.27
Leg Force Index	1.14	2.21	1.66	0.25
Counter Movement Jump (cm)	24.10	42.80	33.97	4.51
Squat Jump (cm)	20.60	37.40	31.30	4.39
Leg Length (cm)	72.25	95.75	85.60	5.89
Lower Leg Length (cm)	36.50	48.25	41.53	2.93
Upper Leg Length (cm)	35.00	46.50	41.18	2.73
Stride Length (m)	1.29	1.73	1.53	0.12
Step Frequency (freq/sec)	3.33	4.84	4.08	0.41

Results

The means and standard deviations of athletes' age, height, body weight, sprint times, leg force index, jumps, leg, lower and upper leg, stride length and step frequency values are shown in the Table 1.

The results of Spearman's correlation analysis between athletes' stride length and other parameters showed a positive strong correlation between stride length and height (r = .644) and leg length (r = .613), a positive medium level correlation between stride length and body weight (r = .592), lower leg length (r = .569), and upper leg length (r = .532). There was a negative medium level correlation between stride length and sprint time in 15m (r = −.484) while there was a negative strong correlation between stride length and step frequency (r = −.880). No significant correlation was found between stride length and other parameters (Table 2).

The results of Spearman's correlational analysis between athletes' step frequency and other parameters showed a negative strong correlation between step

Table 2. Spearman's correlation results for the participants' stride lengths and other parameters

Variables	Stride Length	
	Correlation Coefficient	p
Height (cm)	**.644****	**.002**
Body Weight (kg)	**.502***	**.024**
15m Sprint (sec)	**−.484***	**.031**
20m Sprint (sec)	−.386	.093
25m Sprint (sec)	−.324	.163
30m Sprint (sec)	−.064	.790
35m Sprint (sec)	−.118	.619
40m Sprint (sec)	−.255	.278
Leg Force Index (BW/kg)	−.171	.471
Counter Movement Jump (cm)	−.044	.852
Squat Jump(cm)	.017	.942
Leg Length(cm)	**.613****	**.004**
Lower Leg Length (cm)	**.569****	**.009**
Upper Leg Length (cm)	**.532***	**.016**
Step Frequency (freq/sec)	**−.880****	**.000**

*p < 0.05; **p < 0.01

Table 3. Spearman's correlation results for the participants' step frequency and other parameters

Variables	Step Frequency (freq/sec)	
	Correlation Coefficient	p
Height (cm)	**−.749****	**.000**
Body Weight (kg)	**−.597****	**.005**
15m Sprint (sec)	**.751****	**.000**
20m Sprint (sec)	**.691****	**.001**
25m Sprint (sec)	**.632****	**.003**
30m Sprint (sec)	.357	.122
35m Sprint (sec)	**.460***	**.041**
40m Sprint (sec)	**.635****	**.003**
Leg Force Index (BW/kg)	.149	.531
Counter Movement Jump (cm)	−.211	.371
Squat Jump (cm)	−.151	.525
Leg Length (cm)	**−.658****	**.002**
Lower Leg Length (cm)	**−.658****	**.002**
Upper Leg Length (cm)	**−.575****	**.008**
Stride Length (m)	**−.880****	**.000**

*p < 0.05; **p < 0.01

frequency and height (r = −.749), leg length (r = −.658) and lower leg length (r = −.658), and a negative medium level correlation between step frequency and body weight (r = −.597) and upper leg length (r = −.575). There was a positive strong correlation between step frequency and sprint time in 15m (r = .751), 20m (r = .691), 25m(r = .632) and 40m (r = .635) while a positive medium level correlation with sprint time in 35m (r = .460). No significant correlation was found between step frequency and other parameters (Table 3).

Discussion

This study aimed to determine the running performance in young soccer players. Accordingly, the study examined the correlation between print performance and physical parameters, and stride length and step frequency which are determinants of running performance. The main result of this study showed that there is a significant correlation between stride length and step frequency, and sprint performance. There is a medium level negative correlation between stride length and sprint times. The longer the step length becomes, the shorter the sprint times become. This is an intended situation. On the other hand, there is a statistically significant correlation which is sometimes medium level or strong between step frequency and sprint times but this correlation is positive in this one. In other words, when the step frequency increases, the sprint times also increase. This means longer ground contact times. Çetin, (16) has stated that the ground contact time increased as the step frequency increased. This is not an intended situation. There is a very strong negative correlation between stride length and step frequency. One increases while the other decreases. Salo, Bezodis, Batterham, et al. (23) mentioned that the correlation between step frequency and stride length is generally inversely correlated, and an increase on one of them will probably cause a decrease on the other one because of the negative interaction encountered during the generation of these variables

Written resources on sprint measurements and races show that there is no certainty in terms of the correlation between step frequency and stride length and that some athletes prioritize stride length while some other athletes prioritize step frequency. Biomechanical analysis studies have emphasized that the significance between stride length and step frequency differs. For this reason, more information can be obtained if the same level elite athletes get to be analyzed during a several runs (23). Kuitunen and Komi (24) have shown that the step frequency becomes the dominant factor when the running speed increases from 70% to 100%. Higher step frequency was reported as the biggest difference between three 200 m Olympic finalists. Bezodis, Salo and Kerwin (25) claim that there is a strong correlation between step frequency and running speed while there is a relatively weak correlation between stride length and running speed. On the other hand, Gajer, Thépaut-Mathieu, and Lehénaff (26) have found that better sprinters have longer stride length than slower athletes, and that stride length is significantly correlated to the practicing speed at group level while step frequency is not. Omelko, Fostiak, and Mackala (27) have examined the studies in the literature about

sprint times and found that better sprint times show up with the increase in stride length. Additionally, they have reported about 60 meters sprint times that sprinters increased their stride lengths even between 40th and 60th meters. On the other hand, they have stated that changes in step frequency are less and relatively similar. Hunter, Marshall and McNair (21) have found a strong correlation between sprint speed and stride length and a weak correlation between sprint speed and step frequency. Mackala and Mero (28) have examined whether an increase in step frequency or stride length increases running speed, and found that stride length had a stronger correlation with stride length than step frequency. Tottori, Wakamiya, Shinohara, et al. (29) have determined that step frequency is important for the initial three steps during acceleration for shorter 100 meter sprint times while stride length is important between the 4th and -21st steps. This study found negative correlations between stride length and sprint times in young soccer players. In other words, their sprint times decreased while their stride lengths increased. The athletes' step frequency increased in line with their sprint times, thus, a positive correlation exists between these variables. The study found that short sprint times are related to stride length more than it is related to step frequency. The results of this study are compatible with the related literature to a large extend.

Based on animal studies, Heglund and Taylor (30) have found that increased stride length on various animals refers to the correlation between muscular force and stride length, and that it requires a higher generation of mean muscular force. Weyand et al. (31) have examined sprint performances of humans and found that higher operating speeds were achieved with higher vertical ground reaction forces rather than faster leg movements. Higher mean force generation during contact resulted in quite high stride lengths. The regression analysis has shown that 1.8 fold increase occurred on the highest operating speed with 1.69 fold longer steps (and 0.5 fold bigger mean vertical force generation than body weight) (23). Çetin (16) has stated that training consisting of hill climbing exercises increase the amount of load on the hip extensor muscles to increase the stride length of an athlete and that this increased the impulse of the athlete during the sprint performance conducted on the horizontal ground and was ultimately effective in increasing the stride length. A study performing a combined training (hill climbing and hill descending) using 4° slope determined that 100 meter sprint performance increased based on stride length. This effect of combined training management on maximal speed was because of the positive changes on stride length, in other words, the positive effect of 4° hill climbing training on hip extensor muscles (32) Acceleration increased in direct proportion to the force of muscles which move the hip, knee, and ankle. It should be remembered that reaching high running speeds is possible when the contact time is as short as possible and the maximal impulse is performed in this minimal duration (33, 36).

Being able to sprint and dribble (sprinting with ball) is regarded as critical for the success in the game, and sprinting and dribbling are important components of soccer abilities (37). Various studies (11,38,39) have revealed that the speed of running with a ball determines the best players. Huijgen et al (40) have found that professional young talented players are 0.3 seconds faster than amateur players in 30 meters dribbling performance. It is concluded that dribbling performance during adolescence with the improvement in physical features can help determine the best players for the future.

Conclusion

Stride length is more determinative than step frequency especially in short distance races in terms of running performance in young soccer players. Trainers can concentrate on trainings that develop stride length in sprint practices to improve sprint performance which has an important role in swinging the balance. It should be remembered that stride length is also directly related to force improvement, thus, training on improving muscle force as well as sprint practices should be carried out.

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Original article

The Effect of Sports Attitude on Healthy Lifestyle Behavior in University Students

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Abstract. *Study Objectives:* In this study, it was aimed to determine the effect of university students' sports attitudes on healthy lifestyle behavior and to examine the relationship between these two variables. *Methods:* A total of 749 students who studied in different departments at Bingöl University during the 2019-2020 academic year participated in the study as volunteers (Age: 21.71 ± 2.20). In the research, besides the personal information form, "Healthy Lifestyle Behaviors Scale-II" and "Sports Attitude Scale" were used. In the analysis of the obtained data, Pearson Correlation and Linear Regression analysis were applied using the SPSS package program. *Results:* It was determined that there was a moderate positive relationship between the sports attitude and healthy lifestyle behavior in university students. In addition, it was determined that sports attitude predicted the healthy lifestyle behavior variable by 18%. *Conclusion:* It was seen that students' sports attitudes had a positive effect on healthy lifestyle behaviors. This result shows that students have information about the important roles of sports in health (motivation, stress management, coping with depression, physical ability, regular eating habits, etc.).

Keywords: University student, Sports attitude, Healthy lifestyle behavior

Introduction

The positive interaction between human and sport has continued from the early ages until today. When it is analyzed anthropologically, it is known that the first aim of sports is different. However, one of the main goals in sports today is the desire to live healthy. Individuals' approach to sports and their positive attitudes towards being healthy affect their quality of life positively.

Sports are all the actions that people take to develop and demonstrate their physical, psychological, and intellectual abilities in a predetermined order and certain rules in their activities, alone or collectively (1). Regularly attended sports activities play an important role in being happy individuals and increasing life quality by contributing to the elimination of bad habits, psycho-social strengthening of young people, and prevention of various chronic diseases at a later age with a healthy development (2, 3). Participation of individuals in active physical activities and sports contributes to the development of their characteristics such as self-discipline, fair play, teamwork, leadership skills, as well as their physical, psychological, and social development. In this context gaining a positive attitude towards the sport from an early age is very important (4).

It can be defined as cognitive and emotional preparation, which has the effect of a dynamic effect or a direct effect on the behavior of the individual towards any situation or object that occurs as a result of attitude, experience, and experiences (5). Attitudes are gained through experiences, they continue for a certain period and help the individual understand their environment by ensuring regularity in the interaction between the individual and the object (6). People's behavior in the

face of any event, phenomenon, or situation determines their attitude. For this reason, concrete concepts such as an object, situation, people or groups of people, etc. can be the subject of attitude, as well as abstract concepts such as happiness, anger, sadness or glory, etc. (7). Another concept in which attitude interacts is a sport. Sports attitude can affect people in positive or negative ways, leading to behaviors that result in doing sports or not. Considering the positive effects of sports on people, it is very important to develop healthy attitudes towards sports from an early age.

Health can be defined as not only the absence of illness or disability but also a complete state of well-being in terms of mental, physical, and social aspects. Health understanding today; the family adopts a health-centered care approach that protects, develops, and maintains the health of the individual and the community. Due to this approach, it is aimed to enable the individual to make the right decisions that are necessary for his/her health by adopting the behaviors that will form and maintain a full favor (8).

Healthy lifestyle behaviors aim to improve the individual's general health status at the highest level rather than preventing any disease or disability (9). It is defined as a healthy lifestyle in which an individual chooses, regulates, and controls all behaviors that affect his or her health by choosing appropriate behaviors to improve his or her health capacity while planning daily activities (10).

Walker et al. (1987) gathered healthy lifestyle behaviors under the headings of stress management, the responsibility to protect, and improve health, self-realization, interpersonal relationships, regular physical activity, and balanced nutrition. Stress management is coping with the stressful situations that the individual encounters by using his/her physiological and psychological resources effectively (11). Health responsibility is to increase the health information, take active responsibility, and apply for professional support if necessary, by giving importance to health for the individual to reach a full favor. The main factor that a person needs to feel physically well is a physical activity and the most important issue that must be paid attention to maintain this is eating habits. Nutrition includes adequate and balanced meals created with conscious food selection (12, 13). The nutrients that provide the energy necessary for a long life to grow, develop, healthy and productive should be taken into the body in a sufficient and balanced way without losing their nutritional properties in a way that does not harm health (14). For the individual and the society to reach the targeted quality of life, it is thought that they should make healthy living a life philosophy by increasing their knowledge levels related to these lifestyle behaviors. In this context, university students are important in spreading this lifestyle. Because the university is a healthy, vigorous, dynamic, energetic, and active period for students. This period is very important in the formation of students' personalities in terms of social behavior. For this reason, it is considered that any education to be offered to students in this period should be planned and implemented carefully. Because these trainings will contribute to the physical, psychological, and social development of students.

With this information, determining university students' sports attitudes and healthy lifestyle behaviors, and taking necessary measures can play a key role in raising healthy generations. For this reason, this study, which was carried out to determine the effect of university students' sports attitudes on healthy lifestyle behaviors, aims to provide significant contributions to the literature by developing sports awareness and raising healthy individuals.

Material and Method

Research Model

The study was designed as a cross-sectional quantitative study.

Participants

A total of 749 students who studied in different departments at Bingol University during the 2019-2020 academic year participated in the study as volunteers (Age: 21.71 ± 2.20). While obtaining data from these students, face-to-face survey method was used.

Data Collection

In the research, personal information form of participants, sports attitude, and healthy lifestyle behaviors scale were used as data collection tools.

*Healthy Lifestyle Behaviors Scale-II: T*o measure the health promotion behaviors of the individual in relation to about the healthy lifestyle, the healthy lifestyle behavior scale-2 developed by Walker et al. (1987) and revised by Walker and Hill-Polerecky (1996) was adapted to Turkish by Bahar et al. (2008) (11, 12, 13). It is a 4-point Likert-type scale (1-Never, 2-Sometimes, 3-Frequently, 3-Regularly), consists of 52 items and 6 sub-dimensions (health responsibility, physical activity, nutrition, spiritual development, interpersonal relations, and stress management). The overall score of the scale gives the score of healthy lifestyle behaviors. The lowest score is 52 and the highest score is 208 for the entire scale. While the overall Cronbach alpha reliability coefficient of the scale was .92, it was found in sub-dimensions as health responsibility .77, physical activity .79, nutrition .68, spiritual development .79, interpersonal relations .80, and stress management .64. In the current study, this coefficient was found to be .91 for the overall score of the scale, and it was found in sub-dimensions as health responsibility .76, physical activity .77, nutrition .66, spiritual development .70, interpersonal relations .71, and stress management .61.

Sports Attitude Scale: This scale was developed by entürk (2012) to determine the individual's attitude towards sports (15). The 5-point Likert type (1-Never disagree, 5-Strongly agree) scale consists of 25 items and 3 sub-dimensions (interest in sports, living with sports, doing active sports). The minimum score that can be obtained from the scale is 25 and the maximum score is 125. The high score indicates a high sports attitude. The overall Cronbach alpha reliability coefficient of the scale was found to be .97, and in the sub-dimensions, these coefficients were found to be .98 for interest in sports, .98 for living with sports, and .95 for active sports. In the current study, these coefficients were found to be .92 for the general score of the scale, while in the sub-dimensions it was .84 for interest in sports, .72 for living with sports, and .72 for doing active sports.

Statistical Analysis

SPSS 24 (Statistical Package for Social Science) was used to analyze the obtained data in the research. The skewness and kurtosis values were checked for normality testing of the data. These values were checked and evaluated between −1 and +1 (16). As a result of this evaluation, it was seen that the data showed normal distribution. Accordingly, Pearson Correlation and Linear Regression analysis were used for the statistical evaluation.

Results

The details of the relationship between the sports attitude and the healthy lifestyle behavior of the university students participating in the research and the effects of analysis based on the effect and relation were presented in this section in Table 1-2.

When the result of the pearson correlation analysis was analyzed, it was determined that there was a positive medium relationship between the sub-dimensions of the sports attitude and the sub-dimensions of healthy lifestyle behavior ($p < .01$).

As a result of linear regression analysis to determine the effect of sports attitude on healthy lifestyle behavior, it was determined that sports attitude predicted healthy lifestyle behavior variable by 18% (adj. $R^2 = .180$). In other words, it was observed that the sports attitude had a statistically significant effect on the healthy lifestyle behavior variable ($\beta = .425$; $p < .01$).

Discussion

In this study, which was carried out to determine the effect of the attitudes of the university students participating in the research on the healthy lifestyle behavior and the relationship between them, it was observed that there was a moderate positive relationship between the sports attitudes and the dimensions of healthy lifestyle behavior. In addition, it was determined that sports attitude predicted the healthy lifestyle behavior variable by 18%. It was determined that as the sports attitude level of students increased, the level of healthy

Table 1. Correlation analysis regarding sports attitude and healthy lifestyle behavior level

		1	2	3	4	5	6	7	8	9	10	11
1	r	1										
	p											
2	r	.751**	1									
	p	.000										
3	r	.693**	.657**	1								
	p	.000	.000									
4	r	.882**	.821**	.855**	1							
	p	.000	.000	.000								
5	r	.314**	.313**	.349**	.306**	1						
	p	.000	.000	.000	.000							
6	r	.315**	.357**	.420**	.378**	.640**	1					
	p	.000	.000	.000	.000	.000						
7	r	.312**	.302**	.332**	.302**	.680**	.624**	1				
	p	.000	.000	.000	.000	.000	.000					
8	r	.369**	.385**	.358**	.392**	.413**	.459**	.410**	1			
	p	.000	.000	.000	.000	.000	.000	.000				
9	r	.319**	.338**	.302**	.324**	.420**	.385**	.404**	.618**	1		
	p	.000	.000	.000	.000	.000	.000	.000	.000			
10	r	.323**	.327**	.328**	.314**	.558**	.575**	.585**	.603**	.494**	1	
	p	.000	.000	.000	.000	.000	.000	.000	.000	.000		
11	r	.412**	.430**	.444**	.425**	.795**	.787**	.790**	.744**	.706**	.808**	1
	p	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	

n = 749; **p < .01

1- Interested in Sports; **2-** Living with Sports; **3-** Doing Active Sports; **4-** Sports Attitude (Total); **5-** Health Responsibility; **6-** Physical Activity; **7-** Nutrition; **8-** Spiritual Development; **9-** Interpersonal Relations; **10-** Stress Management; **11-** Healthy Lifestyle Behaviors (Total)

Table 2. The effect of sports attitude on healthy lifestyle behavior

Dependent variable: Health Lifestyle Behavior					
Variable	B	Standard Error	β	t	p
(Constant)	1.656	.068		24.464	.000
Sports Attitude	.010	.001	.425	12.850	.000

R^2 = .181; $_{adj.}R^2$ = .180

F = 165.128; p <.01

lifestyle behavior increased. In line with these results, it is thought that students' awareness of the positive roles of sports on health is sufficient and sports cultures are developed. In addition, it can be said that family, social media, and education was taken at the university and the social environment plays an important role in the sports attitudes and health to become a lifestyle of students. When the literature on the subject is examined, the physical, psychological, social, and cognitive well-being of human health, sustaining their activities, and taking

action; it needs regular exercise to be mobile. In addition, health problems caused by immobility (obesity, body composition disorders, mental problems, premature osteoporosis, low back and back pain, hypertension, bad cholesterol increase, diabetes, musculoskeletal problems, cardiovascular disorders, psycho-social disorders) stated that physical activity and sports have protective and therapeutic properties in their removal (17, 18, 19).

Von Bothmer, and Fridlund (2005) researching university students' motivations for healthy living, being physically active was strongly associated with access to facilities for exercising. One way to promote students 'health would be to create facilities for sporting and calisthenics at university campuses, which could also increase communal physical activity (20). In a study conducted by university students, Söyleyici (2018) found that students who do sports have more positive views on healthy lifestyle behavior total score and interpersonal relawtionships and stress management than their non-sports students, and there is a statistically significant difference between them (21). Hawk et al. (2002) reported that healthy lifestyle behavior scores of students who do regular sports are higher than students who do not do regular sports in their study to examine the level of healthy life behavior among university students (22). In a study conducted by Sarıca (2019) on university students, physical education and sports, physical activity, or wellness, nutrition, etc. during university education. It has been reported that students taking lessons have higher sports attitudes than students who do not take these courses (23). Bailey (2006) stated in his study that he investigated the effect of physical education and sports on students, that students showed improvement in the areas of emotional, cognitive, health development, social, physical, and lifestyles (19). In a study conducted by Kılcı (2019) on high school students, it was determined that attitude towards physical education and sports class has a moderately positive relationship and attitude towards physical education and sports course predicts healthy lifestyle behavior level by 20.6% (24). Koff and Bauman (1997) emphasized that individuals who exercise fitness as physical activity act more consciously about healthy nutrition, develop themselves in stress and time management, and make it a lifestyle (25). In a study conducted by Kılıç (2017) on physical education and sports teachers, it was found that healthy lifestyle behavior levels of teachers who do regular sports and exercise are higher than teachers who do not exercise and exercise regularly (26). In a study conducted by Akarsu (2018) on women, it was observed that there was a positive correlation between physical activity level and healthy lifestyle behaviors (27). Galan et al. (2017) Designing an effective approach to sport for the integration in higher education institutions (the effects of yoga practice), sport for all is an avenue for engaging in developmentally appropriate physical activities designed for students to boost their fitness, gross motor skills, and health as well as form students' reflective ability on motor activity and give them the necessary knowledge, capacity, and skills (28). Kelinske, Mayer, and Chen (2001) reported that university students' participation in sports improved their socialization, competition, health, fitness, and leadership (29). In a study conducted by Yalçın and Ayhan (2020) on women participating in sports activities, physical appearance perfectionism, and psychological well-being had a positive effect on self-confidence. This also contributes to the positive attitude of the participants towards sports and to increase their healthy lifestyle levels accordingly (30).

Conclusion

It was seen that students' sports attitudes had a positive effect on healthy lifestyle behaviors. This shows that students have information about the important roles of sports in health (motivation, stress management, coping with depression, physical ability, regular eating habits, etc.). To make students adopt a healthy lifestyle and make sports a focal point of life, awareness-raising activities and trainings can be held. Since the university period is the transition period from childhood to adulthood and the lifestyle of the individual is formed during this period, if there is no adoption of the habit of doing sports, suitable environments can be created and acquired for this habit.

Conflicts of interest

No potential conflict of interest was reported by the authors.

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Original article

The roles of some agility performance parameters on the linear, single sprint skills of young male basketball and handball players

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Abstract. *Study Objectives:* This study aimed to examine the roles of some agility parameters on the linear, single sprint skills among young male basketball and handball players. *Methods:* The participants in this study were male basketball players (BP) (n = 15, ±SD= 15.30 ± 0.48) and handball players (HP) (n = 32, ± SD = 16.81 ± 1.63) who trained regularly, and a control group (CG) (n = 31, ± SD = 15.87 ± 0.80). They participated in 0 to 30 m linear speed tests, a T test, a 505 agility test, and an Illinois agility test. Changes in direction, side stepping, reversing direction, and running backward were the main sub-parameters of agility performance that constituted the independent variables. A multiple regression analysis was conducted if these independent variables predicted the 0 to10 m, 10 to 30 m, and 0 to 30 m sprint performances separately. One way ANOVA was performed to determine group differences in all the independent variables. *Results:* The ANOVA revealed statistically significant differences between groups for the independent variables ($p < 0.001$). The Tukey HSD test indicated that all three groups significantly differed from each other. *Conclusion:* As a result, it can be concluded that agility parameters contributed to speed skills. It is recommended that the exercises that include agility parameters should be used when designing training, especially in team sports.

Key words: Agility Parameters, Speed, Illinois Agility Test, 505 Agility Test, T Test, Team Sports

Introduction

Because agility is almost the pinnacle of all the physical abilities of an athlete, it cannot easily be defined, but it is a performance parameter that combines speed, strength, coordination, and flexibility skills. Generally speaking, agility is a skill in which reversing, accelerating, and decelerating movements are simultaneously applied in forward–backward–lateral–angular directions in an optimal time (1-4).

Classical agility is defined simply as "the ability to change direction rapidly" (5) or "the ability to change direction rapidly and accurately" (6). Others define agility as "the ability to maintain or control body position while quickly changing direction during a series of movements" (7). Recently, scientific papers from some authors have tried to extend the agility definition by adding "a whole body change of direction as well as rapid movement and changing the direction of body parts" (8).

Speed is a skill where success is traditionally determined by muscle fiber type and innate characteristics, and where training factors partially contribute to its improvement (2). Coordination between the active intramuscular and intermuscular effectiveness in motion is very important in the development of linear speed as a motor characteristic (9). In other words, coordination parameters should not be ignored in speed training to improve linear speed. To that end, speed and agility should be trained together.

Although speed is a component of agility, it must not be confused and be considered equal to agility. Agility should be considered superior to speed, reactions, and coordination abilities. Past researchers defined agility as the ability to change direction, and start or stop movement quickly (9, 10). Newer investigations claim that speed and agility represent independent physical abilities and that their development requires a high degree of muscular specificity (11).

Agility skills have different moving mechanisms than those used by track sprinters, and they are employed more in games of sport and martial arts (12). Agility is needed for changes in direction and is different from straight line speed performance (13). The correct form for evaluating agility must take into consideration rapid changes of direction, acceleration, and stopping quickly. Other components of agility are the acceleration and deceleration movements that involve changes of direction and help improve performance, so they are specific skills that should be trained separately (14).

In reaction speed, acceleration, and continuation of speed sub-forms, a change of direction and reversing direction exercises for agility – and other exercises applied in different directions – are essential, especially for team sports (1,11,15). Sports research concluded that speed is an important component in agility skills, but the old definition of agility is too basic and simplistic. Agility skills have more fundamental components like balance, coordination, the ability to adapt and react to a change in the environment (16). Some specialists consider agility as a complex motor skill and classify agility among mixed physical capabilities (17).

The speed and agility requirements for team sports have been greatly studied in basketball, handball, volleyball, and especially soccer, and significant associations have been found in terms of the performance of related motor skills and their relation to each other (3,18-21). Most researchers consider speed and agility to be complex psychomotor skills (22). Those skills imply moving the whole body as fast as possible, so agility has the extra characteristic of changing direction. When defining speed, most researchers refer to the shortest time required for an object to move through a fixed distance; the definition resembles the definition of velocity but without mentioning the direction of movement (23).

There have been little studies regarding the effect of agility parameters on linear speed in team sports. Therefore, this research was conducted to determine how much the agility performance can predict sprint performance in basketball and handball, where the linear speed effect is profound. In this regard, determining how much the agility parameters contribute to the sprint performance will provide valuable information on guiding the content of training programs.

Material and Methods

Participants

A purposive sampling strategy was adopted whereby basketball and handball players were targeted. Participants of the study consisted of three groups including male athletes aged between 16-18 years old. These groups were a) basketball players (BP; n = 15) who regularly attend to basketball training, b) handball players (HP; n = 32) who regularly attend to handball training, and c) control group (CG; n = 31) who do not attend to any training session (Table 1). Ethical approval for the study was granted from the institutional ethics committee (Decision No: 06/02). Written parental permission was also sought for all participants as they were all under 18 years of age. Only participants who returned written consent forms signed by themselves and their parents or guardians participated in the study.

Experimental Design

Participants were subjected to a 15-minute warm-up protocol before the test, including active stretching, jogging, ABC sprint drills, and incremental running. Subsequently, participants were requested to perform a 30-meter maximal sprint performance twice with a five-minute interval in between.

The participants were asked to perform the Illinois agility test, 505 agility test, and T test twice, with five-minute intervals in between. When evaluating trials with a short duration, time measurements were made with an electronic time measurement system (Microgate REI2, Version 2.2058).

Table 1. Characteristics of the participants

	Basketball (n = 15)		Handball (n = 32)		Control (n = 31)	
	Mean	SD	Mean	SD	Mean	SD
Age (years)	15.30	0.48	16.81	1.63	15.87	0.80
Sports Age (years)	3.80	0.56	6.78	1.89		-
Height (cm)	176.07	7.29	181.66	7.11	174.61	6.25
Body Weight (kg)	69.80	14.00	75.86	11.79	62.92	14.90
Body Fat Ratio (%)	13.36	6.34	11.29	4.54	12.61	6.82
Body Mass Index	22.36	3.25	22.93	2.63	21.66	3.70

Data collection

0 to10m, 10 to 30 m, and 0 to 30 m sprint tests

Three transition gates were placed at the start, and at 10 m and 30 m distances on the racetrack. The best 0 to 10 m, 10 to 30 m, and 0 to 30 m sprint ratings of participants were evaluated (24,25).

Illinois agility test

In addition to the start and finish transition gates on the racetrack, a third gate was also placed at the initial point of slaloms (Figure 1). Participants were assessed for initial sprint-reverse ratings, slalom ratings, then second sprint-reverse ratings, and the total Illinois agility test ratings (24,25).

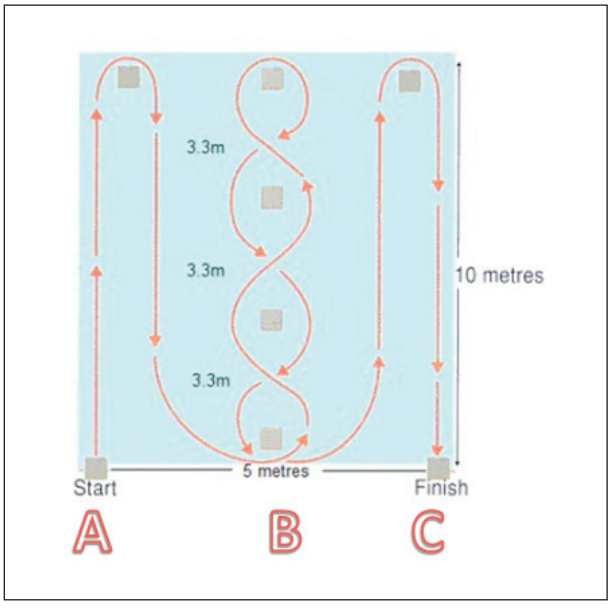

Figure 1. Transition gate locations in the Illinois agility test (A–B–C)

505 agility test

In addition to the single start–finish gate that was available on the original racetrack, a second gate was located at the return point (Figure 2). Participants were assessed first for a sprint transition, then stop, and reverse times and the total 505 test rating (24,25).

T test

In addition to the single start–finish gate that was available on the original racetrack, a second gate was located at the point where participants started side-step movements (Figure 3). Participants were evaluated first for sprint transitions, then side step times, and times for running backward and the total T test rating (24,25).

Statistical analysis

Besides descriptive statistics, One Way ANOVA was performed to determine group differences for all independent variables. A multiple regression analysis was conducted to test if stop and reverse, side stepping, running backward and changes in the direction predicted the linear speed (0 to 10 m sprint), (10 to 30 m sprint), and total sprint (0 to 30 m) performances separately. Firstly, data were screened for multiple regression assumptions. The standard residual analyses were carried out, which showed that the data contained no

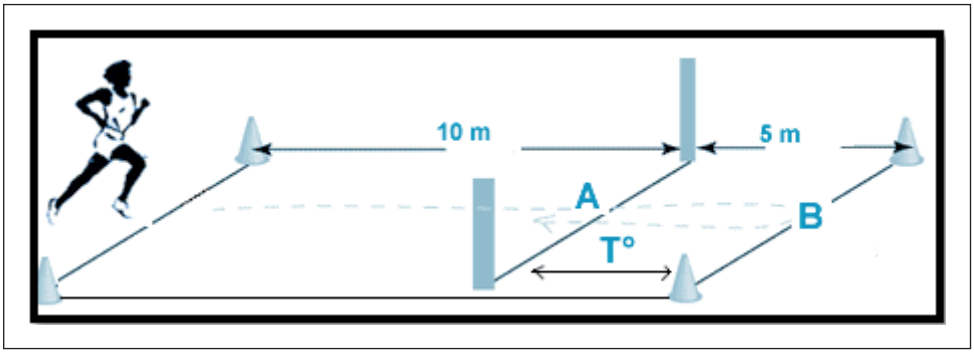

Figure 2. Transition gate locations in the 505 agility test (A–B)

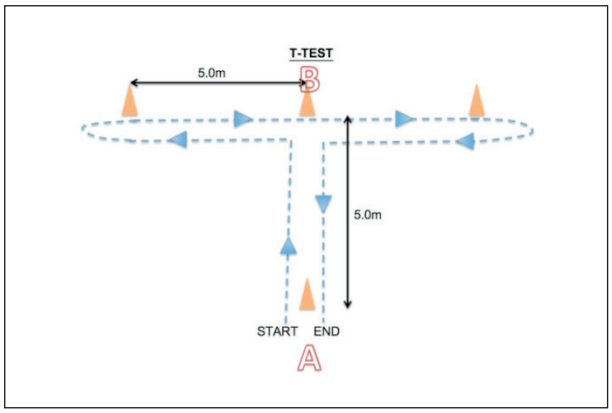

Figure 3. Transition gate locations in T test (A-B)

outliers (Std. residual minimum values ranged from –1.90 to –2.67, Std. residual maximum values ranged from 1.44 to 2.23 for all variables). Both linearity and homoscedasticity assumptions were acceptable according to a scatterplot of the residuals. The ranges for Tolerance (TOL) and the Variance Inflation Factor (VIF) for all independent variables were between 0.32 to 0.71 and 1.40 to 3.09, respectively, and they showed no collinearity. We also found that there was no autocorrelation (*Durbin-Watson* values ranged from 1.72 to 1.99).

Results

Table 2 represents the means and standard deviations of the independent variables, namely stopping and reversing, side stepping, running backward, and change of direction by groups. One Way ANOVA tests revealed statistically significant differences between groups for the independent variables ($p < 0.001$). Post hoc comparisons using the Tukey HSD test indicated that all three groups were significantly different from each other. Inspection of the means showed that handball players had better scores for almost all independent variables except for the change of direction variable in which basketball players were faster than the other two groups. Also, the control group had slower scores than both basketball and handball players.

Multiple regression results indicated that independent variables did not contribute to the prediction of 0 to 10 m, 10 to 30 m, and total sprint (0 to 30 m) performances in the control group (see Table 3, 4, and 5). As seen in Table 3, independent variables explained 69% and 52% of the variance in 0 to 10 m sprint performances for basketball and handball players, respectively ($F_{(4, 10)} = 5.68$, $p < 0.05$; $F_{(4, 27)} = 7.44$, $p < 0.01$). But it was found that only running backward in basketball players ($\beta = 0.53$, $p < 0.05$) and changes of direction in handball players ($\beta = 0.39$, $p < 0.05$) significantly predicted the 0 to 10 m sprint performance.

Results showed that independent variables explained a significant amount of the variance in the values for the 10 to 30 m sprint performance ($F_{(4, 10)} = 7.54$, $p < 0.01$, $R^2 = 0.75$ for basketball players; $F_{(4, 27)} = 11.78$, $p < 0.01$, $R^2 = 0.63$ for handball players (Table 4). Only running backward significantly predicted the 10 to 30 m sprint performance in basketball players ($\beta = 0.59$, $p < 0.02$). Both stopping and reversing ($\beta = 0.29$, $p < 0.05$) and changes of direction ($\beta = 0.35$, $p < 0.05$)

Table 2. Descriptive statistics and One Way ANOVA results for the independent variables

	Basketball (n = 15)		Handball (n = 32)		Control (n = 31)		F
	M	SD	M	SD	M	SD	
Stop and reversing (s)	1.84	0.16	1.69	0.10	2.08	0.16	59.06**
Side stepping (s)	7.06	0.43	6.21	0.36	8.27	0.68	119.81**
Running backward (s)	3.29	0.23	2.91	0.22	3.83	0.51	49.64**
Change of direction (s)	5.91	0.39	6.32	0.35	6.82	0.43	28.77**

**p < 0.001

Table 3. Multiple regression results predicting the 0 to10 m sprint performance for independent variables

Independent Variables	Basketball					Handball					Control				
	B	*SEB*	*β*	*t*	*p*	*B*	*SEB*	*β*	*t*	*p*	*B*	*SEB*	*β*	*t*	*p*
Stopping and reversing	0.25	0.18	.29	1.33	.21	0.13	0.12	.17	1.05	.30	0.17	0.19	.18	0.90	.37
Side stepping	0.10	0.08	.32	1.25	.24	0.01	0.03	.05	0.30	.76	0.01	0.05	.07	0.27	.78
Running backward	0.32	0.12	.53	2.55	.02	0.09	0.05	.28	1.71	.09	−0.01	0.05	−.03	−0.17	.86
Change of direction	−0.07	0.07	−.20	−0.98	.34	0.08	0.04	.39	2.15	.04	0.15	0.09	.44	1.55	.13
R^2			.69					.52					.32		
Adj R^2			.57					.45					.22		
F			5.68* (df: 4.10)					7.44**(df: 4.27)					3.13*(df: 4.26)		

Notes. SEB: Standart error of Beta, df: degrees of freedom, *p < 0.05,**p < 0.01

Table 4. Multiple regression results predicting the 10 to 30 sprint performance for independent variables

Independent Variables	Basketball					Handball					Control				
	B	*SEB*	*β*	*t*	*p*	*B*	*SEB*	*β*	*t*	*p*	*B*	*SEB*	*β*	*t*	*p*
Stopping and reversing	.08	.31	.05	0.26	.79	.42	0.12	.17	1.05	.30	0.17	.04	.28	1.51	.14
Side stepping	.21	.13	.35	1.53	.15	.02	0.03	.05	0.30	.76	0.01	.60	.22	0.92	.36
Running backward	.67	.21	.59	3.15	.01	.17	0.05	.28	1.71	.09	−0.01	.05	.12	0.72	.47
Change of direction	.03	.12	.04	0.25	.80	.13	0.04	.39	2.15	.04	0.15	.03	.28	1.13	.26
R^2			.75					.63					.46		
Adj R^2			.65					.58					.38		
F			5.68* (df: 4.10)					11.78**(df: 4,27)					5.61**(df: 4,26)		

Notes. SEB: Standart error of Beta, df: degrees of freedom, *p < 0.05,**p < 0.01

Table 5. Multiple regression results predicting total sprint (0 to 30 m) performance for independent variables

Independent Variables	Basketball					Handball					Control				
	B	*SEB*	*β*	*t*	*p*	*B*	*SEB*	*β*	*t*	*p*	*B*	*SEB*	*β*	*t*	*p*
Stopping and reversing	.40	.40	.17	1.02	.33	.55	.30	.25	1.82	.07	.84	.57	.27	1.46	.15
Side stepping	.42	.17	.49	2.40	.03	.04	.08	.06	0.47	.64	.14	.17	.20	0.83	.41
Running backward	.87	.27	.53	3.23	.00	.27	.13	.29	2.01	.05	.08	.17	.08	0.46	.64
Change of direction	-.20	.16	-.21	-1.30	.22	.22	.09	.38	2.32	.02	.38	.29	.33	1.30	.20
R^2	.80					.63					.45				
Adj R^2	.72					.57					.37				
F	10.31** (df: 4,10)					11.43**(df: 4,27)					5.44**(df: 4,26)				

Notes. SEB: Standart error of Beta, df: degrees of freedom. **p < 0.01

were significant predictors of 10 to 30 m sprint performance in the handball players. Also, the ability to run backward in predicting the 10 to 30 m sprint performance among handball players approached acceptable levels of statistical significance (p = 0.05).

Results indicated that independent variables accounted for a significant amount of the variance in the value of total sprint (0 to 30 m) performance ($F_{(4, 10)}$ = 10.31, p < 0.01, R^2 = 0.80 for basketball players; $F_{(4, 27)}$ = 11.43, p < 0.01, R^2 = 0.63 for handball players (Table 5). Both side stepping (β = 0.49, p < 0.05) and running backward (β = 0.53, p < 0.01) were significant predictors of total sprint (0 to 30 m) performance in the basketball players. Change of direction was the only predictor for total sprint performance for the handball players.

Discussion and Conclusion

This research was conducted to determine how much the agility parameters predicted the sprint performance in basketball and handball where the linear speed effect was profound. In agility tests, the relationships of the sub-parameters of agility – change of direction, stopping and reversing, side stepping and running backward – with linear speed values were investigated by excluding the total duration.

Examining the statistically significant differences between the groups, in terms of the relevant agility sub-parameter values, handball players had the best values for all parameters except for changes in direction. For the change of direction parameter, basketball players were significantly faster than the other two groups.

For 0 to 10 m sprint performance, it was found that how well basketball players can run backward, and how well handball players can change direction were found to be significant predictors. It was observed that agility sub-parameters were a significant predictor for 10 to 30 m sprint performance, and significant predictors for handball players were found to be the change of direction, stopping and reversing, and running backward, while only running backward was a significant predictor for basketball players. For the 0 to 30 m sprint performance, running backward and side stepping skills determined the performance of basketball players, while change of direction skill was the determining factor for handball players.

Young et al. (1996) could not find a significant relationship between the change of direction and linear speed in soccer players (26-28). Negrete and Brophy (2000) emphasized that acceleration and deceleration differences during the sprint performance before a change of direction were due to the running technique (29).

It was emphasized in some studies in the literature that linear speed and agility performance were not very strongly related, but that speed and agility training must include the requirements specific to the branch of sports involved (26,30-33).

For the same age group as our study, Köklü et al. (2015), performed a study with football players and found a moderately significant relationship between the zig-zag agility test and the 10 and 30 m sprint performance (34).

Chaouachi et al. (2014), in their study carried out with young footballers, emphasized that the relationship between the agility parameters and sprint skill in different directions were improved through game training (35).

In conclusion, it can be said that agility parameters made a positive contribution to speed skills. Particularly in team sports, it is suggested that exercises are employed that include these sub-parameters in training regimes. For high individual performance in team sports in the future, the effect of agility parameters on linear speed should be studied in more depth.

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Conflicts of interest: The authors declare that there is no conflict of interest about this manuscript.

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Original article

Impact of functional speed training on speed-related parameters and performance in youth basketball players

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Abstract. Study Objectives: The purpose of this study was to examine the impact of functional sprint training on the movement components affecting speed in youth basketball players. Methods: The subjects in this study consisted of three groups; a research group ($RG_{,age}$ = 12,5 ± 0,3, n = 16), a basketball group ($BG_{,age}$ = 12,5 ± 0,3, n = 16), and a control group ($CG_{,age}$ = 12,2 ± 0,4, n = 16). In addition to normal basketball training RG performed functional sprint training known as A-B-C training while. BG performed only basketball training. CG did not perform any kind of training. The subjects in the RG and BG carried out a total of 24 training sessions during in eight-week period with 3 times × 45 min´s training per week. All three groups were tested before and after the functional sprint training intervention using a group of well-known agility and sprint tests (Illinois, T-drill, 505 agility test, and a 20-m acceleration test). Results: Differences were found between BG and CG in the percentage of developmental values in 10-20 m ($p < 0.05$) in favor of BG, between RG and both BG and CG in the T-drill and Illinois agility test percentage of developmental values ($p < 0.01$) in favor of RG and between CG and both RG and BG in the 505 agility test percentage of developmental values ($p < 0.05$) against CG. Conclusion: The present findings show that 8 weeks of functional sprint training performed 3 times × 45 min per week had a marked effect on some movement components influencing speed ability in youth basketball players.

Key words: Agility, balance, coordination, sprint technique and mechanics, basketball

Introduction

Speed is one of the motor skills determining in ball games and the player can move himself or an extremity from one place to another at the highest speed. Speed in ball games is a complex movement that includes the ability to perceive and make decisions as quickly as possible and to react quickly to unforeseen situations. In addition, it is correlated with the construction and technique of specific movements, in ball games, it is also important to perform powerful changes in direction while moving quickly over short distances. Thus, speed is directly related to explosive muscle strength (rate of force development), and full recruitment of motor units and high firing rate of the nervous system and under certain conditions to perform motoric movements at the highest intensity and in the shortest possible time (1-2).

The motion components of sprint running include good coordination of the motion, mechanical smoothness, and motion efficiency. Sprint running like the 100m run includes reaction speed, acceleration, maximum speed, and the maintenance of the speed (3). The technique and mechanics of both sprint and agility include the properties needed for motion competence and technique. Acceleration, change of direction, and maximal velocity variables are the three variables related to the sprint technique (1). Agility is a physical skill that includes dynamic balance, coordination, and explosiveness that allows optimal performance of

deceleration, deflecting, and accelerating movements in a very short time (1-4). These agility movements are unique challenging techniques (1). Bilge and Caglar (2016) examined the effect of agility parameters on sprinting skills in basketball and handball where linear velocity is actively used, and they observed that agility parameters contributed positively to velocity (5). Lockie et al. (2014) examined the effects of a traditional speed and agility training program and an enforced stopping program that includes deceleration on multilateral speed and athletic functions (6). It was observed that the traditional training group improved in most of the speed, agility, and strength tests, and the deceleration group improved all values other than the 0-10 and 0-20m sections.

Sprint A-B-C exercises are an integral part of every athlete's warm-up program and are used for coordination and technical training of the athletes. Sprint A-B-C exercises include an athletic training program, technical development, preparation training, increased speed-coordination, improvement of running rhythm, and an increase in required concentration (3-7).

Agility and speed are among the important characteristics of team sports players (8). Ballplayers rarely use straight running in the game, but they often perform movements requiring fast forward, backward, and sideways speed changes. Furthermore, change of direction moves are also applied to react against movements such as ball movements, constantly changing game, and competitor interaction (7). Haugen et al. (2014) studied the role and development of sprinting speed in another ball sport - soccer. They observed that short sprint runs are frequently used in soccer games, especially the movement which is used mostly by assisting and scoring players is a linear sprint run. They emphasized that the sprint training regime similar to the athletics in the world would benefit the players (9).

Agility and speed are crucial to achieving success in many sports (10). Basketball is one of those sports that need speed and acceleration for many features it contains, where different movements need to be utilized in coordination with each other (11–12). The development of an athlete's speed and agility characteristics plays a crucial role to achieve success (13). Sprint A-B-C training is to improve these features and it is noteworthy that these trainings are not given many place in training programs and that there are few studies in the literature investigating the effects of Spring A-B-C training. Therefore, with this study, it is emphasized that sprint A-B-C is important not only for sprinters but also for ball sports players.

Especially in ballplayers training, the application of programs involving speed components followed by agility parameters, which are important components of the anaerobic capacity, will positively affect the overall performance as well as the fitness components (3-13-14). In this study, it is stated that the improvement of the ability of speed and agility of the age of young groups is faster (12).

This study aims to examine the impact of functional sprint training on the movement components affecting speed in youth basketball players.

Material and Methods

Before undertaking the investigation, ethical clearance was obtained from Kırıkkale University Clinical Research Ethics Committee (No: 01/12, 2017).

Participants

Participants of this study consisted of three groups; research group with the mean sports age is 5,18 ± 1,6 ($RG_{,age}$ = 12,49 ± 0.26, n = 16), basketball group with the mean sports age is 4,87 ± 1,5 ($BG_{,age}$ = 12,46 ± 0,34, n = 16) and control group ($CG_{,age}$ = 12,18 ± 0,4, n = 16). RG attended to functional sprint training in addition to the regular basketball training. BG only participated in regular basketball training. The control group (CG) was not trained at all.

Experimental Design

Each test started with a standardized warm-up period before the tests. Then the Illinois agility test, T-drill agility test, 505 agility test, and 20 m acceleration (0-10 m, 10-20 m, 0-20 m) test were performed. All participants received a test in turn and after everybody completed that particular test, the next test was performed. Each test was performed twice and the better score was used for the analyses.

Illinois Agility Run Test

The edge length is 10 m and the horizontal distance between start and finish is 5 m. Four safety cones are placed horizontally at the region between the start and endpoints and 2 more cones are placed at the two turning points. The distance between the cones is 3.3 m. The athlete started from the starting point and followed the path shown in Figure 1 to the finish point, and the running time was recorded (15). The application of the test is shown in Figure 1.

T-Drill Agility Test

Four cones are placed as shown in Figure 1. The distance between A and B is 10 m and the distance between C and B and B and D is 5 m. The participant ran from point A to point B. Then, the participant shuffled sideways from point B to point C, from point C to point D, and from point D to point B. Finally, the participant ran backward from point B to point A. The total duration was recorded (15). The procedure is depicted in Figure 1.

505 Agility Test

The distance between the start point and point B is 10 m and the distance between points B and C is 5m. The participant sprinted from the starting point to point C and ran back to the starting point from after turning around the cone at this point. The total duration was recorded. The test was administered twice and the better result was recorded (15). The application of the test is depicted in Figure 1.

20 Meter Acceleration Test

A photo sensor is placed at 10 m and 20 m distances from the start point. The participant sprinted and the time recorded at 10 m and 20 m. The test was administered twice and the better result was recorded (15). Figure 1 depicts the test procedure.

The training intervention period lasted 8 weeks. RG regularly performed both basketball and functional sprint trainings. Functional sprint training was performed three days a week for 45 minutes a day for eight weeks. The daily training period of the athletes was 90 minutes, half of which was allocated for functional sprint training and the other half was for basketball training. BG performed only basketball training. The training period was 90 minutes which was completely allocated for basketball training. CG did not perform any training program. Pre-tests and post-tests were performed.

Six different groups of materials were used in the preparation of the functional sprint training program.

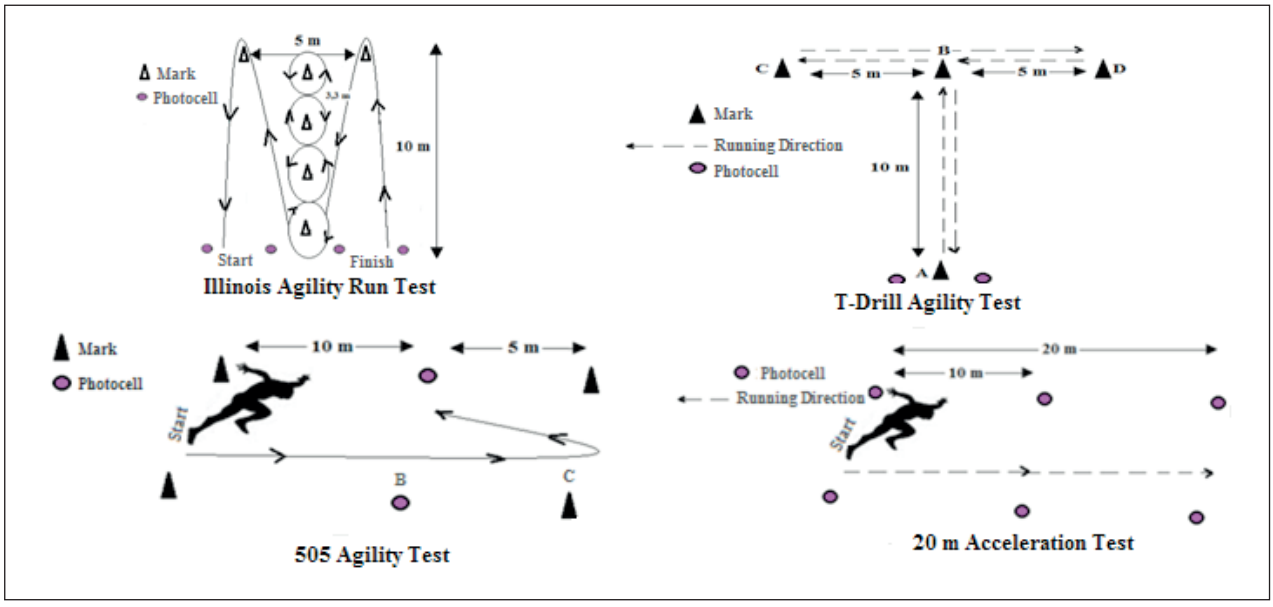

Figure 1. Agility and Acceleration Tests (15)

The materials used were grouped as hoops, obstacles, chocks-step boards, funnels-slalom bars, balls, and without material. For each day of training, a material group was selected predominantly. A total of 12 different daily training programs were prepared, including two different training programs with each material group. Six educational games were designed for warm up at the beginning and one game was played at the beginning of each training session according to the material used. These programs were performed; a different set of programs each day, for the first 4 weeks, and the same program was followed again for the second 4-week period. After the eight week-training program was completed, post-tests were carried out following the same procedure as in the pre-test.

Statistical Analysis

Descriptive statistics were used to describe the obtained data. In addition, normally distributed data were analyzed by one-way ANOVA and non-normally distributed data were analyzed by Kruskal Wallis variance analysis to test the differences between groups. The difference between the pre-test and post-test values of the groups was analyzed by paired samples t-test in normally distributed data, and by Wilcoxon test in non-normally distributed data. The percentages change between pre and post-tests in the agility tests were calculated for each group as there were significant group differences in T-drill, Illinois, and 505 agility pre-test values. These percentage values were used to examine group differences in the dependent variables. One Way ANOVA was conducted to test group differences in normally distributed data and Kruskal Wallis ANOVA was performed in non-normally distributed data. For post-hoc comparisons, Tukey and Dunn's Post-hoc tests were used in normally and non-normally distributed data, respectively.

Results

Wilcoxon test results revealed significant differences between pre-test and post-test values of T-drill, Illinois, and 505 agility tests in RG and BG (Table 1). The post-test values of both groups were significantly lower than those of the pre-test values. No significant differences were found between pre-test and post-test values of T-drill, Illinois, and 505 agility tests in CG.

In the acceleration test of the RG, 10–20 m pre-test and post-test results were significantly different (Table 2). The post-test value was found to be signifi-

Table 1. Wilcoxon test results of the agility pre- and post-test values of the groups

Agility Tests (s)	RG (n = 16)					BG (n = 16)					CG (n = 16)				
	Pre-test	Post-test				Pre-test	Post-test				Pre-test	Post-test			
	Sd	Sd	*z*	*p*		Sd	Sd	*z*	*p*		Sd	Sd	*z*	*p*	
T-drill	0.69	10.94	0.60	−3.51	**.000***	12.41	0.88	11.76	0.96	−3.41	**.001***	14.45	1.05	14.11	1.00	−2.50	.072
Illinois	0.78	16.63	0.97	−3.40	**.001***	18.56	0.78	17.67	0.99	−3.51	**.001***	19.77	0.86	19.62	0.81	−1.68	.093
505	0.16	2.59	0.13	−3.09	**.002***	2.97	0.54	2.71	0.20	−3.18	**.001***	3.15	0.17	3.15	0.14	−0.25	.798

*p < 0.01

Table 2. Paired samples t-test results regarding the acceleration pre- and post-test values of the groups

20m acceleration test	RG (n = 16)						BG (n = 16)						CG (n = 16)					
	Pre-test		Post-test				Pre-test		Post-test				Pre-test		Post-test			
		Sd		Sd	t	p		Sd		Sd	t	p		Sd	M	Sd	t	p
0–10m (s)	2.10	011	2.12	0.14	−0.50	.621	2.10	0.12	2.16	0.10	−2.95	**.010***	2.30	0.08	2.36	0.13	−1.78	.094
10–20 m (s)	1.63	0.09	1.58	0.10	3.01	**.009***	1.66	0.10	1.60	0.11	3.06	**.008***	1.80	0.13	1.79	0.13	0.39	.701
0–20 m (s)	3.76	0.19	3.72	0.21	1.36	.194	3.77	0.21	3.77	0.19	−0.20	.842	4.11	0.20	4.17	0.22	−1.61	.127

*p < 0.01

Table 3. Kruskal Wallis test results for the percentage change test values of the groups

Tests	RG (n = 16)		BG (n = 16)		CG (n = 16)			
		Sd		Sd		Sd	χ^2	p
0–10 m (s)	−0.90	6.39	−3.14	4.30	−2.45	5.36	0.63	.728
10–20 m (s)	2.99	3.91	3.42	4.34	0.22	2.88	6.87	**.032****
0–20 m (s)	1.19	3.65	−0.19	2.66	−1.51	3.63	3.56	.169
T-Drill Agility Test (s)	12.41	3.39	5.27	4.36	2.34	3.28	26.89	**.001***
505 Agility Test (s)	4.97	4.46	7.25	10.46	0.04	4.93	8.53	.014

*p < 0.01, **p < 0.05

cantly lower than the pre-test value. As for the BG, 10–20 m, and 0–10 m pre-test and post-test values were significantly different. It is seen that the 0–10 m post-test value was higher than the pre-test value, and the 10–20 m post-test value was lower than the pre-test value. There was no significant difference between pre-test and post-test values of CG in the acceleration test.

Kruskal Wallis test results showed significant group differences in the percentage change values of 10–20 m, T-drill agility, and 505 agility tests (Table 3). Dunns' post-hoc comparison test, indicated a significant difference between BG and CG in the percentage change values for the 10–20 m section. These values of BG were found to be higher than those of CG. In addition, a significant difference was found between RG and both BG and CG in the percentage change values of the T-drill agility test. It was observed that the highest change was in RG, whereas there was little change in BG and CG. Furthermore, there was a significant difference between CG and both RG and BG in the percentage change values of the 505 agility test. There was a greater change in RG and BG than that in CG.

One-way ANOVA revealed that there was a significant difference between the three groups in the percentage change of the Illinois agility test results (Table 4). The Tukey test indicated that there was a difference among all three groups. Inspection of the means showed that the highest percentage change was in RG and the lowest one was in CG.

Table 4. ANOVA results for the percentage change values of Illinois Agility test

Group		Sd	F	P
RG (n = 16)	10.27	4.20		
BG (n = 16)	4.82	2.50	36.30	**.001***
CG (n = 16)	0.74	2.49		

*p < 0.01

Discussion and Conclusion

The aim of the present study was to examine the effect of functional sprint training performed in 12–13-year-old basketball players on the components of movement affecting speed. The present study found that there was a significant improvement in the post-test values of agility and 10–20 m part of the 20 m acceleration tests after sprint A-B-C trainings in both RG and BG. However, inspection of percentage changes indicated that RG exhibited greater improvement in T-drill and Illinois agility test values than BG. This finding broadly supports the work of other studies in this area linking agility with sprint. For example, Asadi (2016) examined the relationship between leaping ability, agility, and sprint running of young basketball players, and reported that there were strong links between sprint and agility, leap and agility, and leap and sprint performances (16). Also Bilge and Caglar (2016) investigated the effect of agility parameters on sprinting skills in basketball and handball where linear movements are effectively used, and found that agility parameters contributed positively to speed performance (5).

The exercise program and Sprint A-B-C exercises utilized in the present study included exercises that are included in various training programs, such as ladder drills, coordination training, or plyometric training, and these exercises may have been influential in their improvement values. Suna et al. (2016) examined the

effect of coordination training on speed, balance, and agility characteristics of children tennis players (17). Before and after the training, the Illinois agility test, Flamingo balance test, and 5 and 10 m sprint tests were performed, and as a result, they reported that coordination training significantly improved all three features. Kusnanik and Rattray (2017) investigated the effects of agility ladder, speed sprint, and repeated sprint training exercises on agility and speed development (18). Participants were divided into 3 groups: those practicing the ladder exercise, those practicing the repeated sprinting ability exercises, and controls. For speed and agility measurements, the 30 m sprint test and the Illinois sprint test were used, and according to the results, it was observed that ladder and repeated sprinting ability training had a significant effect on agility and speed. However, although both training modes increased agility and speed, the improvement was greater in the repeat sprint ability group compared to the ladder exercise group. Zemkova and Hamar (2010) investigated the effects of a 6-week combined agility-balance exercises on basketball players' neuromuscular performance and found that these exercises improved open and closed dynamic balance, agility performance, contact time, and the ability to differentiate the force of muscle contraction during repeated jumps (19). Chaalali et al. (2016) compared agility training and change of direction drills administered to young elite soccer players and examined the effect of these trainings and drills on straight sprint, change of direction, and agility tests (20). According to the results, the agility group showed more improvement in the reactive agility test (with and without a ball) and the change of direction group showed more improvement in the 505 agility test and the 15m agility test, and the authors emphasized that both training programs improved the straight sprint ability. Asadi (2013) investigated the impact of the plyometric training program on leap and agility in young male basketball players (21). According to the test results, the plyometric training group showed a significant improvement in leap and agility. Rameshkannan et al. (2014) investigated the effect of plyometric training on the agility performance of male handball players and reported that plyometric training is effective and improved agility (22).

In this study, basketball, study, and control groups were composed of 12–13-year-old basketball players and students. In addition to the agility tests administered in the study, the 20 m acceleration test showed improvement in the range of 10–20 m and no significant improvement was observed in 0–10 and 0–20 m ranges. Rumpf et al. (2016) investigated the effects of specific (free sprinting; resisted sprinting by sleds, bands, or incline running; assisted sprinting with a towing device or a downhill slope), nonspecific (resistance and plyometric training), and combined (a combination of specific and nonspecific) training methods on different sprint distances (0–10, 0–20, 0–30, and 31+ m), and reported that the greatest improvement was in 31+ m for specific and nonspecific training methods, and on 0-10 m for the combined training method (23). Lockie et al. (2014) examined the effect of the enforced stopping speed and agility training program (including traditional speed and agility program as well as deceleration) on multidirectional speed and athletic function and found that the traditional training provided improvements in speed, agility, and most of the strength tests and that the deceleration training was effective in all scores other than 0–10 and 0–20m scores (6). Jakovljevic et al. (2012) compared the speed and agility characteristics of 12- and 14-year-old elite male basketball players (24). They also examined the relationship between speed and agility for both age groups. Compared to 12-year-old players, 14-year-old players were better at all of the tests of agility and speed. They observed that 12-year-old players had the same ability in 30m and 50m runs, and different qualities in 20m and 30m runs.

As a result, it is seen that different training programs involving functional speed exercises are effective on agility and speed. It can be concluded that the training program administered in the present study is effective on components such as the agility parameters affecting speed.

Some limitations of the present study should be addressed. First, the findings may be relevant for male in a team of study, which limits the generalizability of the results if considering the study is applied to a specific team. It should also be noted that this study was

conducted in Ankara, the capital city of Turkey, which has more sport and technology facilities compared to other Turkish cities. The second limitation of this study is the cross-sectional design. Irrespective of these limitations, the strength of this study is it is one of the first studies on functional speed training.

In this present study, an 8-week functional sprint training program which has affected the development of movement components and aiming at the development of movement has been searched through pre-test and post-tests. The findings showed that RG exhibited the greatest development in Illinois and T-drill agility tests than BG. In addition, for the RG and BG groups, improvement was observed in the 505 agility test and the 10-20 m range of the 20 m acceleration test.

As a result, the 8-week functional sprint training is effective on components such as agility parameters affecting speed. Basketball is one of the sports that accommodate many agility parameters. Along with technical development, the development of speed and agility is crucial for success. The less energy spent on speed and agility movements in the game means more energy is left for technical application. For this reason, it is recommended to include this type of practice in basketball trainings.

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Conflicts of interest: The authors declare that there is no conflict of interest about this manuscript.

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Original article

The investigation of the weight loss methods and effects on the elite U23 wrestlers

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Abstract. *Study Objectives:* The weight loss in sports is a method that has been implemented so much in several championships for a long time. It is thought that the athletes will be more successful in a lower weight and are considered to be effective, but it is underestimated that the unconscious weight loss causes health problems and negative effects on organisms. In this study, it was aimed to investigate weight loss methods and effects on elite wrestlers and determining the difference between Free-Style and Greco-Roman style. *Methods:* The research consists of a total of 97 wrestlers, who are in the U23 Turkish National Team category and lose weight before the competition. For determining the weight loss methods and effects on a wrestler, "The athlete's weight loss method and effects scale" was used. Mann-Whitney U test was used for comparison of Free-Style and Greco-Roman style wrestlers' weight loss methods and effects scale scores. *Results:* Although there was no significant difference between Greco-Roman and Free-Style wrestlers in the psychological effect, ergogenic aids, diet, and fluid loss sub-dimensions, physiological effect sub-dimension mean were statistically significant between Free-Style and Greco-Roman wrestlers ($p<0.05$). *Conclusion:* As a result, it was found that wrestlers in both groups (Greco-Roman and Free-Style) had more muscle spasms, respiratory disorders, heart palpitations, and injuries with weight loss. It was also found that both Free-Style and Greco-Roman wrestlers preferred to reduce fat consumption and run with raincoats, as a weight loss method.

Keywords: Weight loss methods, wrestling, competition

Introduction

Wrestling, boxing, karate, taekwondo, and judo sports are called weight sports (1). Athletes in weight sports, apply various methods in order to lose weight suddenly, adversely affecting their health and success in these methods (2). Weight loss methods, which are common in competitive sports in the competition period, have been observed as a method since the 1924 Paris Olympics (3). The weight loss is actually an application of the athlete with the hope of being more successful by losing his/her ideal weight to a lower weight classification. In addition to this, it is thought to reveal several disadvantages (2). It is considered that losing weight is not a precise and correct method of success. In weight sports, the biggest problems of athletes are to adjust their weight to competition weights (4). Athletes who control their weight during the competition period, heavier athletes quickly lose weight since they must be in the competition weight at the time of the competition. It is stated that the athletes should keep the consumed and intake calories equal while

performing weight control as the main factor with the training performed during the competition period (5).

The negative effects of short-term weight loss before the competition on athlete's performances were demonstrated through national and international scientific studies. Today, weight athletes, unconsciously applying weight adjustment methods, adjust their weights by various methods without taking any support from a nutritionist. It is thought that random diet arrangements, the reduction of the taken fluid, and various fluid loss methods are the principal weight loss methods (2). It is stated that one of the most common situations in sports competitions and training is dehydration. Dehydration can cause muscle cramps, weakness, temperature regulation mechanisms, fast fatigue, imbalance in electrolytes, and disturbance of concentration (6). If the lack of fluid in the human body is not adequately replaced, not only sportive performance will decrease but also serious health problems resulted from even death may arise (7). The aim of the study was to determine whether there is a difference between Free-Style and Greco-Roman wrestler's weight loss methods and effects, in the U23 wrestling national team.

Material and Methods

Participants

The research consists of a total of 100 (50 male Free-Style, and 50 male Greco-Roman) wrestlers, who are in the U23 Turkish National Team category and lose weight before the competition. Because of 3 Free-Style wrestlers who participated in the study were not filled the questionnaires validly, these 3 questionnaires were not included in the study.

Data Collection

"The athlete's weight loss method and effects scale" developed by Yarar et al. (2016) (8) was used as a data collection tool. The scale is a 5-point Likert type scale (1=Never, 2=Rarely, 3=Sometimes, 4=Often, and 5=Always) consisting of 19 items divided into five sub-dimensions. The scale consists of two parts; the first part of the scale, includes demographic questions about the participants, and the second part includes 5 sub-dimensions (19 items) related to weight loss methods and effects. These 5 sub-dimensions are explained below.

Physiological Effect: This sub-dimension is related to the degree of athletes whether they have muscle cramps, heartbeat, breathing difficulties, disability, and body temperature increase and physiological effects while weight losing (Item 10,11,12,13,14).

Psychological Effect: In this sub-dimension, the situation of the athlete about how they feel psychologically about the desire to do sports, irritability, fatigue, stress status, and performance levels while weight losing (Item 15,16,17,18,19).

Ergogenic Support: This sub-dimension measures weight loss methods, and usage of diuretics, diet pills, etc. It measures the degree of use of chemical substances (Item 7,8,9).

Diet: In this sub-dimension, the level of fat consumption, carbohydrates consumption, and food consumption are measured while weight losing (Item 1,2,3).

Dehydration: In this sub-dimension, it is measured how much the athlete tends to weight loss by using the sauna, spitting, and running with a raincoat (Item 4,5,6).

The data was obtained in the U23 Turkish National Team camp in Istanbul Sarıyer and Ankara Elmadağ. Before applying the scale, necessary permission was obtained from national team coaches.

Statistical Analysis

Statistical analysis of the obtained data was performed with the SPSS 24 package program. Arithmetic means (X), standard deviations (Sd), percentage (%), and frequency were given as descriptive statistics. The normality distribution of the data was conducted through the Kolmogorov-Smirnov test and it was found that the data did not have a normal distribution. Mann-Whitney U test, which is one of the non-parametric tests, was used to compare the sub-dimension scores of Free-Style and Greco-Roman wrestlers. The significance level was accepted as $p < 0.05$.

Results

It was determined that the wrestlers' first weight loss age was 14. In addition, it was determined that the mean weight loss lost for a competition was 6 kg and they lost a mean of 3-4 times in a season (Table 1).

Table 2 showed that Free-Style and Greco-Roman wrestlers are reported that they started weight loss in the last 2 weeks before the competition, checked their weights several times a week, had difficulty while losing weight, and were successful in most of the competitions.

Table 3 showed the results of the comparison of sub-dimensions scores according to wrestling styles. According to the wrestling style, a significant difference was found in favor of Free-Style wrestlers in the physiological effect sub-dimension ($p<0.05$).

Table 1. Mean and prevalence of variables related to a weight loss of Free-Style and Greco-Roman wrestlers.

Questions	Style	N	$\overline{X}$	Sd	Min.	Max.
How old were you when you first lost weight?	Free-Style	47	14,47	2,19	10	20
	Greco-Roman	50	14,00	1,67	11	18
How many kilos have you loss in a competition during your sports life?	Free-Style	47	5,98	2,15	2	11
	Greco-Roman	50	5,91	2,52	2	12
How many times do you weight loss in a season?	Free-Style	47	3,21	1,55	1	8
	Greco-Roman	50	3,62	3,00	1	20

Table 2. Frequency distribution of Free-Style and Greco-Roman wrestlers related to weight loss

Variables	Group	Free-Style		Greco-Roman	
		f	%	f	%
How many days before the competition do you start to weight lose?	1-2 days ago	1	2,1	2	4
	3-5 days ago	4	8,5	3	6
	In the last week	9	19,1	5	10
	In the last 2 weeks	21	44,7	21	42
	3-4 weeksbefore the match	9	19,1	15	30
	More than 1 month	3	6,4	4	8
	Total	47	100	50	100
How often do you check your weight?	Everyday	15	31,9	20	40
	Several times a week	23	48,9	27	54
	Several times a month	4	8,5	1	2
	Once a month	4	8,5	2	4
	Several times a year	1	2,1	0	0
	Once a year	0	0	0	0
	Total	47	100	50	100
Do you have difficulty while losing weight?	Yes	33	70,2	26	52
	No	14	29,8	24	48
	Total	47	100	50	100
What is your success in competitions when you have lost weight?	I have been successful in none of them.	0	0	1	2
	I have not been successful in many of them	10	21,3	8	16
	I have been successful in many of them	37	78,7	39	78
	I have been successful in all of them.	0	0	2	4
	Total	47	100	50	100

Table 3. Comparison of sub-dimensions according to wrestling styles -Mann Whitney U-

Sub-dimensions	Group	N	Mean Rank	Sum of Ranks	z	p
Physiological Effect	Free-Style	47	56,31	2646,50	-2,491	**0,01***
	Greco-Roman	50	42,13	2106,50		
Psychological Effect	Free-Style	47	52,64	2474,00	-1,238	0,22
	Greco-Roman	50	45,58	2279,00		
Ergogenic Aids	Free-Style	47	49,72	2337,00	-0,380	0,70
	Greco-Roman	50	48,32	2416,00		
Diet	Free-Style	47	50,54	2375,50	-0,529	0,60
	Greco-Roman	50	47,55	2377,50		
Fluid lose	Free-Style	47	53,55	2517,00	-1,564	0,12
	Greco-Roman	50	44,72	2236,00		

*p<0,05

According to the findings, Free-Style wrestlers are significantly more physiologically affected than Greco-Roman wrestlers. There is no significant difference in terms of other sub-dimensions (p>0,05).

Discussion and Conclusion

The aim of the study was to determine whether there is a difference between Free-Style and Greco-Roman wrestler's weight loss methods and effects, in the U23 Wrestling National Team. In this study, it was found that the mean of first weight loss age were 14.47 ± 2.19 years in Free-Style wrestlers and 14.28 ± 1.67 years in Greco-Roman wrestlers. In the studies in which the first weight loss age of the athletes was determined, it was found the wrestler's first weight loss experience was 14 years old (9). In a similar study, Farhan et al. (2014) determined the first weight loss ages of Free-Style and Greco-Roman wrestlers as 14.03 and 14.53, respectively (10). In another study, Bradley (2006) found the mean first weight loss age of male wrestlers to be 15,5 years and 15,1 years for women (11). Oppliger et al. (2003) determined the mean weight loss age of the wrestlers as 13.7 years (12), while Yarar et al. (2017) determined as 14.37 years (13). The results of the studies mentioned above are similar to the results of this study.

In the study, it was determined that 44.7% of Free-Style wrestlers and 42.0% of Greco-Roman wrestlers lose weight within the last two weeks before the competition date. In a similar study, Brito et al. (2012) found that the athletes in the judo branch started to lose weight 14.5 days, the athletes in the karate branch started to weight lose 14.8 days before, and the athletes in the taekwondo branch started to weight lose approximately 9.7 days before the competition (14). In the study of Yarar et al. (2017) on wrestlers, most of the wrestlers found that they lost weight within the last two weeks before the competition date (13).

In this study, it was found that Free-Style wrestlers lost a mean of 5.98 ± 2.15 kg of Greco-Roman style and a mean of 5.91 ± 2.52 kg weight. Bradley (2006) determined that the most weight loss was 7,0 kg for male wrestlers and 6,2 kg for female wrestlers (11). Artioli et al. (2010) reported that the most weight loss was 4 kg, the mean weight loss was 1,6 kg in their study on 3 judokas (15). In another study on combat athletes, Andreato et al. (2014) reported that the most weight loss was 7,6 kg and the mean weight loss was 5 kg (16). In a similar study, Farhan et al. (2014) found the most weight loss in wrestlers as 3.58 kg in Free-Style and 3.06 kg in Greco-Roman (10). Yarar et al. (2017) found the most weight loss of 5.72 kg in their study on wrestlers (13). Considering the findings in both the literature and this study, it can be said that the wrestlers change the weights greatly. Yağmur et al. (2019) stated that 47.9% of the wrestlers lost weight, and lost 4.68% of their total body weight (17). In a study by Yağmur et al. (2019) 45% of the wrestlers were exposed

to dehydration while weight loss and those exposed to dehydration lost 4.55% of their body weight (18).

In this study, it has been determined that the majority of both Free-Style and Greco-Roman wrestlers do not use laxative, diet, and diuretic pills, which are considered as ergogenic support that cause rapid weight loss.

The World Anti-Doping Agency (WADA) and the International Olympic Committee (IOC) have set up a list of prohibited substances in sports, and athletes using these substances are punished (19). Therefore, it is thought that the vast majority of wrestlers do not use such items. Similarly, it supports the results of the studies conducted in (8,10,11,14,16,20,21), and it has been observed that athletes do not prefer very much such practices. Yarar et al. (2017) stated that wrestlers generally used weight loss methods such as restricting food intake, running with a raincoat, and reducing fat consumption (13).

In the study, it was found that 14.9% of Free-Style wrestlers had muscle cramps at the end of weight loss, 25.6% Free-Style wrestlers had increasing body temperature. It is stated that 40.5% of Free-Style wrestlers become overly angry, 36.2% of Free-Style wrestlers feel extreme fatigue, 21.3% of Free-Style wrestlers' performance decreased, 27.6% of Free-Style wrestlers get stressed, and 19.2% of Free-Style wrestlers' doing sports desire decreased after weight loss. It is stated that 34% of Greco-Roman wrestlers become overly angry, 22% of Greco-Roman wrestlers feel extreme fatigue, 24% of Greco-Roman wrestlers get stressed, and 16% of Greco-Roman wrestlers' doing sports desire decreased after weight loss.

Considering the physiological and psychological effects of weight loss, Kılıç (1998) stated that wrestlers in the cadet category (15-16 age group) lost weight in a short period (2). Kordi et al. (2001) stated that 77% of the wrestlers had negative effects because of rapid weight loss (5). Alpay et al. (2015) stated in their study on elite wrestlers that they had negative effects as an increase in blood urea nitrogen, sodium, and plasma osmolarity levels of wrestlers who lost weight by examining the body composition and some mineral levels of the two groups of wrestlers (21). Isık (2015) stated that wrestlers who lost weight had skeletal muscle damage (22). Isık and Dogan (2017) determined that weight loss for female wrestlers were mildly depressed (23). Yarar et al. (2017) found that high weight loss caused excessive irritability on wrestlers (13). Considering the studies related to performance after short-term weight loss, they found that there was muscle strength loss (24), shortened performance time (25), and a decrease in VO2Max, which is the most important of endurance performance indicators (8,26,27,28).

As a result of the study, it was found that both Free-Style and Greco-Roman wrestlers started to lose weight in 2 weeks before the competition, their first weight loss age means approximately 14 years, they lose a maximum of 6 kg and this was a negative factor on the sports performance. It was determined that wrestlers in Free-Style and Greco-Roman style preferred to decrease their fat consumption and running in raincoats as weight loss methods. In addition, it was determined that Free-Style wrestlers were more physiologically affected than Greco-Roman wrestlers. This negative effect is thought to be due to the fact that Free-Style wrestlers participated in different wrestling competitions, such as various traditional or local, throughout the year more than Greco-Roman and could not have sufficient rest.

In order to protect wrestlers from the negative effects of rapid weight loss, they need to do weight loss practices in more a long time and gradually. In addition, they can check whether they are exposed to dehydration in weight loss using simple hydration level determination methods (e.g. urine specific gravity). Finally, it can be suggested that they reduce the negative physiological effects in weight loss by methods such as water, isotonic beverage, and mineral supplements.

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Conflicts of interest: The authors declare that there is no conflict of interest about this manuscript.

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Original article

The Effect of Calisthenics Exercises on Body Composition in Soccer Players

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Abstract. *Study Objectives:* The purpose of the study was to examine the effect of calisthenics exercises on body composition in soccer players.*Methods:*18 male soccer players with ages of 18,16±1,04 years, height 174,94±7,68 m, body weight 69,99±8,68 kg participated in the study voluntarily. The soccer players participating in the study were randomly divided into 2 groups. 9 soccer players in the calisthenics exercises group (CEG) performed calisthenics exercise and soccer training, and 9 soccer players in the control group (CG) performed only soccer training. The study lasted a total of 8 weeks, with 3 workouts per week. Analysis of intergroup, intragroup, and the effect of training were carried out with repeated measures ANOVA. Significance was set at 0.05. *Results:* While there was no difference in the BMR and TBW of the subjects, there was a difference in pre and post-test measurements of body composition such as BW, BMI, FP, FM, and FFM. In comparison of pre and post-test changes of upper extremities between groups, there was a significant difference in the all variables of the subjects in pre and post-test measurements of RAFP, RAFM, RAFFM, LAFP, LAFM, and LAFFM in terms of inter-group, intra-group, and group*test interaction. In comparison of pre and post-test changes of lower extremities between groups, there was no difference in the RLFP of the subjects; there was a significant difference pre and post-test measurements of body composition such as RLFM, RLFFM, LLFP, LLFM, and LLFFM. *Conclusion:* It can be said that an 8-week calisthenics exercise can provide positive development of the whole body composition of soccer players.

Keywords: Soccer players, calisthenics exercise, body composition.

Introduction

Football was described as an intermittent sport (1) in which physically demanding, high-intensity actions like changing direction, jumping, and sprinting were important factors for competitive success in both young players (2) and adult (3). Performance in football is determined by physiological, psychological, biomechanical, and environmental factors. Physiological factors include five components of health-related fitness (body composition, cardio respiratory fitness, muscular strength, endurance, and flexibility) and sport-specific characteristics like speed and reaction time (4). In recent years, the health benefits of football have been extensively researched (5-6). Some studies showed that the physiological load during recreational football training (7) was similar to what observed in high-level male elite players (8), and football training 2–3 times per week during one hour for 12 weeks was shown to improve cardiovascular risk profile, VO_2max, muscle mass and reduce body fat percentage (BFP) in a group of untrained males (9). Body composition is considered as a key fitness element relevant to football player performance and in professional football, it is traditionally evaluated several times throughout the season to monitor the efficacy of training and nutrition. Besides,

non-optimal body composition may adversely influence football performance and the risk of injury (10). Excessive fat mass will load the football player with extra body weight, potentially affecting power output and demanding greater energy expenditure during the game (11). It is important to recognize that considerable individual differences in low and high levels of body fat occur between players and this might play a bigger role in optimal performance potential than generalizations about body fat itself. Although today's professional football players are not considered excessively fat, there is continuous pressure by coaches, physiotherapists, managers, and sports scientists to reduce players (ranging from professional to academy) body fat to minimum levels in the knowledge that low levels of body fat can enable them to perform more effectively (12). Since weight control is seen as very important in today's football, the training that provides this should be applied to the players. One of these types of training is considered as calisthenics exercises.

Calisthenic is a type of exercise that consists of a variety of movements that are practically performed without the need for equipment or apparatus that use your body weight. It is designed to increase body flexibility and strength through movements such as swinging, twisting, jumping, kicking, or bending; uses only body weight for resistance (13). There are many different variations such as different gymnastic movements, bounce exercises, push-ups, shuttle, pull-up, lunge, plank, squat, step up, crunch, dips, plyojack, burpee, and mountain climber. There are studies in the literature that convey the positive effects of calisthenics exercises on body composition (14), maxVO^2 (15-16), flexibility, anaerobic power, aerobic capacity, leg strength (17), power, flexibility, blood pressure, resting pulse (18), total cholesterol, triglycerides, systolic-diastolic blood pressure and decrease in obesity rates (19). Also studies are reporting that calisthenics exercises reduce the negative effects of fatigue, insomnia, difficulty concentrating, and depression (16). Regular exercise has an important role in obesity, hyperglycemia, LDL, blood pressure. Cardiovascular output and blood flow to working muscles are increasing throughout physical activity (19). In addition, simple motor skills have an impact on performance (20).

The aim of this study was to the investigate effect of the calisthenics exercises on body composition in soccer players.

Material and Method

Participants

After the pre-test period, 18 football players were divided into two groups; 9 calisthenics exercises group (CEG) and 9 control group (CG). For the sake of no difference between the groups in terms of both physical and physiological terms; the final state of the groups was determined in the form of 9 CEG (age=18,22±1,09 years, height=176,55±5,67 cm, weight=69,82±6,23 kg), 9 CG (age=18,11±1,05 years, height=173,88±9,51 cm, weight=70,16±8,90 kg). In addition, volunteer approval form was obtained from each player to participate in the study.

Procedures

During the training phase of the study, subjects were applied for an 8-week calisthenics exercises program, except for their training days. During the training period, subjects did not participate in any training programs except for technical and tactical training programs of their team. CEG participated in the calisthenics exercises program for approximately 60 minutes, including 15 minutes of warm-up and 15 minutes of cool-up exercises in 3 days (Monday, Wednesday, Friday).

Training Plan

The athletes belonging to the calisthenics exercises completed the exercises determined in the training plan, which lasted for 60 minutes in total 3 days a week and 1 minute rest between each set. 1 week before the first training day; the exercises they will do for 8 weeks were applied one by one, the errors were corrected and it was provided to perform the movement as desired. According to the increased loading principle as time progresses, the versions of the movements became harder and their number was increased. (21).

Table 1. 8-week calisthenics exercises program

Movements	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week	7th Week	8th Week
Plank Climber	2X10	2X15	2X20	2X25	2X25	2X30	2X30	2X35
Lower Ab Plank	2X10	2X15	2X20	2X25	2X25	2X30	2X30	2X35
Plank Pushup Hold	2X10	2X15	2X20	2X25	2X25	2X30	2X30	2X35
Pistol Squat Progression	2X10	2X15	2X20	2X25	2X25	2X30	2X30	2X35
Plyo Jack	2X10	2X15	2X20	2X25	2X25	2X30	2X30	2X35
Superman	2X10	2X15	2X20	2X25	2X25	2X30	2X30	2X35
V-Up					2X25	2X30	2X30	2X35
Mountain Climber					2X25	2X30	2X30	2X35
The Pike Push-Up Tutorial					2X25	2X30	2X30	2X35
Dragon Flag							2X30	2X35
Dive Bomber Push-Up							2X30	2X35
Jack Sit Ups							2X30	2X35

Physical Measurements

Holtain brand stadiometer with a sensitivity of 0,01 cm was used to measure the height of the subjects. The height of the subjects was determined in anatomical position (barefoot) and the result was recorded as "cm". The body weight (BW) of the subjects was measured with a sensitivity of 0,01 kg in anatomical position (barefoot) and the result was recorded as "kg". Body mass index (BMI) values were determined by "BMI = weight (kg) / (height)^2" formula.

Bioelectrical impedance analysis was measured with the Tanita-BC 418 MA device (Tanita BC 418; Tokyo, Japan).Tanita device has 8 electrodes and uses high frequency constant current source (50 kHz, 500A). The individuals who participated in the measurement were asked not to eat anything until at least 4 hours before the measurement, not to drink anything including caffeine-containing drinks, not to use sauna or take a bath, not to drink alcohol until 24 hours before the measurement, and not to do sports on the day of the measurement. Individuals were asked to stand on bare feet on the metal surface of the device, to hold the parts of the device that should be handled with both hands and to release their arms parallel to the body. Measurements lasted for approximately 1-2 minutes for each subject, and the percentage of body fat detected by the bioelectrical impedance analyzer was printed out from the device (22).

Statistical Analysis

The data obtained from the pre and post-training measurements of soccer players were analyzed in the IBM SPSS 22 statistical program. Descriptive statistics are categorized according to all soccer players and groups. The pre- and post-test distributions of the variables were examined according to groups, the normality of the distributions and the homogeneity of the variance were determined by the Shapiro Wilk test and the Mauchly's Sphericity test. Analysis of intergroup, intragroup, and the effect of training were carried out with Repeated Measures ANOVA. Bonferroni test was used for post hoc comparisons; the significance level was accepted as 0,05.

Results

The results of the measurement of groups participating in the study were summarized in the tables below.

As seen in Table 2, the mean age, height, BW and BMI of two groups are respectively 18,16+1,04 years, 174,94+7,68 cm, 69,99+8,68 kg, 22,56+2,01 kg/m^2. Before the training period, there's not any statistically significant difference for all descriptive variables (p>0,05).

In Table 3, while there is no statistically difference in BMR and TBW of the subjects (p>0,05),there is a

Table 2. Descriptive statistics of participants and comparison of physical measurements between groups

Group	Variables	N	Mean± S. D.	Min.	Max.		
CEG	**Age** (year)	9	18,22**±1,09**	16	19		
CG		9	18,11±1,05	17	20		
CEG	**Height** (cm)	9	176,55**±5,67**	168,00	185,00		
CG		9	173,88±9,51	160,00	189,00		
CEG	**BW** (kg)	9	69,82**±6,23**	61,60	77,10		
CG		9	70,16±8,90	57,90	80,70		
CEG	**BMI** (kg/m^2)	9	22,87**±1,56**	21,20	25,20		
CG		9	22,25±2,45	19,00	26,60		
						Chi-Square (X^2)	**P**
Total	**Age** (year)	18	18,16**±1,04**	16	20	0,644	0,214
	Height (cm)		174,94±7,68	160,00	189,00	0,565	0,331
	BW (kg)		69,99±8,68	57,90	80,70	0,158	0,691
	BMI (kg/m^2)		22,56±2,01	19,00	26,60	0,236	0,627

* p< 0,05
BW: Body Weight, **BMI:** Body Mass Index

statistically significance in pre and post-test measurements of body composition such as BW, BMI, BFP, FM, and FFM. It is seen that there is a test*group interaction in five features(p<0,05).

It is seen in Table 4 that there is a statistically significant difference in all variables of the subjects in favor of CEG (p<0,05). These changes affect the test*group relationship.

In Table 5, while there is no statistically difference in RLFP of the subjects (p>0,05), there is a statistically significant difference in the other parameters (p<0,05). These differences affect the test*group interaction except for RLFP parameter.

Discussion and Conclusion

In the study, it was analyzed the effect of the calisthenics exercises on body composition in soccer players. Variables in which these changes have been observed are body weight (kg), BMI (kg/cm^2), body fat percentage (% fat), body fat mass (kg), body free fat mass (kg) and right leg fat percentage (% fat), right leg fat mass (kg), right leg free fat mass (kg), left leg fat percentage (% fat), left leg fat mass (kg), left leg free fat mass (kg). In Table 2, it was understood that before the training period, there's not any statistically significance for all descriptive variables between groups.

When table 3 is analyzed, it is seen that there is no difference in BMR and TBW of the subjects, there is a significant difference in the pre and post-test measurements of body composition such as BW, BMI, BFP, FM, and FFM. It was determined that the interaction in these five parameters was caused by a positive change in the results of the calisthenics exercises.According to the literature, studies are stating that aerobic exercises decrease body fat levels. In a high-intensity aerobic study, it was found a significant reduction in BW as a result of regular exercise (23). In another study conducted on 131 men and women, the subjects were divided into two groups as exercise and control groups and stated that there was a significant decrease in BW of the subjects after the 16-month exercise program (24). In the literature, it is possible to find studies related to reducing the amount of body fat where aerobic and resistance exercises are applied

Table 3. Comparison of pre and post-test changes of the whole body of groups

Variables	Group	N	Pre-Test $\bar{X}$±SS	Post Test $\bar{X}$±SS	In-group Change(%)	Test*Group F	p
BW (kg)	CEC	9	69,82+6,23	70,25+6,35	**0,43 (% 0,61)***	**5,499**	**0,032***
	CG	9	70,16+8,90	70,10+8,97	-0,06 (% -0,08)		
BMI (kg/m2)	CEC	9	22,87+1,56	23,04+1,58	**0,17 (% 0,74)***	**9,881**	**0,006***
	CG	9	22,25+2,45	22,17+2,45	-0,08 (% -0,35)		
BMR	CEC	9	1878,11+134,21	1880,72+136,05	2,61 (% 0,13)	2,821	0,112
	CG	9	1846,88+221,90	1847,66+221,78	0,78 (% 0,04)		
TBW (kg)	CEC	9	45,58+3,55	45,59+3,55	0,01 (% 0,02)	2,631	0,124
	CG	9	44,63+5,26	44,64+5,25	0,01 (% 0,02)		
FP (% fat)	CEC	9	10,44+3,86	10,08+3,68	**-0,36 (% -3,44)***	**18,932**	**0,000***
	CG	9	11,53+4,02	11,57+4,00	0,04 (% 0,34)		
FM (kg)	CEC	9	7,10+3,10	6,73+2,82	**-0,37 (% -5,21)***	**15,095**	**0,001***
	CG	9	8,22+3,62	8,34+3,62	0,12 (% 1,45)		
FFM (kg)	CEC	9	62,20+4,60	62,63+4,83	**0,43 (% 0,69)***	**8,077**	**0,012***
	CG	9	60,95+7,18	60,97+7,18	0,02 (% 0,03)		

* p< 0,05
BW: Body Weight, **BMI:** Body Mass Index, **BMR:** Basal Metabolic Rate, **TBW:** Total Body Water, **FP:** Fat Percentage, **FM:** Fat Mass, FFM: Free Fat Mass

Table 4. Comparison of pre and post-test changes of upper extremities betweengroups

Variables	Group	N	Pre-Test $\bar{X}$ ± SS	Post Test $\bar{X}$ ± SS	In-group Change(%)	Test*Group F	p
RAFP (% fat)	CEC	9	7,66+2,67	7,57+2,64	**-0,09 (% -1,17)***	**6,197**	**0,024***
	CG	9	8,41+3,07	8,42+3,09	0,01 (% 0,11)		
RAFM (kg)	CEC	9	1,35+0,13	1,27+0,10	**-0,08 (% -5,92)***	**7,804**	**0,013***
	CG	9	1,37+0,16	1,36+0,15	-0,01 (% -0,72)		
RAFFM (kg)	CEC	9	3,70+0,51	3,96+0,37	**0,26 (% 7,02)***	**6,733**	**0,020***
	CG	9	3,72+0,51	3,70+0,52	0,02 (% 0,53)		
LAFP (% fat)	CEC	9	7,74+2,63	7,34+2,64	**-0,40 (% -5,16)***	**11,011**	**0,004***
	CG	9	8,10+3,29	8,07+3,28	-0,03 (% -0,37)		
LAFM (kg)	CEC	9	1,35+0,13	1,32+0,12	**-0,03 (% -2,22)***	**7,699**	**0,014***
	CG	9	1,35+0,18	1,33+0,16	-0,02 (% -1,48)		
LAFFM (kg)	CEC	9	3,67+0,54	3,94+0,41	**0,27 (% 7,35)***	**6,865**	**0,019***
	CG	9	3,75+0,56	3,73+0,57	-0,02 (% -0,53)		

*** P< 0.05**
RAFP: Right Arm Fat Percentage, **RAFM:** Right Arm Fat Mass, **RAFFM:** Right Arm Free Fat Mass, **LAFP:** Left Arm Fat Percentage, **LAFM:** Left Arm Fat Mass, **LAFFM:** Left Arm Free Fat Mass

Table 5. Comparison of pre and post-test changes of lower extremities betweengroups

Variables	Group	N	Pre-Test $\bar{X}$ ±SS	Post Test $\bar{X}$ ±SS	In-group Change(%)	Test*Group F	p
RLFP (% fat)	CEC	9	10,05+2,83	9,51+2,46	**-0,54 (% -5,37)***	**3,002**	**0,102**
	CG	9	10,62+3,27	10,66+3,28	0,04 (% 0,37)		
RLFM (kg)	CEC	9	1,23+0,44	1,13+0,39	**-0,10 (% -8,13)***	**7,450**	**0,015***
	CG	9	1,29+0,52	1,31+0,54	0,02 (% 1,55)		
RLFFM (kg)	CEC	9	10,15+1,36	10,33+1,22	**0,18 (% 1,77)***	**9,003**	**0,008***
	CG	9	10,46+1,17	10,41+1,19	-0,05 (% -0,47)		
LLFP (% fat)	CEC	9	9,76+3,22	9,02+2,78	**-0,74 (% -7,58)***	**5,430**	**0,033***
	CG	9	10,30+3,52	10,34+3,52	0,04 (% 0,38)		
LLFM (kg)	CEC	9	1,21+0,49	1,12+0,44	**-0,09 (% -7,43)***	**6,654**	**0,020***
	CG	9	1,25+32,44	1,29+0,53	0,04 (% 3,20)		
LLFFM (kg)	CEC	9	10,50+1,17	10,17+1,37	**0,33 (% 3,14)***	**8,112**	**0,012***
	CG	9	10,51+1,19	10,45+1,17	-0,06 (% -0,57)		

***p< 0,05**
RLFP: Right Leg Fat Percentage, **RLFM:** Right Leg Fat Mass, **RLFFM:** Right Leg Free Fat Mass,
LLFP: Left Leg Fat Percentage, **LLFM:** Left Leg Fat Mass, **LLFFM:** Left Leg Free Fat Mass

together. A study performed an exercise program consisting of a combination of resistance and aerobics for 5 months, 5 days a week and it was reported that it was detected a 10% reduction in fat weight (25). In another study, it was reported that aerobic and resistance training significantly reduced BFP (26). Another study found that 12-week resistance training reduced participants' BW, waist circumference, abdominal fat, lean body mass, and lower body strength (27). In the performance evaluation of elite athletes, fat and lean body mass are important factors that confirm the training effect (28-29). Therefore, body composition is important for the elite athlete and is closely related to performance (30-31). Recent studies suggest that resistance training may also be effective, although more focus or aerobic training is needed to reduce or maintain BW (32). When the literature is searched, there are not many studies investigating the effects of calisthenics exercises on body composition. It was seen that different results were obtained in the studies. Some studies reported that calisthenics exercises improved body composition (33-40); on the other hand some studies reported that calisthenics exercises didn't effect on body composition (41-43). In a study on the swimmers, they practiced 8 weeks of calisthenics exercises on both stable and unstable ground. As a result, it was stated that calisthenics exercises applied to both grounds decreased BFP of athletes (44). In other studies on resistance training; it was observed that strength training had positive effects on body composition in a study in which 30 men performed strength training for 6 weeks (45). It was seen that standard weight lifting exercise was applied to sedentary men for 3 days a week for 10 weeks and pre and post-test BW averages of 85.5 ± 3.3 kg - 86.4 ± 2.9 kg were reported (46).It was performed a 9-month training program in a study on 62 men and was stated that BW decreased significantly (47). It was reported that the decrease in BW of the group performing strength training was statistically significant in a study on 16 male athletes (48). In another study, resistance training was applied to men for 3 days a week and 6 weeks and at the end of the study, it was reported that there was no significant change in BFP (49). It was found a significant decrease in body fat values of the experimental group after 12-week resistance training applied to obese patients (50). Besides, it is understood that if the exercises close to the maximal load intensity (80% and above) are applied

for around 6-8 weeks, there will be an increase in muscle strength between 25-30%, as well as an improvement in muscle hypertrophy is also provided. (51). In literature, it was seen that regular physical activities were effective in reducing the fat under the skin and increasing the lean mass of the body (52). Resistance exercises are an effective mechanism that stimulates muscle hypertrophy along with increases in muscle strength. (53-54). It is known that the first increases in muscle strength during the strength training process are due to the muscular-nervous system adaptations, and the muscle hypertrophy mechanism is effective in the subsequent strength increases (55). BW and BMI may vary depending on the duration, intensity, and frequency of the training. These parameters may also differ depending on the type of strength training performed. Body strength and BMI generally increase in strength studies that are performed to create muscle hypertrophy (25). According to these findings, it is thought that there is a statistically significant increase between the pre and post-test BW and lean body mass averages of the experimental group participating in the study as a result of the increase in BW due to muscle hypertrophy with the development of muscle strength in the direction of exercise. On the other hand, it is thought that there may be a decrease in body fat due to the acceleration of basal metabolism. The reasons for this are thought to be due to the training types applied to the subjects participating in the study, the severity of the load, the physical, physiological and nutritional characteristics of the subjects, and the different methods of measurement of BFP.

When table 4 is analyzed, there is a significant difference in all variables of the; pre and post-test measurements of body composition such as RAFP, RAFM, RAFFM, LAFP, LAFM, LAFFM. Accordingly, when the changes in all variables of the participant are examined, it is seen that there is a test*group interaction in all features. It was determined that the interaction in all parameters was caused by a positive decrease in the results of the experimental group. In Table 5, while there is no difference in the RAFP of the subjects, there is a significant difference in the pre and post-test measurements of body composition such as RLFM, RLFFM, LLFP, LLFM, and LLFFM. The difference between the groups appeared in the second measurements and it was seen that there was a statistically significant difference in the post-test measurements was due to the development of CEG. In the regional body analysis, it is understood that the calisthenics exercise program is very effective on both lower and upper extremities. It is a useful and beneficial form of exercise because of the brisk, low intensity, and modification that large muscle groups are used in the upper and lower extremities.

As a result; it can be said that calisthenics exercises, which are applied to soccer players 3 days a week for 8 weeks, can provide positive development of the whole body composition of footballers and the reduction of BFP of regional extremities and the increase of FFM.

Conflict of Interest: The authors declare that there is no conflict of interest about this manuscript.

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Original article

The effect of goji berry consumption on weight loss in boxers

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Abstract. *Study Objectives:* The aim of this study was to examine whether goji berry consumption has an effect on weight loss in boxers. 24 licensed boxing athletes participated in the study. *Methods:* Athletes were divided into four groups (Group 1: Control group; Group 2: consuming Goji Berry; Group 3: Training group; Group 4: Goji Berry consuming + Training group) by simple random sampling method. Measurements were carried out two times as pre-test and post-test within the scope of the 6-week training program (3 training per week and 75 minutes for each training). The athletes, who subjected to a diet program while spending their periods in clubs, were given goji berry fruit once a day at the same time in the form of 30 g dried fruit. Descriptive statistics (mean and standard deviation) were calculated in the analysis of the data. The percentage of changing body composition of boxing athletes during the test was calculated with the formula "%Δ= (Post-Test – Pre-Test)/Pre-Test × 100".The difference between the body weight percentage changes of the groups was compared with the One-Way ANOVA and Two-Way repeated measures ANOVA was used in the analysis of the variables measured repeatedly (pre-test and post-test) between the groups. The significance level was set at p<0,05 and p<0,01.*Results:* According to the findings of the research, it was determined that the highest decrease in body mass index, fat mass and visceral fat ratio, and the highest increase in free-fat mass and basal metabolic rate per kg were in the Goji Berry consuming + Training group. *Conclusion:* As a result, athletes interested in sports included weight category can use goji berry fruit for body weight control and reduction, which can help them achieve body weight loss and/or control.

Keywords: Sports, Boxing, Training, Goji Berry, Weight loss

Introduction

Sports is an activity that develops the physical and psychological aspects of the individual within the framework of a specific plan and program (1). In order to achieve high success in sports branches, the physical, physiological, and anthropometric structure which is suitable for branches should be appropriate (2). In order to increase performance, besides the parameters of the athlete's circumference, diameter, and length, the rate of fat in the body is also important. In order to be successful in the competition, it is not only the above-mentioned features are important, but also the training methods that form the basis for scientific research and the technical and tactical aspects of the athlete. In addition to various sports, boxing, judo, and wrestling branches are also contested in some weight categories organized by international sports federations. Boxing is a sports branch with physical and physiological features, requiring high combat, between two people (rounds), in a certain area (ring), with punches within the framework of certain rules (3). In addition to being a combat sport, Boxing is an art that includes strength, talent, courage, flexibility, and intelligence. As in many

sports branches, the main goal of boxing is to compete and win. The performance of a weight classification athlete consists of a combination of technical, tactical, physical, and physiological elements (4). Generally, athletes in every branch prefer to compete under one of their available weights. This situation requires constant control of the weight of the athletes by the current requirements (5). A body fat ratio has been determined for optimal performance in many sport branches (6). The negative effects of excessive and rapid weight losses on the athlete's performance have been reported by many researchers (7-10).

Goji Berry, a bright, orange-red, ellipse fruit also known as wolfberry, has quite a nutritional value and is a very powerful antioxidant (11). Goji berry contains macronutrients to fulfill a higher percentage of the calories we spend daily. Goji berry dried fruit has 370 kcal energy in 100 grams (12). It contains 68% Carbohydrate, 12% protein, 10% lipid, and 10% fiber(13). Goji fruit is well known in traditional Chinese medicine, it is used in liver, kidney and eye treatment and has become very popular in the past few years as an important element for health promotion (14). It can lower cholesterol levels and blood pressure, strengthen the immune system, regulate blood sugar levels and hormonal balance, helps with weight loss, slow the aging process, and protect against cancer (12,15,16). It helps to control blood sugar with its chromium substance. It is also known to help increase weight loss and burn fat faster as a result of using lean muscle mass. (11). Weight gain is prevented as muscles burn calories faster than fats (17). It helps the conversion of carbohydrates into energy with thiamine which is also known as vitamin B1 in its structure. Thiamine provides regular operation of thyroid hormones which are quite important in maintaining weight control fastens weight loss. It decreases the level of cortisol hormone which accelerates fat storage and causes weight gain and makes losing weight difficult. It increases the release of human growth hormone secreted from the pituitary gland, which reduces the body fat ratio, gives the body a younger and fresh look (18). It is known to provide muscle regeneration. In addition, it increases the level of physical activity and exercise, as it increases muscle strength. It increases the oxygen utilization rate of the muscles and enabling more calories to be burned (11). Weight loss must be carried out in a controlled manner and without exhausting the organism so that weight athletes can determine the competition weights and they can perform high performance in competition weights.In this context, the purpose of this study was to reveal whether Goji Berry consumption effect on weight loss of boxing athletes.

Material and Methods

Participants

The sample of this research consists of 24 boxing licensed male athletes who were training at Sakarya Boxing Club and voluntarily participated. Before the measurement, the aim of the research was explained to the athletes in detail and a voluntary consent form was signed to the athletes. The athletes trained 3 times a week for 6 weeks and eachtraining was 75 minutes. This study was approved by the ethical and scientific ethics committee members from the Sakarya University Faculty of Medicine Clinical Research Ethics Committee and decided by the ethics committee members (Decision no: 16214662/050.01.04/57).

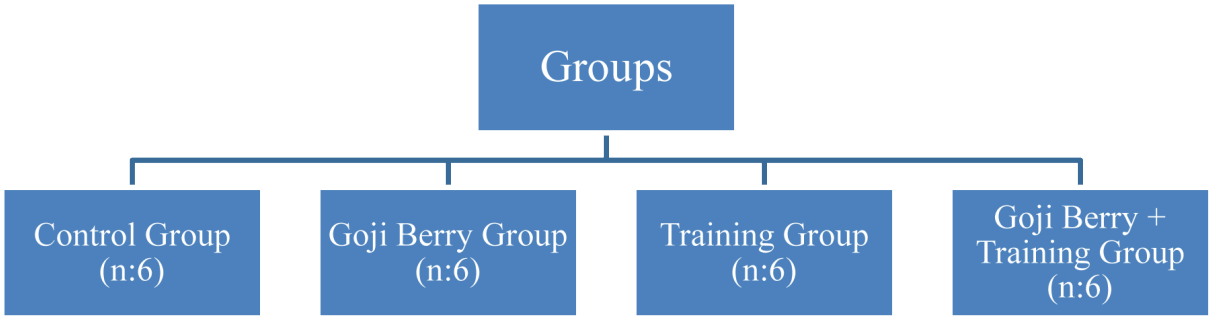
Measurements of Height and Body Composition

Boxers' body heights were measured by the protocols with Seca 213 (Germany) brand 1 mm precision portable stadiometer. The body composition of the boxers was measured in the athletic program by the protocols with the TANİTA MC 780 brand Bioelectrical Impedance Analyzer.

Experimental Design

The experimental design model was used in the research. In the study, measurements were taken twice before and after the 6-week training program. In this study, boxers were divided into four groups by simple random method.

During the 6-week training period, 12 athletes consumed Goji Berry every day at the same time as 30 g of dried fruit (11). In addition, branch-specific boxing training was applied to boxers in the training



groups. Boxers in the control group did not consume both training and goji berry. Since athletes spend this period in their clubs, goji berry fruit is given in the form of dry matter in addition to the athletes who are prepared in line with the dietary habits of individuals in their clubs, and also subject to a diet program that includes a minimum of 1,800 calories, 100 g protein, 100 g fiber and finally 35 g fat (19).

Statistical analysis

Statistical analysis of the data was carried out using the SPSS software. Descriptive statistics (Mean and Standard Deviation) were calculated in the analysis of the data. The percentage of changing body composition of athletes during the test was calculated with the formula "% Δ = (Post Test - Pretest) / Pretest × 100" (20).The difference between the body weight percentage changes of the groups was analyzed by one-way ANOVA. Two-Way Repeated Measures ANOVA was used in the analysis of variables measured repeatedly (pre-test and post-test) between the groups. The significance level was determined as $p < 0.05$ and $p < 0.01$.

Results

When the demographic variables of the boxers participating in the research were examined, it was determined as; the mean age of the control group 20,33±2,42 (year), height mean 177,50±8,19(cm), the mean age of the GojiBerry group 24,00±2,53 (year), height mean 174,00±5,06 (cm), the meanage of the training group 22,33±3,93 (year), height mean 172,83±7,03(cm) and the mean age of the GojiBerry+ training group 21,83±3,37 (year), height mean 177,50±9,09(cm) (Table 1).

Table 1. Descriptive statistics of age and body height of boxers

Groups	Demographic Variables	$\bar{X}$ ± S.D
Control Group	**Age** (year)	20,33±2,42
	Height (cm)	177,50±8,19
Goji Berry Group	**Age** (year)	24,00±2,53
	Height (cm)	174,00±5,06
Training Group	**Age** (year)	22,33±3,93
	Height (cm)	172,83±7,03
Goji Berry + Training Group	**Age** (year)	21,83±3,37
	Height (cm)	177,50±9,09

$\bar{X}$: Mean; SD: Standard Deviation

Table 2. Comparison of body weights pre-test results of groups

Variables	N	Body Weight Pre-test (kg) $\bar{X}$ ± S.D	F	p
Control Group	6	67,57±9,73	0,966	0,428
Goji Berry Group	6	74,78±11,86		
Training Group	6	77,68±13,68		
Goji Berry + Training Group	6	80,88±19,51		

It was determined that there was no statistically significant difference between the body weights pre-test means of the groups($p>0,05$). This result indicates that the research sample shows a homogeneous distribution in terms of body weight (Table 2).

Table 3. Comparison of body weights according to groups and measurement times

Groups / Times	N	Pre-test (kg)	Post-test (kg)	Total	%Δ	F	p
		$\bar{X}$ ± S.D	$\bar{X}$ ± S.D	$\bar{X}$ ± S.D			
Control Group	6	67,57±9,73	69,54±10,02	68,55±9,47	2,92[a]	0,513	0,678
GojiBerry Group	6	74,78±11,86	75,02±11,76	74,90±11,25	0,32[ab]		
Training Group	6	77,68±13,68	76,68±13,25	77,18±12,84	-1,29[b]		
GojiBerry + Training Group	6	80,88±19,51	74,43±20,85	77,66±19,54	-7,97[c]		
Total	24	75,23±14,14	73,92±13,85			Interaction F=649,486; p=0,001**	
F=10,551; p=0,004**							

**p<0,01; $\bar{X}$: Mean; SD: Standard Deviation;%: Percent; abc: There is a difference between averages containing different letters.

Table 4. Comparison of body mass index values according to groups and measurement times

Groups / Times	N	Pre-Test (kg/m²)	Post-Test (kg/m²)	Total	%Δ	F	p
		$\bar{X}$ ± S.D	$\bar{X}$ ± S.D	$\bar{X}$ ± S.D			
Control Group	6	21,43±2,48	22,08±2,71	21,76±2,49	3,03[a]	1,211	0,331
GojiBerry Group	6	24,67±3,83	24,77±3,82	24,72±3,64	0,41[ab]		
Training Group	6	25,97±3,92	25,77±3,90	25,87±3,72	-0,77[b]		
GojiBerry+ Training Group	6	25,31±4,52	23,32±5,11	24,31±4,71	7,86[c]		
Total	24	24,34±3,93	23,98±3,97			Interaction F=20,286; p=0,001**	
F=8,060; p=0,010*							

*p<0,05; **p<0,01; $\bar{X}$: Mean; SD: Standard Deviation;%: Percent; abc: There is a difference between averages containing different letters.

When Table 3 was analyzed, it was determined that there was a difference between pre-test and post-test body weight means according to the measurement times. (F=10,551; p=0,004). Body weight means were not found to be statistically different from training groups. (F=0,513; p=0,678). In addition, the interaction between training groups and measurement times was found statistically significant. (F=649,486; p=0,001). Accordingly, after 6-weeks of training, the highest body weight reduction was found to be in the Goji Berry + Training Group as -7,97%.

When Table 4 was analyzed, it was determined that there was a difference between pre-test and post-test body mass index means according to the measurement times (F=8,060; p=0,010). Body mass index means were not found to be statistically different from training groups (F=1,211; p=0,331). In addition, the interaction between training groups and measurement times was found statistically significant. (F=20,286; p=0,001). Accordingly, after the 6-week training, the highest body mass index reduction was found to be in the GojiBerry + Training Group as -7,86%.

When Table 5 was analyzed, it was determined that there was no difference between pre-test and post-test body fat mass percentages according to the measurement times (F=0,900; p=0,354). Body fat mass percentage were found to show no difference statistically compared to training groups (F=0,306; p=0,820). Additionally, the interaction between training groups and measurement times was found to be not statistically significant (F=1,702; p=0,199).

When Table 6 was analyzed, it was determined that there was no difference between pre-test and post-test free-fat mass percentages according to the meas-

Table 5. Comparison of body fat mass percentage according to groups and measurement times

Groups / Times	N	Pre-Test (%)	Post- Test (%)	Total	%Δ	F	p
		$\bar{X}$ ± S.D	$\bar{X}$ ± S.D	$\bar{X}$ ± S.D			
Control Group	6	12,85±6,73	13,07±7,88	12,96±6,98	1,71	0,306	0,820
GojiBerry Group	6	16,52±13,55	16,85±12,05	16,68±12,22	2,00		
Training Group	6	14,37±5,19	14,33±4,13	14,35±4,74	-0,28		
GojiBerry+ Training Group	6	18,05±6,90	15,65±6,39	16,85±6,46	-13,30		
Total	24	15,45±8,37	14,97±7,73			Interaction F=1,702; p=0,199	
F=0,900; p=0,354							

$\bar{X}$: Mean; SD: Standard Deviation;%: Percent

Table 6. Comparison of free-fat mass percentage according to groups and measurement times

Groups / Times	N	Pre-Test (%)	Post-Test (%)	Total	%Δ	F	P
		$\bar{X}$ ± S.D	$\bar{X}$ ± S.D	$\bar{X}$ ± S.D			
Control Group	6	87,16±6,75	86,93±7,88	87,05±6,99	-0,26	0,310	0,818
GojiBerry Group	6	83,46±13,55	83,14±12,07	83,30±12,23	-0,38		
Training Group	6	85,66±5,16	85,69±4,13	85,67±4,45	0,04		
GojiBerry+ Training Group	6	81,96±6,89	84,33±6,41	83,15±6,46	2,89		
Total	24	84,56±8,37	85,02±7,74			Interaction F=1,660; p=0,208	
F=0,876; p=0,360							

$\bar{X}$: Mean; SD: Standard Deviation;%: Percent

urement times (F=0,876; p=0,360). It was determined that the average of free-fat mass does not show a statistical difference compared to training groups(F=0,310; p=0,818). In addition, the interaction between training groups and measurement times was not found to be statistically significant. (F=1,660; p=0,208).

When Table 7 was analyzed, it was determined that there was a difference between pre-test and post-test visceral fatpercentages according to the measurement times (F=7,424; p=0,013). It was found that the levels of visceral fat did not show a statistical difference compared to training groups (F=1,213; p=0,331). In addition, the interaction between training groups and measurement times was not found to be statistically significant(F=1,768; p=0,186).

When Table 8 was analyzed, it was determined that there was no difference between pre-test and post-test basal metabolic rate per kg according to the measurement times(F=1,501; p=0,236). It was determined that the basal metabolic rate per kg did not show a statistical difference compared to training groups (F=0,199; p=0,895). In addition, the interaction between training groups and measurement times was not found to be statistically significant (F=1,609; p=0,222).

Discussion and Conclusion

Belonging to the Solanaceous family, Goji Berry fruit has been used in traditional Chinese medicine for many years (21). Today, L. Barbarum fruit, which is known to have many beneficial effects on health, is used as a functional food (22). Foodborne bioactive

Table 7. Comparison of visceral fat levels according to groups and measurement times

Groups / Times	N	Pre-Test (%)	Post-Test (%)	Total	%Δ	F	P
		$\bar{X}$ ± S.D	$\bar{X}$ ± S.D	$\bar{X}$ ± S.D			
Control Group	6	1,17±0,41	1,17±0,41	1,17±0,39	0,00	1,213	0,331
GojiBerry Group	6	3,00±2,53	2,67±2,25	2,83±2,28	-11,00		
Training Group	6	3,33±2,66	3,17±2,64	3,25±2,52	-4,80		
GojiBerry+ Training Group	6	3,33±2,58	2,67±1,86	3,00±2,17	-19,82		
Total	24	2,71±2,29	2,42±2,00			Interaction F=1,768; p=0,186	
F=7,424; p=0,013*							

*p<0,05: $\bar{X}$: Mean; SD: Standard Deviation;%: Percent

Table 8. Comparison of the basal metabolic rate per kg according to groups and measurement times

Groups / Times	N	Pre-Test (Kcal)	Post-Test (Kcal)	Total	%Δ	F	P
		$\bar{X}$ ± S.D	$\bar{X}$ ± S.D	$\bar{X}$ ± S.D			
Control Group	6	25,60±1,52	25,60±2,07	25,60±1,71	0,00	0,199	0,895
GojiBerry Group	6	24,67±3,50	24,50±3,08	24,58±3,14	-0,69		
Training Group	6	25,17±1,72	25,33±1,51	25,25±1,54	0,64		
GojiBerry+ Training Group	6	24,60±1,95	25,40±1,67	25,00±1,76	3,25		
Total	24	25,00±2,23	25,18±2,08			Interaction F=1,609; p=0,222	
F=1,501; p=0,236							

$\bar{X}$: Mean; SD: Standard Deviation;%: Percent

compounds are very important in preventing cancer, delaying aging, helping weight loss, regulating hormonal balance, and strengthening the immune system (12). It may be suggested to use goji berry fruit especially to prevent weight gain (23). Moreover, Balcı et al. (2014) revealed that the fresh and dry goji berry fruits contain phenolic substances, anthocyanin, vitamin c, total carbohydrate, and mineral substance and goji berry fruit is very important in terms of nutrition and human health (24). In this context, the main purpose of the study is to examine whether Goji Berry consumption has an effect on weight loss in boxers. Many studies reveal that physical exercise alone is not sufficient in providing weight loss, but also functional food supplements are needed (11,25,26).

When the literature was examined, Yıldız (2018) reported thatgoji berry extract reduces the level of serum lipids, prevents weight gain, and may be effective in the treatment of obesity in rats fed a high-fat diet (23) Amagese, Sun,and Nance (2009) found that consumption of LyciumBarbarium (goji berry) increased metabolic rate and reduced waist circumference in overweight men and women (27). In this study, when the body weights of the boxers were compared after 6 weeks of training, it was found that the body weights of the training group decreased by 1.29%, whereas the goji berry + training group decreased by 7.97%. This result shows that the athletes who were training during the preparatory period can achieve a higher level of weight loss by consuming goji berry in addition to the training. In addition, when the body mass index changes of the athletes were examined in our study, it was found that only the training group decreased the body mass index by 0.77%, while the goji berry + train-

ing group decreased the body mass index by 7.86%.

Physical fitness is the most important way to reveal sportive performance.In order to show high success in sports branches, the physical, physiological, and anthropometric structure suitable for the branches should be appropriate. The human body consists of fat, bone, muscle cells, and extracellular fluids. Body composition reaches a good level with these four groups coming together in certain proportions (28,29). In addition, the rate of fat in the body of the athlete is also very important (27). Alpay et al. (2015) compared the body composition of the wrestlers who had or did not lose weight before the competition in sixty-nine elite wrestlers and found that there was a difference between the total body water levels and lean mass levels of the wrestlers who lost weight (7). Kulczyński and Gramza-Michałowska (2016) in their study investigating the properties of goji berries and their contribution to health, they found that goji berry fruit lowers cholesterol levels and blood pressure, strengthens the immune system, regulates blood sugar levels, helps with weight loss, slows the aging process and protects against cancer (12). When the body compositions were examined in our study, it was found that there was no statistically significant difference in the body fat percentage, free-fat mass, and basal metabolic rate per kg of the boxers according to the measurement times and groups. However, it was determined that there was a percent of changes in measurement times between groups. Accordingly, it was determined that the body fat percentage of boxers in the training group only decreased by 0.28% with the 6-week branch-specific boxing training, whereas the goji berry + training group decreased the body fat percentages by 13.30%. Again, it was found that the free-fat mass of the boxers who only trained increased by 0.04%, while the goji berry + training group increased by 2.89%. In addition, when the metabolic rate levels per kg were compared, it was found that only the boxers who trained were increased by 0.64% in the metabolic rate per kg, whereas the goji berry + training group increased by 3.25%. Finally, it was found that the boxers in the training group only had a 4.80% reduction in visceral fat levels, whereas in the goji berry + training group there was a 19.82% decrease. This result shows that the goji berry fruit used with the training reduces visceral fat levels. Demirkan et al. (2010) reported that dehydration can be prevented by gaining a sufficient and appropriate amount of fluid intake before, during, and after the training or match in order to prevent the negative effects of dehydration on performance in weight athletes (30). In this context, it can be thought that consumption of Goji berry fruit or extract may also help weight athletes to achieve weight loss.

As a result, during the preparatory period, athletes often gain body weight, as they perform maximal strength training. However, they can control their body weight using goji berry fruit or extract, especially since athletes who do weight sports have to control their body weight throughout the season. This controlled weight loss will help athletes to show themselves best during each game, which is very important for athletes.

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Conflicts of interest

No potential conflict of interest was reported by the authors.

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Original article

A research on the evaluation of nutrition knowledge levels of soccer coaches

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Abstract. *Study Objectives:* The study aimed to compare the nutritional knowledge levels of soccer coaches according to their educational status, different league levels, and job variables. *Methods:* A total of 240 coaches, including technical directors (n = 73), assistant coaches (n = 74), goalkeeper coaches (n = 43), performance specialists / analysts (n = 50) participated in the study voluntarily. Nutritional knowledge of soccer coaches was determined by "The Nutrition for Sport Knowledge Questionnaire" (NSKQ). One-Way ANOVA test was used to determine the difference between the groups, and the Scheffe test, one of the Post-hoc tests, to determine which group the difference was originated from. *Results:* As a result of the statistical analysis, while there was no significant difference between the nutrition knowledge total scores of soccer coaches and both the league level and job description, performance specialists/analysts had higher scores in the job description variable. It was determined that sports science and university graduate coaches had higher total score values with their weight control, sports nutrition, and alcohol sub-dimensions compared to high school and undergraduate coaches ($p < 0.05$). *Conclusion:* As a conclusion, it is vital to apply correct loading and nutrition strategies to protect the overall health of soccer players and increase their performance efficiency. However, it has been determined that the information on sports nutrition of the trainers who organize the nutrition programs in the lower leagues is low. It can be suggested that soccer coaches should increase their awareness about sports nutrition and follow up-to-date nutrition knowledge for their professional development.

Key words: Soccer, sports nutrition, soccer coach

Introduction

Sports nutrition is a specialty that occurs with the interaction of exercise and nutrition sciences. In addition to maintaining health and performance in sports nutrition (1), it is aimed to reach and maintain the body composition specific to the sports branch, to provide functions such as recovery after exercise and body fluid balance (2). Adequate and balanced nutrition is very important in achieving optimum body function and composition in athletes (3). The energy requirements of athletes differ according to the duration and intensity of the exercise in daily and annual training plans (4). It is known that the nutritional time and meal contents of athletes help increase their training and competition performances. For this reason, athletes need to develop nutritional strategies to improve both physical and mental performance before, during, and after exercise. (5). In addition, correct hydration, adequate energy, and macro and micro-nutrients in athletes achieve the performance target, as well as an increase in training adaptation and a decrease in disease and injury risks (6).

Athletes must adopt nutritional techniques that improve their performance before and after exercise. A certain level of nutritional knowledge is required to apply these techniques. Low nutritional knowledge is considered to harm on food intake and performance in athletes (7). In a study conducted by Kolodinsky et al. (2007), it was found that in athletes with low nutri-

tional knowledge, fat and sugar consumption and energy intake were high and nutrient intake was low (8). In a similar study, it was found that athletes with low nutritional knowledge levels were not aware of current nutritional recommendations and their carbohydrate consumption was insufficient (9,10). In addition, it has been stated that athletes do not have sufficient information about the use of food supplements and doping, which can adversely affect health (11).

It is known that both amateur and professional soccer players in the soccer branch have inadequate nutritional knowledge and have problems with branch-specific nutrition (12,13). In addition, it was determined in different study results that athletes preferred their trainers as the main source of knowledge rather than a specialist in nutrition (14,15). Therefore, the nutritional knowledge level of coach, strength and conditioning specialist, and other support team members is very important for a high performance in athletes (16).

In the absence of a specialist in the field of nutrition in several teams with limited opportunities in the soccer branch, it is considered that the nutritional knowledge levels of the trainers are important for the athletes to be fed in an adequate and balanced manner. In the literature, studies are investigating the nutritional knowledge level of athletes and coaches (17,18). However, a study comparing the athlete's nutrition knowledge levels of the trainers according to their educational status, different leagues, and job descriptions have not been found. Therefore, the current study aimed to compare the nutritional knowledge levels of soccer coaches according to their educational status, different league levels, and job variables.

Methods

Participants

A total of 240 coaches, including technical directors (n = 73), assistant coaches (n = 74), goalkeeper coaches (n = 43), performance specialists/analysts (n = 50) working in the professional and amateur football teams voluntarily participated in the study. The mean age of the participants was 40.57 ± 8.92 years and the mean working duration of coaches was 12.09 ± 6.42 years.

Experimental Design

The scale used in the study is used in the evaluation of the nutritional information of adult athletes developed by Trakman et al (2017), whose original name is "The Nutrition for Sport Knowledge Questionnaire" (NSKQ), (19). The Nutrition for Sport Knowledge Questionnaire (NSKQ) was adapted into Turkish by Çırak and Çakıroğlu in 2019 and its both validity and reliability were determined. The validity and reliability levels of the study were determined as (α = 0,908). According to the results of the evaluation, 68 items are included in the NSKQ. The scale also includes 6 subdimensions related to weight management (3 items), macronutrients (22 items), micronutrients (12 items), sports nutrition (11 items), supplements (11 items), and alcohol (9 items). The items of the scale are composed of multiple choice and 3-likert type (20).

As a result of the research, knowledge scores are calculated based on the correct responses and overall performance (68 items 100 points; "weak" knowledge (0-49%), "average" knowledge (50-65%), "good" knowledge on the Sports Nutrition Information Scale (NSKQ) (66-75%) and "excellent" knowledge (75-100%) are evaluated using means of the scoring system).

Statistical Analysis

Data analysis was conducted through SPSS 24 program. One-Way ANOVA test was used to determine the difference between the groups and Scheffe test, one of the post-hoc tests, was used to determine from which group the difference was originated from. The relationship between the ages of the coaches and their nutritional knowledge levels was determined by Pearson Correlation Analysis. In the study, the level of significance was accepted as $p < 0.05$.

Results

According to Table 1, there was a significant difference between high school and under school graduates,

the faculty of sports science graduates and university graduates in the weight management sub-dimension. It is seen that there was significant difference, which is in favor of coaches who are graduates of the faculty of sports sciences and university graduates. In addition, there was a significant difference between high school and undergraduates and the faculty of sports science graduates in the sub-dimensions of sport nutrition, alcohol, and total score. It was determined that there was a significant difference, which is in favor of coaches graduating from the faculty of sports sciences ($p < 0.05$).

According to Table 2, there was a significant difference between the technical directors and performance specialists/analysts. It was determined that there was a significant difference, which is in favor of performance specialists/analysts in weight management and sports nutrition sub-dimension. In addition, it was found that there was a difference between the assistant coaches and goalkeeper coaches in favor of goalkeeper coaches in the alcohol sub-dimension.

When Table 3 is examined, it was determined that there was a significant difference between the coaches working in the Super League and the coaches working in the TFF 1st League in favor of the coaches working in the Super League ($p < 0.05$).

When the table 4 is examined, it is clear that as the ages of the coaches increase, the scores received from the supplement sub-dimensions and weight management sub-dimensions decrease ($p < 0.05$).

Discussion and Conclusion

This study was conducted to compare soccer coaches' sports nutrition knowledge levels according to their education level, league level, and job descrip-

Table 1. Comparison of nutritional knowledge levels according to coach's educational status

	Education status	N	Mean ± S.D.	F	p
Weight management	High School and under	39	,56 ± ,86[b]	11,02	,00*
	Faculty of Sports Science	144	1,63 ± 1,30[a]		
	University	57	1,44 ± 1,37[a]		
Macronutrients	High School and under	39	12,59 ± 5,62	,74	,47
	Faculty of Sports Science	144	13,31 ± 4,25		
	University	57	12,59 ± 4,29		
Sports nutrition	High School and under	39	6,86 ± 3,34[b]	4,11	,01*
	Faculty of Sports Science	144	8,56 ± 3,38[a]		
	University	57	7,99 ± 3,16[ab]		
Supplement	High School and under	39	4,33 ± 2,15	1,65	,19
	Faculty of Sports Science	144	5,10 ± 2,24		
	University	57	5,03 ± 2,77		
Alcohol	High School and under	39	4,97 ± 3,01[b]	5,94	,00*
	Faculty of Sports Science	144	6,64 ± 2,63[a]		
	University	57	5,93 ± 2,94[ab]		
Micronutrients	High School and under	39	7,54 ± 2,96	,40	,67
	Faculty of Sports Science	144	7,74 ± 2,65		
	University	57	7,37 ± 2,46		
Total Score	High School and under	39	36,87 ± 11,88[b]	5,52	,00*
	Faculty of Sports Science	144	43,01 ± 10,12[a]		
	University	57	40,37 ± 10,72[ab]		

*p < 0,05; S.D.: Standart Deviation; a, b: Different letters represent the difference between groups.

Table 2. Comparison of nutritional knowledge levels according to coaches' job status

	Job Descriptions	N	Mean ± S.D	F	p
Weight management	Technical Directors	73	1,16 ± 1,17[b]	3,69	,01*
	Assistant Coaches	74	1,49 ± 1,42[ab]		
	Goalkeeper coach	43	1,16 ± 1,30[ab]		
	Performance Specialists/Analysts	50	1,88 ± 1,22[a]		
Macronutrients	Technical Directors	73	12,89 ± 4,72	,04	,98
	Assistant Coaches	74	13,15 ± 4,98		
	Goalkeeper coach	43	13,06 ± 3,88		
	Performance Specialists/Analysts	50	13,00 ± 4,03		
Sports nutrition	Technical Directors	73	7,55 ± 2,85[b]	2,83	,03*
	Assistant Coaches	74	7,94 ± 3,02[ab]		
	Goalkeeper coach	43	8,20 ± 3,04[ab]		
	Performance Specialists/Analysts	50	9,29 ± 4,46[a]		
Supplement	Technical Directors	73	4,75 ± 2,29	1,80	,14
	Assistant Coaches	74	4,98 ± 2,50		
	Goalkeeper coach	43	4,54 ± 1,72		
	Performance Specialists/Analysts	50	5,58 ± 2,69		
Alcohol	Technical Directors	73	5,68 ± 2,67[ab]	4,93	,00*
	Assistant Coaches	74	5,64 ± 2,63[b]		
	Goalkeeper coach	43	7,11 ± 1,92[a]		
	Performance Specialists/Analysts	50	7,02 ± 2,91[ab]		
Micronutrients	Technical Directors	73	7,89 ± 2,59	,38	,75
	Assistant Coaches	74	7,53 ± 2,71		
	Goalkeeper coach	43	7,52 ± 2,28		
	Performance Specialists/Analysts	50	7,44 ± 3,00		
Total Score	Technical Directors	73	39,94 ± 10,28	1,70	,16
	Assistant Coaches	74	40,75 ± 10,27		
	Goalkeeper coach	43	41,62 ± 10,05		
	Performance Specialists/Analysts	50	44,23 ± 12,39		

*p < 0,05; S.D.: Standart Deviation; a, b: Different letters represent the difference between groups.

tion variables. According to the results of the study, although there is no significant difference between the nutritional knowledge levels of the soccer coaches and the level of the league in which they work, it is determined that the total score of the athlete nutrition knowledge of all coaches working in different leagues is in the weak category. The reason for this result may be since all candidates have participated in a common training program in soccer coaching courses. Therefore, this can be explained by the fact that soccer coaches receive the coaching certificate at the end of a common training process, regardless of amateur or professional league separation. In addition to field practices such as technical and tactical, soccer coaches' opinions and suggestions on sports health and nutrition are thought to effect on athletes' eating habits. In addition, the absence of a nutritionist, especially in teams at lower league levels, is a factor that increases the responsibility of coaches in the nutrition of athletes. For this reason, a low level of nutritional knowledge determined

Table 3. Comparison of nutritional knowledge levels according to the league categories of coaches

	League Category	N	Mean ± S.D.	F	p
Weight management	Super League	36	1,96 ± 1,40[a]	3,29	,00*
	TFF 1. League	41	,93 ± 1,33[b]		
	TFF 2. League	48	1,34 ± 1,20[ab]		
	TFF 3. League	40	1,32 ± 1,09[ab]		
	Local Amateur League	39	1,77 ± 1,39[ab]		
	Amateur League	36	1,22 ± 1,19[ab]		
Macronutrients	Super League	36	13,43 ± 4,98	,60	,69
	TFF 1. League	41	13,05 ± 4,48		
	TFF 2. League	48	12,62 ± 4,33		
	TFF 3. League	40	12,24 ± 4,60		
	Local Amateur League	39	13,19 ± 4,08		
	Amateur League	36	13,80 ± 4,69		
Sports nutrition	Super League	36	8,41 ± 3,56	1,14	,34
	TFF 1. League	41	8,71 ± 3,84		
	TFF 2. League	48	7,65 ± 3,73		
	TFF 3. League	40	7,57 ± 2,98		
	Local Amateur League	39	8,86 ± 2,98		
	Amateur League	36	7,80 ± 2,78		
Supplement	Super League	36	4,53 ± 2,36	,41	,84
	TFF 1. League	41	4,98 ± 2,86		
	TFF 2. League	48	5,26 ± 2,05		
	TFF 3. League	40	5,00 ± 1,96		
	Local Amateur League	39	5,01 ± 2,62		
	Amateur League	36	4,86 ± 2,37		
Alcohol	Super League	36	6,53 ± 2,75	,83	,52
	TFF 1. League	41	6,63 ± 2,48		
	TFF 2. League	48	5,88 ± 2,78		
	TFF 3. League	40	6,25 ± 2,95		
	Local Amateur League	39	6,41 ± 2,98		
	Amateur League	36	5,55 ± 3,02		
Micronutrients	Super League	36	7,47 ± 2,99	,57	,71
	TFF 1. League	41	8,21 ± 2,34		
	TFF 2. League	48	7,59 ± 2,71		
	TFF 3. League	40	7,31 ± 2,43		
	Local Amateur League	39	7,42 ± 2,90		
	Amateur League	36	7,67 ± 2,56		
Total Score	Super League	36	42,36 ± 12,25	,53	,73
	TFF 1. League	41	42,53 ± 10, 06		
	TFF 2. League	48	40,37 ± 9,61		
	TFF 3. League	40	39,7 ± 11,31		
	Local Amateur League	39	42,68 ± 11,60		
	Amateur League	36	40,93 ± 10,14		

*p < 0,05; S.D.: Standart Deviation; a, b: Different letters represent the difference between groups.

Table 4. Relationship between age and nutritional knowledge

		Alcohol	Supplement	Sports nutrition	Macro-nutrients	Weight management	Micro- nutrients	Total Score
	r	,02	-,15*	,02	,06	-,31**	,85	-,01
Age	p	,73	,01	,74	,32	,00	,18	,84
	N	240	240	240	240	240	240	240

*p < 0,05

by coaches working in the league variable may lead to the misleading of athletes regarding nutrition. In several studies conducted in the literature, although athletes showed their trainers as the main source of knowledge, it was found that the trainers' nutritional knowledge level was low (14,18,21).

As a result of the comparison between the coaches' sports nutrition knowledge levels and the job descriptions of coaches, it was determined that despite a significant difference the technical directors and performance specialists/analysts had, the total score averages of all coaches were weak in the job description variable. The significant difference determined in sports nutrition and weight control sub-dimensions was in favor of performance specialists/analysts. In soccer, the field of performance specialists/analysts are regarded as relatively new coaching. Therefore, the nutrition knowledge of performance specialists/analysts is considered to be more up-to-date than the technical directors. Soccer coaches are free to participate in a development seminar or an informative training activity for sports nutrition after receiving the coaching certificate. Therefore, the significance determined in favor of the performance specialists/analysts coaches can be explained by the fact that the knowledge of the coaches regarding the sports nutrition is not up to date. In addition, performance specialists/analysts are generally graduates of sports sciences, and their nutritional knowledge levels are considered to be partially higher due to taking nutritional courses as part of formal education. In the study of Torres-McGehee et al (2012) on coaches, the fact that athletic trainers stated that their nutritional knowledge scores were higher than the technical directors supports the results of the current study (17). On the other hand, due to the limited opportunities in soccer, especially in the lower league teams, there is no nutritionist or even performance specialists/analysts in the technical team. In this case, the nutrition planning of the teams is conducted by the technical directors. Even if a coach with a low nutritional knowledge level applies correct loading and rest strategies to his athletes, it is thought that athletes who lack a sufficient and balanced nutrition program will experience performance losses. To achieve a high performance in sports, balanced, regular, and purposeful nutrition is required in addition to protecting the health of an athlete. In different studies conducted in the literature, it was stated that malnutrition negatively affects training and match success in athletes (22,23). Therefore, regardless of the job descriptions of soccer coaches, sufficient nutritional knowledge is required to increase the efficiency of the training and to achieve high performance.

In the current study, according to the results of the evaluation between soccer coaches level of sports nutrition and their educational status, it was determined that sports science and university graduate coaches, weight control, sports nutrition and alcohol sub-dimensions and total score values were higher than the high school and undergraduate coaches. However, it was determined that the sub-dimensions and total scores of NSKQ were weak according to the educational status variable of all coaches. It is thought that this result may stem from some reasons. The coaches who completed his high school and lower level education completes the sports nutrition course with an accelerated program in a short period in the coaching course they attended. On the other hand, students must be successful in the exams held by participating in the course for 14 weeks in the sports nutrition course included in the sports science education program at universities. Therefore, the significant difference in favor of soccer coaches graduating from sports nutrition and alcohol sub-dimensions and the total score of sports

science is expected since the sports nutrition course taken within the scope of formal education. Trakman et al. (2017) stated that there was a significant difference in favor of athletes who took nutritional education as a result of the comparison of nutritional knowledge scores of athletes who took nutritional education and those who did not (19). Şanlıer et al. (2017), in a similar study, it was found that the average score of students who took a nutritional course was higher as a result of the comparison of the nutritional knowledge of the students who took basic nutrition courses in the health sciences and those studying in other departments (24). The above-mentioned studies confirm the results obtained in the current study as individuals who take a nutritional course indicate that their nutritional knowledge level is higher.

As a result of the study, a significant negative correlation was determined between the knowledge level of the soccer coaches' sports nutrition and the age variable. In other words, as the age of the coaches increased, it was determined that there was a decrease in the scores of the supplement and weight control subdimensions. As in all areas of sports, scientific studies on sports nutrition are increasing rapidly. Along with the increase in the number of studies on sports nutrition, existing knowledge may change as well as new knowledge is added to the literature. Therefore, as the ages of the coaches increase, it is thought that the knowledge about the supplement and weight control sub-dimensions is since the current studies are not followed sufficiently. In addition, the fact that the new generation can access a good amount of knowledge easily and quickly using the internet tools more effectively may be the reason for the increase in the nutritional knowledge level of young coaches. The absence of a study in the literature evaluating soccer coaches by age variable can be considered as the originality of the current study.

In conclusion, athletes' nutrition, along with other factors, is vital for maintaining their overall health and improving performance. Correct loading and proper nutrition strategies are required to increase efficiency as a result of the exercises applied to athletes. However, although the level of knowledge of the nutrition of coaches graduating from the field of sports science is partially higher, it is noteworthy that it is very low when evaluated according to the sub-dimensions and total scores of the NSKQ. It is essential to keep the nutrition of the athletes at the forefront in the training courses of the soccer federation. Moreover, it may be recommended that there should be an increase in the number of nutrition courses in the Faculty of Sport Sciences which train and educate the coaches of tomorrow and to follow the current nutrition knowledge for their professional development.

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Original article

Weight loss methods and effects on the different combat sports athletes

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Abstract. *Study Objectives:* This study was carried out to determine the weight reduction methods of athletes engaged in weight sports. The sample of the study consists of 99 judo players, 89 taekwondo players, 74 wrestlers and 262 athletes in Ankara. *Methods:* In this study, Athlete weight reduction methods and effects scale was developed by Yarar et al. (2016) and personal information form developed by the researcher were used as data collection tools. Independent sample test and one-way ANOVA were used for percentage, frequency, arithmetic distributions, and Tukey HSD and Spearman Correlation test, which are the second level tests, were used for significant differences between ANOVA analyzes. *Results:* As a result, judo, taekwondo and the wrestling athletes were slightly affected by the diet size. There was a difference in weight reduction behaviors according to gender. Again, male athletes were more affected by fluid loss than girls. Significant differences were found in case of physiological, Psychological and fluid loss sub-dimensions. It was determined that wrestlers used Psychological methods. According to the age variable of the athletes, the sub-dimensions are mostly used by athletes aged 19 and over. *Conclusion:* It is a point that regularly athletes' bodyweight must be controlled to prevent their loss of weight in pre-competitive. Such an approach is beneficial for both athletes' health and performance. In cases where adult athletes must lose weight, it would yield better results to determine the percentage of body fat and to lose weight by reducing the rate of fat.

Keywords: Weight Loss, Combat Sports, Wrestling, Judo, Taekwondo

Introduction

In the Olympics –the highest level of sports organizations- the elite level of many athletes focuses on their physical performance before the competition. Athletes who increasingly fall short of physical demands make efforts to raise their performance in methods with minimum side effects (1).

To maintain body composition and weight loss before the competitions, athletes use several methods in combat sports (2). Weight loss induces negative energy balance in athletes- which results in a diet other than the usual (3). In the recent Olympic games, 53 out of 306 gold medals were won by combat sports athletes (4). Therefore before the competition, combat athletes (judo, karate taekwondo, boxing, etc.) have dietary restrictions for weight loss and to classifying for different weight levels (5,6). Rapid weight loss is a strategy that combat sports athletes commonly use to compete in weight classes which are not appropriate to their body composition (7). Thus, athletes try to obtain physical and mental advantages by losing weight rapidly (8). Those athletes lose approximately 2-10% weight 2 or 3 days before the competition to compete in lighter weight and thus to get an advantage. They use various common methods such as doing high intensity exercise, diets, hypohydration, and/or hunger to lose weight rapidly and in such a short time (9,10). Athletes who wish to lose weight rapidly and in a short time use several methods (sauna, highly intensive exercise, and food and

liquid diet), and thus they lose liquid and electrolyte and suffer from dehydration (11,12). Dehydration generally causes a physical and physiological loss in liquid in the body and brings about changes in organisms by limiting liquid intake, using the sauna, and with or without warm clothes on (13-16).

It is argued that this situation has negative effects (2) on combat sports athletes in terms of nutrition (17), immune functions (18,19), and hormones (20). In addition to that, it is also pointed out that it will not be appropriate in terms of ethical concerns because such an athlete competes in a lighter category with his voluntary loss of weight (21). According to the codes of the World anti-doping agency (WADA), using such substances or methods which remove the soul of sport and which causes risks to athletes' health is a major issue that violates the sense of fair play (22). It is known that rapid loss of weight causes hypohydration and a decrease in the volume of plasma which increases blood viscosity acutely and it causes serious problems chronically (23). It is said that those acute responses will give harm to the cardiovascular system and that they will also cause serious cardiovascular risks (24). Even if the amount of water lost through dehydration is low (25), the body can suffer from intense hypohydration because the body has difficulty in adjusting body temperature (26). Along with this irregularity in adjusting body temperature, clothes made of materials such as plastic or rubber and saunas cause more heat stress (27). Heat stress and dehydration, which create the major factors of hypothermia (24), pose a vital risk for combat sports athletes (21). Therefore, this study aimed to identify weight loss methods- which have physical and physiological consequences for athletes- used by combat sports athletes, to determine the physiological, psychological ergogenic support and the types of changes that occur in athletes performance with diet and loss of water and to find appropriate solutions to the problems.

Materials and Method

Participants

The research sample was composed of 262 combat sports athletes (155 male and 107 female) of different branches such as wrestling (f=74), taekwondo (f=84) and judo (f=99) who were elites($\bar{X}$ ±SD=168.16±9.45 cm; $\bar{X}$±SD=65.01±16.30 kg before competition; $\bar{X}$±SD =63.20±16.40 kg at the weigh-in time; $\bar{X}$±SD=2.04±1.78 kg weight loss amount). The athletes included in the study were given the necessary information before completing the scales. The scales were given to the participants who were volunteers before and after measuring their weight before the competitions. First, the participants were asked to answer questions about personal information. They were allowed approximately 20-25 minutes to answer the questions.

Data Collection

For the current study, 'Athlete Weight Loss Methodology and Effects Scale' (Yarar et al. 2016) is a 19-item self-report measure used to asses an athlete's weight loss method and effects with five sub-dimensions (physiological effect, psychological effect, ergogenic support, diet, and fluid loss) (28). Also personal information forms were used. The Cronbach's alpha coefficient was found as .74 for the scale. The scale is a 5-point Likert type (Never=1, Rarely=2, Sometimes=3, Often=4, Always=5).

Statistical analysis

SPSS 20 statistics program was used in analyzing the data. Whether or not the variables had normal distribution or not was analyzed with Kolmogorov-Smirnov and the variables had normal distribution ($p>0,05$). Comparisons among the groups were performed using an independent sample t-test for two groups and Analysis of variance (ANOVA) for more than two groups. Moreover, the Tukey HSD post-hoc test was used for multiple comparisons of groups. A Pearson correlation analysis was used to determine the relationship between variables. Significance was set at $p<0.05$ and $p<0.01$ respectively.

Results

The descriptive information about the study group, athletes' weight loss methods and their effects, and the statistics for the variables about judo athletes, wrestlers, and taekwondo athletes are described in this section.

On examining the means for athletes' weight loss before competitions according to branches, statistically, significant differences were found (p=<0.05). Judo athletes' mean for weight loss ($\bar{X}$=1.35±1.32) was smaller than taekwondo athletes' ($\bar{X}$=2.1±1.63) and wrestlers' ($\bar{X}$=2.78±2.12) means (Table1).

According to Table 2, an examination of athlete weight loss methodology and effects and its sub-dimensions makes it clear that statistically significant differences are available in athletes' score means for physiological (p=<0.05), psychological (p=<0.05), dehydration (p=<0.05), and weight loss methods and effects (p=<0.05). Accordingly, judo athletes' effect means ($\bar{X}$=1.38) in the sub-dimension of physiological effects is smaller than taekwondo athletes' ($\bar{X}$=1.59) and wrestlers' means. Judo athletes' means in the sub-dimension of psychological effect ($\bar{X}$=1.76) is smaller than taekwondo athletes ($\bar{X}$=2.14) and wrestlers' means ($\bar{X}$=2.05) in the sub-factor of a psychological effect. In the sub-dimension of dehydration, however, wrestlers' mean ($\bar{X}$=2.61) is higher than taekwondo athletes' ($\bar{X}$=2.19) and judo athletes' ($\bar{X}$=2.26) means. The mean for weight loss methods and effects ($\bar{X}$=1.86) is smaller than taekwondo athletes' ($\bar{X}$=2.01) and wrestlers' ($\bar{X}$=2.13) means. On examining the athletes' means for the sub-dimensions of ergogenic support effects and diet according to branches, no statistically significant differences were found (p<0.05).

Table 1. Comparison of Athletes' Weight Loss means before the Competitions according to Branches

Branches	N	$\bar{X}$± S.D	F	P
Judo	99	1.35 ± 1.32[ab]		
Taekwondo	89	2.18 ± 1.63[a]	15.754	**0.000***
Wrestling	74	2.78 ± 2.12[b]		

*p<0.05; a,b: Different letters represent the difference between groups

Table 2. Comparison of Scores Received from Athletes' Weight Loss Methods and Effects Scale according to Branches

	Branches	N	$\bar{X}$ ± S.D	F	P
Physiology	Judo	99	1.39 ± .48[ab]	5.403	**0.005***
	Taekwondo	89	1.60 ± .54[a]		
	Wrestling	74	1.62 ± .55[b]		
Psychology	Judo	99	1.77 ± .63[ab]	6.943	**0.001***
	Taekwondo	89	2.15 ± .86[a]		
	Wrestling	74	2.05 ± .64[b]		
Ergogenic support	Judo	99	1.10 ± .29	2.634	0.074
	Taekwondo	89	1.23 ± .56		
	Wrestling	74	1.13 ± .41		
Diet	Judo	99	3.20 ± .88	1.855	0.159
	Taekwondo	89	3.26 ± 1.18		
	Wrestling	74	3.57 ± 1.84		
Dehydration	Judo	99	2.27 ± .69[a]	5.813	**0.003***
	Taekwondo	89	2.19 ± .96[b]		
	Wrestling	74	2.62 ± .86[ab]		
Weight loss method and effects	Judo	99	1.87 ± .41[ab]	8.724	**0.000***
	Taekwondo	89	2.02 ± .40[a]		
	Wrestling	74	2.13 ± .47[b]		

*p<0.05; a,b: Different letters represent the difference between groups

Table 3. Analysis of the Correlations between Athlete Weight Loss Methods and Effects Scale and the weight Lost before the Competitions

n=262		Physiology	Psychology	Ergogenic support	Diet	Dehydration	Weight loss method and effects
Weight lost before the competition	r	.194	.103	.183	.037	.118	
	p	.002**	.095	.003**	.547	.057	

p<0.01

Positive and low correlations were found between the weight loss before the competitions and the sun-dimensions of physiological effects by 19.4% (r=.194; p=<0.01). Positive and low correlations were found between the weight loss before the competitions and the sub-dimensions of the ergogenic support effect by 18.3% (r=.183; p=<0.01). Again, positive and low correlations were found between the weight loss before the competitions and weight loss methods and effects scale by 18.9% (r=.189; p=<0.01).No significant correlations were found between the weight loss before the competitions and the sub-dimensions of psychological, diet, and dehydration (p>0.05).

Discussion and Conclusions

Weight loss methods and their effects are an indispensable part of combat sports. So it is argued that there are several weight loss methods used by athletes (6,27,29) and that the methods are used at the rate of 60-70% although the methods have negative effects on athletes' performance and health (6,30). On examining the averages for athletes' weight loss before competitions according to branches, statistically, significant differences were found. Accordingly, it was found that wrestlers lost more weight than other athletes. Similarly, other studies also found that wrestlers lost more weight than athletes of other combat sports (12,31). Yarar et al. (28) found that wrestlers generally started to lose weight two weeks before competitions whereas Brito et al (32) found that judo athletes started to lose weight 14.5 days ago, karate athletes started to lose weight 14.8 days ago and taekwondo athletes started to lose weight 9.7 days ago. It is stated that starting to lose weight as the competition is approaching can affect athletes physiologically and psychologically (33) and that dehydration in a short time and great amounts can result in an imbalance in the cardiovascular system and electrolyte levels, can cause problems in heat functions and failure in kidney functions (34-36). Significant differences were found according to branches and the sub-factors of physiological, psychological, and dehydration between groups. Thus, it was found in the sub-factors of physiological and dehydration that wrestlers used the methods more than the athletes of other branches and that taekwondo athletes used the psychological method more than the athletes of other branches. According to several studies (6,37-39), wrestlers are influenced negatively by physical and physiological problems stemming from dehydration. Similarly, Aslan (40) states that wrestlers use physiological and dehydration methods more frequently than the athletes of other branches. Researchers said that taekwondo athletes are influenced psychologically more in weight loss before competitions (41,42). On examining the correlations between the scale of competition weight and weight loss methods and effects and the competition weight, positive correlations were found between the sub-factors of physiological, psychological, diet, and dehydration. It is stated that athletes lose more weight during competitions by using those methods. In parallel to this current study, some studies found a fall in oxygen consumption, loss in performance, and decrease in liver glycogen storage due to weight loss in athletes who are to measure their weight soon (16,28,34,43). Imamoglu et al (44) also obtained similar results and said that other combat sports athletes used a method or several methods in combination to lose weight for competitions. Therefore, families and experts look at methods such as nylon training clothes, diet pills, diuretics, and laxatives with hesitation and fear (32).

As a result of this study, athletes regularly bodyweight controls to prevent their loss of weight in precompetitive. Such an approach is beneficial for both athlete's health and their performance. In cases where adult athletes must lose weight, it would yield better results to determine the percentage of body fat and to lose weight by reducing the rate of fat. The fat rate should not fall below 5% for men and below 12% for women. Methods that can be harmful to health and to performance (such as remaining hungry for long, using the medicine, sauna, etc.) should be avoided.

Conflicts of interest
The authors declare that there is no conflict of interest in this manuscript.

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Original article

The relationship between athletes' belief in nutritional supplements and disengagement of sports ethics with doping

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Abstract: *Study Objective:* The aim of this study was to examine the relationship between the belief of athletes in nutritional supplements and the disengagement from sports ethics with doping. *Methods:* A total of 627 athletes with mean age of 22.76±5.30 years, mean of 9.51±5.64 sports years, 307 of whom were women, and 320 of whom were men, participated in the study. The research used the scale of belief in nutritional supplements and the disengagement from sports ethics with doping scale. The Mann Whitney U and Kruskal Wallis tests were used to analyze data from non-parametric tests. *Results:* The results had shown that athletes were moderate agreed with the belief in sports nutritional supplements, while they didn't agree with the disengagement from sports ethics with doping. According to the correlation analysis, there was a positive low level of significant correlation between the total score for the sports nutritional supplements belief scale and the total score for the disengagement from sports ethics with doping. A significant difference was found in the total score of sports supplements based on gender, nationality, and age variables, and in the total score of the disengagement from sports ethics with doping according to national and branch variables. *Conclusion:* As a result, increased belief in nutritional supplementation in sport appears to have led athletes to disengage from sport ethics with doping.

Keywords: Doping, Nutritional Supplements, Sports Ethics

Introduction

Adequate calorie and nutrient intake is an important factor for achieving and maintaining high-level performance in sports. In situations where nutrition is not sufficient, athletes often turn to nutritional supplements or use doping agents to achieve competitive advantage.

Nutritional supplements can be defined as non-doping substances used to increase energy production and consumption, delay fatigue, and improve performance (1). In other words, a nutritional supplement is called the use of some substances, methods, and materials other than natural ability and training to improve sporting performance (2). Athletes can gain an advantage by increasing their current performance through nutritional supplements (3). In contrast with the sport's goals and objectives, high transfer fees, combined with the athlete's desire to leave a trace, achieve recognition, win medals in competitions and earn prizes, result in pulling athletes away from being ethically virtuous, and the use of doping, which is a societal problem (4). Increasing unconscious drug use and doping levels in many of our country's sports is drawing attention (5). Doping is one of the issues that require resolution in sports. That as doping use becomes commonplace, it is thought to compromise fair play, athlete health, and the spirit of the sport (6). The reasons for athletes' propensity for doping are assumed to be linked to their desire to maximize performance,

desire to win, and adequate financial support, according to Yalçın et al. (2019) research results (7). The use of doping in sport is a kind of trick that is considered to be unethical, illegal, and harmful to health (8). In other words, athletes' use of prohibited drugs violates the sport's ethics and can put the athletes' health at risk (9). The human ego's desire to be privileged, to stand out, to succeed, to earn a lot of money can cause it to ignore both ethical values and legal regulations (10).

When an adequate and balanced diet is not properly performed in sports, the energy balance can't be used correctly and the athlete can't achieve his / her goal or perform the expected performance of the athlete. Although most athletes try to add nutritional supplements to fulfill this nutritional deficiency, some athletes may employ a doping agent to perform at a high level. In other words, unethical behavior is considered an unfair advantage and is claimed to be contrary to the sport's nature. In this context, the aim of this study was to examine the relationship between the belief of athletes in nutritional supplements and their disengagement from sports ethics with doping, and to determine whether they differ by gender, age, sports year, and nationality.

Material and Methods

Participants

A total of 627 athletes with an mean age of 22.76±5.30 years, an mean of 9.51±5.64 sports years, 307 of whom were women and 320 of whom were men, 333 (53.1%) were national athletes, 346 (55.2%) were in individual sports and 281 (44.8%) were in team sports participated in the study. 286 of these athletes stated that they used nutritional supplements, while 341 stated that they did not. In addition, 8 of the 627 athletes stated using doping substances.

Data Collection

The sports nutritional supplements belief scale and the disengagement from sports ethics with doping scale are used for data collection in the research.

The sports nutritional supplements belief scale, developed by Hurst et al. (2017) and adapted to Turkish by Karafil, Ulaş and Atay (2019), consists of six questions and one dimension. This is a 6-likert-type scale. The scale items are rated as (1) strongly disagree, (6) strongly agree. The content of the scale is intended to test the athlete's belief in nutritional supplements based on training and competition. The lowest score that can be scored from the scale is 6 and the highest score that can be scored is 36. With the highest score that can be taken from the scale, it can be concluded that people may be more likely to use doping and similar prohibited nutritional supplements (3).

The disengagement from sports ethics with doping scale developed by Kavussanu et al. (2016) to measure the mechanisms of demoralization in the use of performance-enhancing prohibited substances has been adapted to Turkish by Gürpınar, Nalbant and Kavussanu (2019). The scale is rated between strongly disagree (1) and strongly agree (7). The disengagement from sports ethics with doping scale consists of six questions and one dimension (11).

Statistical analysis

The Kolmogorov-Smirnov test was examined to determine whether the data analyzed using SPSS showed normal distribution and the data were not normally distributed ($p<0.05$). The Mann Whitney U and Kruskal Wallis tests were used for comparing of continuous data between two independent groups and comparing of continuous data between independent groups which are more than two, respectively.

Results

When Table 1 was examined, it was observed that the athletes participated moderate in the sports nutritional supplements belief (3.85±1.26), while they did not participate in the disengagement from sports ethics with doping (2.28±1.23).

Table 1. Analysis of mean scores of the sports nutritional supplements belief scale with the disengagement from sports ethics with doping scale

Scales	N	Mean± Std. Dev.
The sports nutritional supplements belief scale	627	3,85±1,26
The disengagement from sports ethics with doping scale	627	2,28±1,23

According to Table 2, there was a positive low level of statistically significant correlation between the total score of the sports nutritional supplements belief scale and the total score of the disengagement from sports ethics with doping scale (p<0,05; r=0,267).

In Table 3, a statistically significant difference was observed in the total score of the sports nutritional supplements belief scale (p<0.05), while no significant difference was observed in the total score of the disengagement from sports ethics with doping scale (p>0.05).

When Table 4 was examined, there was a statistically significant difference between the total score of the sports nutritional supplements belief scale and the total score of the disengagement from sports ethics with doping scale (p<0.05).

In Table 5, there was no statistically significant difference in the total score of the sports nutritional supplements belief scale according to the branches of the athletes (p>0.05), while the total score of the disengagement from sports ethics with doping scale was significantly different (p<0.05).

In Table 6, a statistically significant difference was found in the total score of the sports nutritional supplements belief scale according to age (p<0.05), while the total score of the disengagement from sports ethics with doping scale did not differ significantly (p>0.05).

When Table 7 was examined, there was no statistically significant difference in total scores of sports

Table 2. Correlation test results of the sports nutritional supplements belief scale and the disengagement from sports ethics with doping scale

Scales		The sports nutritional supplements belief scale	The disengagement from sports ethics with doping scale
The sports nutritional supplements belief scale	r	1,000	,267**
	p	.	,000
	N	627	627
The disengagement from sports ethics with doping scale	r	,267**	1,000
	p	,000	.
	N	627	627

Table 3. Mann Whitney-U test analysis results of the sports nutritional supplements belief scale with the disengagement from sports ethics with doping scale by gender

Scales	Gender	n	Median (Q_1-Q_3)	p
The sports nutritional supplements belief scale	Women	307	3,83 (2,67-4,67)	,000
	Men	320	4,33 (3,17-5,00)	
The disengagement from sports ethics with doping scale	Women	307	2,00 (1,17-3,00)	,122
	Men	320	2,00 (1,33-3,00)	

Table 4. Mann Whitney-U test analysis results of the sports nutritional supplements belief scale and the disengagement from sports ethics with doping scale according to the status of being a national athlete

Scales	Status of being a national athlete	n	Median (Q_1-Q_3)	p
The sports nutritional supplements belief scale	Yes	333	4,33 (3,17-5,00)	,001
	No	294	3,67 (2,83-4,67)	
The disengagement from sports ethics with doping scale	Yes	333	1,83 (1,00-2,83)	,001
	No	294	2,17 (1,50-3,00)	

Table 5. Mann Whitney-U test analysis results of the sports nutritional supplements belief scale and the disengagement from sports ethics with doping scale according to sports branches

Scales	Branches	n	Median (Q_1-Q_3)	p
The sports nutritional supplements belief scale	Individual	346	4,00 (2,83-4,83)	,306
	Team	281	4,00 (3,00-5,00)	
The disengagement from sports ethics with doping scale	Individual	346	2,00 (1,17-2,83)	,015
	Team	281	2,00 (1,33-3,17)	

Table 6. Mann Whitney-U test analysis results of the sports nutritional supplements belief scale and the disengagement from sports ethics with doping scale according to ages

Scales	Ages	n	Median (Q_1-Q_3)	p
The sports nutritional supplements belief scale	Ages 18-21	347	3,83 (2,83-4,67)	,010
	Age 22 and over	280	4,17 (3,17-5,00)	
The disengagement from sports ethics with doping scale	Ages 18-21	347	2,00 (1,33-3,00)	,256
	Age 22 and over	280	2,00 (1,00-3,00)	

Table 7. Kruskal Wallis test analysis results of the sports nutritional supplements belief scale and the disengagement from sports ethics with doping scale according to sports year

Scales	Sports year	n	Median (Q_1-Q_3)	p
The sports nutritional supplements belief scale	1-5 years	179	3,83 (2,83-4,67)	,088
	6-10 years	219	3,83 (3,00-5,00)	
	11 years and over	229	4,33 (3,25-5,00)	
The disengagement from sports ethics with doping scale	1-5 years	179	2,00 (1,50-3,00)	,467
	6-10 years	219	2,00 (1,17-3,00)	
	11 years and over	229	2,00 (1,00-3,00)	

nutritional supplements belief scale and disengagement from sports ethics with doping scale according to sports year ($p>0.05$).

Discussion and Conclusion

The results have shown that athletes were moderate agreed with the belief in sports nutritional supplements, while they didn't agree with the disengagement from sports ethics with doping. In other words, athletes believe that nutritional supplements can be used from time to time, but the use of doping generally leads to disengagement from sport ethics. In Karatas and Cevrim's study (2011) with athlete students, the students' answer to the question "Why didn't you use doping?" was that they thought it would be "ethically wrong" (10). In the study of enel et al. (2004), a significant proportion of athletes (91.7 %) said they would never use illegal substances (12). Dierickx, Deckx and Hens (2012) reported that doping was considered a threat to fair play by the athletes (13).

The relationship between the total sports nutritional supplements belief scale score and the total disengagement from sports ethics with doping scale score were found to be positively significantly lower. Therefore, as the belief of athletes in nutritional supplements increases, so does the idea that the use of doping becomes not unethical. In other words, according to athletes using nutritional supplements, doping is considered to be an available substance. As a result of their work, Karafil, Ulaş and Atay (2019) emphasized that athletes are turning to the use of doping and similar prohibited substances by increasing their belief in sports nutritional supplements (3). Similarly, in their study, Hurst et al. (2019) found that athletes who believed that nutritional supplements were effective and who used nutritional supplements were more prone to the use of doping (14).

The results in the study showed no significant difference in the total score of the disengagement from sports ethics with doping scale by gender.

In this study, it was determined that the beliefs of national athletes in nutritional supplements were higher than those of non-national athletes, and that the total scores of the disengagement from sports ethics with doping were significantly higher than those of national athletes. Accordingly, non-national athletes believe that doping can be used and that it is not a behavior that would disengage of sports ethics with doping. However, it can be said that national athletes believe in the use of nutritional supplements that do not substitute for doping substances to improve their performance and regain their lost energy. Similar to this study in literature Ersöz›s (2007) study, the vast majority of athletes, wrestlers, judokas, and weight-lifters

who play sports at the national level stated that the use of doping in sports damages the spirit of fair-play (15). Unlike to this study, Yıldırım and Sahin›s (2019) study found that nearly half of the national team wrestlers tolerate doping and other unethical behavior (16).

According to another finding, the total score of the disengagement from sports ethics with doping scale of team athletes was significantly higher than that of individual athletes, while the total score of the sports nutritional supplements belief scale was not significantly different from that of the branch. Accordingly, team athletes believe that, unlike individual athletes, the use of doping does not disengage of sports ethics. The reason why team athletes such as football, basketball, handball, and volleyball participated in the study normalized the use of doping compared to individual athletes is due to factors such as high premiums, a desire to gain individual fame and high transfer fees to their clubs after a successful season.

In this study, it was observed that the beliefs of older athletes in sports nutritional supplements were significantly higher than those of younger athletes, while the disengagement from sports ethics with doping scale was not significantly different according to age. In other words, experienced athletes think that the use of nutritional supplements without a legal sanction would be more appropriate.

According to another finding, there was no significant difference between the sports nutritional supplements belief scale and the disengagement from sports ethics with doping scale in terms of the sports year. Unlike the research results, Dinçer (2010) concluded that athletes with the sports year between 1-3 years and 4-7 years strongly agree that using doping leads to unfair competition, while athletes with the sports year between 7-11 years disagree with this view and accordingly, as the age of sport increases, athletes do not care about unfair competition and winning becomes a more important phenomenon than unfair competition (17).

As a result, it has been observed that increasing beliefs in nutritional supplementation in sport cause athletes to disengage of sports ethics with doping. It has been concluded that doping, which is used to achieve success initially in team athletes and non-national athletes, does not disengage from ethics, is more dominant and that male athletes, national athletes, and older athletes had higher faith in nutritional supplements in sports.

Conflicts of interest

The authors declare that there is no conflict of interest about this manuscript.

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Original article

How balance training on different types of surfaces effect dynamic balance ability and postural sway of gymnast children?

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Abstract. *Study Objectives:* This study aimed to examine the impact of balance training performed on stable and unstable surfaces on the dynamic balance of children. *Methods:* The sample of the study consisted of 40 female gymnasts (7 years old). The sample was randomly divided into two groups and the first group (122.85±1.14 cm in height, 24.05±1.04 kg in weight) performed unstable surface training while the other group (123.92±1.33 cm in height, 24.95±1.36 kg in weight) performed stable surface training. Eight-week balance training programs were administered three days a week for 40 minutes a day. The pre and post-dynamic balances of the participants were measured with the Tecno-body ProKin PK200 model dynamic balance device. ML, PL, AGP, MS, and AP parameters were assessed, and comparisons were made by the paired t test in SPSS 17.00 package program. *Results*: While there was a statistically significant difference in all parameters, except for ML values, in the group who performed the balance training on an unstable surface ($p < 0.05$), no statistically significant difference was found in the other group ($p > 0.05$). *Conclusion*: The results showed that training on unstable surface effect dynamic balance and postural sway in a positive way.

Keywords: Dynamic balance, Training, Postural sway, Gymnast, Children

Introduction

In daily life, we experience walking and posture in many different environments. These environments can be very bright or dark, flat, or unstable surfaces. This change in the visual environment provides inconsistent visual input to the postural control system, which leads to a re-estimation of body direction to prevent postural instability (1,2). In this process, a change in the contribution of sensory systems happens because the central nervous system relies less on the sensory system with the discordant formation and on other sensory systems with reliable formation, afterward, inputs from different planning systems are reassembled for use in motor planning and implementation (2,3). Based on this sensory information, the postural response model quickly and efficiently returns the center of body mass to an unbalanced equilibrium position on the support base (4). The rate at which this equilibrium position is captured and the length of time it can be maintained is directly related to the individual's development level of balance.

Assessment of balance ability is a method to determine the muscular response to efferent or afferent stimulation. The equilibrium is said to be mediated by the same peripheral afferent mechanism mediating joint proprioception but may represent lower limb function compared to assessments at a non-weight bearing position (5). Various studies have been conducted to assess postural control and balance to compensate for compensatory distortions and it is seen that, generally, these studies have documented that children show well-organized muscle responses to impairments between the ages of 7 and 10 years, but the amplitude, latency, and duration of responses are greater than that of adults (6-9).

Balance is divided into dynamic balance and static balance. Dynamic balance can be defined as ensuring balance under the conditions that activate the center of gravity in response to one's body muscle activity (10). It is one of the critical auxiliary motor features that optimize the efficiency of functional skills and constitutes the infrastructure of the movement. Factors affecting balance are composed of internal and external factors and various nerves and biomechanical factors work together to affect balance (11). The factors affecting balance include sensory information from the somato-sensor, visual and vestibular system, motor reactions affecting coordination, mobility, and force. Ensuring balance requires three different sources of sensory information, which are visual, vestibular, and proprioception. As a provider of important sensory information, proprioception may help to accurately perceive the position, posture, and movement of the human body, which is important in sensory information (12). The training of each level of the sensory-motor chain (somatosensory, visual, vestibular) may improve the balance control in complex conditions (13,14). Additionally, training age and the types of training affects the postural control directly.

With the increasing number of sports on unstable surfaces and the number of athletes compete on unstable grounds (15). One of these sports which is very popular around the world is gymnastics and balance plays a crucial role in gymnastics. While keeping the aesthetics of movements, the balance must also be maintained. Therefore, balance training should be an important part of gymnastic training (16). The children that have better-developed motor skills could be much more active than the others with less developed motor skills and basic movement skills develop before the age of 8 years (12,17). Consequently, systematic balance, proprioception, and gross motor training in the period before the age of 8 will contribute to the development of the basic movement.

In this context, our hypothesis proposes that training on unstable surfaces would have a positive effect on dynamic balance and sway. The purpose of this study was to investigate the impact of different types of balance training on postural sway and the dynamic balance of children.

Material and Methods

Participants

The sample of the study consisted of n=40 female gymnasts (7 years old) who have been licensed at least 1 year and still active in gymnastics.

Experimental Design

Groups were randomly divided into 2 groups of n=20. The first group (122.85±1.14 cm in height, 24.05±1.04 kg in weight) performed unstable surface training while the other group (123.92±1.33 cm in height, 24.95±1.36 kg in weight) performed stable surface training.

The training was scheduled every other day after the participants get out of the school and administered for 40 minutes. The training was followed in the gym of Ulugazi Primary School Gymnasium. The pre-and post-tests were performed in the same school and gym. The data set was recorded accordingly. Bose ball, sponge, and unstable balance board were used for unstable surface training and a stable balance board, stable surface, balance beam used for stable surface balance training.

General and special warm-ups, including walking, jumping, and running were performed at the beginning of each training session (15 minutes). At the end of the training, a 10-minute cooling down and lower extremity stretching were done and the training

Table 1. Training sample for stable surface group

Monday Wednesday Friday
Warm-up (Walking, running, gymnastic specific jumping trainings, stretching) 15 min
Changing direction while standing on one leg (1 set both for right and left) (15 sec work-30 sec rest)
Collecting objects from the floor while standing on one leg (right and left feet (1 set both for right and left) (15 sec work-30 sec rest)
One leg standing stark (1 set for both right and left feet) (15 sec work-30 sec rest)
One leg standing stark while hands ahead (1 set for both right and left feet) (15 sec work-30 sec rest)
One leg standing stark while hands up(1 set for both right and left feet) (15 sec work-30 sec rest)
Cool down 10 min
The duration of the training session is 40 minutes.

Table 2. Training sample for unstable surface group

Monday	Wednesday	Friday
Warm-up (Walking, running, gymnastic specific jumping trainings, stretching) 15 min		
Double foot balance on Bosu ball (15 sec work – 30 sec rest x 2 sets)		
Double foot balance on Bosu ball while eyes-closed (15 sec work – 30 sec rest x 2 sets)		
One leg standing stark on Bosu ball (1 set for both right and left feet) (15 sec work-30 sec rest)		
One leg standing stark on Bosu ball while eyes-closed (1 set for both right and left feet) (15 sec work-30 sec rest)		
Forward jumps onto Bosu balls (15 sec work – 30 sec rest x 2 sets)		
Cool down 10 min		
The duration of the training session is 40 minutes.		

was terminated. The duration of each training session was 40 minutes. The training was carried out with certified coaches who are experts in the field. During the first 2-week phase, participants were first adapted to the study by providing basic balance training designed specifically for the groups. The level of training of the groups was updated according to the surface characteristics in the 3rd and 4th weeks. The intensity for each of the groups was increased in the 5th and 6th weeks. Then, training intensities of the groups were increased to the planned level at the 7th weeks to 8th weeks. Bose ball, balance board, sponge, and trampoline were used in unstable surface training.

Test Protocol

Before the study, ethical approval was obtained from Kocaeli University Ethics Committee in accordance with the Helsinki Declaration regarding the content of our study. The approval number is stated as KOÜ KAEK 2015/223. It was explained to the participants before the test protocol that the testing procedure would be terminated in case of holding on to anywhere, stepping down the platform, touching the ground, and looking somewhere other than the monitor. The position of the participants on the platform was explained using auxiliary signs on the device. The pre- and post-tests were applied to each participant 30 seconds in the form of 2 trials - 1 test. The participants were given a 1-minute rest period between each trial.

Tecno-body ProKin PK200 model dynamic balance device was used as the data collection tool in the study. The device has a slope position of 12˚ from the center to each direction on its horizontal axis. This device is capable of measuring three different difficulty levels (Easy-Medium-Hard). The measurements of the study were done based on 1 trial right to each participant in the "easy" level with a double foot method. Besides, the device was calibrated after each measurement. The examined parameters are as follows:

PL: Perimeter Length

AGP: Area Gap Percentage

MS: Medium Speed (˚/sec.)

AP: Medium equilibrium center = Anterior-posterior

ML: Medium equilibrium center = Medial-lateral

The heights of the participants were measured with the help of a tape measure. They were weighted with the EKS brand manual weighing device and the values were recorded.

Statistical Analysis

The data obtained from the pre- and post-tests were analyzed in IBM Statistics SPSS 17.0 for Windows package program. The Paired Samples T-Test was used for the differential analysis of the groups. All tests were performed at 95% confidence interval and $p<0,05$ significance level.

Results

The mean height of unstable surface group was 122,85 ±1,14 cm and the average weight of unstable surface group was 24,05±1,04 kg. The average height of stable surface group was 123,70±1,33 cm and the average weight of stable surface group was 24,95±1,36 kg. There was no statistically difference found between the height and the weight of the groups (Table 3).

The statistically significant difference was found in the PL, AGP, MS, and AP values between pre-test and post-test results for unstable surface training

Table 3. Demographic information of study group

N=40	Unstable surface(n=20)	Stable Surface(n=20)	p
Height (cm)	122,85±1,14	123,70±1,33	0,272
Weight (kg)	24,05±1,04	24,95±1,36	0,568

Table 4. Results of the Unstable Surface Training Group

		N	$\bar{X}$	SD	t	p
PL	Pre-test	20	349,18	26,62	4,819	**0,001***
	Post-test	20	206,34	16,23		
AGP	Pre-test	20	,099	,022	5,473	**0,001***
	Post-test	20	-,023	,008		
MS	Pre-test	20	11,64	,887	4,820	**0,001***
	Post-test	20	6,87	,541		
AP	Pre-test	20	-,559	,300	-2,286	**0,034***
	Post-test	20	,230	,238		
ML	Pre-test	20	-,164	,362	-,261	0,797
	Post-test	20	-,063	,150		

*p<0,05

group (p <0.05). Although there is a difference in the mean value, no significant difference is found in ML (p> 0.05) (Table 4).

There were no significant differences in PL, AGP, MS, AP, and ML values between pre-test and post-test results for stable surface training group (p> 0.05) (Table 5).

Discussion and Conclusion

The purpose of this study was to investigate the impact of different types of balance training on postural sway and the dynamic balance of children. Unstable surfaces training group showed a statistically significant difference in the PL, AGP, MS, and AP values (p <0.05). Although there was a difference in the mean value, there is no significant difference in medial-lateral sway (p> 0.05). Childhood is a stage of growth characterized by various biological features. The development in motoric abilities may help children for their physical adaptation to variable situations and increase in performance, consequently, interventions that provide these changes become critical. Distortion of the balance re-creates a flexible signal through the receptors. These receptors are responsible for detecting sudden and unexpected postural changes due to changes in muscle activation and gamma-motor neurons innervate the muscle spindle and adjust the sensitivity of the muscle spindle. Thus, it provides the most appropriate response during muscle contraction (alpha-gamma co-activation) to provide balance as fast as possible (18).

Table 5. Results of the Stable Surface Training Group

		N	$\bar{X}$	SD	t	p
PL	Pre-test	20	377,32	32,37	,371	0,715
	Post-test	20	365,72	32,15		
AGP	Pre-test	20	,138	,027	1,441	0,166
	Post-test	20	,101	,029		
MS	Pre-test	20	12,57	1,07	,372	0,714
	Post-test	20	12,19	1,07		
AP	Pre-test	20	,086	,400	-,549	0,589
	Post-test	20	,294	,154		
ML	Pre-test	20	,503	,368	-,277	0,785
	Post-test	20	,622	,210		

*p<0,05

The improvement in anterior-posterior could be related to the response or activity of gastrocnemius that block moving the center of mass away and keeping it close to the center of pressure, reducing sway on posture. Due to these improvements, perimeter length did decrease directly, because the sway on the body reduced and the center of mass didn't change. Therefore, the distance traveled on the device was minimized and the amount of angular displacement on the surface was lowered. As opposed to these findings, the stable surface training group didn't show a statistically significant difference in any parameters. Since the balance and body sway were not controlled according to the movement of the surface during the training on unstable surfaces, we found that the control of the body sway and body weight center did not improve significantly in the evaluation on the unstable surface. These results support our hypothesis.

It was previously shown that unstable balance training and gymnastic training have positive effects on dynamic balance and the balance characteristics of the athletes in branches where dynamic balance is prominent are more developed than those in other branches (19-23). In another study, it is indicated that trampoline training was effective in increasing the dynamic balance level (24). By adapting to the unbalanced trampoline surface to achieve stability, changes in complex sensory motor stimulation can be expected and therefore improve balance performance. When previous studies on balance training and muscle activity on unstable surfaces are considered, it is found out that unstable surfaces have positive effects on improving dynamic balance and postural reflex activity (25,26).

Some scientists reported that the subjects who did stable surface training had less development than the ones who did unstable surface training (27). When we evaluate our results together with the results in the literature, we see that one of the criteria for dynamic balance development is to activate visual and sensory motor units by training on unstable surfaces and to adapt the body sway and body stability to these surfaces. Of course static balance training is a method to improve balance, but it is not as effective in improving dynamic balance as dynamic balance training. Literature review revealed that unstable objects, such as biodex balance device, balance disc with soft and hard surfaces, balance board, and swiss ball were used in balance training and balance tests, and some types of balance training were performed on these objects in the upright position, standing on knees and sitting on them (28-31). Additionally, the balance platforms within the Prokin PK series were also used in the studies on dynamic balance tests (32-34).

Recent studies have shown that only children under the age of 12 use different sensory information to maintain a silent posture, and do not compensate for changes in sensory signal quality and size as adults do. Based on these recent results and assuming that the complex relationship between sensory information and motor action is assumed in the development of postural control, balance, and especially postural control, it is assumed that the use of sensory information can be altered in physically practicing postural control and sway (35-37).

The results show that training on unstable surfaces improve dynamic balance ability and reduce postural sway statistically. Improving the balance at younger ages could help the performance in many sport branches. In addition to this, experts can plan similar studies with different sex and age groups. The monthly duration of the training program can be extended to investigate the different motoric effects of trainings. Similar to this study, it can be analyzed the effect of static balance training on dynamic balance by organizing a new experimental group and new training program. Balance trainings can be diversified by using different tools.

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Conflict of interest statement

The authors declare that they have no conflict of interest.

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Original article

The mediating role of nutrition knowledge level in the effect of mindfulness on healthy nutrition obsession

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Abstract. *Study Objectives:* The study aimed to determine the mediating role of nutritional knowledge level in the effect of mindfulness of individuals, who receive sports education at the undergraduate level, on the healthy nutrition obsession. *Methods:* The sample of the study consists of 339 participants, 163 of which are female and 176 are male, who continue their education in a higher education institution, which provides undergraduate sports education, in Ankara province in the 2019-2020 academic year. "Mindfulness Scale", the "Orto-11 (Healthy Nutrition Obsession) Scale" and "Nutrition Knowledge Level for Adults Scale" were used as data collection tools. In addition to descriptive statistics, structural correlation models aimed at testing the Pearson Correlation and the constructed theoretical model were used in the analysis of the data. *Results:* The mean score obtained by the participants was determined as ($\bar{x}$=3.76) for the Mindfulness Scale, as ($\bar{x}$=2.20) for the Healthy Nutrition Obsession Scale, and as ($\bar{x}$=2.31) for the Adult Nutrition Knowledge Level Scale. A statistically significant effect was found in the relationship of mindfulness with a healthy nutrition obsession (β_1=.16; p<.05). However, the fact that mindfulness does not affect significantly nutritional knowledge level indicates that the mediating role is not realized. However, the Squared Multiple Correlations (R^2) values of the model show that nutritional knowledge level and mindfulness explain healthy nutrition obsession by 22.4% and mindfulness explains the nutritional knowledge level by .001%. *Conclusion:* It can be stated that mindfulness is important to eliminate the healthy nutrition obsession of individuals.

Keywords: Mindfulness, Healthy nutrition, Nutritional information, Sports.

Introduction

Nutrition has always played an important role in our lives. Several times every day, we choose foods that affect the health of our bodies. Daily food choices can have little benefit or harm to health, but over time, the results of these choices become important. When this is the case, paying close attention to good eating habits then promotes a healthy life. On the contrary, a careless selection of food can lead to chronic diseases (1). Therefore, nutrition is an issue that should always be emphasized during life. It is because it forms the basic elements of a healthy life from infancy to childhood, from childhood to adulthood, and the end of life (2).

Healthy eating obsession is an eating disorder that defines excessive mental struggle against healthy foods (3). Nutritional disorder is a psychological condition that is characterized by a permanent, severe discomfort in a person's eating habits, causing inadequate or excessive dietary intake, which can cause serious physical and psychosocial impairments (4). Today, many scientifically unproven foods and beverages are presented to the information of the society with the wrong directions. However, it is thought that mindfulness will be much more effective in creating a healthy lifestyle. Awareness is an individual's understanding of the environment in

which s/he lives with all his/her senses, as well as being aware of what should be known, paying attention or showing sensitivity to something to be understood (5,6). Mindfulness is a process of acceptance, being open to experience, a skill that is related to curiosity, and a regular attention process that allows not to miss the awareness of the current events (7). Mindfulness means self-awareness at all times (8). The main feature of mindfulness is clear or accepting awareness and carefulness, which can be reflected as being more aware of the ongoing events and experiences than usual (9).

While the concept of mindfulness was originally explored in a clinical context, it has expanded in recent years towards behavioral research, social areas, and education (10). With this expansion, it has been the subject of various studies in the field of nutrition, which concerns the society. Mindfulness is thought to be an important factor in separating individuals from stereotypes, habits, and unhealthy behaviors in creating a healthy lifestyle in societies. From this point of view, it was aimed to reveal the effect of mindfulness on healthy nutrition obsession and to examine the mediating role of nutrition knowledge level on the model.

Material and Methods

Research Model and Hypotheses

The model of the research is designed with a relational screening model. Relational screening model is used to determine the relationship between two or more variables and to obtain hints about cause and effect (11). As a result of the literature review, the model of the research was created based on the variables preferred within the scope of the research. The model created was tested using the structural equation model. The structural equation is a combination of factor analysis, regression analysis, and is a theoretical structure represented by latent and observed variables (12,13). The hypotheses of the model created under the aim of the research as a result of the literature review are given below.

H_1: Mindfulness (M) positively affects healthy nutrition obsession (HNO).

H_2: Mindfulness (M) positively affects the nutrition knowledge level (NKL).

H_3: Nutrition knowledge level (NKL) positively affects healthy nutrition obsession (HNO).

Participants

The study group of the research consists of 339 participants who continue their education in a higher education institution in Ankara province that provides undergraduate sports education in the 2019-2020 academic year. In this study, the convenience sampling method, which is one of the purposeful sampling methods, was used (14). While 163 (48.1%) of the participants were female, 176 (51.9%) were male students, and 229 (67.6%) exercise regularly while 110 (32.4%) do not. In addition, 206 (60.8%) of the participants have a license from any sports branch, while 133 (39.2%) are not. The mean age and standard deviation of the participants was determined as 21.91±3.37.

Data Collection

In this section, besides the personal information form, scales of mindfulness, Orto 11, and Nutrition knowledge level for adults are used.

Mindfulness Scale (MS)

The Mindfulness Scale was developed by Brown and Ryan (2003) and adapted to Turkish by Özyeşil, Arslan, Kesici and Deniz (2011). The scale consisting of 15 items in total has a 6-point Likert type structure. The internal consistency coefficient of the scale is given as .80. Cronbach Alpha internal consistency coefficient obtained from the data set used in the study was determined as .88.

Orto-11 (Healthy nutrition obsession) Scale

This scale was developed by Donini et al (2004) and adapted to the Turkish by Arusoğlu, Kabakçi, Köksal and Merdol (2008). The scale, which is one-dimensional and consists of 11 items in total, is designed in a 4-point Likert type structure. The scale's total score is obtained by adding all the items on the scale where the answers reflecting the orthotic tendency have "1", and the answers reflecting the normal eating behavior tendency have the score "4", and the low scores obtained from the scale represent the orthorexic trend. The Cronbach Alpha internal consistency coefficient of the scale was .70, and the internal consist-

ency coefficient obtained from the data set used in the study was .73.

Nutrition knowledge level for Adults Scale

The Nutrition knowledge level for adults scale was included in the literature by making validity and reliability analyses by Batmaz (2018). The scale, which has 20 items in total, consists of a single dimension and has a 5-point Likert type structure. The highest score that can be obtained from the scale is 80. As the total score obtained from the scale decreases, the nutrition knowledge level decreases, while the total score increases, the nutrition knowledge level increases. The Internal consistency coefficient of the scale is given as .74. Cronbach Alpha internal consistency coefficient obtained from the data set used in the study was determined as .73.

Statistical analysis

The normality of the data obtained from the scales was examined by the Shapiro-Wilk test ($p<0.05$). Skewness and Kurtosis values were examined. For all three scales, these values are between -1.5 and +1.5. This shows that the data are normally distributed (23). Whether the data is suitable for factor analysis was determined by carrying out Kaiser-Mayer-Olkin (KMO) coefficient and Bartlett test. According to the results of the analysis, the KMO, measure of sampling adequacy, was .91 for the Mindfulness Scale, .78 for the Healthy nutrition obsession scale, and .80 for the Nutrition knowledge level for adults scale. However, the result of the Bartlett test was also significantly determined for the scales used in the study ($p <.001$). Therefore, these values show the suitability of the data for factor analysis (24, 25). The demographic characteristics of the participants are shown with percentages and frequency. Descriptive statistics were used to determine the mean scores of the scales used in the research.

In the research, the theoretical model created by establishing structural equation models were tested. Structural equation models are accepted as the basic method especially in studies where there are multiple relationships between latent and observed variables (13, 26). The main purpose of the structural equation models is to statistically test a theoretical model with the data obtained and to determine how much the theory and research findings match (27). The analyses in this study were carried out using SPSS 22.0, AMOS 22.0 package programs, and Excel database program.

Results

First level confirmatory factor analysis was applied to test the construct validity of the Mindfulness, Healthy nutrition obsession, and Nutrition knowledge level scales. To make the results of the analysis more compatible, considering the suggestions of the Amos 22 package program, covariance assignments were made between the items 9 and 10 of the Mindfulness Scale, items 3 and 6 of the Healthy nutrition obsession Scale, and items 6 and 8 of the Nutrition knowledge level Scale. As a result of the application of the proposed modifications, the fit index values produced by the measurement model are given in Table 1. The fit index values determined as a result of the analysis show that the single-factor structures of the measurement tools are verified (20-22).

Correlation analysis was used to test the relationships between the "healthy nutrition obsession", which

Table 1. Confirmatory factor analysis results of Mindfulness, Healthy Nutrition Obsession and Nutrition Knowledge Level Scales

Model Fit Index	Perfect Range	Acceptable Range	MS	HNOS	NKLS
X^2/sd	$0<X^2/sd<2$	$2<X^2/sd<5$	2.99	4.08	3.39
RMSEA	0.00<RMSEA<0.05	0.05<RMSEA<0.10	.07	.08	.07
PGFI	0.95<PGFI<1.00	0.50<PGFI<0.95	.67	.60	.66
PNFI	0.95<PNFI<1.00	0.50<PNFI<0.95	.72	.61	.68
GFI	0.90<GFI<1.00	0.85<GFI<0.90	.91	.92	.89
AGFI	0.90<AGFI<1.00	0.85<AGFI<0.90	.88	.87	.86
CFI	0.95<CFI<1.00	0.90<CFI<0.95	.91	.93	.91

Table 2. Mean scores of the participants from the Mindfulness, Healthy Nutrition Obsession and Nutrition Knowledge Level Scales

Scales	N	$\bar{x}$	S.D.
Mindfulness Scale	339	3.76	.88
Healthy Nutrition Obsession Scale	339	2.20	.46
Nutrition Knowledge Level for Adults Scale	339	2.31	.40

is the primary variable observed during the analysis of the data, and the "mindfulness", which is the latent variable, and the "nutrition knowledge level", which is the mediator variable in the model. The relationships between the variables were determined by the Pearson Moments Product Correlation Analysis method. Analysis results are given in Table 3. The mean score of the participants from the Mindfulness Scale was ($\bar{x}$=3.76), ($\bar{x}$=2.20) from the Healthy nutrition obsession Scale, and ($\bar{x}$=2.31) from the Nutrition knowledge level for Adults Scale.

Considering Table 3, it is observed that there is a positive and low-level relationship between the participants' total scores of "nutrition knowledge level" and the healthy nutrition status (r=.27, p<.01) and "mindfulness" (r=.22, p<.01). In addition, a positive and low-level correlation was determined between the

Table 3. Examination of the relationship between variables with Pearson Moment Product Correlation

Variable	Nutrition Knowledge Level	Healthy Nutrition Status	Mindfulness
Nutrition Knowledge Level	1	.27**	.22**
Healthy Nutrition Obsession	.27**	1	.20**
Mindfulness	.22**	.20**	1

**p<.01

"healthy nutrition obsession" and "nutrition knowledge level" (r=.27, p<.01), and "mindfulness" (r=.20, p<.01). A positive and low-level relationship was found between "Mindfulness" and "nutrition knowledge level" (r=.22, p<.01), and "healthy nutrition obsession" (r=.20, p<.01).

After examining the relationships between the latent, observed, and mediator variables of the research, the predictive effect of mindfulness on healthy nutrition obsession variables were tested with SEM analysis.

The fit indices in the model given in Figure 1 are shown in Table 4.

When Table 4 is analyzed, it is seen that the model provide the necessary goodness of fit criteria, the data obtained with the model established with a different ex-

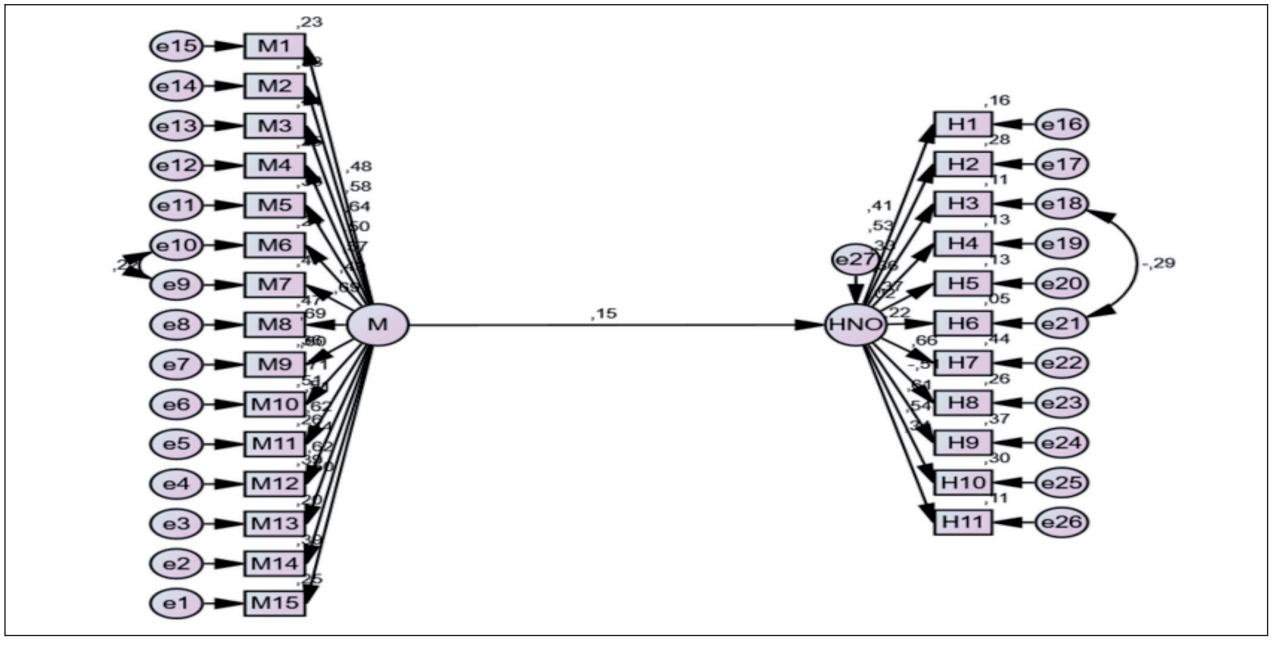

Figure 1. Structural equation model

Table 4. Structural equation model fit index values

Model Fit Index	Perfect Range	Acceptable Range	Model
X^2/sd	0<X^2/sd<2	2<X^2/sd<5	2.63
RMSEA	0.00<RMSEA<0.05	0.05<RMSEA<0.10	.07
PGFI	0.95<PGFI<1.00	0.50<PGFI<0.95	.71
PNFI	0.95<PNFI<1.00	0.50<PNFI<0.95	.65
GFI	0.90<GFI<1.00	0.85<GFI<0.90	.88
AGFI	0.90<AGFI<1.00	0.85<AGFI<0.90	.85
CFI	0.95<CFI<1.00	0.90<CFI<0.95	.93

pression provide a sufficient level of compliance and the model is verified (x^2/sd= 2.63, RMSEA= .07, PGFI= .71, PNFI= .65, GFI= .88, AGFI= .85, CFI= .93).

After examining the goodness of fit index values for the model, the paths in the model, and the parameter estimates for the model were examined. Standardized β coefficients, standard error, critical ratio, p, and R^2 values between variables are shown in Table 5 according to the model created.

As a result of the analysis, a statistically significant effect was found in the relationship of mindfulness with healthy nutrition obsession (β_1=.16; p<.05). According to the findings obtained, the hypothesis number 1 of the study was accepted. When the model's Squared Multiple Correlations (R^2) value is considered, it is seen that 2.5% of the healthy nutrition obsession is explained. With the acceptance of the hypothesis number 1 of the study, the test was performed by adding a mediating variable to the model.

The mediating role of nutrition knowledge level in the effect of mindfulness on the healthy nutrition obsession was tested by the method consisting of three stages proposed by Baron and Kenny (1986). The first stage proposed is to determine the effect of the latent variable on the observed variable (Figure 1). The structural equation model created to investigate the second and third stages is presented in Figure 2.

Standardized β coefficients, standard error, critical ratio, p and R^2 values between variables are shown in Table 7 according to the model created.

The mediation effect cannot be mentioned for the model since mindfulness does not significantly affect the nutrition knowledge level and cannot provide the second stage specified in the reference of Baron and Kenny (1986). According to this reference, in the first stage, the independent variable affects the dependent variable; In the second stage, the independent variable affects the mediating variable; in the third and final stage, when the

Table 5. Structural equation model results

Variables		Standardized β	Standard Error	Critical Ratio	p	R^2
Mindfulness	**Healthy nutrition obsession**	.15	.04	2.25	.02	.025

Table 6. Structural equation model fit values created to measure the mediation effect

Model Fit Index	Perfect Range	Acceptable Range	Model (Mediating)
X^2/df	0<X^2/df<2	2<X^2/df<5	3.75
RMSEA	0.00<RMSEA<0.05	0.05<RMSEA<0.10	.07
GFI	0.90<GFI<1.00	0.85<GFI<0.90	.86
CFI	0.95<CFI<1.00	0.90<CFI<0.95	.90
PGFI	0.95<PGFI<1.00	0.50<PGFI<0.95	.70
PNFI	0.95<PNFI<1.00	0.50<PNFI<0.95	.81
AGFI	0.90<AGFI<1.00	0.85<AGFI<0.90	.90

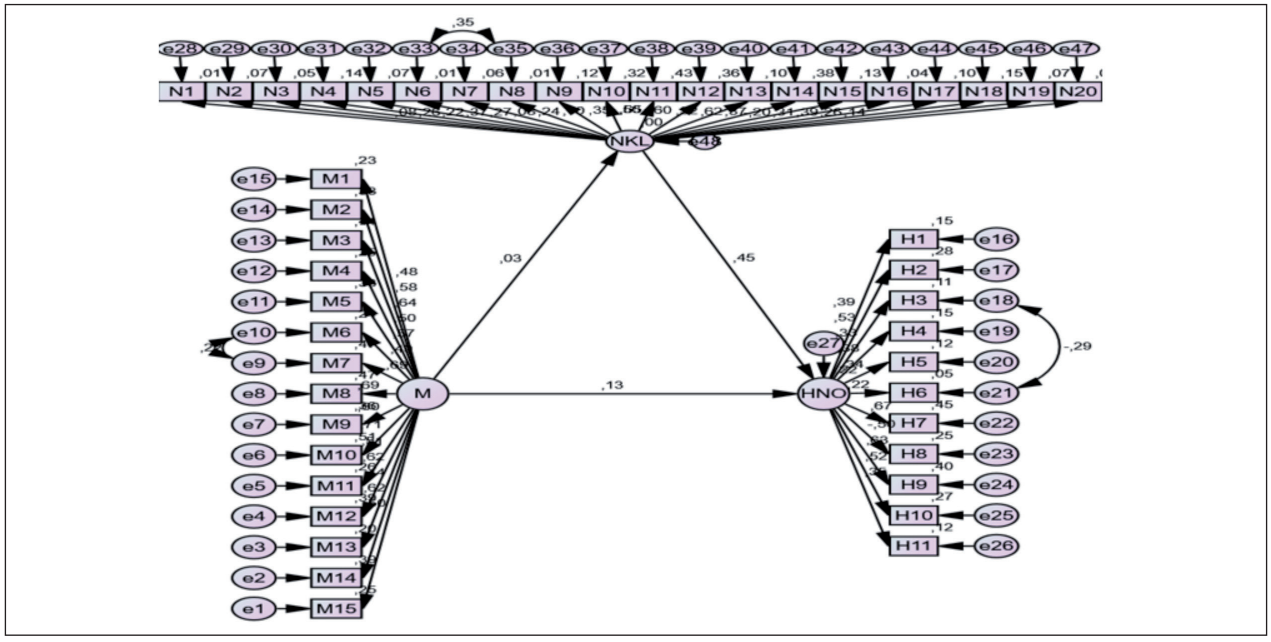

Figure 2. Structural equation model created for mediation effect

mediating variable is included in the model in the first stage, the effects of the independent variable on the dependent variable decrease while the mediating variable affects the dependent variable. Therefore, hypotheses 2 and 3 in the study were rejected.

When the results of the analysis are taken into consideration, the Squared Multiple Correlations (R^2) values obtained from the model indicate that the nutrition knowledge level and mindfulness explain the healthy nutrition obsession by 22.4%, and mindfulness explains the nutrition knowledge level by .001%.

Discussion and Conclusion

The results of longer working hours, travels and current lifestyles that the modern world has brought to human beings have had negative effects on human health. Especially stuck in the monotony of urban life, people are affected by many negative environmental factors (intense work tempo, pressure, fatigue, etc.). The long time spent in front of television and computer outside of business life has become an addiction especially for children and young people and has become the main element of the culture of sedentary lives (33). All these processes that have made rapid changes in human life have had a direct impact on the field of healthy nutrition. This effect resulted in a nutritional system with fast and processed foods. This nutritional change has greatly changed people's lifestyles.

Physical inactivity, environmental pollution, and unhealthy nutrition have become the most important causes of chronic disease worldwide (34). In addition, an unhealthy diet and lifestyle habits can cause obesity and metabolic syndromes (35). Nutrition forms the basis of healthy lifestyle behavior (36). It has become

Table 7: Structural equation model coefficients created to measure the mediation effect

Variables		Standardized β	Standard error	Critical Ratio	p	R^2
Mindfulness	**Nutrition Knowledge Level**	.025	.008	.35	.72	.001
Nutrition Knowledge Level	**Healthy Nutrition Obsession**	.45	2.51	.88	.37	.224
Mindfulness	**Healthy Nutrition Obsession**	.13	.038	2.06	.039	

one of the main risk factors for some chronic and non-communicable diseases, including other situations related to unhealthy eating habits, cardiovascular diseases, cancer, diabetes, and other conditions associated with obesity (37, 38). To prevent these changes, the most important solution is seen as increasing the nutrition knowledge level. It is considered that university students, who are seen as a step from youth to adulthood, are an important group in this regard. In addition, studies Kabat-Zinn (1994) in the field of nutrition knowledge level shows that the focus is on university students globally. Research results focusing on the relationship between nutritional habits and mental abilities in recent years have shown the existence of the relationship between individuals' mental functions and healthy nutritional characteristics. These mental functions include the concept of mindfulness, which is often defined as a person's focus on those currently occurring by accepting and without judging (9, 39). In the study, it was determined that mindfulness levels of university students had a positive effect on healthy nutrition obsession level. In other words, the concept of mindfulness is a predictive variable in university students' adoption of a healthy diet. Studies show that awareness application can help individuals develop conscious and healthy eating behaviors (40, 41). In other studies (42-45), it shows that awareness has the potential to promote sustainable consumer behavior. In this way, it can be said that the awareness level has an important potential to develop the right behavior style for healthy eating. It can be stated that there is a consistency between the empirical results obtained in the studies and the findings obtained from this study.

In terms of healthy nutrition, nutritional knowledge levels of individuals as well as their mindfulness levels are an effective concept. Many studies showed that nutrition knowledge level has a decisive effect on nutritional behavior (46-48). In addition, many studies emphasized the relationship between increased nutrition knowledge level and healthy food preference (47, 48).

Conflicts of interest

The authors declare that there is no conflict of interest about this manuscript.

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Original article

The relationship between dietary habits of late adolescent individuals and the heavy metal accumulation in hair

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Abstract *Study Objectives:* This study aimed to determine the effects of smoking status and dietary habits on heavy metal accumulation in late adolescent students studying at Sinop University. *Methods:* This experimental research was conducted between 09 October and 15 November 2019. The population of the study was composed of 18-21 age (late adolescent period) students studying at Sinop University, School of Health. In the determination of the research sample, the selection of students who accepted to participate in the research as the case selection criteria, who did not have any mental or chronic disease/syndrome, and who did not use drugs continuously was taken into consideration. For the collection of research data, an information form about the weekly consumption of foods and smoking status was prepared by the researchers considering the geographical and physical locations where the students are located. After collecting the forms filled by students, 0.5 g hair samples were taken from volunteered 41 students to analyze the concentration of heavy metal in the hair and analyzed in the ICP-MS device. The data were evaluated using the Mann-Whitney U test in the SPSS (version 22.0) statistical program. *Results:* As a result of this research, it has been revealed that there was a statistically significant relationship between some food groups (lettuce, chips, instant soup, salami, and trout) that students express at least once a week and the heavy metal concentration detected in their hair. *Conclusion:* It was revealed that there is a relationship between individuals' dietary habits and heavy metals in late adolescence.

Keywords: Heavy metal, Adolescent, Smoking, Hair

Introduction

The effects of environmental pollution on human health can be analyzed with some biological materials such as teeth, hair, and nails, and it is possible to monitor changes in the body. Hair and nails are biomaterials in the structure of fibrous protein consisting of keratin (1,2), a long-term with many trace elements accumulating in the hair that can provide data for a long time in determining the health status of an individual's body hair. (3,4). On the other hand, the concentration of these elements can be used to investigate dietary exposure to chemical pollutants, especially toxic metals, including the effects of smoking and drug use of an individual or population (5). For this reason, hair and nails are considered as valuable tissues for studies to monitor the exposure of individuals to environmental pollution. The International Atomic Energy Agency (IAEA) also accepts the use of mineral analysis of hair to measure the levels of essential and toxic trace elements in living organisms, including humans (6,7).

Elements are naturally occurring chemical compounds and can be found in various concentrations in the environment. However, industrial, domestic, agricultural, etc. applications affect not only water, air, and soil, but also crops and animals and cause these elements to rise above their natural levels in the environment. Therefore, the food chain is one of the most important

ways of exposure to metals (8,9). These metal concentrations in foodstuffs can also pose various health risks on populations associated with the food chain.

Heavy metal concentration in the body is an important indexing parameter in the determination of toxicity and assessment of its severity (10). Nail and hair growth in humans are life-long processes and provides a longer integration period for heavy metals. Its roots are heavily influenced by the state of cells and human hair and nails provide continuous recording of element concentration (11,12). Studies already showed that there is a correlation between trace element concentration in hair and human diseases (13). In addition, studies have shown that, after prolonged exposure to certain trace elements, it creates an increased sensitivity to various diseases such as diabetes, cardiovascular diseases, cancer, and mutagenicity (14-16). An element can be caused by elements that accumulate in certain tissues for a long time until it reaches a critical level that causes disease in the body, or it can remain hidden for a long time between exposure and the first symptoms of the disease (17,18).

In this study, it is aimed to explain the relationship between the smoking status, domestic smoking and feeding regimes of the late adolescent period students of Sinop University, School of Health, and toxic and heavy metal levels in the hair.

Material and Methods

Participants

The population of the study consisted of 18-21 age (late adolescent period) group studying at the School of Health. As the case selection criterion for determining the sample of the study, students who accepted to participate in the study at this college, who did not have any mental or chronic disease/syndrome, and who did not use drugs continuously were selected. Necessary explanations were made to the students. Necessary verbal and written permissions were obtained.

Study Objectives

This study aimed to determine the effects of smoking status and dietary habits on heavy metal accumulation in late adolescent students studying at Sinop University.

Experimental Design

This experimental research was carried out between 09 October and 15 November 2019. Ethics Committee permission was obtained from Sinop University for the research numbered 2019/38. While the population of the study was composed of 18-21 age group studying at Sinop University School of Health, the sample was 41 students who volunteered to participate in the study according to the case selection criteria. For the collection of research data, an information form about the weekly consumption of foods and smoking status was prepared by the researchers considering the geographical and physical locations where the students are located. This information form is about the frequency of dietary questions including lettuce, salami, trout, instant soup, and chips. The forms were filled face to face with the students participating in the research. After collecting the forms filled by students, 0.5 g hair samples were collected from 41 students who volunteered to be analyzed for the concentration of heavy metal in their hair. In order not to affect the analysis result, care was taken not to have the hair dyed while collecting the hair sample. Hair samples taken, ultra high purity 3 mL HNO_3, and 9 mL HCl were added and dissolved in high pressure Teflon containers for half an hour at 200 ˚C. Samples were then transferred to 50 mL falcon tubes. The obtained filtrate was completed with 50 ml of ultrapure water and dissolved. In measuring the metal content from samples, it was measured with inductively-connected plasma mass spectrometry (ICP-MS) at Sinop University (ICP-MS) and reported as micrograms per kilogram (μg / kg).

Statistical analyses

The normality test of biochemical values obtained from the study performed with Shapiro Wilk tests. It was determined that the data didn't have normal distribution ($p < 0.05$). Mann-Whitney U test was used to compare heavy metal values (Al, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Cd, Hg, and Pb) according to some demographic features and the type of food consumed. The values obtained as a result of the analysis are given in the tables as median (Q_1-Q_3). Analyzes were carried out in IBM SPSS 22.0 package program. $p < 0.05$ significance level was chosen.

Results

A total of 41 students participated in the study, and the mean ages of the students is 19.70±09.

Heavy metal values were compared according to the smoking status of the participants (Table 1). Accordingly, Fe value showed a statistically significant difference according to smoking status (p <0.05). Me-

Table 1. Comparison of heavy metal values by participants' cigarette exposure

Variables	Smoking status		Smoking status of the family	
	Yes	No	Yes	No
Al	19876,80 (12817,84-29297,65)	21064,60 (15007,05-35485,93)	25022,69 (18490,00-38246,43)	17423,58 (11710,12-19826,62)
	p=1,000		p=0,005*	
Cr	327,37 (195,54-430,02)	318,68 (254,31-483,32)	327,37 (268,57-509,47)	285,92 (166,53-432,43)
	p=0,678		p=0,197	
Mn	1216,72 (593,48-1625,08)	1017,31 (746,44-2042,59)	1168,29 (770,52-2480,28)	833,67 (604,46-1517,34)
	p=0,758		p=0,248	
Fe	19802,86 (16725,04-23143,55)	26293,66 (23245,42-31396,78)	24907,81 (20257,78-31460,65)	22133,60 (17166,05-26440,54)
	p=0,003*		p=0,085	
Co	87,82 (66,07-366,83)	124,22 (65,64-299,86)	139,60 (77,39-348,14)	68,68 (63,44-237,58)
	p=0,841		p=0,154	
Ni	1249,04 (906,17-1834,31)	1831,55 (987,19-2797,27)	1684,95 (1120,82-3436,08)	1019,14 (843,31-2289,20)
	p=0,398		p=0,059	
Cu	26285,32 (19496,43-28869,97)	21917,09 (9719,70-29960,46)	26908,23 (20369,78-41891,65)	16118,21 (7580,74-24606,78)
	p=0,211		p=0,001*	
Zn	642887,30 (325944,30-944914,50)	919638,27 (432531,94-1668253,46)	642887,30 (467829,71-1158994,91)	798090,76 (356154,32-1697527,86)
	p=0,231		p=0,625	
As	120,27 (104,20-1365,91)	117,54 (106,41-171,40)	117,66 (104,17-169,62)	115,20 (105,06-169,09)
	p=0,925		p=0,802	
Cd	37,03 (33,22-65,16)	44,55 (35,57-61,52)	45,77 (38,85-67,53)	35,60 (30,58-46,86)
	p=0,301		p=0,010*	
Hg	63,04 (43,15-128,26)	90,14 (71,30-118,56)	98,33 (69,62-125,53)	68,88 (43,96-92,97)
	p=0,445		p=0,049*	
Pb	661,09 (355,84-941,23)	1026,06 (471,34-1431,83)	941,23 (590,00-1334,14)	542,31 (355,22-1297,95)
	p=0,211		p=0,147	

*p<0,05

dian Fe value is lower in smokers than non-smokers. Similarly, Al, Cu, Cd, and Hg values showed a statistically significant difference according to the status of smokers in the family. (P <0.05). Accordingly, the median values of Al, Cu, Cd, and Hg of the participants who have smokers in their family are higher.

Heavy metal values were compared according to the food type consumption of the participants (Table 2). Accordingly, Mn value showed a statistically significant difference according to lettuce consumption (p <0.05). Those who do not consume lettuce have a lower Mn value. Co value showed a statistically significant difference according to salami and processed food consumption (p <0.05). Those who do not consume salami and processed food have a lower Co value. Cu value showed a statistically significant difference according to the consumption of instant soup (p <0.05). Those who do not consume instant soup have a lower Cu value. Cd value showed a statistically difference according to trout consumption (p <0.05). Those who do not consume trout have lower Cd value. Pb value varies statistically significantly according to the consumption of chips (p <0.05). Those who do not consume chips have a lower Pb value.

Discussion and Conclusion

The term heavy metal is used as a side meaning in terms of pollution and toxicity with environmental pollution. Some of these elements are micronutrients for plants and animals (Fe, Cu, Zn, Mn, Mo, and Ni) and do not show toxic effects unless they exceed the permissible limit (19). Some heavy metals such as Zn, Fe, Cu, Mn are among the absolutely necessary metals, even in trace amounts for both the plant and the human body, and are also known as micronutrients (trace elements). However, high doses of these elements can create a poison effect on the body (20).

The fact that the essential elements obtained from the hair analysis are more or less, for example, Fe, and Zn element concentration deficiency also indicates that there may be serious problems in the physiological structure of the human (21, 22). It can also be used to investigate their exposure to chemical pollutants, such as toxic metals, including the effects of drug use

Table 2. Comparison of heavy metal values according to the consumption of different food types

Variables	Lettuce consumption		Processed food like salami		Package soup		Trout		Chips	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Al	22183,09 (15883,81-36984,32)	18505,35 (5995,48-25022,69)	18557,07 (11112,25-30524,40)	22226,56 (15113,70-36786,69)	21762,58 (17546,68-37637,25)	19670,82 (12177,44-28082,86)	29427,21 (17197,04-88940,35)	19876,80 (13752,47-29784,66)	23013,72 (15605,97-37883,96)	18608,79 (13227,29-29784,66)
	p=0,231		p=0,362		p=0,260		p=0,315		p=0,273	
Cr	336,58 (278,44-505,69)	258,17 (114,51-435,17)	333,07 (242,51-503,48)	319,53 (201,73-435,17)	305,87 (248,63-391,74)	337,28 (181,46-475,63)	444,86 (331,95-654,27)	317,84 (198,64-442,15)	318,68 (171,74-458,85)	327,37 (256,35-463,86)
	p=0,096		p=0,860		p=0,628		p=0,188		p=0,549	
Mn	1283,30 (746,44-2849,75)	826,61 (417,21-1238,91)	955,54 (549,41-2042,59)	1164,80 (717,98-1625,08)	1389,09 (919,13-1592,59)	836,60 (600,87-3095,98)	1345,32 (788,19-1551,53)	1022,97 (630,22-2057,10)	1150,97 (586,22-5038,70)	1011,64 (690,32-1449,76)
	p=0,046*		p=0,776		p=0,249		p=0,751		p=0,389	
Fe	23998,36 (19593,51-29955,39)	23972,87 (17015,69-31588,39)	24065,41 (19033,41-34694,85)	23848,78 (18965,47-29807,86)	26651,03 (21068,69-37165,71)	23674,06 (18464,88-27118,08)	26489,70 (25278,85-36147,07)	23499,34 (18727,28-29961,57)	25453,85 (22069,22-30852,27)	22336,12 (18711,14-26973,00)
	p=0,947		p=0,755		p=0,096		p=0,203		p=0,220	

Table 2. Comparison of heavy metal values according to the consumption of different food types

Variables	Lettuce consumption		Processed food like salami		Package soup		Trout		Chips	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Co	176,83 (82,83-354,18)	69,81 (23,63-98,11)	70,30 (53,36-200,19)	159,02 (73,76-436,36)	98,11 (63,61-572,10)	123,86 (67,62-237,83)	429,32 (141,58-612,14)	99,18 (65,13-233,32)	124,22 (63,97-330,78)	98,11 (68,19-339,35)
	p=0,005*		p=0,032*		p=0,967		p=0,111		p=0,754	
Ni	1571,70 (1031,31-3159,58)	1218,78 (873,94-1987,19)	1109,41 (824,69-2797,27)	1368,87 (1071,91-2550,15)	1978,15 (810,36-4246,75)	1343,74 (984,12-2173,60)	3245,30 (1047,42-4601,88)	1340,11 (950,79-2470,01)	1353,75 (944,02-3458,03)	1347,37 (950,49-2373,46)
	p=0,231		p=0,269		p=0,730		p=0,431		p=0,876	
Cu	24038,01 (18052,28-28266,75)	21134,65 (7655,22-41640,33)	20159,84 (12015,82-41356,92)	24794,08 (14157,12-29414,38)	27938,69 (20159,84-153502,57)	21557,64 (11572,35-27880,64)	39014,10 (23456,19-401240,91)	21872,15 (12452,46-29142,18)	22251,86 (10481,30-38300,43)	23281,93 (18025,26-28898,53)
	p=0,602		p=0,596		p=0,036*		p=0,067		p=0,676	
Zn	647077,16 (493585,67-1517932,77)	941484,79 (325944,30-1397516,51)	507042,66 (325761,20-1298223,49)	824750,38 (494112,19-1512103,21)	589395,99 (376978,06-1033695,08)	731263,62 (488709,83-1529591,88)	1076187,28 (862076,70-1553573,50)	589395,99 (376978,06-1423402,13)	943199,65 (489236,34-1496399,34)	589395,99 (376978,06-1267682,46)
	p=0,461		p=0,294		p=0,463		p=0,203		p=0,389	
As	116,06 (107,13-173,49)	123,66 (60,25-145,01)	118,84 (93,21-173,78)	117,66 (105,61-165,91)	112,30 (106,63-160,08)	118,97 (103,10-169,54)	140,81 (94,75-182,72)	117,66 (104,91-165,01)	122,10 (93,52-182,56)	114,70 (106,63-154,56)
	p=0,779		p=0,924		p=0,923		p=0,816		p=0,549	
Cd	45,41 (36,15-66,71)	37,03 (34,70-47,81)	35,03 (30,79-50,84)	46,26 (37,03-65,16)	45,77 (35,03-70,93)	40,32 (34,78-56,79)	75,97 (54,33-101,49)	39,74 (34,80-49,06)	46,26 (36,17-68,04)	38,48 (33,19-53,59)
	p=0,253		p=0,059		p=0,609		p=0,010*		p=0,159	
Hg	91,97 (61,42-110,76)	81,26 (49,81-127,19)	86,01 (46,13-147,25)	89,78 (56,55-111,56)	74,65 (49,24-120,61)	91,61 (58,27-119,53)	93,88 (64,77-100,93)	89,78 (52,13-123,03)	92,27 (75,04-115,90)	74,65 (43,03-129,49)
	p=0,799		p=0,946		p=0,463		p=0,983		p=0,335	
Pb	876,25 (408,56-1197,98)	784,44 (448,29-1404,93)	551,84 (325,65-1320,36)	941,23 (553,05-1395,28)	989,85 (465,79-2135,45)	816,95 (378,95-1243,82)	1195,69 (513,73-3234,38)	784,44 (437,21-1220,90)	1109,05 (711,19-1506,50)	553,05 (355,43-965,54)
	p=0,820		p=0,176		p=0,570		p=0,382		p=0,016*	

*p<0,05

(5). In addition to the toxic elements that can be taken from the smoke during smoking, passive smoking also plays an important role in the exposure of children to these toxic heavy metals (23). Inhalation of cadmium-containing tobacco smoke is a dominant source of cadmium exposure (24). Children are more sensitive to the effects of toxic elements such as Pb than adults (23). When the heavy metal status of the participants according to their smoking status was compared, the Fe value showed a statistically significant difference ($p < 0.05$) between smokers and non-smokers. Fe value median is lower in smokers than non-smokers. Similarly, Al, Cu, Cd, and Hg values showed a statistically significant difference ($p < 0.05$) in individuals who have a smoker in their family. Median values of Al, Cu, Cd, and Hg are higher in participants who have a smoker in their families (Table 1). Researches on this subject showed that the levels of Cu, Cd, and Pb elements (4, 25, 26) are significantly higher in the hair of smokers and due to the increase in the number of smokers in the home. It shows that Cd and Pb levels (26, 27) increased. Similarly, it is reported that there was a positive correlation between the frequency of smoking at home and Pb, Cd, Cu, Ni, and Sb levels, and this correlation between family members' smoking status and toxic trace element levels in the hair was more significant with Pb and Cd levels (28). In addition, when the relationship between the average element concentration ($\mu g.kg^{-1}$) in the hair of the students participating in the study and their smoking status was examined, it was found that Fe concentration was statistically significant ($p < 0.05$).

Environmental pollution, which can develop due to the transition of modern agriculture, industrialization and urbanization with the impact of the rapidly increasing population in the world (29), affects various food sources such as cereal products, meat, and milk of animals fed with grass contaminated with metals, aquatic organisms hunted from polluted waters and food chain. It can reach people and create important health problems (30-33). As a result of this research conducted at Sinop University, it has been revealed that there is a statistically significant relationship between some food groups (lettuce, chips, instant soup, salami, trout) that students express at least once a week and the heavy metal concentration detected in their hair. It has been reported by various researchers that the primary source of essential and toxic elements in food is soil and contains a wide range of varying concentrations of metal with the elements necessary for growing the plant (34-37). It has been revealed by various studies that the nutrients grown in metal-containing soils also increase their heavy metal content (38-42). However, it has been reported by some studies that some fertilizers and pesticides also contain high levels of toxic metals and this can lead to heavy metal contamination in foods (43-45).

In the current study, it was determined that there was a statistically significant between the students' preferences of eating lettuce ($p < 0.05$) in terms of Mn and Co concentration values and it was found that it was higher in students who ate lettuce in terms of average concentration value. However, another important metallic pollution factor in foods is wastewater originating from various industrial activities, sometimes being trace and sometimes heavy metal at high concentrations (46). In addition, researches reveal that sewage water wastes have high concentrations of various potential toxic elements, generally Cd, Cu, Fe, and Zn (47, 48). Indeed, it is reported a high level of Pb, Zn, Cr, and Ni accumulation in vegetables grown around the river where wastewater mixes (49). Therefore, people who feed on fish hunted from areas where wastewater and sewage are mixed can also reach heavy metals through the food chain (50-52). It has been determined that there is a statistically significant relationship between the students who stated that they consumed trout at least once a week and heavy metals in their hair in terms of Cd ($p < 0.05$) (Table 2). Meat products, offal, and seafood are high levels of cadmium sources (53). Cadmium can dissolve in water, and it can reach many fish products that can be consumed as food by fish, including molluscs and crustaceans (mussels, crabs, etc.) that live and feed at the bottom by sinking to the bottom of the spilled water source (54,55). Therefore, at least once a week obtained as a result of this research, trout consumption is considered as the reason for the significant difference in Cd concentration in the hair. Methyl mercury (MeHg), the most toxic form for humans, is found in contaminated fish and poses a high health risk with high fish consumption (56-58).

There can also be heavy metal transitions into foods from various tools and cooking containers used during cooking and storage of foods. In a study it was reported that 0.13-0.22 ppb nickel contaminated food from stainless steel containers after one hour of cooking (59). In another study, it has been reported that some type of stainless steel pans are transmitted with an acid content of more than 400 ppm of nickel (47). However, that was reported that nickel content in traditional and fast-food foods increased due to spice, dried fruit, whole grain, mushroom contaminated with Nickel, which is added to foods (60) and claimed that dishes cooked in copper pots contain twice as much copper as dishes cooked in aluminum or stainless steel pots (61). In addition, it has been reported that the Pb level in pyrene cabbage in tinned copper pans increased from 0.15 mg/kg to 0.79 mg/kg and the Cu level increased from 1.36 mg/kg to 2.07 mg/kg (62). Most of the aluminum taken with food can be through the aluminum container, canned food, and aluminum foil used in cooking with additives (63). In addition, some detergents used to clean the equipment can cause As, Pb, and Cd dissolution in stainless steel and cause contamination (64). It is also reported that heavy metal contamination may occur during the packaging process. One of the research showed that Pb is a high percentage above bread packages (65). Furthermore candy packs that children frequently consume contain high levels of lead, especially in yellow and green ones (66).

It was found that there was a significant difference ($p < 0.05$) between the students who stated that they consumed ready-made soup at least once a week and those who did not, in terms of the concentration of Cu element detected in their hair. This suggests that this is probably due to the use of a variety of tools, cookware and heavy metal contaminated foodstuffs (spices, etc.) used during the industrial processing of instant soup. However, foods such as offal, cookies, and whole grain products can contain high levels of Cu (67). In addition, the average Pb concentration in the hair of students who stated that they consumed chips at least once a week was higher than those who did not consume, and a statistically significant difference was found between them ($p < 0.05$). The reason for this situation suggests that it developed due to Pb contamination during the packaging of chips in the light of related literature.

With physical exercise, blood circulation and metabolic rate increase (68), and secondary metabolites and harmful waste products produced by the body can also be excreted through sweat and urine (69,70). Although knowledge about the accumulation and excretion mechanisms of toxic elements in the human body is still limited, it suggests that sweat may be a better test example to monitor the accumulation and removal of toxic elements in the body (69-72). With sweating, a large amount of harmful substances can be removed from the body in the form of inorganic salts (73). Another of the harmful substances that can adversely affect human health when it accumulates excessively is heavy metals and can be removed from the human body by sweating. Some studies have reported that excretion rates of arsenic, cadmium, lead, and mercury are excreted with more sweat than urinary excretion (74). Indeed it is seen that sweat and urinary excretion of the heavy metals (Cr, Cu, Zn, Cd, and Pb) that were excreted from the body after physical exercise were significantly higher than those that were excreted in the urine after strenuous exercise (72). They also reported that physical exercise has a significant effect on the balance of trace elements, and that sweating during physical exercise can effectively remove toxic heavy metals from the body and reduce heavy metal buildup in the body. As a result of the research, they stated that they should actively participate in physical exercise to increase the detoxification capacity of individuals and to reduce the damage caused by heavy metals to their bodies.

The positive lifestyle he will acquire in the late adolescent period (18-21 years old), where he tries to step into the world of adults by trying to develop a new identity independently from his family, independent of his family, affects his well-being in the future. The development of risky behaviors such as smoking in this period causes the individual to adopt and maintain this behavior during adulthood as well (75). In addition, it is important to develop proper nutrition at this age. Fast-food eating or junk-eating habits are frequently encountered at this age. However, the proper eating habits acquired at these ages prevent the diseases that may be encountered in the future by forming a basis for the health of the individual in adulthood (76). Again at this age, sports form a very important basis

for creating a healthy lifestyle. Regular sports activities that adolescents will start doing at this age affect bone, muscle, and adipose tissue and protect it from diseases such as osteoprosis, obesity, and respiratory system in the future (77). Health education to be provided by the nurse in preventive diseases is very important at this point (78). This research revealed the risks of heavy metal coming from various sources based on the answers given to the questionnaire questions of late adolescent students studying at Sinop University and the results of the heavy metal analysis in their hair. As a result of the study, it was determined that the students' smoking habits, their families were exposed to second or third-hand smoke due to smokers, and also the heavy metal element concentration in their hair varied due to differences in eating habits. In addition, it has been revealed in this research that regular consumption of foods containing different amounts of heavy metal can lead to heavy metal accumulation in the body. However, it has also shown that long-term consumption of foods contaminated with heavy metals due to various sources can also lead to accumulation in the body. Therefore, both nutritional habits and lifestyles of individuals are among the most controlling factors on heavy metal accumulation in the body. As a result, the individual encounters heavy metals in the late adolescent period. To prevent this, determining a healthy lifestyle, adding nutrition and regular sports into this style, staying away from risky behaviors such as smoking may contribute positively to his/her future life.

Conflict of interest statement

The authors declare that they have no conflict of interest.

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Original article

Health belief regarding leisure time physical activity and nutritional attitude: are they related in athletic and sedentary university students

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Abstract. *Study Objectives:* The present study aimed to investigate the differences in the perception of health belief regarding leisure-time physical activity and nutritional attitudes of athletic and sedentary university students. Besides, analyzing the correlations between the phenomena was another aim. *Materials and Method:* The study was designed as a cross-sectional quantitative study, and 286 university students from Hatay Mustafa Kemal University participated in the study. In analyzes of the data independent samples t-test and Partial Correlation analyzes were used. *Results:* As a result, this study showed that only self-efficacy makes a difference in the health belief regarding leisure-time physical activity for the athletes. Besides, the health belief regarding leisure-time physical activity and nutritional attitude correlates in both athletic and sedentary samples. *Conclusion:* To achieve substantive health benefits, efforts to increase leisure time physical activity and healthy nutritional attitudes should be encouraged.

Key Words: Health Belief, Leisure-Time Physical Activity, Nutrition, Malnutrition, Sedentary

Introduction

A significant proportion of the studies in the literature show that regular physical activity has various health benefits in all age groups (1). For instance, physical activity is related to the enhancement of overall health among children and adolescents (2-3), it helps to reduce the prevalence of common chronic conditions, and to improve mental health among older adults (4). Besides, it is also well documented that physical activity reduces the risk of premature mortality and is an active primary and secondary preventive strategy for at least 25 chronic medical conditions (5).

Leisure-time physical activity (LTPA) is defined as the exercise performed during free time for at least 20 minutes without stopping. It is thought to be part of a healthy lifestyle and has positive health effects across various age cohorts, ethnic populations, and chronic diseases. Different types of leisure-time physical activity can be performed. These activities include walking, jogging, running, bicycling, swimming, and aerobics (6). At that point, when one thinks about the benefits of leisure-time physical activity, it is thought that he/she would become more physically active. However, according to Grsitwood 2011 (7), an individual's value and belief system have shown to have a significant impact on the identification and evaluation of individual risk factors as well as the readiness to take action. In a study conducted by Cronbie et al. 2004 (8) showed that although the levels of knowledge about the specific health benefits of physical activity were high among the participants, the most potent deterrent was lack of interest. Besides, increasing leisure-time physical activities poses significant challenges. Similarly, Haase et al. 2004 (9) suggested that leisure-time physical activity was below recommended levels in a substantial proportion of the participants, and the knowledge about activity and health was disappointing, with only 40–60% being aware that physical activity was relevant to the risk of heart disease.

Different groups of people may not share the same physical activity beliefs (10), and thus this sometimes prevents our intention of physical activity from turning into action. This situation can be explained with the theory of the health belief model. The theory simply assumes that the likelihood of performing specific health behavior is related to people's conviction that they are threatened with certain diseases, their evaluation of the severity of these diseases, and to the conviction that the target health behavior allows averting the risk of developing the said diseases (11). When applied to physical activity engagement, this model can help explain the likelihood of an individual engaging in physical activity, based on the perceived threats brought about by inactivity and the individual's conclusion that the potential benefits could far outweigh the risks (7).

Health belief regarding leisure-time physical activity is associated with different kinds of nutritional habits (12). According to Pate et al. 1996 (13), both adolescents and adults who choose to be regular exercisers also tend to adopt other positive health habits, such as smoking less or consuming healthier diets. A study conducted on young adults in America showed that physical activity levels of the participants had a positive correlation with the consumption of fruit and 100% fruit juice (14). However, when considered jointly, there is a gap in the literature. Only a few studies examined the associations between the health belief regarding leisure-time physical activity and nutritional attitude in the athletic and sedentary sample. Given the information above, in the present study, we analyzed the associations between nutritional attitudes and health beliefs regarding leisure-time physical activity in an athletic and sedentary university sample.

Material and Methods

Participants

The study sample consisted of 286 university students from Hatay Mustafa Kemal University. The participants included in the athletic cluster (N= 52; = 20.04±3.05) were chosen according to the purposive sampling method. The inclusion criteria were the membership of the university gym at least three months and doing regular exercise. The participants included in the sedentary cluster (N=234; = 23.92±3.25) were chosen according to the random sampling method.

Data Collection

Health Belief Regarding Leisure Time Physical Activity Scale

Ertüzün, Bodur, and Karaküçük initially developed the scale in 2013. The scale has five factors compatible with the Theory of Health Belief as Perceived Seriousness (e.g., Participating in leisure-time physical activities is vital for all of my body functions), Perceived Barriers (e.g., I am afraid of being injured while participating in sportive recreational exercises), Physical Benefit (e.g., I believe that my excretory system works more regularly when I do sportive recreational exercises), Psycho-Social Benefit (e.g., I believe that recreational exercises have positive effects on my mental health), and Self-Efficacy (e.g., For participating in recreational exercises, I sacrifice from my economic condition). The scale has twenty-one items anchored with a 5-point Likert type scale (1 = strongly disagree … 5 = strongly agree) (15).

Nutritional Attitude Scale

Tekkurşun Demir and Cicioğlu initially developed the scale in 2019. The scale has four factors and twenty-one items. Sample items include "I know which foods contain protein" (nutritional knowledge), "I enjoy eating fast-food products (feeling for nutrition), "I drink at least 1.5 liters of water a day" (positive nutrition), "I eat different kinds of snack every day" (malnutrition). The answers given to the scale are evaluated with a 5-point Likert type scale (1 = strongly disagree … 5 = strongly agree). The items 6., 7., 8., 9., 10., 11., 17., 18., 19., 20., and 21 are reversely coded (16).

Statistical Analysis

Descriptive statistics were presented as Mean ± Standard Deviation (SD). Comparisons among the groups were performed using the independent sample t test. Partial correlation analyses were conducted between the sub-dimensions of scales. All correlation analyses were controlled for being athletic or sedentary. IBM SPSS 22.0 for windows was used for the statistical analysis.

Results

Descriptive data

The descriptive statistics are given in Table 1. Regarding group comparison, we found that athletes reported significantly higher scores on self-efficacy. Nevertheless, athletes and sedentary participants did not show any statistically significant differences in the other sub-scales.

Correlations

Table 2 shows the partial correlation analyses between health belief regarding LTPA sub-dimensions and nutritional attitude sub-dimensions. In the test being athletic/sedentary was the control parameter. Results showed that health belief regarding LTPA and nutritional attitudes were positively correlated ranging from 0.287 (perceived severity-malnutrition) to 0.624 (perceived severity-positive nutrition). Besides, negative correlations were also found between some of the sub-dimensions ranging from -.181 (perceived barriers and malnutrition) to -.401 (perceived barriers and feeling of nutrition).

Table 1. Descriptive statistics and comparison between athletes and sedentary subsamples

	Athletes (n=52)		Sedentary (n=234)		*p*
	Mean	SD	Mean	SD	
Perceived Severity	4,26	0,59	4,10	0,85	0,108
Perceived Barriers	3,78	0,72	3,86	0,78	0,501
Physical Benefit	4,07	0,74	4,05	0,85	0,903
Psycho-Social Benefit	3,97	0,69	3,89	0,68	0,439
Self-Efficacy	3,98	0,66	3,61	0,88	0,001*
Nutritional Knowledge	4,33	0,81	4,08	0,95	0,057
Feeling of nutrition	2,75	0,73	2,55	0,77	0,082
Positive nutrition	3,65	0,77	3,59	0,73	0,592
Malnutrition	3,08	0,81	3,03	0,78	0,706

Discussion

In the present study, we aimed to analyze the associations between the health belief regarding LTPA and nutritional attitudes among athletic and sedentary university students. According to analyze results, participants' health beliefs regarding LTPA significantly differed in the self-efficacy sub-scale in favor of athletic university students. We can say that this result of the study is compatible with the literature. Because when we examine the literature, we see that self-efficacy is an essential factor for LTPA related behaviors. For instance, a study conducted by Stutts 2002 (17) showed that among other patterns such as perceived barriers and benefits, self-efficacy was the only variable to predict physical activity. A more recent study conducted by Beville et al. 2014 (18) reported that self-efficacy (β = .166) significantly associated with LTPA for female university students. Similarly, in their study Orsega-Smith et al. 2007 (19) specified that the self-efficacy domain of perceived physical ability was significantly related to LTPA for older adults. According to Kayhan and Üstün 2019 (20), individuals who have the belief

Table 2. Correlations between the variables

	1	2	3	4	5	6	7	8	9
1. Perceived Severity	1	,540**	,781**	,591**	,498**	,529**	0,097	,624**	,287*
2. Perceived Barriers		1	,635**	,549**	,338**	,470**	-,401**	,318**	-,181**
3. Physical Benefit			1	,766**	,472**	,630**	-,357**	,512**	-0,018
4. Psycho-Social Benefit				1	,506**	,558**	-,218**	,483**	-0,031
5. Self-Efficacy					1	,362**	-,181**	,339**	-,192**
6. Nutritional Knowledge						1	-,305**	,534**	-0,006
7. Feeling of nutrition							1	-,250**	,467**
8. Positive nutrition								1	-0,046
9. Malnutrition									1

*Partial correlation test controlling for being athletic/sedentary **p < 0.01 *p < 0.05*

that LTPA is useful for the treatment of chronic diseases show higher self-efficacy in health belief regarding LTPA.

According to analyze results, although both athletic and sedentary participants scored the highest in the nutritional knowledge subscale, there was not any significant difference in the nutritional attitudes of the participants. There are several possible explanations for this result of the study. First, we can consider that knowledge does not turn into practice. Second, individual differences (income-level, etc.) may affect the phenomenon. When we examine the literature, we can see studies with similar or different results. For instance, in their study Raymond-Barker et al. 2007 (21) reported that nutritional knowledge and eating attitude appeared to be independent for both athletes and controls. A study conducted with 100 athletes and 100 sedentary individuals reported that nutritional knowledge of the participants was good enough; however, it was not significant (22). On the other hand, in a more recent study, it was reported that only one of the participants (0.5%) had good nutritional knowledge, 9 (4.2%) had moderate nutritional knowledge. In contrast, most of the participants, 202 (95.3%), had poor nutritional knowledge with no statistically significant differences compared to whether they were professional athletes or not (23).

Analyze results also showed significant positive and negative correlations between health belief regarding LTPA and nutritional attitude. We think to some extent that these results are the consequences of that the students with physical activity levels need to adapt their nutritional knowledge and increase levels as their demands such as calorie needs will increase. Besides, participants who engage in LTPA should pay attention to their daily nutrition intake to show a performance. As stated before, health beliefs and leisure-time physical activity are associated with different kinds of nutritional attitudes. Previous studies showed that the nutritional attitude of university students was associated with physical activity prevalence. Students with a higher level of LTPA had a higher food addiction as well (24-26). Supporting our result, in a study conducted with lower-educated Dutch, Turkish, and Moroccan adults in the Netherlands showed that the essential attitude beliefs concerning healthy eating and physical activity were taste and health benefits (27). However, according to Rosenberg et al. 2007 (28)'s longitudinal study results, there was not any significant primary evidence of multi-behavior co-variation between dietary, physical activity, and sedentary behavior.

Conclusion

This study showed that only self-efficacy made a difference in the perceived health belief regarding LTPA. Perceived severity, perceived barriers, physical benefit, psycho-social benefit, self-efficacy, nutritional knowledge, and positive nutrition were positively correlated. On the other hand, perceived barriers, physical benefit, psycho-social benefit, self-efficacy, the feeling of nutrition and malnutrition were negatively correlated.

Limitations and Future Studies

The present study demonstrated significant differences as well as correlations between health belief regarding LTPA and nutritional attitude in athletic and sedentary university students; however, it is not without limitations. The first limitation was that the data collection tools were self-report measures. The second limitation was that all the participants were university students. That may intervene in some of the results as young adults are still learning and adapting their lifestyles from adolescence to the developmental stage of risk-taking (29). So, future studies must focus on different age groups with a different type of instrumentation to have a better understanding of the phenomena.

Conflicts of interest

The authors declare that there is no conflict of interest in this manuscript.

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Original article

The effect of eight-week TRX exercises on mild and moderate posture disorders

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Summary. *Study Objectives:* This study was conducted to measure the effect of eight-week TRX exercises on mild and moderate posture disorders. *Methods:* 40 people (f: 24; m: 16), with exercise and control groups having 20 each, participated in the study. It was ensured that the exercise group performed various exercises with TRX instruments, three days a week for eight weeks. Before and after the exercise, measurements were taken from both groups with the "Scoliometer", and only the degree of curvature, shoulder, and chest circumference measurements were taken without applying any exercise program to the control group. Statistical data were obtained using frequency and percentage values in SPSS 22; the independent sample t test was applied to compare descriptive statistics, and the repeated measures ANOVA was used, whereby the level of significance was taken as 0.001 and 0.005. *Results:* A statistically significant difference was found between the pre-test and post-test scores of the male exercise-control, female exercise-control, and total study groups based on the variable of shoulder, chest, and posture degree of curvature. Compared with the Bonferroni family-wise-error control method, a significant difference was found between the male exercise group participants and the control group in shoulder measurements ($p < .0001$), and no difference was found between female groups. In comparison of female exercise and control groups based on the chest variable, the difference was found to be significant ($p < .0001$), but no statistically significant difference was observed between the male exercise and control groups and a significant difference was observed between the pre-test and post-test in the degrees of curvature of women and men (exercise-control), and the pre-test predicted the post-test in the same degree of curvature and group ($p < .0001$). *Conclusion:* Besides, TRX exercises provide positive changes in the anthropometric structure and reduce posture curvature, especially those with high degrees of curvature were found to decrease significantly.

Keywords: Posture, TRX exercise, Women, Men.

Introduction

TRX Training (Total Resistance Exercise) is strength training, a method of working against gravity, which is created with a suspension system consisting of thick woven ropes, which enables the exercise of the resistance of the exercises with its body weight (1). TRX training creates similar effects in functional mobility, strength, and balance (2). The training method with TRX is a working system that has just started to be used in Turkey. Different exercises are applied by placing hands or feet on two handles on the TRX. For the lower and upper limbs, it allows multi-joint and multi-planar exercises on unstable ground or under unstable conditions. On the other hand, it enables the movements of the belts to be applied at different loads by increasing or decreasing the ground heights and angles (3).

In exercises using TRX, three principles are used to adjust the severity of movements or difficulty levels. The first principle is the principle of "Vector Resistance" in which the resistance is reduced or increased by changing the angle of the body with the ground. The second principle is the principle of "stability-balance"

in which the stability and balance of movement are adjusted by changing the support points of the hands and feet. The last principle is the pendulum principle in which the resistance is adjusted according to the starting position under the TRX hanger or away from the hanger (4).

Stabilization exercises applied to the musculoskeletal system, stabilizing muscles around the joints and the body can become more active against unwanted movement. For this reason, the hanging exercise system training can be particularly useful for athletes in overhead sports (for example, baseball, softball, volleyball and handball players and quarterbacks in American football). For, it can increase the control of the scapula and the strength of the serratus anterior muscles. These improvements can help prevent both acute and chronic shoulder injuries (5).

Today, the gradually decreasing physical activity level affects body posture as well as different health problems (obesity, diabetes, cardiovascular, etc.) that affect people of all ages. Physiologically and biomechanically good posture is the posture that provides maximum efficiency in the body with minimum effort. Bad posture progresses with unnecessary contraction and compensation mechanisms in the muscles. These changing mechanisms trigger a spasm in the shoulder and back muscles, reduce the effectiveness of biomechanical functions, and weaken soft tissues. Although there are genetic, physiological, and psychological causes of posture disorders, long sitting at the table or in front of the computer in early childhood, using non-ergonomic tables and chairs, carrying heavy school bags and physical inactivity affect body awareness and cause bad posture (6).

The general approach to moderate and mild posture disorders that are non-structural or functional are mostly corset use or exercise applications. At this stage, people are recommended to practice exercises that refer to a practical and effective method that increases the quality of life, reduces the severity of pain, and decreases the curvature level in the spine (7). For this purpose, the effects of TRX exercises, which are exercise injuries for the muscular and skeletal system, on the degree of curvature of the posture were investigated by.

Method

Study Group

A total of 40 people (f: 24; m: 16), with exercise and control groups having 20 each, who voluntarily participated in TRX exercise, did not have any disadvantage in terms of health and did not actively participate in sports, participated in the study.

Data Collection

Power pull, row, squat, side squat and push-up exercises were performed with the TRX apparatus for 45 minutes (with warm-up and then cool-down exercises) three days a week for eight weeks for the exercise group. The degree of posture curvature was measured with a scoliometer. While chest circumference was measured at the level of the breasts when it was at the mid-point of the tidal volume, the pre-and-post-test measurement of shoulders was carried out by tape measure from the point where the sternum and the 2nd rib meet from the maximal protrusion of the deltoid muscle (8, 9).

Statistical Analysis

Statistical data were obtained using frequency (frequency) and percentage (%) values in SPSS 22 program; the independent sample t test was applied to compare descriptive statistics of two groups, and; the repeated measures ANOVA was used, whereby the level of significance was taken as 0.001 and 0.005.

Results

The mean age, height, and weight of the groups are shown in Table 1. The mean age of the people in the exercise group is 22.85 ± 4.80, their mean height is 168.60 ± 7.74 and their mean weight is 67.08 ± 12.48. The mean age of the individuals in the control group is 25.50 ± 5.79, the mean height is 168.40 ± 6.83 and the mean weight is 74.78 ± 20.32. Considering the general mean, it can be said that the groups are not very different from each other, and the mean age, height, and weight are close to each other.

Table 1. Mean of Age, Height, and Weight of Exercise and Control Groups

	Groups						
	Exercise		Control		General		
Variable	$\bar{X}$	S.D	$\bar{X}$	S.D	$\bar{X}$	S.D	p
Age	22.85	4.804	25.50	5.79	24.02	5.61	0.124
Height	168.60	7.748	168.40	6.83	168.50	7.21	0.931
Weight	67.08	12.48	74.78	20.32	70.93	17.10	0.157

Table 2. Main Summary Table for the repeated measures ANOVA Effect of Shoulder Circumference Dependent Variable According to Groups

Source of variance	**df**	**S.D**	**MS**	**F**	**p**	**η^2**
Men						
Shoulder Pre-tests	1	1406.746	1406.746	1480.337	0.000	0.986
Group	2	7.284	3.642	3.833	0.049	0.005
Error	13	12.354	0.950			
Women						
Shoulder Pre-tests	1	1166.518	1166.518	161.593	0.000	0.882
Group	2	4.096	2.048	0.284	0.756	0.003
Error	21	151.596	7.219			
Total						
Shoulder Pre-tests	1	4521.786	4521.786	993.715	0.000	0.962
Group	2	7.510	3.755	0.825	0.446	0.001
Error	37	168.364	4.550			

In the main summary table for the repeated measures ANOVA effect of the shoulder circumference dependent variable in men, there was a significant difference between the pretest and posttest between F (1,13 = 1480.337, p <.0001), and also between the study groups, and in women in terms of posttest F (1.21 = 161.593, p <.0001) according to the shoulder variable. However, there was no significant difference in the group variable in terms of shoulder measurement in both women and total and control groups.

A significant difference was observed between the male exercise and control groups in terms of the shoulder variable (Figure 2) and no significant difference was found between the female and total groups (Figure 1-3).

Results show that there was a significant difference between the pretest chest and posttest scores of men F (1.13 = 1693.598, p <.0001), and no statistically significant difference was observed between male exercise and control groups. There was a significant difference between both pretest-posttest and study groups in women (p <.0001). Considering the total exercise and control groups, it is understood from Table 3 that the chest measurement is significant in terms of posttest score F (1.36 = 2197.459, p <.0001). The degree of the chest and the total of the group also proved to be significant in terms of F (1.36 = 5.371, p <.0001). However, no significant difference was observed between total exercise and control groups in terms of the group variable (p = 0.125).

Figure 4 highlights that there is no significant difference between male exercise and control groups in terms of chest measurement (p = 0.178). In Figure 5, when the female exercise and control group is compared with the Bonferroni family-wise-error control method, the difference between them is significant (p = 0.000). When the Graphic showing the Binary Comparison of Total Exercise and Control Groups is examined in terms of pretest and posttest, it is observed that there is a decrease in the chest posttest measurement of the exercise group compared to the pretest measurement (Figure 6).

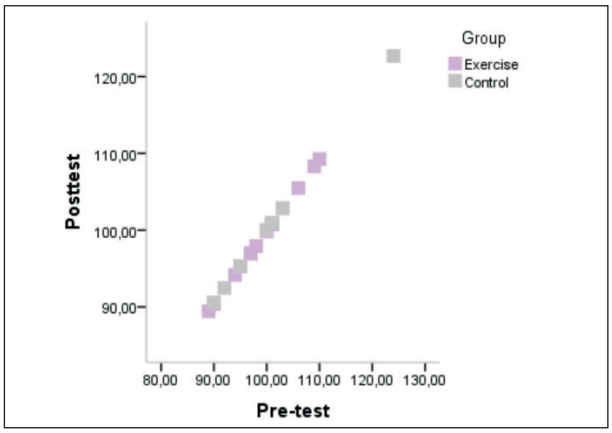

Figure 1. Female Exercise and Control Groups

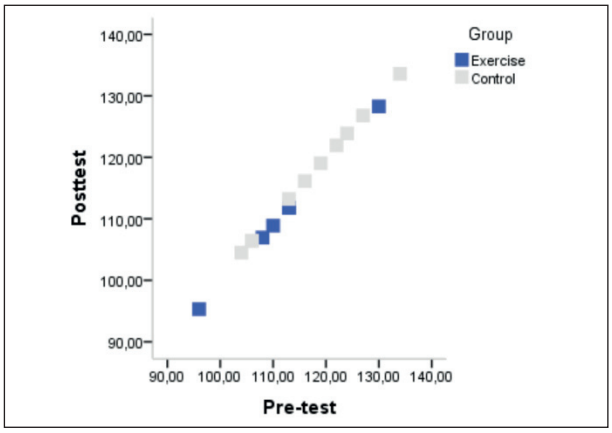

Figure 2. Male Exercise and Control Groups

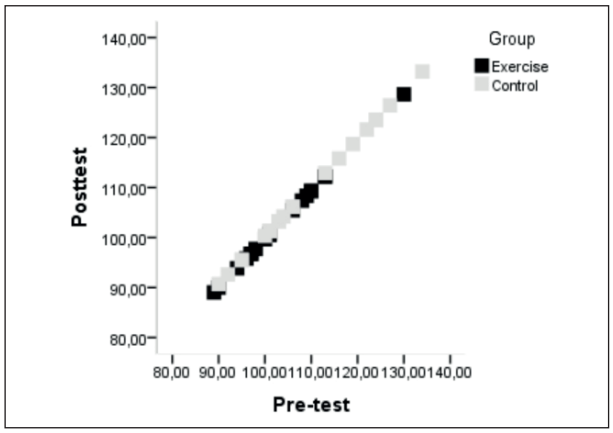

Figure 3. Total Exercise and Control Groups

Considering the main summary table for the repeated measures ANOVA effect of the Degree of Curvature according to total groups, there is a significant difference between the pre-test and post-test F (1.36 = 225.840, p <.0001) and considering the degree of curvature and group total, it is seen that the pre-test predicts the post-test F (1.36 = 13.445, p = 0.001). It is also observed that there is a significant difference between the pretest and posttest in the degree of curvature of women and men, and the pretest predicts the posttest in the same degree of curvature and group totals (p <.0001). However, there is no significant difference between the pretest and the posttest in all participants in terms of the group variable.

Table 3. Main Summary Table for the repeated measures ANOVA Effect of Chest Circumference Dependent Variable According to Groups

Source of variance	df	S.D	MS	F	p	η^2
Men						
Chest Pre-tests	1	2248.739	2248.739	1693.598	0.000	0.990
Group	2	3.484	1.742	1.312	0.303	0.001
Error	13	17.261	1.328			
Women						
Chest Pre-tests	1	1856.056	1856.056	1258.440	0.000	0.959
Group	2	46.956	23.478	15.919	0.000	0.024
Error	21	30.973	1.475			
Total						
Chest Pre-tests	1	3648.631	3648.631	2197.459	0.000	0.979
Group	2	7.307	3.654	2.200	0.125	0.001
Chest + Group	1	8.918	8.918	5.371	0.026	0.002
Error	36	59.774	1.660			

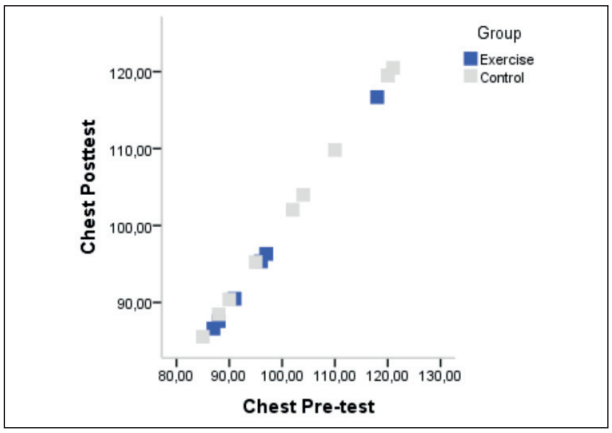

Figure 4. Male Exercise and Control Groups

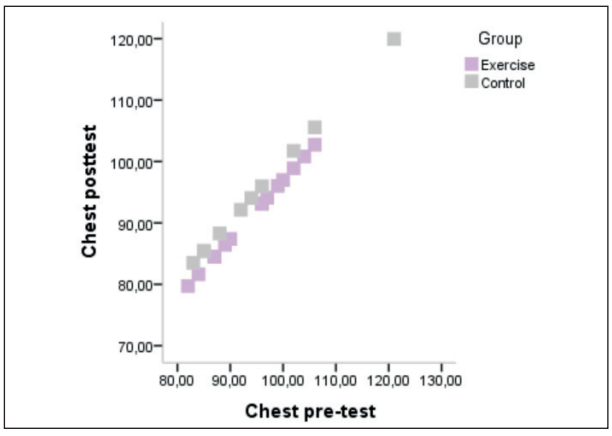

Figure 5. Female Exercise and Control Groups

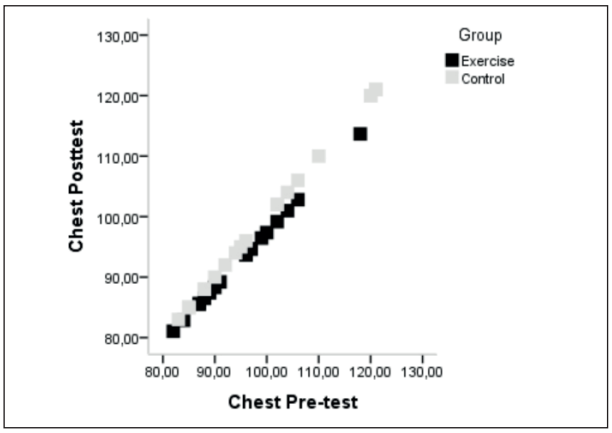

Figure 6. Total Exercise and Control Groups

When the female exercise group is analyzed in Figure 7, it is observed that the degree of curvature decreases after the second measurement, and especially the degree of curvature of those with high degrees decreases. It is seen that there is a decrease in the measurement level of the male exercise group in Figure 8. In the comparison graph between the groups, there is a significant decrease in the degree of curvature between the pretest and posttest in the exercise and control groups. When the control group and exercise group are compared, it is seen that the difference is significant (Figure 9, p <.0001).

Table 4. Main Summary Table for the repeated measures ANOVA Effect of the Degree of Curvature Dependent Variable According to Groups

Source of variance	df	S.D	MS	F	p	η^2
Men						
The Degree of Curvature Pre-tests	1	24.771	24.771	52.814	0.000	0.656
Group	2	1.773	0.887	1.891	0.193	0.047
The Degree + Male Group	1	5.532	5.532	11.794	0.005	0.146
Error	13	5.628	0.469			
Women						
The Degree of Curvature Pre-tests	1	80.108	80.108	153.835	0.000	0.854
Group	2	0.196	0.098	0.188	0.830	0.002
The Degree + Female Group	1	2.983	2.983	5.729	0.027	0.079
Error	21	10.415	0.521			
Total						
The Degree of Curvature Pre-tests	1	113.242	113.242	225.840	0.000	0.819
Group	2	0.173	0.087	0.173	0.842	0.001
The Degree + Group	1	6.742	6.742	13.445	0.001	0.048
Error	36	18.051	0.501			

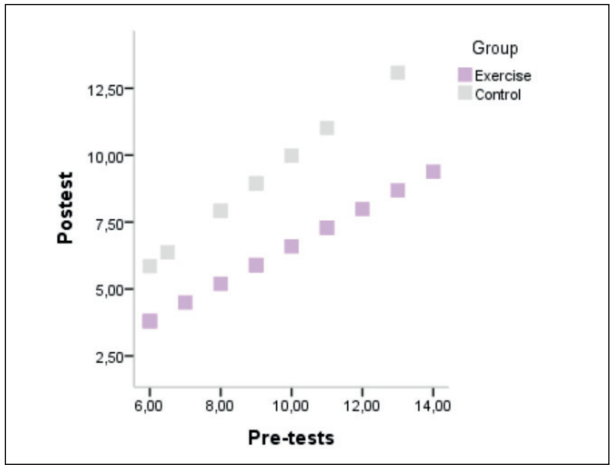

Figure 7. Female Exercise and Control Groups

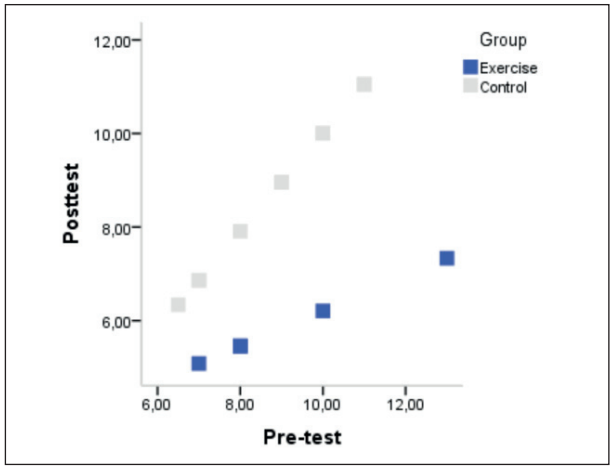

Figure 8. Male Exercise and Control Groups

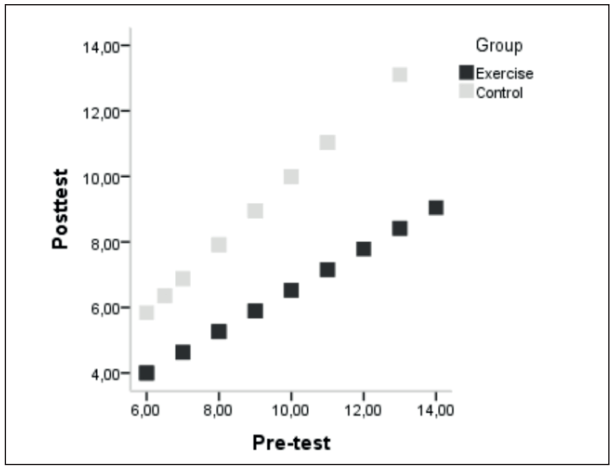

Figure 9. Total Exercise and Control Groups

Discussion and Conclusion

The aesthetic stance in terms of physical appearance has positive effects on people in physical, physiological, social, psychological, and many other aspects. In addition to posture disorders caused by factors such as genetics, etc., wrong postures obtained since the development period may cause weak back muscles and painful spinal deformations over time. Through resistance exercises with TRX, the main goal is to increase muscle strength and endurance in unbalanced body positions, to strengthen the muscles of the power zone, and to minimize the risk of disability (5). Thanks to the strengthening of the postural muscles and cooperation between certain muscles, TRX trains not only the muscles but also their antagonists, agonists, and synergists, helping improve the correct body posture (10).

Gulbani and Shevchuk used the physical rehabilitation technique for posture disorders that included TRX simulator, exercise therapy, and self-mobilization techniques for the first time in their study in which they made posture evaluation and analysis in schoolchildren aged 10-12. As a result, they found that TRX simulator exercises had positive effects such as flexing and simultaneously increasing the deep muscles of the body (11). In their study conducted with older participants, Gaedtke and Morat reported that TRX exercises had positive effects regarding mostly gaining strength compared to gait and balance improvements (12).

Pastucha et al. stated that the functional 3D training is an effective method to strengthen the postural muscles of the human body, to increase joint stability, to strengthen ligament groups, and to improve the stability and lung capacity of muscle groups, especially the back muscles (13). In another study, it was concluded that TRX suspension exercises are very effective in increasing the core region muscle strength and endurance as well as in improving static and dynamic balance, explosive force, and flexibility in healthy individuals (14). Curiţianu and Balint found in their study with those suffering idiopathic scoliosis that avoiding a more aggressive treatment even if only for six months of doing with people with idiopathic scoliosis TRX Suspension Training Exercises is clinically meaningful (15).

Numerous studies have revealed that regular physical activity and exercise provide positive improvements in anthropometric measurements. Smith et al.

stated that regular participation in TRX Suspension Training could positively alter the risk factors for many major cardiovascular diseases, including muscle fitness, body fat, and decreased waist circumference (14). Notarnicola et al. stated that CrossFit and TRX training methods led to improvements in terms of both anthropometric and aerobic resistance (16). In this study, it was observed that after the TRX exercise, decreases occurred in the shoulder area in men compared to the control group, and decreases occurred in chest measurements in women (Figure 2, 5).

In addition to such effects of TRX exercises, in this study which has been designed to determine the potential effects of TRX exercises in moderate and mild posture disorders, it has been revealed that there is a positive decrease in the degree of curvature in individuals. There are studies in the literature that examine different effects, but studies on postural disorders are limited, and similar research is recommended with young groups in this field.

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Original article

The acute effects of caffeine ingestion on reactive agility performance in soccer players

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Abstract. *Study Objectives:* Caffeine has been shown to provide ergogenic benefits to sports performance. However, limited research is available on the effects of caffeine on agility performance. The study aimed to evaluate the acute effects of caffeine ingestion on reactive agility performance in soccer players. *Methods:* A total of forty-eight healthy male (age = 16.5 ± 0.5 years, height = 172.3 ± 4.5 cm, body mass = 64.5 ± 5.6 kg, training age: 6.77 ± 1.56 years) youth soccer players volunteered to participate in this study. Participants ingested 6 $mg \cdot kg^{-1}$ caffeinated coffee (caffeine group) or 6 $mg \cdot kg^{-1}$ decaffeinated coffee (placebo group) or no coffee (baseline group) with randomized, counter-balanced, single-blind, and repeated-measures experimental design. Movement time (MT), sprint time (ST), total agility time (TAT), and decision time (DT) were analyzed using by one-way repeated-measures ANOVA. *Results:* There were statistically significant differences among the baseline, caffeine, and placebo conditions on MT (p=0.005), ST (p=0.000), TAT (p=0.000), DT (p=0.000). There were significant differences in MT with caffeine compared with the placebo group (p=0.005). It is seen that the ST value has a significant difference in baseline condition compared to caffeine and placebo group (p=0.000 and p=0.002). There were statistically significant differences between caffeine and baseline status on TAT (p=0.000). There were statistically significant differences between caffeine and baseline condition (p=0.000) and placebo (p=0.000) condition on DT. *Conclusion:* It can be said that caffeine intake has a positive effect on ST, TAT, and DT components compared to baseline and placebo. Considering the MT values, it is seen that the mean of MT with caffeine is lower than the placebo but higher than the baseline. Caffeine ingestion may supply ergogenic benefit on the reactive agility performance of the soccer players.

Keywords: Caffeine Ingestion, Athlete, Performance, Reactive Agility

Introduction

Soccer is a team sport and achievement in this discipline depends on some factors including physical fitness, technique, and tactics. Soccer is defined by the continuous combination of short sprints, fast accelerations/decelerations, and changes of direction dabbled with jumping, kicking, tackling. Also, these physical fitness factors, techniques, tactics, cognitive ability, and psychological factors may affect on soccer performance (1,2). The investigation of the effects of ergogenic supplementation on athletic performance has become a major topic for players and trainers associated with soccer because it can enhance achievement during the play (2).

Caffeine is a drug that is commonly consumed in the world. It has an important effect on many activities of people. They who use this drug can feel better themselves and have more energy and quality of life (3). Caffeine is also mostly used by athletes, and there are many studies about caffeine's ergogenic or "work enhancing" effects in sport fields (4). Related studies determined that caffeine at doses of 6-9 mg/kg/body mass, or ~3-4 cups of coffee, was effective at improvement of endurance in sport fields (4-7). Foskett, Ali, and Gant (2009) evaluated that the ingestion of 6 mg/

kg of caffeine before exercise developed passing accuracy and accrued considerably less penalty time during the test (8). Jordan et al. (2014) reported that the consumption of 6 mg/kg of caffeine 1 hour before the test remarkably developed the reaction time of the soccer players (9). Apostolidis et al. (2018) observed that the intake of 6 mg/kg of caffeine 1 hour before the test developed neuromuscular performance and aerobic endurance in well-trained athletes (10). According to the results of the research, the intake of the caffeine may be efficient to increase performance in athlete' abilities and soccer-specific skills.

Agility can be described as "a rapid whole-body movement with change of velocity or direction in response to a stimulus" (11). In the literature agility and change of direction are used interchangeably. In some sports, during the game a change of direction is often executed in response to un-predictable visual stimuli, and the maneuvers are related agility might not be pre-planned (12). That's why, the real-sport-agility depends on fast and accurate responses to stimuli specific to sport environments. As you can see while a change of direction is used in planned movements, the reactive agility is used to explain unplanned movements in sports (13,14). Many traditional tests of agility only assess change-of-direction speed; they do not incorporate a decision-making component (11). These tests include the planned movements and could not be representative of the agility needed during the game. Because they do not have a cognitive component in which a player reacts to an opponent's movements. In addition planned agility has also been found to not differentiate between players of different athletic skills (15).

The reactive agility tests (RAT) in which the ability of players to read and react to a stimulus were developed by researchers to have a correct evaluation of the agility (12,15). These tests are valid and reliable and could find out the differences between the high level and low level of athletes in the sports of netball (15), rugby league (12), and Australian football (13). In the literature there is much research about the effect of caffeine on athletic performance in adults (16,17). But there is a lack of literature evaluating caffeine's effect on the athletic performance of young athletes. The first research was conducted by Pontifex et al. (2010) to test caffeine's effects on a RAT in adults. They reported that a caffeine supplement did not have a significant development on the RAT when compared with the placebo (18). Hovewer, Young and Farrow (2013), Lorino et al. (2006), and Duvnjak-Zaknich et al. (2011) detected that caffeine intake increased reactive agility performance in male athletes in their studies (19-21). Much research is necessary to measure the effect of caffeine on reactive agility where the performance requires both a cognitive and a physical response. Therefore, the present study aimed to evaluate the acute effects of caffeine ingestion on reactive agility performance in soccer players.

Material and Methods

Participants

Forty-eight healthy male, youth soccer players volunteered to participate in this study (mean ± *SD*: age = 16.5 ± 0.5 years, height = 172.3 ± 4.5 cm, body mass = 64.5 ± 5.6 kg, training age: 6.77 ± 1.56 years). All subjects were elite status. They had similar conditioning levels and expertise participating in 4 training sessions and 1 match per week. The participants were limited to the players of the same team so that the training effect did not affect the test results. The subjects were informed about the possible risks and benefits of the study and gave their informed consent to participate in this study, which was approved by the Clinical Research Ethical Committee of Pamukkale University (60116787-020/28623).

Experimental design

On the first day, anthropometric measurements were taken and players were adapted to the RAT. Each subject's height and body mass were recorded before completing any testing. Participants ingested 6 $mg \cdot kg^{-1}$ caffeinated coffee (caffeine group), 6 $mg \cdot kg^{-1}$ decaffeinated coffee (placebo group), and no coffee (baseline group) with randomized, counter-balanced, single-blind, and repeated-measures experimental design. There were 48 hours between each testing session for the recovery. Players were asked to refrain from consuming caffeine in the 24-hr period before testing and were given a list of foods and beverages that contain caffeine. Participants were also asked to

refrain from food and beverages 1-hr before testing. All subjects were tested at the same time of the day (between 09:00-12:00). It was requested to be consumed their coffees which dissolved in 300 ml of hot water 10 minutes by the participants. One hour later RAT test was carried out. As the literature indicates caffeine's peak blood serum levels are reached in this time frame, a 1-hour wash-in period was considered (17). Before testing, players completed standard team warm-up which consisted of a 10-minute possession game interspersed with squat jumps and concluded with 5 to 10 near maximum sprints of no more than 10 m in distance.

Reactive agility test (RAT)

Reactive agility test was completed on a regulation indoor soccer court surface. Four dual beam timing gates (Swift Technologies) were placed on the court surface to allow the collection of movement time, sprint time, total agility time and decision time resulting from completion of a soccer specific agility pattern (Figure 1).

Four parameters were measured from a combination of the timing gates and the video record. All times are reported in milliseconds. *Movement time (MT*) was defined as from the start of the test until the completion of the side-stepping component and the first meter of forward movement (or from the start gate to gate 2). *Sprint time (ST)* was the time it took subjects to complete the final 8.1 m sprint (or from gate 2 to gate 3 or 4). *Total agility time (TAT)* was the time it took from the start to finish of the test. *Decision time (DT)* of the subjects was recorded through the post-hoc inspection of the video-footage (50 Hz). DT was the difference in time between ball release by the passing player (on the video projection) and the first definitive foot contact of the participant that initiated her final direction of travel in an attempt to intercept the pass. This was considered to reflect the subject's assessment of the perceptual display and time to decide as to which direction to respond (15). Participants were given 60 seconds of rest between each trial. 3 measurements were taken and the best score was recorded.

Statistical analysis

In the statistical analysis of the data, descriptive analyzes of test measurements of soccer players were

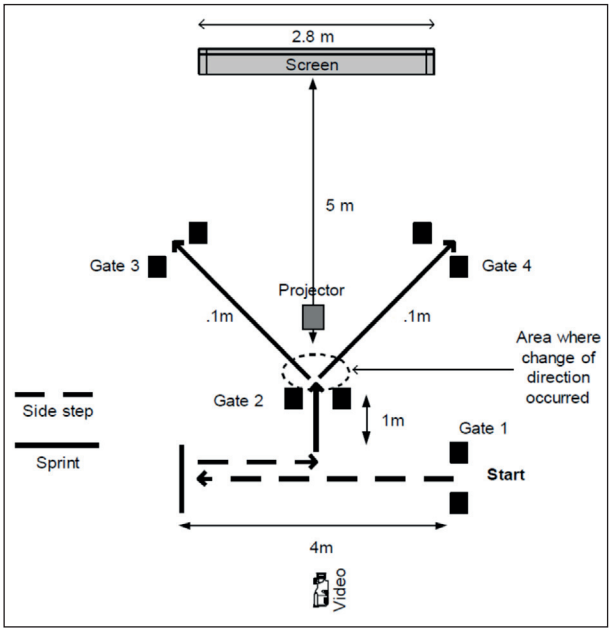

Figure 1. Reactive agility test set-up (15).

Picture 1. Reactive Agility Test View

calculated as mean and standard deviation. Dependent variables (MT, ST, TAT, and DT) were analyzed using by one-way repeated-measures ANOVA. Bonferroni post hoc analysis was applied to determine the condition under which the difference originated. The obtained data were evaluated with SPSS 23.0 program and the statistical significance was set at $p<0.05$.

Results

There were statistically significant differences among the baseline, caffeine, and placebo conditions on movement time (WilksLambda = 0.795; F = 4.589;

p=0.005; $\Delta\eta^2$=0.205) (Table 1). A post hoc test using a Bonferroni adjustment revealed a significantly different MT with caffeine compared with the placebo condition (p=0.005). We can explain that caffeine has a positive effect on MT compared to the placebo condition.

There were statistically significant differences among the baseline, caffeine, and placebo conditions on sprint time (WilksLambda = 0.520; F = 13.084; p=0.000; $\Delta\eta^2$=0.480) (Table 1). According to the Bonferroni test results, it is seen that the baseline status creates a significant difference with both caffeine and placebo status (p=0.000 and p=0.002). When we look at the sprint time values, it is seen that the sprint time is 1,936s in the case of caffeine condition and 1,965s in the placebo case. It is seen that the ST value has a significant difference in baseline condition compared to caffeine and placebo condition.

There were statistically significant differences among the baseline, caffeine, and placebo conditions on total agility time (WilksLambda = 0.201; F = 4.349; p=0.000; $\Delta\eta^2$=0.799) (Table 1). According to the Bonferroni test results, there were statistically significant differences between caffeine and baseline status (p=0.000). It can be said that caffeine intake caused a significant decrease in total agility time.

There were statistically significant differences among the baseline, caffeine, and placebo conditions on decision time (WilksLambda = 0.132; F = 1.419; p=0.000; $\Delta\eta^2$=0.868) (Table 1). According to the Bonferroni test results, there were statistically significant differences between caffeine and baseline condition (p=0.000) and placebo (p=0.000) condition. It can be said that caffeine intake has a positive effect on decision time. When the decision periods in all three conditions are analyzed, it is seen that the decision time is faster in caffeine intake.

Table 1. Repeated-measures ANOVA results

	Mean ± SD	N	df	F	p	$\Delta\eta^2$
Movement Time (sec)						
Baseline	2,71 ± ,13					
Caffeine	2,73 ± ,11*	48	2	4,58	0,005	,205
Placebo	2,75 ± ,11					
Sprint Time (sec)						
Baseline	2,06 ± ,19**					
Caffeine	1,93 ± ,12	48	1	13,08	0,000	,480
Placebo	1,96 ± ,18					
Total Agility Time (sec)						
Baseline	4,78 ± ,22#					
Caffeine	4,69 ± ,20	48	1	4,34	0,000	,799
Placebo	4,73 ± ,25					
Decision Time (sec)						
Baseline	0,84 ± ,11					
Caffeine	0,77 ± ,09&	48	1	1,41	0,000	,868
Placebo	0,83 ± ,10					

** significant difference with placebo (p=0,005); ** significant difference with caffeine (p=0,000) and placebo (p=0,002); # significant difference with caffeine (p=0,000); & significant difference with baseline (p=0,000) and placebo (p=0,000)*

Discussion and Conclusion

The present study aimed to evaluate the acute effects of caffeine ingestion on reactive agility performance in soccer players. By using a reactive agility test, caffeine's effect on agility performance was evaluated based on cognitive and physical components of agility. There were significant differences among the baseline, caffeine, and placebo conditions on MT, ST, TAT, DT (p<0.05). We can explain that caffeine has a positive effect on MT compared to the placebo condition. Also, it is seen that the ST value has a significant difference in baseline condition compared to caffeine and placebo condition. It can be said that caffeine intake caused a significant decrease in TAT and caffeine intake has a positive effect on DT. We can see from the table 2, DT value with caffeine was lower in all conditions.

The findings from our study show similarity with the finding by Duvnjak-ZaZaknich et al. of improvements from caffeine intake in total time, reactive agility time, movement time, and decision time measurements of a RAT (21). But, they failed to document a level of statistical significance, potentially due to the small sample size (n=10). This result shows that there is potential for caffeine to develop the reactive agility performance in elite youth athletes. However, Jordan et al. (2014) reported that caffeine intake did not have a significant effect on sprint performance including RT and MT in their studies. Caffeine may affect TAT performance through improvements in RT and

so could be important during the game (9). The results of this study are an incoherent result with the results of our and other researches assessing caffeine's effect on MT (23-25).

Most experimental studies evaluating the potential for caffeine to enhance athletic performance has been done in laboratory conditions with firmly controlled trials. Some studies have evaluated the effects of caffeine on repeated sprinting tasks (26), reactive agility tests (21), and sport situations including tennis, soccer, rugby, volleyball, basketball, and field hockey (6,27,28). These studies have shown documents that caffeine develops athletic performance and skill performing in intermittent type sports.

Caffeine is a potent drug that produces a wide range of metabolic, hormonal, and physiologic effects on the organism (29,30). These effects can support an improvement in sports performance. It has been detected that caffeine intake enhances the perceived muscle power during simulated competitions of athletes in several sports activities (31). For instance, the acute ingestion of caffeine increased the rate of technical elements qualified as positive for the game in male (32) and female volleyball players (28). In basketball players, caffeine was found to increase the number of rebounds, assists, and the performance parameters (33). Foskett, Ali, and Gant (2009) detected that 6mg per kilogram of body mass increased both passing accuracy and jumping performance (3.9% better than placebo), in 12 male footballers during a 90-min football-specific intermittent running trial (8).

A lot of studies have examined the effects of caffeine on cognitive function and perception during the game in team sports. Hogervorst et al. (2008) suggest that a low dose of caffeine enhances cognitive performance during and after vigorous exercise. In that study, the athletes completed the tests considerably faster and took longer to finish the time to exhaustion test after taking caffeine compared to the placebo (34). Therefore, caffeine intake can remarkably improve endurance performance and cognitive ability during and after extensive exercise. Caffein's effects may be considered for athletic performance in sports activities in which concentration and decision making play a major role. In addition Stevenson, Hayes, and Allison (2009) demonstrated how caffeine intake not only improved the performance of golf players, but also managed to increase their alertness and positively affect their mood compared to the placebo (35).

Much data recommend that caffeine also increases the physical and technical elements of performance in athletes during the game in sport fields. For instance, caffeine can improve repeated sprint and reactive agility (21,36) during intermittent-type sports. Some studies have evaluated the effects of caffeine on repeat sprint performance in team sports (21,26,36-38). Paton and Vollebregt (2001), and Woolf, Bidwell, and Carlson (2009) all detected that there was no difference in sprint performance when caffeine intake was compared to placebo (37,38). And also, Astorino and Robertson (2012) reported no effect of caffeine on sprint times in soccer players (39). But caffeine has been evaluated to increase sprint performance in team sport players following intaking of anhydrous caffeine (23) and a caffeinated beverage (40) compared to placebo.

Although high-speed actions which include agility only contribute to; 11% of the total distance covered during the game, they constitute the more crucial moments of the game and contribute directly to winning possession of the ball and to scoring or to conceding of goals (22). So, the ingestion of caffeine may be useful for developing the athlete's sprint performance and so may influence the results of soccer matches.

Caffeine's effect on the central nervous system (CNS) may be the reason for the improvements in reaction time. Because caffeine can function as an adenosine receptor antagonist, which lowers the threshold for motor unit recruitment (41). The caffeine could reduce the effect of unrelated visual information and support decision-making accuracy, especially as athletes become fatigued during the game. When the athletes are not tired, a direct stimulation of the CNS, developing neural firing rates, and the release of stimulatory neurotransmitters may clarify the progression in the agility performance of the athletes (21). According to the findings of this study, significant improvements were found on ST, TAT, and DT parameters with caffeine intake. The reason for this may be the blocking of adenosine receptors in various tissues in the body, producing a stimulatory effect on the CNS. However, for more realistic results, more research with the caf-

feine intake and youth sports performance is needed.

As a result, it can be said that caffeine intake has a positive effect on ST, TAT, and DT components compared to baseline and placebo. Considering the MT values, it is seen that the mean of MT with caffeine is lower than the placebo but higher than the baseline. Caffeine ingestion may supply ergogenic benefit on the reactive agility performance of the soccer players.

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Conflicts of interest

The authors declare that there is no conflict of interest about this manuscript.

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Original article

The effect of nutrition course on the nutrition knowledge level

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Abstract. *Study Objectives:* It is a well-known fact that knowledge about athletes 'and coaches' nutrition is very important. There are several studies on the nutrition of athletes. In this study, to determine the athletes' nutritional knowledge levels; it was conducted to determine the sports knowledge scores of the students, the future coaches of today's athletes, studying in the Faculty of Sports Sciences. *Methods:* 394 students voluntarily participated in the study. "Sports Nutrition Knowledge Scale (SNKS)" was used to determine students' sports nutrition knowledge scores. Independent samples-t test was used to compare the groups, and One-Way ANOVA test was used to determine the difference between the departments. *Results:* The mean knowledge score of the students who took the nutrition course was determined as 37.11% and the mean knowledge score of the students who did not take the nutritional course was determined as 22.67%. It was determined that the difference between the nutritional knowledge mean score of the students who took and did not take a nutritional course was in favor of the students taking a nutritional course. While the nutritional knowledge mean scores of male students were 30.23%, the mean of nutritional knowledge of females was 29.50%. No difference was found in the comparison of the nutritional knowledge score means of male and female students. The mean of nutritional knowledge scores among the departments in the teaching department was found to be 32.52% in the coaching department and 27.01% in the management department. When the sub-dimensions were evaluated, there was a significant difference in micronutrients, sport nutrition, supplement, and alcohol sub-dimensions. *Conclusion:* It was determined that the nutritional knowledge levels of the students who took both nutrition courses and those who did not take the nutritional courses were found to be poor, while the nutritional knowledge total scores of the students who took the nutritional courses were higher. For this reason, it is thought that it will be beneficial to increase the nutrition course duration and to add these course to the standard education as a compulsory course to keep the nutritional knowledge levels of the students who can coach in the future.

Keywords: Students, Nutrition knowledge, Nutrition course

Introduction

Nutrition is one of the basic needs for human survival. In addition, nutrition has become a subject of constant research and new developments to ensure that athletes struggle better both in individual and team games, a continuous increase in performance, and maintain this increase (1). Nutrition is considered as one of the most important factors for athletes. Athletes can keep their diet under control provided that they have sufficient knowledge about the subject, which can have a positive effect on their performance (2).

Sports nutrition; is a specialization area where nutrition science and exercise science are related and put into practice. The main goal in sports nutrition is to ensure adequate and balanced nutrition of the athlete, thus protecting the health and performance of the athlete (3). Regular and balanced nutrition is important

for the athlete in several ways. Many situations that affect the athlete directly or indirectly can be achieved through balanced nutrition, such as increasing performance, preventing weight loss and overweight, preventing discomfort caused by electrolyte losses in the body, regular functioning of the digestive system, and renewal of energy sources during recovery (4).

At a time when nutrition and sports nutrition are so important, a good many different types of research are conducted on the subject. In the last 20 years, major developments in the field of sports nutrition have followed each other. The fact that sports nutrition has become a popular topic in the world and our country has brought with it plenty of misinformation and beliefs (5). Accurate nutritional knowledge is essential for high performance, which is a common goal of professional athletes, coaches, strength and fitness coaches, and sports teams from the field of sports (6). It is important to evaluate nutritional knowledge at different times so that the sports dietitian can determine the nutritional knowledge level of the athletes, provide nutrition education for the subjects that the athletes are lacking, and develop strategies for increasing nutritional knowledge. Thus, to set individual goals to increase the performance of the athlete; to give effective suggestions; it will be possible to help treatment plans in eating disorders (7).

Nutritional status and forms vary in complex social structures. Misinformation by all segments of society becomes accepted as correct in time. In this case, knowledge, attitude, and wrong beliefs are the main factors in behavioral change. Knowledge is not behavior, but it is an important factor since it is the main factor that determines healthy eating habits (8). They stated that conferences or educational activities that students voluntarily participate in nutrition increase their breakfast rates and improve their eating behavior (9).

Nutrition knowledge is an important factor in the nutritional habits of children, young people, and therefore the whole society. The negative effects of inadequate and unbalanced nutrition on health can only be eliminated with the right nutrition knowledge and the conversion of this knowledge into behavior. Therefore, it is known that the education to be given to the individual/society is also a dynamic process and it should be continuous to adapt to the differences due to the constantly changing conditions (10). Especially university years are the periods when individuals gain wrong eating habits and carry risks in terms of protecting and improving health. Young people leaving their families during the first years of university education begin to obtain unhealthy eating habits during the adaptation phase of this new environment (11,12).

To prevent negative behaviors such as unhealthy nutrition with the work to be done, and since the athletes learn the nutrition knowledge mostly from the school and their coaches, in the light of the nutrition information supported by scientific studies, it is widely believed that the training of athletes and trainers, seminars, course, panel, etc. Moreover, it would be beneficial to emphasize activities on the importance of nutrition in print and visual media (13,14). Considering these situations, the purpose of the study was to determine the nutritional knowledge score means of the students studying in the Faculty of Sports Sciences.

Materials and Methods

Participants

A total of 394 students, 229 males and 165 females studying at the Faculty of Sport Sciences at Niğde Ömer Halisdemir University voluntarily participated in the study.

Experimental Design

The scale, originally used in the study is "The Nutrition for Sport Knowledge Questionnaire" (NSKQ), which was developed in 2017 by Trakman et al. (16), Adrienne Forsyth, Russell Hoye and Regina Belski to evaluate the nutritional knowledge of adult athletes. The Sports Nutrition Knowledge Scale was found to be valid and reliable in Turkish by Çırak and Çakıroğlu in 2019 (17). The reliability level of the study was determined as (α = 0,908). As a result of its evaluation, Sports Nutrition Knowledge Scale consists of 68 items and weight control (3 items), macronutrients (22 items), micronutrients (12 items), sports nutrition (11 items), supplements (11 items), and alcohol (9 items) titled 6 sub-dimensions. The items of the scale are multiple choice and 3-point Likert type (I agree, disagree; I›m sure - I›m not sure; effective- ineffective).

Knowledge scores were calculated from the correct answers and the overall performance (68 items accepted as 100) in NSKQ should be evaluated using the scoring system; «Weak» knowledge (0-49%), «average» knowledge (50-65%), «good» knowledge (66-75%) and «excellent» knowledge (75-100%) were evaluated through the scoring system.

Statistical analysis

The obtained data were analyzed through SPSS 22 package program. Independent samples-t test was used to compare two groups, and the One-Way ANOVA test was used to determine the difference between departments. Tukey test from Post Hoct test was used to determine which group the difference originated from.

Results

It was determined that the number of people participating in the study was 394 and their mean and standard deviation of age was 21.24±2.10 years. While the knowledge score percentages of the students taking nutrition lessons were included in the 'good' information classification, the information score percentages of the students who did not take nutritional lessons were included in the 'weak' information classification.

Table 1. Distribution of nutritional scores by gender

Variables	Gender	N	Mean±S.D.	p
Total score	Male	229	30.23±11.26	.510
	Female	165	29.50±10.56	
Weight check	Male	229	1.68±1.42	.180
	Female	165	1.48±1.35	
Macronutrients	Male	229	11.13±4.61	**.009***
	Female	165	9.95±4.04	
Micronutrients	Male	229	6.09±2.99	**.031***
	Female	165	6.76±3.05	
Sports nutrition	Male	229	4.71±2.92	.844
	Female	165	4.65±2.59	
Supplement	Male	229	3.29±2.43	.818
	Female	165	3.35±2.56	
Alcohol	Male	229	4.40±3.45	.373
	Female	165	4.09±3.28	

*p < .05

When table 1 was analyzed, according to the gender variable, it was clear that there was a significant difference in the macronutrients and micronutrients of athletes' nutritional knowledge scale were in favor of females, and as for in macronutrients they were in favor of the male.

When Table 2 was examined, it was stated that there was a significant difference in 6 sub-dimensions and total score according to the nutritional course taking variable and the difference is in favor of the students taking nutritional courses.

According to the information given in Table 3, it was seen that the students studying in the teaching department have higher levels of nutrition than those studying at the coaching and management depart-

Table 2. Distribution of nutrition points according to taking nutrition courses

Variables	Taking Nutrition Courses	N	Mean±S.D.	p
Total score	Yes	198	37.11±8.22	**.000***
	No	196	22.67±8.29	
Weight check	Yes	198	1.98±1.46	**.000***
	No	196	1.21±1.21	
Macronutrients	Yes	198	12.75±3.62	**.000***
	No	196	8.50±4.10	
Micronutrients	Yes	198	7.79±2.58	**.000***
	No	196	4.93±2.77	
Sports nutrition	Yes	198	5.87±2.82	**.000***
	No	196	3.48±2.18	
Supplement	Yes	198	4.41±2.37	**.000***
	No	196	2.21±2.07	
Alcohol	Yes	198	5.68±3.47	**.000***
	No	196	2.86±2.62	

*p < .05

Table 3. Distribution of nutrition points According to departments

Departments	N	Mean±S.D.	F	P
Teaching (a)	120	32.72±11.34[a]	11.617	**.000***
Coaching (b)	171	27.01±10.18[b]		
Management (c)	103	31.52±10.70[a]		

*p < .05; ab: Different letters represent the differences between the group

ment. It was observed that the students of the management department have higher levels of nutrition than the students of the coaching department (p <0.05).

When Table 4 was examined, it was clear that there was a significant difference between the nutrition knowledge score mean of the departments according to the sub-dimensions variable. It was seen that the difference between the departments is more clearly revealed in post-hoc analysis.

Discussion and conclusion

This study aimed to determine the levels of nutrition knowledge of the students studying in the Faculty of Sports Sciences, the future coaches of today's athletes. In the study, the total knowledge score mean of the students who took a nutritional course was determined as 37.61, and the mean score of the students who did not take a nutritional course was 22.67. It was determined that the difference between the nutritional knowledge score mean of the students who took and did not take a nutritional course was in favor of the students taking a nutritional course. According to the nutritional course taking variable, a significant difference was detected in 6 sub-dimensions of the scale (weight control, macronutrients, micronutrients, sports nutrition, supplement, alcohol), and the difference was in favor of students who took nutrition courses.

Trakman et al., (15) found the nutritional knowledge mean score of athletes as 48.2%. Trakman et al., (16) found that the nutritional knowledge mean score of the athletes who took nutritional education was 64.65, while the nutritional knowledge mean score of the athletes who did not take nutritional education was 52. They found a significant difference in comparing the scores of athletes who took and those who did not take nutritional education and stated that the difference was in favor of athletes who took nutritional training. Yılmaz et al. (18) in their research, nutritional knowledge of university students who took nutrition courses was found to be 72.44 those who did not take nutrition courses were 78.23. They stated that there was a significant difference in favor of students who took nutrition courses.

In a study conducted on university students, Alması (19) found that the mean score of students who took a nutritional course was 67.00 ± 8.80 and those who did not take a nutritional course was 55.60 ± 13.00. He found a difference in nutritional knowledge and stated that the difference was in favor of students taking nutrition courses.

In a study on university students conducted by Vançelik et al. (20); they stated that the rate of students who have a good nutritional knowledge level among students taking a nutritional course is higher than that of students who did not take a nutritional course. It has been determined that the students who

Table 4. Distribution of nutrition scores according to sub-dimensions

Variables	Departments	N	Mean±S.D.	F	p
Micronutrients	Teaching	120	6.68±3.03^{ab}	4.195	**.016***
	Coaching	171	5.87±2.98^{b}		
	Management	103	6.83±3.03^{a}		
Sports nutrition	Teaching	120	5.67±3.03^{a}	13.364	**.000***
	Coaching	171	4.00±2.54^{b}		
	Management	103	4.66±2.56^{b}		
Supplement	Teaching	120	3.73±2.40^{a}	6.483	**.002***
	Coaching	171	2.81±2.51^{b}		
	Management	103	3.67±2.40^{a}		
Alcohol	Teaching	120	4.94±3.72^{a}	4.645	**.010***
	Coaching	171	3.73±3.10^{b}		
	Management	103	4.39±3.29^{ab}		

*p < .05; ab: Different letters represent the differences between the groups

take nutrition lessons have higher nutrition knowledge scores than those who did not take nutrition courses. Unfortunately, it is thought that athletes and coaches who have incomplete or incorrect knowledge related to sports nutrition will cause some adversities in terms of performance.

In the study conducted, the nutritional knowledge mean score of males was determined as 30.23±11.26 and the nutritional knowledge mean of females was 29.50±10.56, and no difference was found between the students. When the nutritional score distribution is analyzed according to the gender variable, a significant difference was found in the macro-nutrients in favor of males while in terms of in the micronutrients it was found to be in favor of females.

Yılmaz et al. (18) determined the nutritional knowledge mean of females as 75.36 and the nutritional knowledge mean of males as 76.53. When the mean of nutritional knowledge and nutritional attitudes were compared according to the gender variable, no significant difference was found between the groups although the mean of females was higher. In his study on university students, Ata (21) found that the nutritional knowledge means of females were 65.55 and the nutritional knowledge means of males were 60.95. When the mean scores of nutritional knowledge according to gender variable were compared, a significant difference was found and stated that the difference was in favor of female students. Coşkun (22) determined the nutritional knowledge score means of males as 69.8 ± 21.56 and the nutritional knowledge score mean 81.50 ± 18.76.

Koldaş (23) stated that there is no significant difference in the comparison of the nutrition knowledge level of males and females in their study on students studying in the School of Physical Education and Sports. Murathan et al., (24) stated that the nutritional knowledge score of females was 25.75 and that of the males was 26.12 in the study conducted on the nutritional knowledge levels of males and females, whereas the mean of the nutritional knowledge of males was higher than that of females, but there was no statistically significant difference. Labban (25) determined that the mean nutritional knowledge of females was 38.37 and the mean of nutritional knowledge score of males was 37.29.

Tütüncü et al. (26) compared the nutritional knowledge scores between male and female students in their study. As a result of the research, they stated that there was no statistically difference in the gender variable. El-Sabban et al. (27) stated in their study on Kuwaiti university students that nutritional knowledge score means were not different in terms of gender. In his study, Erten (28) determined the mean nutritional knowledge of females as 26.95±4.16 and males as 23.78±3.69. He determined that there was a significant difference in the mean of nutritional score according to gender, and stated that this difference was in favor of girls.

Barzegari et al., (29) and. Süel et al. (30) stated in their study that there was no difference in the mean score of nutritional knowledge according to gender. Vançelik et al., (20), in their study, the nutritional knowledge mean score of female students was 10.9 ± 2.1, and the nutritional knowledge mean score of male students was 9.5 ± 2.4. They stated that there was a difference between the nutritional knowledge score mean according to gender, and this difference was in favor of female students.

It is known that especially women always want to be thinner, have the idea of being liked as well as the idea of going on diet more. For this reason, it is known that the nutritional intake and calorie knowledge levels are higher than the males. They think that the higher mean score of female students› nutrition knowledge than males may be the result of women being more interested in this issue than men.

When the findings were evaluated according to the departments, it was found that the nutrition knowledge score of the teaching department was 32.72, the coaching department was 31.52, and the sports management department was 27.01.

In the study conducted on the students of School of Physical Education and Sports, Murathan et al., (24) determined that the teaching department took the first place in the nutrition knowledge level of the students, while the coaching section took the second place and the sports management section took the third place. Özdoğan et al. (31) found that students› nutritional knowledge levels were low in their study on the students studying in the sports sciences departments of universities.

In studies conducted on various departments, Ata (21) determined the nutritional knowledge score mean of the students of the Faculty of Education as 58.05 and the nutritional knowledge score mean of the students of the Faculty of Health Sciences as 71.65.

Şanlıer et al., (31) ensured that the nutritional knowledge mean scores of the basic nutrition education courses given to students studying in the health sciences were higher than those studying in other departments. In another study, it was found that although the female students were more knowledgeable, the nutritional knowledge of the youth was insufficient and therefore, the insufficient information could not turn into habits and behaviors (32). In another study conducted by Mazıcıoğlu et al. (33) on 3rd and 4th grade students at a university, it was found that 47.2% of the students took nutritional courses and 52.8% of them did not take any nutritional courses during their education. In addition, 31.6% of students reported that the nutritional education or courses they took had a positive effect on their eating habits.

It is known that only the knowledge of training and physiology is not sufficient for those studying at the department coaching. It is thought that every trainer should have a good nutritional level knowledge since it is important to adjust the nutritional status to maintain the performance and high performance of athletes. For this reason, it is our suggestion to increase the number of hours of nutrition courses of the students studying in the coaching department and to make the nutrition lessons compulsory.

As a result, the nutritional knowledge score percentages of students who took a nutritional course and did not take a nutritional course were found to be weak, while the nutritional knowledge score percentages of students taking a nutritional course were higher. It may be thought that nutrition courses are elective courses, students who select the courses are closely interested in the courses, and they are active in sports. It is thought that it will be beneficial for athletes and coaches to take nutrition education and to emphasize the importance of this issue in print and visual media.

Conflict of interest

The authors declare that there is no conflict of interest about this manuscript

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Original article

Comparison of Creatine Kinase Myocardial Band (CK-MB) and high sensitive Troponin I (hsTnI) values between athletes and sedentary people

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Summary. *Study Objectives:* This study was conducted to examine and compare CK-MB and hsTnI values between people who exercise regularly and actively and those who do not, considering that men have a higher muscle mass than women, but also the higher amount of estrogen secreted in women. *Methods:* The test group was composed of 18 men, 17 women, a total of 35 (23.28±4.09 years) persons who engaged in active sports with no problems in terms of blood measurement. The control group was formed from a total of 34 (24.50±5.60 years) persons, including 17 men and 17 women with a sedentary lifestyle that do not engage any sport. Statistical analyses were evaluated in the SPSS program and the Independent Samples t Test was used to determine the difference between the groups. *Results:* The CK-MB values of active athletes were found to be less than 5 U/L (1.95±1.04), which is the mean value, and higher values than the control group. hsTnI values have a significant difference between the test group and the control group and this difference was found to below the middle level. The mean CK-MB and hsTnI values of men participants were found to be statistically significant, with more than the mean value of women participants. The men test group CK-MB values were found to be higher than the control group and there was a significant difference ($p<0.05$). There was no statistically significant difference in hsTnI values between men's test and control groups. *Conclusion:* As a result of CK-MB and hsTnI measurements of the women test and control groups, it was observed that there was no significant difference between them. Herewith, it has been revealed that there are differences in CK-MB and hsTnI values among those who do active sports compared to those who do not, but also among women and men.

Keywords: CK-MB, hsTnI, Sports, Women, Men

Introduction

Troponins are tropomyosin-bound protein complexes found in all skeletal and cardiac muscle cells. Tropomyosin covers the actin-myosin binding sites on the actin filaments and prevents muscle contraction. During the flow of calcium into the muscle cell, calcium binds to the troponin complex. The actin-myosin binding of these binding sites initiates a conformational change, which ultimately leads to muscle contraction exposure. Troponin has three different subunits (troponin T, troponin I, and troponin C) and two of them exist in cardiac-specific forms; cardiac troponin T and cardiac troponin I. Detection of acute increased cardiac troponin concentrations in circulation is a sign of acute myocardial damage. However, it does not provide etiological information about the underlying condition or emission causing disease. According to this, although cardiac troponins are most commonly used to detect acute ischemic injury, various other primary cardiac (e.g. myocarditis, cardiac arrhythmias) and non-cardiac (e.g. sepsis, burns, exercise) conditions may be associated with acutely increased circulation concentrations (1).

Cardiac enzymes are enzymes present in myocardial cells. When the myocardial is damaged for whatever reason, these enzymes are released in the blood, and the level of enzyme increases (2). Creatine kinase myocardial band (CK-MB) is one of three isoforms of creatine kinase (CK) enzyme. CK is not specific for acute myocardial infarction (AMI) for the reason of, it is present in cerebral, myocardial, and skeletal tissues. In some cases, with mild myocardial infarction, CK elevation may not be detected, indicating a lack of satisfactory sensitivity. Therefore, the CK test was gradually abandoned and replaced by CK-MB. Because it's more specific in the heart muscle. CK-MB has been considered the gold marker of acute myocardial infarction for the past two decades. The plasma concentration of CK-MB increases 4-6 hours after the acute myocardial infarction and reaches its highest level within 24 hours. Generally, the CK-MB level returns to a normal range of 48-72 hours after the onset of acute myocardial infarction. As a biomarker, CK-MB is effective, rapid, and economical for the diagnosis of acute myocardial infarction. Therefore, it is widely applied globally in clinical applications. Some studies (3-6) have also proven that CK-MB can be used to estimate infarction size or even left ventricular ejection fraction (6,7). In addition, CK-MB can also be used as a marker for ischemia-reperfusion injury (IRI). Numerous clinical studies have accepted CK-MB as an adjunct examination to assess reperfusion injury after the restoration of the coronary circulation (6-9). In addition, CK-MB is thought to have prognostic significance for post-ischemic mortality and long-term death (6,10,11). However, Domanski et al. showed that troponin T is a better prognostic factor than CK-MB for long-term post-operative mortality after coronary artery bypass grafting (CABG) (6, 12). However, CK-MB has some disadvantages when used as a marker for acute myocardial infarction (AMI). Although the specificity of CK-MB is much better than CK, it is still not suitable. Because skeletal disorders can also cause CK-MB elevation. Because skeletal disorders can also cause CK-MB elevation. In addition, the sensitivity of CK-MB loses its reliability within 6 hours after acute myocardial infarction (AMI), which is not suitable as an early predictor. Some studies have also shown that CK-MB is a less suitable biomarker than cTnI for the diagnosis of small myocardial injury (6, 13, 14). Nevertheless, CK-MB is the most popular acute myocardial infarction (AMI) biomarker, although new biomarkers are continuously reported (6).

Despite the numerous benefits of sports on health, one of our daily needs for life is; more efforts are required to become one of the mandatory tasks such as nutrition and sleep much researches have been done on increasing interest and participation in sports for a healthy life, especially in order to be protected from cardiovascular diseases and to protect the body completely against many diseases. The cardiovascular system is one of the systems that benefit most from aerobic exercises such as running, swimming, cycling. Regular exercise, which is one of the important factors in preventing or slowing the atherosclerotic process that can develop in all arteries in the body, has an important place in preventing diseases such as heart attack and stroke with this feature. During sports, the heart muscle contracts stronger and faster in order to meet the increased oxygen demand in the muscles. Thus, sports can help strengthen the heart muscle in the long term (15). Despite the strong effects of physical activity and exercise on cardiovascular health, frequent physical activity is known to promote cardiorespiratory crispness. However, the processes and mechanisms that reduce the risk of cardiovascular disease remain unclear. Over the past few years, research has been carried out aimed at detecting the significant physiological and biochemical effects of exercise on the benefits of the cardiovascular system. As a result, significant progress has been made from observational and interventional studies in which the participants were people (16). Hematological and biochemical levels can play an important role in adapting exercise in humans, adaptation of cardiovascular activity, and organizing physiological responses such as physical, physiological balance. Depending on the type, severity, and duration of exercise, there may be changes in hematological and biochemical parameters. Variations in biochemical values during and after intense exercise may vary due to differences such as a person's training status, gender, age, environmental conditions, and nutrition (17). However, this study has been planned since the specific sudden deaths in athletes, the scope and duration of the exercise, and the risk of cardiovas-

cular disease remain uncertain. Thus, it was considered to examine and compare CK-MB, known as the gold standard in the biochemical diagnosis of myocardial damage (18), and high sensitivity troponin I (hsTnl), the most specific marker of increased myocyte damage as a result of myocardial ischemia (19), values between those who do regular and active sports and those who do not.

Method

Participants

The test group was composed of 18 men, 17 women, a total of 35 (23.28±4.09 years) persons who engaged in active sports with no problems in terms of blood measurement. The control group was formed from a total of 34 (24.50±5.60 years) persons, including 17 men and 17 women with a sedentary lifestyle that do not engage any sport. Participants who do not have any acute or chronic health problems and who do not consume alcohol and similar substances are included in the research. Subjects participating in the study were warned not to use drugs that could affect their performance such as steroids, anti-inflammatory drugs, and vitamin supplements during the 2 weeks before the test.

Biochemical Analysis

They were asked to avoid caffeine or heavy-handwork exercise for 24 hours before the test. Blood samples taken from both study groups were analyzed in the biochemistry laboratory and CK-MB and hsTnI values were examined. Peripheral venous blood (approximately 5 ml) was collected, stood for 15 min, and centrifuged for 5 min at 5000 rpm. The serum was separated, and then CK-MB, and hsTnI levels were detected using an immunoassay analyzer (Beckman Access II, United States) (20).

Data Statistic

Statistical analysis was evaluated in the SPSS 22.0 program. Descriptive statistics including arithmetic mean, standard deviations, frequency, and percentage values. Independent Samples t Test was used to determine the difference between the groups. According to the central limit theorem, t-test results can give healthy results even when normal distribution acceptance is not achieved. Since the sample size in each group is over 30, normal distribution acceptance was tested based on the central limit theorem.

Results

As can be seen from Table 1, 50.7% of the participants in the study consisted of the test group and 49.3% of them were the control group. When the sports branches were analyzed, it was seen that parallel to the non-sports control group consists of 34 people, do not have any branch 20 (basketball, football, volleyball, handball) and 15 people playing individual sports (sports, swimming, tennis, fighting).

According to the results shown in Table 2, the mean CK-MB values of the test group participants are 0.50 more than the mean CK-MB values of the control group participants ($p<0.05$). The calculated 95% confidence interval for this difference was found to be

Table 1. Demographic information of the participants

	Women		Men		Total	
	n	%	n	%	n	%
Group						
Test	18	51.4	17	48.6	35	50.7
Control	17	50.0	17	50.0	34	49.3
Sports Branch						
None-	17	50.0	17	50.0	34	49.3
Team Sports	11	55.0	9	45.0	20	29.0
Individual Sports	7	46.7	8	53.3	15	21.7

Table 2. CK-MB and hsTnI values of test and control groups

	Test (n=35)		Control (n=34)			
Group		**Sd**		**Sd**	**t**	**p**
CK-MB	1.95	1.04	1.45	0.49	2.535	0.014
hsTnI	1.95	1.61	1.33	0.78	2.062	0.045

Not: represents the group mean, sd standard deviation. According to the Levene test results, Welch's t test results for independent groups were reported, since variance equality was not accepted in both analyzes.

(0.102-0.889). Cohen's D = 0.608, which is the calculated effect size statistics regarding the mentioned difference, indicates that there is an effect above the middle. When the hsTnI values were examined, the mean difference between the test group and the control group is 0.62, and 95% confidence interval (0.015-1.238) for the difference. The effect size statistics regarding the difference is Cohen's D = 0.494 and it indicates that there is an effect below the middle level.

The CK-MB value of the men test group was investigated 2.69 ± 0.88 and the control group was investigated 1.76 ±0.46. The CK-MB value of the women test group was investigated 1.25 ±0.60 and the control group was investigated 1.14 ±0.30. The hsTnI value of the men test group was investigated 2.86 ± 1.88 and the control group was investigated 1.68 ±0.91. The hsTnI value of the women test group was investigated 1.10 ±0.49 and the control group was investigated 0.97 ±0.41. There was a statistically significant difference between men and women in terms of CK-MB and hsTnI values ($p<0.001$).

Discussion

CK-MB is an enzyme with high sensitivity and specificity. While CK-MB activity is normally lower than 5 U / L, activities such as resistance exercise, long-term running, and marathon in healthy people doubt the accuracy of the practice of CK-MB in the diagnosis of acute myocardial infarction. CK-MB activity is similar in percentage among marathons and patients with acute myocardial infarction. In addition, there are differences in the removal of this enzyme. Enzyme removal is slower in athletes (20). In this study, it was revealed that the active athletes had a CK-MB value in the normal reference range of less than 5 U / L (1.95 ± 1.04) and higher than the control group (Table 2).

Many researchers have noted that exercise increases plasma CK and CK-MB activities, which are the most commonly used marker of skeletal muscle damage caused by exercise (22). A study to examine the effects of acute exercise on CK, CK-MB level in sedentary men individuals, thus determining the level of muscle damage caused by exercise, showed a greater increase in CK-MB levels during acute exercise and the result of exercise may cause more heart muscle damage (23). The type, duration, and intensity of muscle-related activity depend on the effect of exercises on CK and CK-MB. It is stated that the status of CK-MB and serum CK does not show a clear difference in athletes and varies according to the severity of the exercise and age (24). Kayhan stated that in the study of the effect of different strength training on creatine kinase enzyme activity and blood parameters, there was a difference between pre- and posttest in terms of CK-MB values (25). In another study, it was aimed to evaluate the cardiac effects of athletes exercise with biochemical parameters and there was a statistically significant increase in serum BNP, IMA, Copeptin, and CK-MB values after exercise in wrestling and football branch athletes compared to pre-exercise and control groups. Besides that, there was no statistically significant difference in cTnI values (26). With this study, we have done on athletes interested in different sports branches, the CK-MB values of the active sports test group were higher than those who did not and it supports the literature (Table 2). To evaluate the cause of CK-MB differences in terms of gender, it is also seen in Table 3 that CK-MB values in men (Control Group 1.76±0.46, Test Group 2.69 ±0.88) is higher than women. The main reason for this is the fact that men have larger heart muscle mass (27-30).

When CK-MB differences were examined as exercise and non-exercise, it was revealed that the CK-MB value of the test group (1.95 ±1.04) was higher

Table 3. Comparison of CK-MB and hsTnI values between test and control groups by gender

		Group				
		Test		Control		
	Gender	X	Sd	X	Sd	p
CK-MB	Men	2.69	0.88	1.76	0.46	0.000
	Women	1.25	0.60	1.14	0.30	
hsTnI	Men	2.86	1.88	1.68	0.91	0.000
	Women	1.10	0.49	0.97	0.41	

than the control group (1.45 ±0.49) (Table 2). The most important reason that there is an increase in cardiac output during exercise as well as the combination of different mechanisms (27, 30-32). To evaluate both of the different gender and exercise conditions, it was determined that exercise increases serum CK level in both men and women, but the serum CK level is lower in women than men. This is because the less secreted estrogen hormone transfers less enzyme from the muscle to the serum. After all, it reduces membrane permeability after exercise (23, 33).

In this study, it should be noted that hsTnI values cannot be compared with clear expressions such as CK-MB values. Because almost all of the studies, reported for hsTnI in the literature, were made for cardiovascular events, acute myocardial infarction (AMI), acute chest pain, etc. (34-39). In other words, the majority of the studies are about the subject of sick individuals. However, since the individuals in this study, both the control group and the test group, are people who do not have any acute or chronic health problems, they are considered to be healthy. Therefore, this study is considered to be very important in terms of both originality and scientific value. On the other hand, in the literature research, there are a few important studies that are related to exercise size. However, this study differs especially with gender discrimination (40-42).

To evaluate the reason of hsTnI differences in this study in terms of gender, it is seen in Table 3 that hsTnI value is higher in men (Control group: 1.68 ±0.91, Test group: 2.86 ±1.88) than women (Control group: 0.97 ±0.41, Test group: 1.10±0.49). To examine the reason for hsTnI differences as those who exercise and do not, it can be seen in Table 2 that the hsTnI value of the test group (1.95 ±1.61) is higher than the control group (1.33 ±0.78). To evaluate both different gender and exercise conditions, it has been determined that exercise increases the hsTnI level in both men and women, but the hsTnI level is lower in women than men.

The reasons for all these differences about CK-MB and hsTnI, if not clearly stated that women tend to have heart function that gradually disappears after entering menopause, gender differences in myocardial recovery after arrhythmogenic activity and infarction, the women sex hormone estrogen has a cardio-protective mechanism responsible for gender-specific differences in normal heart function and disease outcome (30), men myocytes were exposed to a higher degree of hypertrophy than women (28), the women heart is smaller than the men heart, but beats more per minute (27), maybe possible to rank like. However, although its clinical significance is not fully understood, high troponin I concentrations are common after exercise (41), physical activity may be more important in less active individuals in protecting against subclinical cardiac ischemia or myocardial stress and injury (43), these facts are also seen in other studies. Although the knowledge that exercise increases the hsTnI value and the hsTnI value is higher in men, many prospective studies are needed on the subject, as Parsons et al. (43).

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Conflict of Interest

Deniz Çakaroğlu and Mustafa Oğuzhan Kaya declare that they have no conflict of interest.

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Original article

Monitoring change of urine specific gravity levels of the wrestlers in an official wrestling tournament

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Abstract. *Study Objectives:* Wrestling is a weight sport with a weight classification and wrestlers is performed weight loss frequently before the wrestling competitions and they exposed dehydration. In this context, the aim of this study was to monitor the change in the urine specific gravity (U_{SG}) of wrestlers in an official wrestling tournament. Thirty-six wrestlers competing in an official wrestling tournament were included in the study. *Methods:* Bioelectric impedance analyzer and refractometer were used to determine the change of body weights and the U_{SG} levels of the wrestlers between the weigh-in and the competition times. Shapiro-Wilk test was used for the normality test of the obtained data. Wilcoxon Signed-Rank test was used to analyze non-normally distributed data. *Results:* According to the results of this study, it was determined that there was no difference in the body weights of the wrestlers between the weigh-in and the competition times, whereas there was a difference in the U_{SG} levels. Accordingly, although U_{SG} levels decreased, it could not be reduced to the reference range between the weigh-in and the competition times. *Conclusion:* These results indicate that the lose body weight before the competition is regained between the weigh-in and the competition times, whereas dehydration in the U_{SG} levels continues in the wrestlers.

Keywords: Combat Sports, Dehydration, United World Wrestling, Urine Specific Gravity, Weight Loss

Introduction

Wrestling is one of the most ancient sports (1) and today, it has millions of spectators worldwide (2). In today's wrestling, opponents are paired by size (bodyweight) and power. Nevertheless, it is probable and expectable that opponents at the same weight class might differ in relative power (3). Of course, lean body weight is important for aerobic performance as the total weight for anaerobic performance (4). In wrestling, athletes compete after they are classified according to their body weights (5). For this reason, to gain an advantage over weaker and smaller competitors, many wrestlers lose weight before the competition. In wrestling, although the adverse effects of weight loss on health status are well documented, weight loss practices (e.g. food and fluid restriction) are widely used by the wrestlers (6).

United World Wrestling (UWW) often makes minor changes to the wrestling competition rules to increase the popularity of wrestling, to make more understandable for the spectators, and to protect the athletes' health. For example, even though the duration between the weigh-in (one day before competitions, at 06:00 pm) and the competition (one day after the weigh-in, at 12:00 am) times of the official national and international competitions was ~18 hours according to old wrestling competition rules and therefore, wrestlers were frequently performing weight loss practices before the competitions (7). A study on a similar sport, judo, showed that more time between weigh-in and competition does not mean less dehydration. Although there were 15 hours between the weigh-in and competition it was seen that 81% of the athletes were still dehydrated (8). For this reason, the UWW has decided to carry out the competition weigh-in

(two hours before competitions) on the morning of the competition according to the new wrestling competition rules to prevent weight loss in wrestlers (9). Because the hydration level is one of the most important physiological variables for athletic performance especially in combat sports. However, wrestlers are still known to carry out weight loss practices.

Many studies have reported that wrestlers who lose weight using various methods such as sauna, food and fluid restriction, repetitive intensive exercises, nylon, or rubber dressing were exposed to dehydration (6,10,11). Moreover, there are many methods in determining dehydration in athletes such as urine specific gravity (U_{SG}), urine color (U_{Col}), urine osmolality (U_{Osm}), and plasma osmolality (P_{Osm}), and it was reported to have positive relationships between these methods and have a cut-off point for each dehydration measurement method (12-14). Testing and measurements are two important components of the performance assessment, some details during the procedures that may seem underestimated may however directly affect the test results (15). For example, dehydration cut-off points are ≤700 (mmol/kg) for U_{Osm}, ≤290 (mOsm/L) for P_{Osm}, ≤4 (U) for U_{Col}, and ≤1020 (g/cm³) for U_{SG} (16). If a measured hydration marker has a value above the cut-off point, hypohydration and/or dehydration occurs and this dehydration can cause athletes to lose athletic performance.

U_{SG} is a measure of the ratio between the density of urine and the density of water. Urinary concentration is determined by the number of particles (electrolytes, phosphate, urea, uric acid, proteins, glucose, and radiographic contrast media) per unit of urine volume (13). The National Collegiate Athletic Association recommends U_{SG} as the most practical and optimal method for determining the hydration status of athletes (17,18). It is important to determine the change in the hydration status of the wrestlers using U_{SG} between the weigh-in and the competition times according to the new wrestling competition rules. Thus, we have tested the new weigh-in rule in the wrestling competition. In this context, the aim of this study was to monitor the change in the wrestlers' U_{SG} levels dehydration-induced in an official wrestling tournament.

Material and Method

Participants

At the beginning of the study, all participants were informed of the research procedures, purposes of the investigation, and taken their written consent prior to participation. Thirty-six volunteer elite male wrestlers (age: 21.67±1.82) participated in the research. Wrestlers who did not have an acute or chronic disease and did not use diuretics while performing weight loss for the competition were included in the study. The study was conducted in accordance with the guidelines of the revised Helsinki Declaration.

Experimental Design

All measurements (Body weight and U_{SG}) were performed in an official competition in the 2019 Interuniversity Wrestling Turkey Championships. The first measurements for the weigh-in time were between 8:30-9:00 am in the morning of competition and the second measurement for the competition time was between 10:30-11:00 am. The wrestlers followed their routines (food and fluid consumption etc.) within 2 hours and no encouragement was provided for consuming fluid between the two measurements.

Measurement Body Weight

Body weights of the wrestlers were measured two times (before the weigh-in and the competition times) with wrestling singlet using Bioelectric Impedance Analyzer (TANITA BC 418, USA). From the total body weights of the wrestlers, 250 g tare was subtracted for the wrestling singlet.

Measurement of U_{SG}

The urine samples were taken two times (before the weigh-in and the competition times) from each wrestler immediately before each body weight measurement. In agreement with the American College of Sports Medicine´s hydration testing guidelines, (19) each participant was instructed to provide a small urine sample collected mid-flow from the first void in the measurement times. The samples were placed in plastic cups and the U_{SG} levels of the wrestlers were determined with a digital refractometer (ATAGO PAL-10S, Tokyo, Japan; measurement range USG 1.000–1.060 with a resolution of 0.001). Refractometry is an indirect estimation of USG by measuring the ratio of the velocity of the light

in urine (20). The digital refractometer was calibrated before the analysis of each urine sample. As soon as the urine samples were analyzed for U_{SG}, they were immediately disposed. The cut-off point of U_{SG} for assessment of the hydration status was determined as ≤1020 (g/cm³).

Statistical Analysis

The normality test of the obtained data was tested with the Shapiro-Wilks test. Descriptive statistics were given with mean and standard deviation. Wilcoxon Signed-Rank test was used for comparisons of the measurement times in the analysis of non-normally distributed data. Significance was set at $p < 0.05$.

Results

Body weights of the wrestlers for weigh-in and competition times were found 78.73±14.98 and 78.98±14.77, and U_{SG} were 1.026±.007 and 1.021±.009, respectively. This result shows that the U_{SG} levels of the wrestlers were above the reference range in both the weigh-in and competition times (Table 1).

It was determined that there was no difference between the body weights of the wrestlers between the weigh-in and the competition times, whereas there was a difference in the U_{SG} levels. However, although U_{SG} decreased, it could not be reduced to the reference range between the weigh-in and the competition times (Table 2; Fig. 1).

Discussion and Conclusion

The death of six college wrestlers in six weeks in the United States of America drew the attention of the world. As a result of the autopsy, it was found that the wrestlers died of weight loss performed in a short time and they performed 15% of dehydration of total body weight (21). After these deaths, many methods have been designed by the researchers to detect hydration levels in the human body such as a change in percentage of body weight (22), bioelectric impedance (23), skinfold thickness (24), and hematological (25) and urine parameters (26). Especially, U_{SG} is one of the

Table 1. Descriptive statistics of wrestlers' body weights and U_{SG} levels

Variables	Measurement Times	Mean±S.D.	Reference Range
Body Weight (kg)	Weigh-in	78.73±14.98	-
	Competition	78.98±14.77	
U_{SG} (g/cm³)	Weigh-in	1.026±.007	≤1.020
	Competition	1.021±.009	

Table 2. Comparison of wrestlers' body weights and U_{SG} levels

Variables	Measurement Times	Median	z	P
Body Weight (kg)	Weigh-in	78.20	-.480	.631
	Competition	77.50		
U_{SG} Levels (g/cm³)	Weigh-in	1.025	-3.214	.001
	Competition	1.024		

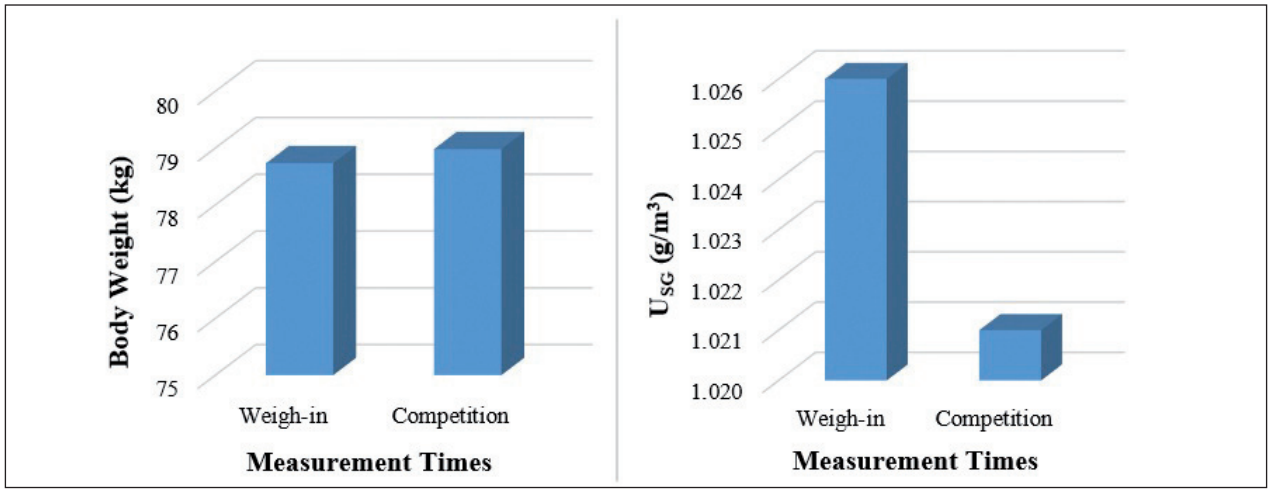

Figure 1. Changing of wrestlers' body weight and U_{SG} levels

most common and safe hydration measurement methods easily used in non-clinical situations.

Previous studies on the hydration status of the wrestlers have been including the results of a period of ~18 hours between the weigh-in and competition times (7,11). In the present study, the duration between weigh-in and competition times was 2 hours. For this reason, this study is the first study of determining the hydration status of the wrestlers according to the new weigh-in rule in wrestling.

Many studies on combat sports have emphasized that the duration between weigh-in and competition times is not sufficient for rehydration after dehydration. For example, Gürses et al. (2018) reported that the judo athletes regain their lost body weights between the weigh-in and the competition times (~13 hours) despite, the increase in U_{SG} could not be reduced (26). Moreover, Pettersson and Berg (2014) compared the rehydration status after dehydration for combat athletes weighed the one-day before and on the same day of competition for the official competitions, and reported that hypohydration status from both athlete groups continued (27). In sum, they reported that neither weigh-in close to competition nor evening weigh-in with more time for rehydration seems to prevent hypohydration before the competition. Also, they reported that the amount of body weight loss was lower in the branches held on the same day of competition and weigh-in. According to the results of the present study, it was determined that there was no difference between the body weights of the wrestlers between the weigh-in and the competition times, whereas there was a difference in the U_{SG}. These results show that the wrestlers regain their body weight between the weigh-in and the competition times. Moreover, although there was a decrease in U_{SG} levels, it was determined that U_{SG} levels had a value above the reference range before the competition and showed that dehydration continued in the wrestlers.

A small decrement in hydration status can impair cognitive, physical, physiologic function, and athletic performance (28-30). For this reason, weight loss practices must be prevented to perform high-level athletic performance of the wrestlers for a longer period. However, many previous studies show that the wrestlers have a higher amount of body weight loss due to the UWW's old weigh-in rule (31-33). Because the wrestlers thought the duration between weigh-in and competition times was sufficient for rehydration after dehydration. UWW's new weigh-in rule caused wrestlers to reduce their amount of body weight loss. Because in this study, body weight loss in wrestlers was almost non-existent but still we found above the reference range of the wrestlers' U_{SG} levels.

As a result of the present study, the wrestlers regained their lost body weight in duration between the weigh-in and competition times. In addition, although the wrestlers' U_{SG} levels decreased, it remained above the reference range. This result shows that wrestlers were still dehydrated. Moreover, when comparing the body weights of wrestlers in weigh-in and competition times, UWW's new weigh-in rule was minimized the amount of weight loss in wrestlers. However, supplementation of appropriate fluid in weight loss training may prevent hypohydration. Thus, athletes can be in euhydration status and achieve maximum performance.

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Original article

The effect of use of protein supplements on muscle damage

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Abstract. *Study objectives:* The purpose of this study was to examine the effect of ingested protein supplementation on muscle damage and delayed onset muscle soreness followed acute maximal weightlifting exercise. *Method:* Twenty-four males were included in this study who between the ages of 19-25 and were performing the physical activity for an average of 60 minutes 2 days a week. The volunteers were randomly divided into two groups as the experimental group that takes a protein supplement and control group that doesn't take a protein supplements. Blood samples were taken from all volunteers before exercise. Followed warming, 3 sets 10 repetitions weightlifting exercise were performed at 80% 90 and 100 of pre-determined maximal weights. The diets of athletes were determined by an expert dietitian as 1 g/kg per day of all participants by dividing into three meals. In addition, the experimental group was taken protein supplement also 35 grams of whey protein (total: 1.5g/kg per day) after the lunch by dissolving in 500 ml water. The blood samples of both groups were taken at the before, immediately after, 24th, 48th, and 72nd hours after exercise at the same time of the day and the VAS scores were recorded. *Results:* There was no significant difference between experimental and control groups before and immediately after exercise in terms of CK and Mb values when the group effect is considered ($p>0.05$). When, the VAS score were examined independent from the group effect, it was observed that the values of control group were higher than the experimental group in the 2nd, 3rd, and 4th comparisons ($p<0.05$). *Conclusion:* Consequently, although 1.5 g/kg protein supplementation did not significantly decrease the CK and Mb values after weightlifting exercise, it was observed that DOMS was decreased significantly.

Keywords: Weightlifting, Whey Protein, Myoglobin, Creatine kinase

Introduction

Nowadays beneficial effects of exercise and sports are known by everyone. This situation causes an increase in the number of people who perform exercise and sports. However, certain problems may occur in beginners. Most of the people experience a kind of pain or trouble due to performing an unusual activity. In the scientific literature, the symptoms of pain and loss of strength in the following hours and days of new exercises are usually attributed to the physical damage or tear of muscle structure and for this reason, they are called "muscle damage that starts with exercise" (1). As is known, unusual eccentric exercise induces muscle damage that is represented by the long-term loss of muscle function, delayed onset muscle soreness (DOMS), and increase in muscle proteins such as creatine kinase (Ck) and myoglobin (Mb) (2).

A proper and balanced diet is as important as training for athletes. However, active individuals use supplements in order to form muscle, gain strength, prevent future diseases, and increase performance in sports (3). The effect of most of the supplements was not scientifically proven. The main purpose of taking dietary supplements is to fill the gap in lack of nutrition, however, there are other reasons to consume supplements such as improving certain functions. For instance, a high-protein diet is required for burned vic-

tims and athletes who want to maximize their skills and potentials (4).

A healthy diet is regarded as an inseparable component of physical fitness. In addition to health reasons, people believe that a special diet based on the high intake of a certain nutrient such as protein increases their sports performance (5). It can be observed that the reason people incline towards the consumption of protein supplements is the belief of increased effects, increased competitive performance, or decreased risk of injury or disease (6).

The consumption of protein supplements among the people who perform physical exercise increased significantly (7). Protein supplements are taken for increasing the muscle mass and supporting the post-exercise regeneration. The purpose of this study was to examine the effect of ingested protein supplementation on muscle damage and DOMS followed acute maximal weight lifting exercise.

Material and Method

Participants

24 males were included in this study who were studying at the School of Physical Education and Sports, between the ages of 19-25 and were performing the physical activity for an average of 60 minutes 2 days a week. The voluntary participants underwent a medical examination at the Faculty of Medicine, Sports Medicine Outpatient Clinic for the fitness to the exercise. Volunteers who were inconvenient for heavy exercise were excluded from the study. Individuals who were using prescribed medication, smoking, drinking alcohol, and using other hazardous substances, and had chronic diseases were also excluded. Written consents were taken from athletes by giving information about the exercise procedure.

Experimental Design

The volunteers were divided randomly into two groups as the experimental group that takes protein supplement (15 individuals) and the control group that does not take protein supplements (9 individuals). By determining the weights that volunteers can lift in the following exercise equipment, 80%, 90%, and 100% of these weights were recorded (bench press, butterfly, butterfly reverse, shoulder press, triceps pushdown, biceps curl, sit-up, reverse sit-up, squat, leg press, leg extension, leg flexion, adductor, calf press). Then, the athletes did not perform any exercise and sports for one week. After a week, 5 ml of blood samples were taken from the antecubital vein of all participants at 09:00 am and the VAS scores were recorded. 10 minutes after taking blood samples, athletes performed warm-up and stretching exercises for 15 minutes on a treadmill. Then, the above-mentioned exercises were performed with 80%, 90%, and 100% of the maximal with 3x10 repetitions in each one. Stretching exercises were performed again after the exercises and blood samples were taken again after giving a break for 60 minutes. The blood samples were kept at -80 °C. The diets of athletes were determined by an expert dietitian as 1 g/kg per day of the participants by dividing into three meals. The experimental group was taken protein supplement also used 35 grams of whey protein after the lunch by dissolving in 500 ml water (Optimum Nutrition Gold Standard Whet Protein). The control group did not take protein supplements did not receive any supplement apart from the 1g/kg/day protein diet.

Collecting Blood Samples

The blood samples of both groups were taken at the before, immediately after, 24th, 48th, and 72nd hours after exercise at the same time of the day and the VAS scores were recorded as in Table 1. The volunteers did not eat anything apart from their diet and did not perform any exercise within this period. The blood

Table 1. The recording of blood samples and VAS scores

The times of bloodletting and VAS measurement	CK	Mb	VAS
Blood samples and VAS score at before exercise	CK0	Mb0	VAS0
Blood samples and VAS score at immediately after exercise	CK1	Mb1	VAS1
Blood samples and VAS score at the 24th hours after exercise	CK2	Mb2	VAS2
Blood samples and VAS score at the 48th hours after exercise	CK3	Mb3	VAS3
Blood samples and VAS score at the 72nd hours after exercise	CK4	Mb4	VAS4

samples were analyzed in the Biochemistry laboratory of Erciyes University. Mb was analyzed by 4 ELISA method and CK was analyzed by 4 enzymatic spectrophotometric method in Roche Cobas analyzers.

Statistical Analysis

The data were evaluated by using IBM SPSS 22 statistics package. The suitability of the data for normal distribution was evaluated by the histogram, Q-Q graphs, and Shapiro-Wilk test. Variance homogeneity was tested with the Levene test. For determination of the difference between groups and measurement times, Two-way repeated measures ANOVA was used Mauchly test for Sphericity was used to control whether the Sphericity hypothesis was provided or not. In the cases that Sphericity hypothesis was not provided, one of the Greenhouse-Geisser, Huynh-Feild, or Lower-Bound fixes was used. The significance level was taken as $p<0.05$.

Results

There was no significant difference between the control and experimental groups after the exercise in terms of CK and Mb values when the group effect is considered ($p>0.05$), (Tables 2, 3). In addition, there was a significant difference in the comparison of in-group variables when the CK and Mb variables both control and experimental groups ($p<0.05$), (Tables 2, 3).

When the VAS scores were examined, independent from the group effect, it was observed that the values of the experimental group were higher than the control group in the 2nd, 3rd, and 4th comparisons. There was a statistical difference in favor of the experimental group ($p<0.05$; Table 4). Moreover, there was a significant difference in the comparison of in-group variables when the VAS scores both the control and experimental groups ($p<0.05$), (Table-4).

Discussion

When the literature is examined, it can be observed that there aren't many studies about the effect of

Table 2. The change of Creatine Kinase (CK) values according to time and group

	The group that takes protein supplement	The group that does not take a protein supplement	p
CK0	160.62±102.86^{a}	138.80 ± 37.58^{a}	**0.464**
CK1	293.00±172.54^{b}	252.20 ± 96.71^{b}	**0.472**
CK2	489.37±245.48^{c}	1826.80 ± 292.20^{bc}	**0.099**
CK3	1358.62±152.27^{abc}	5372.73 ± 960.74^{ba}	**0.134**
CK4	4880.00±516.45^{d}	9728.93 ± 1516.82^{d}	**0.394**
***p**	**0.041**	**0.031**	

Ck: creatine kinase, 0: 1 hour before the exercise, 1: 1 hour after the exercise, 2: 24 hours after the exercise, 3: 48 hours after the exercise, 4: 72 hours after the exercise.
p<0.05; p<0.01; ***p<0.001*
There isn't a difference between the measurements with the same letters in the same column.

Table 3. The change of Myoglobin (Mb) values according to time and group

	The group that takes protein supplement	The group that does not take a protein supplement	p
Mb0	54.25±19.04^{a}	32.80 ± 12.38^{a}	**0.412**
Mb1	69.87±37.11^{ab}	188.20 ± 27.50^{b}	**0.122**
Mb2	168.87±12.14^{bcd}	101.06 ± 32.79^{c}	**0.188**
Mb3	342.25±32.29^{abcd}	719.26 ± 107.80^{de}	**0.226**
Mb4	631.25±62.18^{cd}	960.86 ± 120.42^{de}	**0.397**
***p**	**0.044**	**0.010**	

Mb: myoglobin, 0: 1 hour before the exercise, 1: 1 hour after the exercise, 2: 24 hours after the exercise, 3: 48 hours after the exercise, 4: 72 hours after the exercise.
p<0.05; p<0.01; ***p<0.001*
There isn't a difference between the measurements with the same letters in the same column.

Table 4: The change of VAS values according to time and group

	The group that takes protein supplement	The group that does not take a protein supplement	p
VAS0	0.00±0.00^{a}	0.00±0.00^{a}	-
VAS2	6.46±2.53^{bcd}	3.11±2.14^{b}	**0.003**
VAS3	8.00±1.88^{bc}	4.77±3.19^{c}	**0.018**
VAS4	5.46±2.03^{d}	3.44±2.96^{db}	**0.059**
***p**	**0.001*****	**0.001**	

VAS: visual analog scale score, 0: 1 hour before the exercise, 1: 1 hour after the exercise, 2: 24 hours after the exercise, 3: 48 hours after the exercise, 4: 72 hours after the exercise.
There isn't a difference between the measurements with the same letters in the same column.

protein supplements on muscle damage. Thus, the obtained results from the present study gain more importance. It is known that muscle damage emerges after an unusual or heavy exercise (9). It was demonstrated in several studies that muscle damage occurs within 24-48 hours after the eccentric exercise, peaks at 72 hours, and recovers within 5-7 days (10-12).

Muscle damage emerges as a result of myofibrillar damage depending on eccentric exercise and causes intracellular edema (10). The most important parameter of muscle damage is the measurement of CK and Mb values (13). These values reach a maximum within 24-48 hours and then start to decrease (14).

In the present study, muscle damage was formed in volunteers by performing concentric and eccentric weight exercises. Similar to the studies in the literature, CK and Mb values increased within 24-48 hours and peaked at 72 hours. Chen et al. (2019) stated that the CK which is the marker of muscle damage increased after the eccentric exercise that was performed by the athletes in their study (15). An increase was observed in CK and Mb values after the exercise in similar studies (16, 17).

In the present study, when the question of whether protein supplements decrease the muscle damage is examined, it can be observed that CK and Mb values were lower in the group that took protein supplement. This result can be interpreted as; the muscle damage in the group that took protein supplement was lower. However, the fact that the difference between the groups was not statistically significant weakens our hypothesis. It was observed that in the conducted studies, 2 g/kg protein was given to participants after acute exercises in order to decrease muscle damage (18).

However, participants in our study received 1.5 g/kg protein. 70% of this was provided with natural nutrients and the rest was provided with protein powder. The control group, on the other hand, received 1g/kg protein with natural nutrients. It is considered that the reason why there wasn't a statistically significant difference between the groups is that the amount of given protein powder was inadequate. The amount of protein powder was kept low intentionally by considering the health of athletes. In the study of Coochburn et al. (2010) reported that milk protein-derived supplements were effective in decreasing the CK increase. It is asserted that this inhibition and protein procurement is based on the increase of muscle-protein balance by increasing the synthesis and classifying the increases in degradation (19).

One of the most important parameters of muscle damage is DOMS and it is measured with the VAS (20). It is widely accepted that DOMS emerges when an individual is exposed to high successive eccentric muscle contractions or unusual exercises (21). DOMS usually continues to increase after the exercise and peaks within 24-48 hours after the exercise (22).

DOMS was also monitored in our study. In parallel to the data in the literature, after reaching the maximal value within 24-48 hours, DOMS started to decrease after 72 hours. Parallel to the CK and Mb values, VAS scores were lower in the group that took protein supplement. This indicates that muscle pain was lower in the group that took protein supplements. Furthermore, VAS scores were statistically lower in the group that took protein supplements than the control group at 24^{th} and 48^{th} hours.

Conclusion

Consequently, although taking 1.5 g/kg protein did not significantly decrease the CK and Mb values which are muscle damage parameters, a numerical decrease was observed in the group that took protein supplement. When the results about the DOMS are examined, it can be observed that DOMS was decreased significantly.

Limitations of the study

The low number of volunteers participating in the study weakens the strength of the study. Additionally, it is considered that giving 2 g/kg protein to the volunteers would affect the results more specifically. Another issue is that muscle damage parameters can be said that the increased more by performing the isolated eccentric exercise.

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Original article

Associations between Life-Time Physical Activity Levels, Sedentary Time and Health Outcomes among Older Adults

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Abstract. *Study Objectives:* The aim of the study was to evaluate the associations between the participation levels of the elderly in physical activities through their lives, their sedentary time, and health outcomes. *Methods:* The data of the study were collected in 2017 with a questionnaire, in which 300 older adults were selected by convenience sampling method in Ankara, Turkey. The questionnaire consists of questions for determining the socio-demographic characteristics and health status of older adults, life-time physical activity indicators, and sedentary time. The research was evaluated with descriptive statistics, Chi-square analysis, Independent Samples t-test, and Pearson correlation coefficient. *Results:* 53.7% of the 300 older adults participating in the study were female and the average age was 67.74 ± 3.67 years. 58.3% of the participants were categorized as physically "active" currently or in two periods of their lives. The average sedentary time of participants was 5.7 hours for one day. According to Chi-square analysis, those who were younger, those with lower household income, those who evaluated their health status as good and who had no chronic diseases were physically more active ($p < 0.05$). Independent samples t-test results demonstrated that the quality of life scores of those who were physically active was higher in comparison to those who were inactive ($p < 0.05$). According to independent samples t-test, the average sedentary time of those who evaluated their health status as good and those with a chronic disease was found to be shorter. It was found that there was a negative moderately significant relationship between sedentary time and quality of life scores among older adults. *Conclusion:* In this study, it was concluded that life-time physical activity levels and sedentary time of older adults were an important indicator for their health outcomes.

Key words: Physical Activity, Sedentary Behavior, Older Adults, Life Time

Introduction

Physical activity is defined as any bodily movement which is produced by skeletal muscles and requires energy consumption (1). It is reported by the World Health Organization that every year approximately 3.2 million individuals lose their lives due to physically inactivity (2). Researches suggest that improvement in the physical activity level could prevent functional restrictions increasing with advanced age and thus, more active and independent aging could be ensured (3). Increased physical activity in the older population is associated with decreased frequency of chronic diseases (4,5), decrease in cognitive impairment (6), improved physical health (7,8,9), improved mental health (6), decrease in mortality rates (7,9) and higher quality of life (10-13).

Although the symptoms of chronic diseases usually appear in older ages, the development of the diseases may have started in childhood period (14).

The cumulative energy consumption of an individual with physical activity throughout his/her life is thought to play a key role in determining the risk of the development of some chronic diseases in advanced ages (5,7). This view corroborates the importance of adopting and maintaining a physically active lifestyle at early ages (15). However, studies demonstrate that physical activity is reduced during adolescence, adulthood, and transition to old age (14-16). Although there are studies investigating the relationship between the physical activities in different periods of life and health outcomes in advanced ages in the international literature (6,8,9,11,16,17,18), studies in Turkey examining and aimed at increasing the physical activity levels of the elderly are in initial stages. A better understanding of the relationship between the physical activity levels in certain periods of life and health outcomes in the advanced ages will help determine the critical periods for interventions in terms of physical activity.

Although the benefits of physical activity for health are widely accepted, the sedentary lifestyle tends to be an increasingly common behavior and lifestyle in all age groups, particularly among the elderly (19). Sedentary behavior is defined as any type of activity that leads to an energy consumption equal to and below 1.5 MET (Metabolic Equivalent) level while the individual is awake, either in lying or sitting position (20-21), and 7 hours or more per day spent in this way is usually accepted to be extreme (22). In the systematic analyses conducted by Harvey et al. (2015) and Wullems et al. (2016), it was reported that the elderly spent approximately 8 hours per day by sitting, that this period constituted 65-80% of their awake time, and that this situation made them the most sedentary population group (23,24). Thus, when it is considered that especially reducing the sedentary time will play an active role in making the elderly more active, it is particularly important to examine the relationship between the sedentary time and health outcomes and how they are correlated.

On a global scale, the older population makes up the fastest-growing age group. The percentage of the elderly above 65 years old is expected to increase to 22% of the world population and reach 2 billion by 2056 (25). When the increase in the percentage of the elderly population is considered in relation to increased chronic diseases, the importance of physical activity as a habit for protecting health comes to the fore. Particularly, the most important deficiency in the lifestyle habits of the Turkish elderly is lack of physical activity (11,26). The study aimed to evaluate the associations between the participation levels of the elderly in physical activities through their lives, their sedentary time, and health outcomes. The study is expected to serve as a multidisciplinary guide for health research at micro and macro levels and health and sports professionals who aim to improve the physical activity levels of the elderly.

Material and method

The study was planned as cross-sectional field research which aimed to assess the relationships between the participation levels of the elderly in physical activities through their lives, their sedentary time, and health outcomes.

This study was approved by the Baskent University Institutional Review Board and Ethics Committee (Project no: KA17/115) and supported by the Baskent University Research Fund.

Study sample

The population of the study was composed of a total of 87.067 individuals between the ages of 65-80 who resided in the Cankaya district of Ankara province, based on the 2017 data of the Turkish Statistics Institute. The sample group of the study was determined as 300 individuals with a 95% confidence level and 5% deviation. 300 individuals included in the study were chosen through a convenience sampling method, which is one of the improbable sampling methods. The inclusion criteria were determined as being between the ages of 65-80, residing in Cankaya district, living at home, having no physical and mental disability, and participating in the study on a voluntary basis.

Data collection

A questionnaire consisting of 3 sections was administered to the participants. In the first part of the

questionnaire, there were 7 questions related to demographic information and socio-economic status, while the second part included 15 questions aimed at determining general health status. The sedentary behavior of the participants was measured through the 16th question (How much time do you usually spend sitting or reclining on a typical day?) included in the Global Physical Activity Questionnaire which was developed by WHO and whose validity and reliability studies were performed. The quality of life of the participants was measured through the first question (How do you evaluate your general health condition?) of the Short Form-36, the Turkish validity and reliability studies of which were conducted, and Visual Analog Scale (between the scores of 0 and 100) was employed. The third part of the questionnaire included the "Lifelong Physical Activity Assessment Form" developed by the researchers on the basis of the literature review. In this part, the elderly evaluated their status of having performed any or some of the 22 physical activities during certain periods of their lives (youth, adulthood, late adulthood and old age) and how long and how many days a week and how many hours a day they practiced these, if any. According to the physical activity recommendations for different age groups offered by the World Health Organization (1), if the participants fulfilled the required physical activity recommendations for each age group, they were categorized as "active", and if not, they were classified as "inactive." Regarding the lifelong physical activity level, those who were categorized as "active" in at least two periods of their lives were accepted as "active", and the others were labeled as "inactive."

Statistical analysis

The data were analyzed using the PASW 18.0 package program (SPSS Inc., Chicago, 2009). While the dependent variables of the study were determined to be the presence of chronic disease, general health assessment and quality of life score, the independent variables were accepted as demographic characteristics, socio-economic status, health status indicators, sedentary time, and lifelong physical activity assessment. Kolmogorov-Smirnov test was employed to test whether the data were normally distributed. The data were analyzed through descriptive statistics, Chi-square analysis, Independent Samples t-test, and Pearson correlation coefficient. Significance level was set at $p < 0.05$ for the evaluations.

Results

The mean age of the participants was 67.74 ± 3.67 years, and 76.3% were in the 65-74 age group. 53.7% of the participants were female, 56.3% were married, 54.3% had an educational level of high school and above, 37.3% were blue-collar workers, and 80% had an income level of lower than 5.331 Turkish Liras (Turkish poverty line as of 2017) (Table 1).

As seen in Table 2, 25% of the participants had normal Body Mass Indices (BMI). 35% of the elderly reported that they smoked, 74.7% stated that they had a chronic disease, 61% evaluated their health status as poor or moderate.

Table 1. The distribution of older adults by socio-demographic characteristics

Demographic characteristics	Frequency (n)	Percentage (%)
Age Group		
65-74 years	229	76,3
75-79 years	71	23,7
Gender		
Female	161	53,7
Male	139	46,3
Marital status		
Single	131	43,7
Married	169	56,3
Education		
Under high school	137	45,7
High school and above	163	54,3
Occupation		
House worker	107	35,7
White-collar	81	27
Blue-collar	112	37,3
Household income		
< 5.331 TL	240	80,0
≥ 5.331 TL	60	20,0

Table 2. The distribution of older adults by their health indicators

Health Indicators	Frequency (n)	Percentage (%)
BMI		
Normal	75	25,0
High	144	48,0
Obese	81	27,0
Chronic disease		
No	76	25,3
Yes	224	74,7
Self-rated health		
Poor	183	61,0
Good	117	39,0
Smoking		
Yes	105	35,0
No	195	65,0
Falling		
Yes	133	44,3
No	167	55,7
Fear of falling		
Yes	199	66,3
No	101	33,7

Table 3. The distribution of older adults by their physical activity indicators

Physical activity indicators	Frequency (n)	Percentage (%)
Youth period (< 21 years)		
Inactive	81	27,0
Active	219	73,0
Early adulthood period (21-34 years)		
Inactive	130	43,3
Active	170	56,7
Adulthood period (35-50 years)		
Inactive	212	70,7
Active	88	29,3
Late adulthood period (51-64 years)		
Inactive	240	80,0
Active	60	20,0
Old age period (> 65 years)		
Inactive	258	86,0
Active	42	14,0
Lifelong time		
Never	4	1,3
One period	121	40,3
Two periods	104	34,7
Three periods	41	13,7
Four periods	23	7,7
All life	7	2,3
Lifetime Physical Activity Levels		
Inactive	125	41,7
Active	175	58,3
Daily Step Number (Mean ± SD)	5.165 ± 1.783 step	
Daily Sedentary time (Mean ± SD)	5,70 ± 2,50 hours	
Daily Sleeping time (Mean ± SD)	7,51 ± 1,28 hours	

Table 3 summarizes the participants' status of doing lifelong physical activity. As can be seen in the table, 73% of the participants were active in their young ages, while this percentage fell down to 56.7% in early adulthood, to 29.3% in adulthood with a sharp decrease, 20% in late adulthood, and 14% in old ages. While those who were "active" throughout their lives constituted only 2.3% of the participants, 40.3% were physically "active" in a period of their lives. 58.3% of the participants were categorized as physically "active" currently or in two periods of their lives. The average sedentary time of the elderly was calculated as 5.7 hours.

Table 4 shows the factors related to the physical activity levels of the participants. According to Chi-square analysis, the participants in the 65-74 age group were physically more active compared to the ones over the age of 75 ($p < 0.05$). The number of physically active individuals was higher in the group of participants with lower household income. When the dependent variables of the study were analyzed, it was determined that the share of those who were physically active was higher among those who evaluated their health status as good and who had no chronic diseases ($p < 0.05$). Independent pairs sample t-test results demonstrated that the quality of life scores of those who were physically active were higher in comparison to those who were inactive. As expected, the average sedentary time of those who were physically active was shorter ($p < 0.05$).

Table 4. The factors relating to the physical activity levels of older adults

	Inactive		Active		
	n	**%**	**n**	**%**	**p**
Age (year)					
65-74 years	87	%38	142	%62	0,015*
75-79 years	38	%53,5	33	%46,5	
Household income					
< 5.331 TL	94	%37,9	154	%62,1	0,003*
≥ 5.331 TL	31	%59,6	21	%40,4	
Self rated health					
Poor	78	%42,9	104	%57,1	0,045*
Good	47	%39,8	71	%60,2	
Chronic disease					
No	24	%31,6	52	%68,4	0,026*
Yes	101	%45,1	123	%54,9	
Quality of Life (Mean ± SD)	57,68 ± 16,27		61,60 ± 18,00		0,048*
Sedentary Time (Mean ± SD)	6,06 ± 2,66		5,44 ± 2,36		0,037*

**p < 0.05*

Table 5. The factors relating to the sedentary behavior of older adults

Sedantary behavior	**Sedentary Time**	**p**
Self-rated health		
Poor	5,96 ± 2,64	0,027*
Good	5,30 ± 2,23	
Chronic disease		
No	4,88 ± 2,21	0,001*
Yes	5,98 ± 2,54	
Quality of Life (r)	-0,651	0,002*

**p < 0.05*

As can be inferred fromTable 5, the average sedentary time of those who evaluated their health status as good according to independent samples t-test was statistically significantly shorter ($p < 0.05$). Besides, the average sedentary time of those with a chronic disease was found to be shorter ($p < 0.05$). Pearson correlation coefficient calculated in order to determine the relationship between sedentary time and quality of life indicated a negative and moderately significant relationship between these two factors ($r = -0,651$; $p < 0.05$); as the sedentary time shortens, quality of life score increases.

Discussion

In order to determine the relationships between lifelong physical activity level, sedentary time and health outcomes in the elderly, the physical activity and health indicators of 300 old individuals between the ages of 65-80 residing in Ankara who were chosen with convenience sampling method were analyzed in the study.

Three significant results related to health outcomes of active and inactive individuals in their old ages were contained in the study. First of all, while there were more individuals who stated that they were physically active in the earlier periods of their lives among the participants, the percentage of those who were currently physically active (14%) or who were physically active throughout their lives (7%) was quite low. Although no study was found in the national literature examining the regular physical activities of the elderly from the life course perspective, studies in the international literature have proven that extended physical activity brings more gains (6-10,14,18), that those who perform regular physical activity have a higher quality of life in old ages (11-13) and that they had shorter averages of hospital stay (19).

The second result obtained from the study is that the health outcomes of physically active old individuals are much better. National (11,26,29) and international (5,7,12,17,19,30) researches show that being physically active creates positive effects on health outcomes.

Finally, the results of the study revealed the importance of shortening the sedentary time in the elderly; sedentary time is negatively correlated with all health outcomes. Though no study evaluating the sedentary time was found among the studies conducted on the elderly in Turkey was come across, many studies in the world have proven the significance of the interventions made in terms of shortening the sedentary time (18,20,22,23,27,28,30).

The results of the study should be evaluated with its certain limitations. Firstly, the cross-sectional design of the study aimed to reveal only the relationships rather than casual relationships. Longitudinal studies are needed in order to assess the effect of extended physical activity on health outcomes. Secondly, since the sample of the study was selected through convenience sampling method, it would be misleading to generalize the results. Thirdly, the results of the study were based on the retrospective data obtained about previous periods of the participants' lives. Therefore, the fact that the old individuals may not accurately remember how many hours a week they did physical activity 40 years ago can affect the reliability of the data of the study. On the other hand, the results of a study conducted by Havari and Mazzonna (2015) revealed that the explanations made by the elderly about their childhood period could also be reliable (4). In the study, in order to make the questionnaire form shorter, quality of life was assessed through VAS. For future research, it could be more useful to employ a more comprehensive health-related quality of life scales such as WHOQOL-AGE or WHOQOL-OLD. In the study, only leisure time and in-house physical activity levels of the participants were measured. Their physical activity levels in terms of their occupation can be considered in future researches.

Conclusion

The results of the study showed that very few of the elderly participating in the study had lifelong physical activity habits, but that even extended physical activity positively affected health outcomes. There is no doubt that gaining physical activity habits in younger ages and maintaining those habits through life course perspective will result in better health indicators in older ages. There exist needs for both health specialists and sports experts to seriously intervene in terms of guiding the society in this issue through a multidisciplinary approach. On the other hand, the result that the old individuals who were active for a long time had the shorter sedentary time and that as sedentary time was shortened, the health outcomes improved brings along another area of intervention. Developing plans and programs by health and sports specialists aimed at shortening the sedentary time in the elderly could provide benefits for public health.

Conflict of interest: The authors declare that there is no conflict of interest in this manuscript.

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Original article

Cerebral laterality and body composition in judo athletes

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Abstract. *Study Objectives:* In this study, it was aimed to determine cerebral lateralization and functional asymmetry of the brain not only by adhering to hand preference, but also with the relation of the foot, eye, ear preferences, and somatotype. *Methods:* The sample was composed of 120 athletes (79 males and 41 females) who had participated in the Turkish Judo Championship. Their mean age and training experiences were 21.05 years (range 18–26) and 9.61 years (range 3-18) respectively. Hand preference was assessed using the Edinburgh Handedness Inventory. Some questions were asked to the subjects in the questionnaires in order to evaluate the range of preferences about a foot, eye, and ear. The hand grip strength measurements were made via the Jamar hydraulic hand dynamometer. Total body fat percentage was estimated by single-frequency, 8 electrodes bioelectric impedance analyzer system (BC-418, Tanita Corp, Tokyo, Japan). The components of somatotype were calculated according to the Heath-Carter technique. Data were collected, to SPSS program and Independent Samples T-test and Chi-Square test was used for the analysis of the obtained data. Analysis results were evaluated in the %95 confidence interval. *Results:* When the distribution of hand preference of the subjects (n = 120) was considered, 87.5% (n = 105) of the subjects preferred the right hand and 12.5% (n = 15) of the subjects preferred the left hand. Somatotype features of judo athletes were determined as the generally mesomorph. *Conclusion:* The results show that there was a difference between the dominant hand and the preferred foot, eye, and ear, and it is predicted that it can be reliable in all four preferences in determining the cerebral hemispheres. Despite that, according to the dominant hand preferences in judokas, there were no difference between BMI, body fat percentages, and somatotype features.

Key words: Cerebral laterality, Body composition, Hand preference, Somatotype, Grip Strength

Introduction

Judo is a sport with high-intensity actions and judo athletes' (judoka) performance may be determined by several physical abilities, in which muscle strength in upper and lower limbs is of major importance (1). Upper limb strength is an important aspect considered in judo performance, mainly during grip combat (Kumi-kata) to attack, defend, and maintain balance (2). During the fight, judokas spend a considerable amount of time grasping the Judogi of the adversary (using the Kumi-kata). The Kumi-kata is the first contact between two athletes in the fight and provides the basic support for the execution of other techniques. Therefore, the ability of maintain the grip force for long periods of time might be an important aspect of this technique (3).

During judo combat, strength and muscle power have been related to performance and judo throw efficiency (1). Considering the importance of bilaterally in judo, these strength factors should be equally exhibited by both sides of the body (4). Therefore, athletes with bilateral dominance and a high level of muscular strength and skills ought to have a tactical advantage over their opponents and increase their chances of success (5). The hand is a complex anatomical system comprising 27 bones and 15 joints with approximately 308 of rotational and translational freedom designed

to grasp and apply force to objects of all shapes and sizes and to perform a combination of intricate finely controlled movements (6).

In hand-to-hand combat sports, such as wrestling, judo, jiu-jitsu, and mixed martial arts, maximum handgrip strength (HGS) is important when pushing, pulling, throwing, and controlling your opponent. Possessing a high level of HGS endurance is also believed to be important, if, and when the match/fight progresses into the later rounds (7-9). Therefore, it is recommended to include measures of maximum HGS and HGS endurance in the physical assessment battery of hand-to-hand combat sports (10).

The lateralization of brain and behavior in both humans and non-human animals is a topic that has fascinated neuroscientists since its initial discovery in the mid of the nineteenth century (11,12). The concept of handedness is a specific term, and typically refers to the hand preferentially used for a simple or complex motoric activity (13,14). Roughly 90% of people have a preference for using the right hand for complex manual tasks (15,16). A minority of roughly 10% prefer to use the left hand, and a smaller group of roughly 1% has no clear preference, the so-called 'ambidextrous' people (17).

Cerebral lateralization is defined as the morphological and functional differences between two brain hemispheres (18). Cerebral laterality is defined as anatomical and functional differentiation between the right and left hemispheres of the brain. Examination of hand, foot, eye, and ear preferences is important for the evaluation of this anatomical and functional differentiation (19,20). Control of mixed and successive movements and the control of left hemisphere and holistic-spatial functions, right hemisphere are lateralized for humans (21). Left brain hemisphere audits the right part of the body, right brain hemisphere, the left part of the body (22). Brain hemispheres provide left-right symmetry of the body (23). Although the left and right human cerebral hemispheres differ both functionally and anatomically, little is known about the environmental or genetic factors that govern central nervous system asymmetry. Nevertheless, cerebral asymmetry is strongly correlated with handedness, and handedness does have a significant genetic component (24). Handedness is the most obvious manifestation of hemispheric asymmetries (25).

Laterality in sports is typically determined by validated and verified tests or self-reported use of hand, foot, eye, ear preference and/or surveys, such as the Edinburgh Handedness Inventory. (26), for manual dexterity and bimanual coordination, etc. Research on the regional anatomy of the human cerebellum has revealed topographically defined functional distinctions and asymmetries (27). Traditionally considered a component of the motor system (28), emerging evidence links functions of individual cerebellar lobules to higher-order cognitive functions (29), such as language (30,31), visuospatial attention (32), working memory (33,34) and performance monitoring (35).

Unfortunately, in the current literature, there is little research on comparing variables between hand dominance in judo athletes. Besides body laterality, another relationship of interest is the one between muscle strength and body composition (5). In this regard, a positive correlation has been reported between these two variables (36), e.g. muscle strength increases according to the heavier category.

Successful competition in sports has been associated with specific anthropometric characteristics, body composition, and somatotype (37,38). Understanding and quantifying human body composition has formed a central part of medical research for the best part of a century (39). Because body composition is an important health and performance variable. The measurement of body composition occurs in many areas of biology and medicine when the outcome is a better understanding of nutrition and growth status assessment in disease states and their treatment in populations (40). Body mass index (BMI) is the cornerstone of the current classification system for obesity and its advantages are widely exploited across disciplines ranging from international surveillance to individual patient assessment. However, like all anthropometric measurements, it is only a surrogate measure of body fatness (41).

A better understanding of the integrative role of the central nervous system in energy homeostasis becomes increasingly important as the prevalence of obesity and obesity-related diseases are rising worldwide (42,43). From experimental studies in animals, it has long been established that certain brain areas are critical for the regulation of caloric intake, notably the prefrontal cortex, the limbic and paralimbic regions,

the hypothalamus, and the brain stem. To unravel the neuroanatomical correlates of eating behavior in humans, two different neuroimaging techniques are increasingly explored (44).

As obesity is a complicated issue, differences in brain function is likely to be important (45). The anatomical asymmetries of the human brain have been documented for over a century and are still widely investigated for their functional, physiological, and behavioral implications (46). However, similarly, in the case of hand dominance, there are no reports investigating this relationship with other strength parameters such as explosive force and muscular endurance in the upper and lower extremities (47).

In this context, the aim of this study was to determine whether there was a difference between the hand grip strength, body fat percentage, and somatotypes and dominant hand preferences of male and female judokas and to determine whether there was a difference between the dominant hand preferences and foot, eye and ear preferences determined.

Material and method

Participants

The sample was composed of 120 athletes (79 males and 41 females) who had participated in the Turkish Judo Championship. Their mean age and training experiences were 21.05 years (range 18–26) and 9.61 years (range 3-18) respectively. All athletes were instructed to maintain a normal diet prior to the day of the test. The participants were informed about the purposes and methods of the study before signing a consent form. The participants were informed that they would be free to withdraw from the study at any time.

Hand, foot, eye and ear preferences measurements

Hand preference was assessed using the Edinburgh Handedness Inventory, and the Geschwind Scores (20) were calculated. The participants were asked 10 questions regarding their hand preferences for writing, drawing, throwing, using various implements like scissors, toothbrush, a knife without fork, spoon, striking matches, and jar opening. They were asked to put "+" in the column associated with the hand they used to carry out the activity. They were asked to put "++" in the associated column if their preference for one hand was very strong, and to put a "+" in both columns if they were using both hands equally. A "++" in the right column was assigned 10 points, a "+" in the right column 5 points, whereas a "++" in the left column –10 points and a "+" in the left column –5 points. The sum of these points was used to determine the Geschwind Score (GS), as an indicator of the direction and degree of hand preference. Hand preference was evaluated in 5 groups depending on the value of GS, consistent right-handers: $+80 < GS < +100$, weak right-handers: $+20 < GS < +75$, ambidexterity: $-15 < GS < +15$, weak left-handers: $-75 < GS < -20$, and strong left-handers: $-100 < GS < -80$ (20.47).

Foot preference was assessed by three items (kicking a ball, picking up a pebble, stepping onto a chair), eye preference was assessed by three items (looking through a keyhole, looking into a bottle, and looking through a telescope), and ear preference was also assessed by three items (listening at a door, listening to a heartbeat, and using an earphone). Items were scored on a three-point scale of left, mixed, and right, scored as -1, 0 and +1 (48).

Hand grip strength measurements

The hand grip strength measurements were made via the Jamar hydraulic hand dynamometer (Sammons Preston, USA). The dominant side was given priority. The measurement was made when a subject was in a sitting position while the forearm was in a 90 – degree flex (without support from the body). During the measurements, the wrist was regarded to be in a neutral position. The measurement was made in three successive replications and the mean value was used as data. Values were recorded in kilograms (49).

Anthropometric assessment and body composition measurements

Body height was measured using a digital stadiometer (SECA 213, Hamburg, Germany) and body

weight were measured using a digital scale (SECA 813, Hamburg, Germany).

The three components of somatotype - endomorphy, mesomorphy, and ectomorphy were calculated according to the Heath-Carter technique (37). The measurements were taken during the peak of the competition season, just before the national competition. An anthropometric method was used for obtaining the judokas' somatotype. Anthropometry included 10 following variables: body height (in cm), body weight (in kg), four skinfolds (over triceps, subscapular, suprailiac, medial-calf; in mm), biceps girth (flexed 90° and tensed; in cm), standing calf girth (in cm), bicondylar humerus and femur breadth (in cm).

Total body fat percentage (BF %) was estimated by using a commercially available single-frequency, 8 electrodes bioelectric impedance analyzer system (BC-418, Tanita Corp, Tokyo, Japan). The reliability and validity of this system in measuring BF% has been previously verified in multiple ethnicities (50,51). All measurements were taken during morning hours (08:30–12:00) and the subjects didn't have any vigorous activity during the preceding 12 hours of the measurement.

Statistical analysis

Data were analyzed with the SPSS for Windows 21.0 packet program. Descriptive statistics were given as "mean ± standard deviation". Independent Samples t-test and Chi-Square test was used for the analysis of the obtained data. If the expected values in chi-square analysis were above 5%, Pearson Chi-Square values were used for p value and Fisher's Exact Test values were used if less than 5%. Analysis results were evaluated in the 95% confidence interval and the significance level was set at $p < .05$.

Results

With varying ages of subjects between 18 and 26 in the study, the athlete's mean ages, heights, and weights were identified as 21.05 ± 1.99, 171.13 ± 9.07, and 76.59 ± 19.46, respectively. Of the 120 judo athletes, 82 were identified to be at national athletes and 38 were licensed. The subjects were determined to play sports for 2.10 ± 0.51 hours in a day, 4.16 ± 2.08 days in a week, and 9.63 ± 3.55 years in their lifetime.

When the distribution of hand preference of the subjects (n = 120) was considered 87.5% (n = 105) of the subjects preferred the right hand, 12.5% (n = 15) of subjects preferred the left hand (Table 1).

When the distribution of foot preference of the judo athletes was analyzed, 79.2% were observed to prefer the right foot and 20.8% the left foot. Similarly, when the distribution of the eye preference of the subjects was analyzed, 80.8% were observed to prefer the right eye and 19.2% left eye. However, when the distribution of ear preference of the subjects was analyzed, 83.3% were observed to prefer the right ear and 16.7% the left ear (Table 2).

Table 2. Distribution of the dominant foot, eye and, ear preferences of the subjects.

Variables		n	%
Foot Preference	Right Foot	95	79.2
	Left Foot	25	20.8
Eye Preference	Right Eye	97	80.8
	Left Eye	23	19.2
Ear Preference	Right Ear	100	83.3
	Left Ear	20	16.7

Table 1. Distribution of the hand preference groups based on the results of the lateralization survey.

Variables		Lateralization Survey Scoring	Score	Distribution of hand preference	n	%	Total n	Total %
Hand Preference	Right-handed	Between +80 and+100	85	Strong right-handed	73	69.5	**105**	**87.5**
		Between +20 and +75	60	Weak right-handed	32	30.5		
	Left-handed	Between -20 and -75	-70	Weak left-handed	9	60	**15**	**12.5**
		Between -80 and -100	-90	Strong left-handed	6	40		

According to the dominant hand preferences of male and female judokas, there were no difference between hand grip strength, BMI, body fat percentages, and somatotypes (Table 3).

When the preferred foot, eye, and ear and somatotypes of judokas were compared according to the dominant hand preferences, it was found that there was a difference between the foot, eye, and ear preferences, but there was no difference in their somatotypes. These results showed that right-hand dominant judokas generally prefer right foot, eyes, and ears. Despite that, while left hand dominant judokas generally preferred left foot and left eye but 53.3% of left hand dominant judokas preferred their right ears (Table 4).

Table 3. Comparison of the dominant hand preference results of male and female athletes.

Variable		Male (n = 79)					Female (n = 41)				
		Right-handed (n = 71, 89.9%)		Left-handed (n = 8, 10.1%)			Right-handed (n = 34, 82.9%)		Left-handed (n = 7, 17.1%)		
		$\bar{X}$	sd	$\bar{X}$	sd	p	$\bar{X}$	sd	$\bar{X}$	sd	p
Height (cm)		174.7	7.9	176.3	10	.612	164.7	5.5	160	7.5	.057
Weight (kg)		82.6	20.3	82.8	13.1	.981	66	13	59.7	11.3	.243
Grip Strength	*Right hand*	52.7	9.2	50.7	4.8	.548	32.4	5.3	31	3.1	.533
	Left hand	52.1	7.9	52.4	7.3	.929	31.6	5	31.3	4.6	.893
BMI		23.8	1.9	24	1.6	.716	22.8	2.8	22.7	2.1	.910
Fat mass (%)		13.2	7	12.9	7.6	.901	18.8	7.4	18.6	7.8	.958
Fat free mass (%)		70.5	11.6	71.9	11.7	.754	52.9	6.6	47.9	4.6	.069
Somatotype	*Endomorph*	3.2	1.2	2.7	1	.186	3.8	.7	4.1	.6	.202
	Mesomorph	5.5	.2	5.6	.3	.665	5.3	.3	5.1	.2	.478
	Ectomorph	1.6	1.5	1.1	.9	.212	1.8	1.1	1.9	1.3	.312

$p < 0.05$

Table 4. Comparison of the preferred foot, eye, ear, and somatotypes of judokas according to dominant hand preferences

Variable		Right-handed (n = 105, 87.5%)		Left-handed (n = 15, 12.5%)		X^2	p
		n	%	n	%		
Foot Preference	Right foot	95	90.5	-	-	65.143	.001*
	Left foot	10	9.5	15	100		
Eye Preference	Right eye	97	92.4	-	-	72.298	.001*
	Left eye	8	7.6	15	100		
Ear Preference	Right ear	92	87.6	8	53.3	11.109	.004*
	Left ear	13	12.4	7	46.7		
Somatotype	Endomorph	4	3.8	1	6.7	3.969	.137
	Mesomorph	98	93.3	12	80.0		
	Ectomorph	3	2.9	2	13.3		

* $p < 0.05$

Discussion and conclusion

Cerebral lateralization is a concept that includes all organically significant factors and mechanisms involved in the acquisition of a number of specific neurological functions of the cerebral hemisphere. Lateralization means that a hemisphere is predominantly responsible for particular procedure. Many behavioral asymmetries have emerged as a result of hemispheric asymmetry. The most obvious of these is hand preference. In order for the relationship between hand preference and hemisphere functions to become more evident, hand dominance must first be defined (22). In this study, it was aimed to determine cerebral lateralization and functional asymmetry of the brain not only by adhering to hand preference, but also with the relation of the foot, eye, ear preferences and hand grip strength and it was investigated the differences between body composition and somatotype with the dominant preferences.

According to the Edinburgh Handedness Inventory determining the hand preferences of elite judo athletes; 105 judokas (87.5%) were identified as right-handed, 15 judokas (12.5%) were left-handed were found.

The incidence of left-handedness in the general population is about 13% during the teenage years and declines gradually with age, reaching about 6% in the seventh and eighth decades of life (52,53). About 90 percent of people are right-handed, says Corballis. The remaining 10 percent are either left-handed or some degree of ambidextrous, though people with "true" ambidexterity i.e., no dominant hand at all only make up about 1 percent of the population (54). In a study conducted by Tarman, (2007), the relationship between hand dominance and cerebral lateralization in musicians was investigated. Three-hundred and thirteen music graduate students from four different universities participated in the study. The Oldfield survey was used to determine the hand dominance and 88% of the musicians were identified as right-handed, 5% ambidexter, and 7% left-handed. In conclusion, the vast majority of the subjects who participated in the study were right-handed and their left hemisphere was dominant (55). Also, recent noninvasive imaging studies demonstrate that approximately 95% of normal right-handed subjects have left-hemispheric dominance for language (56). In a research performed on the student-athletes of the Yaşar Doğu Physical Education and Sports School of the Ondokuz Mayıs University, 39.27% of the students were reported to be strong right-handed, 52.81% weak right-handed, 2.97% ambidexter, 3.30% weak left-handed and 1.65% strong left-handed (57). Among the athletes of national weightlifting, gymnastics, taekwondo and wrestler sports participated in their researches, Gümüş and Akalın, (2016) determined the ratio of right-handedness, strong right-handedness, left-handedness, and strong left-handedness as 84.1%, 42.9%, 12.7%, and 3.2%, respectively (58).

Many authors have focused on the over-representation of left-handers in certain sports such as tennis, fencing, judo, wrestling, and boxing compared to the general population (59,60). Wood and Aggleton (1989) reported that left-handers (or left-footers) appear to be more common in what are called fast ball sports (19.5%, n = 322). Left-handers' (or left-footers') overrepresentation also prevails in non-interactive sports like golf (61) and in interactive or confrontational sports (62). The existence of a higher percentage of left-handers in certain sports has been generally attributed to a greater chance of success (6,63). World- and Olympic-level male judokas usually had lower than 10% body fat (64). Although the studies in the literature are similar to the present study, the percentage of athletes who use left hands in the present study group has found high. Judo sport is thought to be due to the need to use raid in both hands due to the game features.

While one of the hemispheres to be more dominant than the other is considered as the anatomic lateralization, the hand preference is considered as the functional cerebral lateralization. Similar to the hand use preference, the eye, ear, and foot dominances are also used to determine cerebral lateralization (65). When the foot preference distributions of judo athletes participating in this study were examined; 79.2% were observed to prefer the right foot and 20.8 the left foot. Similarly, when the distribution of the eye preference of the subjects was analyzed, 80.8% were observed to prefer the right eye, 19.2% left eye, and 83.3% were observed to prefer the right ear and 16.7% the left ear.

Tran and Voracek (2016) utilizing latent class analysis and structural equation modeling, they investigated in a series of studies (total n > 15300) associations of handedness and footedness with self-reported sporting performance and motor abilities in the general population. The present series of studies obtained replicable evidence of footedness being a more relevant predictor of sporting performance and motor abilities than handedness. Specifically mixed- and left-footedness showed positive effects in various interactive and non-interactive sports, suggesting better bodily coordination and speed, but also strategic advantages that are consistent with frequency-dependent effects (66). However, about 10% of the population prefer to use their left hand and about 30% prefer to use their left eye in such situations (67). In a study conducted the degree of genetic and environmental influence on hand and other lateral preferences were estimated from the covariance between hand, foot, and ear preferences (68).

Handedness is further divided into measures of preference and performance. Hand preference identifies the preferred hand for completing a task, whereas performance differentiates between the abilities of the left and right hand on a particular task (69). A relationship is commonly observed between these two constructs, such that performance abilities (i.e., skill) increases with the preferred hand (70). In recent studies related to hemispheric asymmetry, determination of the performance of individual's hand, foot, and eye was aimed in order to be able to form a study basis on cerebral lateralization by Barut et. al. based on this study's results, performances of hand, foot, and eye preferences were determined to play an important role in the evaluation of brain lateralization (71). In order to determine the functional asymmetry of the brain, a lot of research has been done in which the hand preference and the dominant eye are examined together, the relationship between the hand preference and the dominant eye has not been fully clarified. According to the results of the current study, parallel results were achieved in the choice of foot, eye, and ear with the dominant hand preference. These results show that the dominant hand is generally similar to the laterally preferred foot, eye, and ear and it is predicted that it can be reliable in all 4 preferences in determining the cerebral hemispheres.

It appears that tasks requiring precision aiming result in larger performance differences between the hands than less complex tasks (72). Corey et al. (2001), the results of their studies show that hand preference is a multi-dimensional feature; therefore, many components of hand preference and performance should be considered during the evaluation (73). Usually, the evaluation of the handgrip strength (HGS) is utilized in the clinic and occupational practice, performing an important role in the determination of the clinical effects of surgeries, in the control of the rehabilitation process (74), providing practical information regarding the muscles, nerves, articular (75) and cardiac diseases (76), being also utilized in the study of the ergonomics of hand held tools (77), in admission tests of various types of work (78) and in the sports field (79,80).

In this study, dominant hand grip strength of male judokas was found 52.7 ± 9.2 for right-handed, 52.1 ± 97.9 for left-handed, these values for non-dominant hands were 50.7 ± 4.8, 52.4 ± 7.3, respectively and female dominant hand 32 ± 36.1 for right-handed and 32.4 ± 5.3 for left-handed, these values for non-dominant hands were 31 ± 3.1 and 31.3 ± 4.6 respectively. The differences in HGS between elite and sub-elite female combat sports athletes were more pronounced than those in their male counterparts. A pooled analysis revealed very large HGS differences between elite and sub-elite junior female wrestlers and judokas (9,81). The accentuated HGS differences between elite and sub-elite combat sports athletes within the female population may be in part attributed to the differences in age, overall strength, and training experience (81). Similar to our study, there is a similar difference between male and female athletes in the mentioned study. But this is an expected result and it does not affect present study. In the findings of the current study were consistent with the relevant literature within the scope of hand preference and right- and left-hand grip strengths. In the studies of Koley and Singh (2010), dominant hands and non-dominant hands of 151 male university students were compared from the aspect of grip strength force for both right and left-handed and found no statistically meaningful difference was available (82).

The rate of dominant hand grip strength to non-dominant hand grip strength is higher than the other

hand in all studies. In general, HGS seems to be an attribute of elite athletes and a covariate of overall upper- and lower-body strength, impulsive ability (i.e., sprinting and jumping), body mass, lean muscle mass, age, and training experience (i.e., training age) (10).

In elite judo competitor's physique is an important factor affecting performance, exhibits the greatest similarity in morphological traits and motor abilities (83). Most authors have come to one, the most prominent somatotype model of judokas: endomesomorphic (with mesomorphy being more dominant and endomorphy less) (84,85). Several investigations evaluated the relevance of anthropometric variables in judo performance. The body structure is related to accomplish the elite level in judo and it may influence the type of techniques applied during a match (86). The somatotype analysis of Serbian judokas proved of the endomesomorphic type (3.29-5.23-2.88), which is generally the predominant type in other countries as well (87). The studies by Lewandowska et al. on Polish judo players indicated that the values of mesomorphic somatotype components influenced muscle torque and power output (88). Judoists have higher mesomorphic component values and lower endomorphic and ectomorphic component values in the somatotype than the non-athlete comparison group (89). A study which examined the somatotype of top athletes of a variety of sports, among which were judokas at that time the future contestants in the 2000 Olympics in Athens, placed them into the group of athletes with the highest values of the mesomorphic component and the significantly lower values of the ectomorphic one (2.84-5.72-1.51) (90). Similar to hand preference, eye, ear, and foot dominance are also used in determining cerebral lateralization.

When the results of the body composition of the athletes participating in this study; results of men; dominant hand BMI (right hand 23.8 ± 1.9, left hand 24 ± 1.6), fat mass (13.3 ± .7, 12.9 ± 7.6) and fat free mass (70.5 ± 11.6, 71.9 ± 11.7), women; dominant hand BMI (right hand 22.8 ± 2.8, left hand 22.7 ± 2.1), fat mass (18.8 ± 7.4, 18.6 ± 7.8) and fat free mass (52.9 ± 6.6, 47.9 ± 4.63). Monterrosa Quintero et.al. (2019) examined the body composition and somatotypes of 50 Colombian judo athletes and compared them with studies conducted in 7 different countries. Studies presented a wide range of values, and several methods of measurement were reported. According to the results female body fat (%) (17.3 ± 4.94 and endomorph (4.94 ± 1.8), male (15.2 ± 5.8 and endomorph 3.5 ± 1.3) (91). One of the most important factors affecting performance is body composition. Therefore, the fat and lean body mass of athletes has been the focus of scientific studies. Successful judo athletes have very low levels of body fat – both male and female – with the exception of heavyweight athletes. Mesomorphy is the most predominant somatotype component in male athletes, while females have similar components of mesomorphy and endomorphy (92). Previous studies give the body fat percentage values of different judo players as follows: Male; Franchini et al. (Brazilian team) (13.7%), (Jayasudha and Itagi (12.6%), Hungarian team (14.0%), US (10.8%), Canadians (14.6%), Polish (13.7%), Female; Polish team (20.9%), Canadians (15.2%), US (15.8%), Brazilian Olympic team (22.0%) (92). When the data obtained from the body composition measurement results in the present study were compared with similar studies in the literature, a similarity was observed between the data.

Although one hemisphere is heavier than the other is anatomical lateralization, hand preference is accepted as functional cerebral lateralization. Similar to hand preference, eye, ear, and foot dominance are also used in determining cerebral lateralization.

As a result, it was determined in the current study that Judo athletes were mostly right-handed in all their preferences regardless of gender and that the athletes used their left hemispheres dominantly. These results show that the dominant hand is generally similar to the laterally preferred foot, eye, and ear and it is predicted that it can be reliable in all 4 preferences in determining the cerebral hemispheres. However, in elite judo athletes, there was no significant difference between the dominant and non-dominant hands in terms of grip strength, suggesting that the effect of hand preference, which is determined as multi-factor, on the grip strength is low. Also according to the dominant hand preferences in judokas, there were no difference between BMI, body fat percentages, and somatotype features.

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