Central European Journal of Sport Sciences and Medicine | Vol. 39, No. 3/2022: 27–47
ISSN (print): 2300-9705 | ISSN (online): 2353-2807 | DOI: 10.18276/cej.2022.3-03

THE USE OF DIETARY AND PROTEIN SUPPLEMENTS BY WOMEN ATTENDING FITNESS CLUBS ON A RECREATIONAL BASIS AND AN ANALYSIS OF THE FACTORS INFLUENCING THEIR CONSUMPTION

Joanna Witkoś[A, B, D]

Faculty of Medicine and Health Science, Andrzej Frycz Modrzewski Krakow University, Poland
ORCID: 0000-0002-5813-113X | e-mail: jwitkos@afm.edu.pl

Magdalena Hartman-Petrycka[B, C, D]

Department of Basic Biomedical Science, Faculty of Pharmaceutical Sciences in Sosnowiec, Medical University of Silesia, Katowice, Poland
ORCID: 0000-0003-3986-3295

[A] Study Design; [B] Data Collection; [C] Statistical Analysis; [D] Manuscript Preparation

Abstract The aim of the study was to assess the dietary supplements used by amateur sportswomen training in fitness clubs (F – Fitness) compared to women who do not train (C – Control). Methods. 248 women aged 16 to 31 years (F: 120, C: 128) participated in the study. Results. In group F, 60.00% of women used protein products, 40.83% other dietary supplements, most often: creatine 17.50%, vitamin complexes 10.00%, vitamin D 10.00%, branched chain amino acids 7.50%, fish oil/omega acids 7.50%. A positive predictor of the use of protein supplements was the consumption of vegetables (B: 1.26, 95% CIs: 1.13–11.01). Total supplement use: age (B: 0.27, 95% CIs: 1.09–1.59), number of months of training (B: 0.59, 95% CIs: 1.15–2.81), following the advice of a dietitian (B: 1.50, 95% CIs: 1.45–13.87) and calorie counting (B: 1.54, 95% CIs: 1.49–14.53). Positive predictors of creatine use were: age (B: 0.54, 95% CIs: 1.21–2.42) and calorie count (B: 2.09, 95% CIs: 1.35–48.32). Conclusions. Supplements were more often used by women who were older, who did long training sessions, who were counting calories and those who were seeing a dietitian. Creatine was used more frequently by older women and women counting calories.

Keywords diatery supplements, amatour women, fitness clubs

Introduction

Dietary supplements are products for special nutritional purposes designed to supplement deficiencies in certain nutrients in the daily diet. They therefore do not replace a properly balanced diet and are not a substitute for it. The purpose of taking supplements is to correct a deficiency of nutrients by delivering to the body, in a concentrated form, the nutrients that are lacking in the daily diet. They help in the appropriate fulfilment of the demand for energy and nutrients, thus preventing diseases resulting from deficiencies, e.g., of certain vitamins. They contain "dietary components", which can be: vitamins, minerals, herbs or other botanical ingredients, amino acids, or substances such as enzymes. Dietary supplements are bioactive substances which come in many different forms, such as: tablets, capsules, liquids, powders or bars and which are a selected source of nutrients or other substances with a nutritional or physiological effect (Maughan et al., 2018; Kerksick et al., 2018; Harty, Zabriskie, Erickson, Molling, Kerksick, Jagim, 2018; Vitale, Getzin, 2019).

The use of dietary supplements is now more and more widespread both in the world of professional sports and among people practising sports recreationally. They play a significant role in supplementing the nutrition of athletes, who need to take particular care in consuming the correct amount of carbohydrates, proteins, and other nutrients necessary for the proper functioning of the body. While most dietary supplements available to athletes and their potential role in increasing body performance are not supported by scientific research, supplementing with these nutrients can help broaden the daily diet to optimise sports performance (Savino et al. 2019; Peeling, Castell, Derave, de Hon, Burke, 2019; Housman, Dorman, 2008; Ward et al., 2019).

All substances, whose effect on the body is scientifically proven in terms of supporting performance in sports, are called ergogenic aids (Santesteban Moriones, Ibáñez Santos, 2017). Safety, effectiveness, classification and subdivision of individual dietary supplements used to improve sports performance, as well as recommendations for their proper use, were determined by the International Olympic Committee (IOC) (Maughan et al., 2018) and the International Society of Sports Nutrition (Kerksick et al., 2018). Controversy surrounds the ergogenic value of various supplements for athletes. Some experts believe that they should only be used when scientific research clearly shows that they have a significant effect on increasing performance in sport. Others, on the other hand, believe that if the supplement helps prepare the athlete for training or accelerates post-workout regeneration and training adaptations, it should be used and considered an ergogenic aid. Due to the fact that there is still no scientific evidence for the effectiveness of many dietary supplements available on the market, their use should be under the supervision of dietitians or sports medicine physicians (Maughan et al., 2018; Kerksick et al., 2018; Ward et al., 2019).

Supplementation in sport is aimed at achieving a specific effect related to sport or competition, mainly by increasing the body's efficiency and accelerating its regeneration. Furthermore, it aims to hydrate the athlete's body and replenish the electrolytes lost in sweat during training, to provide carbohydrates before, during and after exercise, or to supplement proteins and provide the amino acids necessary for post-exercise adaptations. Permitted supplements used in sports can be divided into those that increase muscle mass, accelerate fat burning, increase the body's immunity, regenerate joints, and improve psychophysical fitness. Supplements also aim to stimulate the immune system, reduce oxidative stress, and maintain overall health (Savino et al., 2019; Peeling et al., 2019; Housman, Dorman, 2008; Ward et al., 2019; Rawson, Miles, Larson-Meyer, 2018).

A large percentage of dietary supplements are also the so-called meal replacement (MRP) and ready-to-drink (RTD) supplements, as well as energy bars and gels (Maughan et al., 2018; Kerksick et al., 2018; Gavrilova et al., 2020). Depending on the manufacturer, they differ in the amount of carbohydrates, fats, and proteins, the mineral and vitamin content, and the specific nature of their operation. They are either used to promote muscle gain or to increase weight loss or enhance the body's performance (Maughan et al., 2018; Kerksick et al., 2018; Gavrilova et al., 2020; Burke, Hawley, 2018; Baume, Hellemans, Saugy, 2007). They are believed to be both a convenient and a good way to satisfy energy deficiencies as they arise, when it is not possible to eat a balanced meal. They are definitely a good alternative to fast food or other low-nutritional foods (Burke, Hawley, 2018). However, they should be used with caution – to supplement the dietary needs with macronutrients when they arise, and used as a substitute for a balanced diet (Brożyna, Tkaczyk, Rutkowska, 2019).

Athletes use supplements mainly because they believe that they have a beneficial effect on increasing the body's performance (Krejpcio, Skwarek, Hyżyk, Dyba, 2011; Mujika, Burke, 2010). Good nutritional practices, which form part of a training program and satisfy the ongoing energy needs of the body is one of the ways of adapting the body to increased physical exertion. Athletes who eat a properly balanced diet, thus providing the body with the correct amounts of calories, proteins, carbohydrates, and fats in order to prevent vitamin deficiencies, as well as the necessary macro- and microelements, can certainly increase the body's adaptation to the training loads imposed on it (Burke, Hawley, 2018).

Each person who practices sports should bear in mind that proper nutrition and proper planning of meals throughout the day, together, are one of the key elements of the training program that determine the possibility of achieving satisfactory results in sports. It is obvious that in the case of sportspeople, the demand for energy and nutrients increases, which also results from the loss of water, electrolytes, and minerals, as well as the necessary biological renewal of the body. An incorrect diet and lack of nutrients when the body needs them lead to a negative energy balance and can inevitably contribute to a loss of muscle mass and strength, increased trauma, and fatigue (overtraining) of the body (Maughan, Shirreffs, 2018; Jîtcă, Tero-Vescan, Miklos, Vari, Ősz, 2018).

In order to meet the expectations of modern athletes, dietary supplements, especially those intended for athletes, are often advocated. Depending on the sports discipline, these supplements are designed to provide certain necessary nutrients, including biologically active substances. The nutritional needs of individual groups of athletes are varied, depending on the duration and intensity of training and the nature of the sports discipline (speed, endurance). Therefore, there is no single method of nutrition or supplementation recommended for all athletes and the individual needs of a given person should always be taken into account (Jîtcă et al., 2018; Martinovic et al., 2021; Kotnik, Jurak, Starc, Puc, Golja, 2018).

Unfortunately, unlike professionals, amateurs often do not know enough about the correct rules of nutrition in sport or about suitable supplementation, and very often they use supplements in an ill-considered manner, for example following the advice of friends or the advertising of specific products on the Internet. It is believed that people who train recreationally, eg 3–4 times a week for 30–60 minutes, can usually meet their own macronutrient needs, that is, 45–55% carbohydrates (3–5 g/kg/day), 10–15% protein (0.8–1.0 g/kg/day) and 25–35% fat (0.5–1.5 g/kg/day) by consuming a normal daily diet (Maughan et al., 2018; Kerksick et al., 2018).

Certainly, the level of knowledge about nutrition and supplementation in sport for many competitors and sports enthusiasts may be inadequate (Sparks, Janse van Rensburg, Fletcher, Jansen van Rensburg, 2018; Andrews, Wojcik, Boyd, Bowers, 2016). They often do not have the financial resources to discuss their decisions with a professional dietitian or personal trainer who are able to estimate the additional nutritional need based on a general training program daily diet. Failure to provide the body with the necessary energy substrates leads to the occurrence of physical and mental symptoms of overtraining.

The aim of the research was to assess the dietary supplements used by sportswomen training recreationally in fitness clubs and to examine the factors influencing the use of protein supplements, general supplements and creatine.

Matrials and methods

Participants

The study involved 248 women. This comprised 120 women who attended a fitness club in Kraków in the Malopolska Voivodeship in Poland, hereinafter referred to as the Fitness Group, and 128 women who declared that they did not participate in any sport and did not exercise in fitness clubs – this was the Control Group. The Control Group consisted mainly of students of physiotherapy from one of the universities in Krakow and other women from among their families and friends. Most of the respondents from both groups lived in Kraków and its vicinity, in the Małopolska.

The inclusion criteria for the Fitness Group were regular exercise in fitness clubs, at least 1–2 hours a week, and for the Control Group it was declaring a lack of regular physical activity. The criteria for exclusion for both groups was the lack of a correctly completed questionnaire.

Participation in the research was voluntary and anonymous in accordance with the Declaration of Helsinki. The research protocol has been reviewed and approved by the Bioethical Committee of the Andrzej Frycz Modrzewski Kraków University (Permission number KBKA/93/O/2020).

Questionnaire

The research was conducted in spring and summer 2020 using the authors' own questionnaire. It is known that the level of physical activity varies throughout the year, usually higher in spring and summer. In the questionnaire, all the women were asked about the dietary supplements they used. Furthermore, the Fitness Group was asked about the time and type of training, sources of knowledge about dietary supplements that should be used in sports. The survey was conducted online using the Google Forms application. The Control Group questionnaire was slightly modified, and detailed questions about the time and type of training were removed.

Statistical Analysis

The statistical program in which the analysis was carried out was IBM Corp. Released 2020, IBM SPSS Statistics for Windows (Version 27.0. Armonk, NY: IBM Corp). The distribution of data was assessed using the Shapiro-Wilk test. The women's age and BMI were compared using the Mann-Whitney U test. The use of supplements in the Fitness Group and in the physically inactive group was compared using the Chi-Square test. Then an examination of the factors influencing the use of protein supplements and general supplements was performed excluding protein supplements and creatine. Creatine is the most frequently mentioned dietary supplement in the Fitness Group. At the outset, an analysis of the correlation of these components with age, BMI, time and type of training, sources of knowledge about nutrition and nutritional behaviours using the rho Spearman or phi coefficient was carried out. Next, a multiple logistic regression analysis was performed with selected predictors. The results of $p < 0.05$ were considered statistically significant.

Results

The age of the women in the Fitness Group ranged from 16 to 31 years (mean ± standard deviation: 21.5 ±2.9 years) with a Body Mass Index (BMI) of 16.3 to 34.1 (21.9 ±3.0), while in the Control Group the age of the women ranged from 17 to 31 years (mean ± standard deviation: 22.0 ±3.8 years), with a BMI of 15.8 to 37.2 (22.4 ±4.5). There were no statistically significant differences between the Fitness and Control Groups in terms of age ($p = 0.177$) and BMI ($p = 0.268$).

Women who trained in fitness clubs consumed protein products more often than the Control Group (Table 1). It was also noted that the percentage of women in the Fitness Group who used dietary supplements, other than protein products, was higher than the percentage of women in the Control Group. However, this difference did not reach statistical significance (Fitness vs Control; 40.83% vs 30.47%; $p = 0.088$). The most frequently used dietary supplements within the Fitness Group were: creatine, vitamin complexes, vitamin D, Branch-Chain Amino Acids (BCAA) and fish oil/omega acids.

Creatine, BCAA, vitamin complexes, fish oil/omega acids were taken significantly more often in the Fitness Group when compared to the Control Group. There was also a trend at the level of $p = 0.072$ for more frequent use of thermogenics, L-Carnitine and Ashwagandha by the women who were training. In the Control Group, vitamin A and iron supplements were used more often than in the Fitness Group.

Table 1. The use of protein products and other supplements in the Fitness Group and the Control Group

	Control		Fitness		chi^2	p
	n	%	n	%		
1	2	3	4	5	6	7
Protein products	0	0.00	72	60.00	108.22	<0.001
Dietary supplements	39	30.47	49	40.83	3.57	0.088
Creatine	0	0.00	21	17.50	24.47	<0.001
Vitamin Complex	4	3.13	12	10.00	4.85	0.028
Vitamin D	19	14.84	12	10.00	1.33	0.251
BCAA	0	0.00	9	7.50	9.96	0.002
Fish oil/Omega acids	2	1.56	9	7.50	5.15	0.023
B-group vitamins	8	6.25	4	3.33	1.14	0.287
Thermogenics	0	0.00	3	2.50	3.24	0.072
L-Carnitine	0	0.00	3	2.50	3.24	0.072
Ashwagandha	0	0.00	3	2.50	3.24	0.072
Collagen	1	0.78	3	2.50	1.15	0.285
Vitamin C	8	6.25	3	2.50	2.05	0.153
Vitamin K	1	0.78	3	2.50	1.15	0.285
Magnesium	7	5.47	3	2.50	1.41	0.237
Zinc	1	0.78	2	1.67	0.41	0.526
Probiotics	0	0.00	2	1.67	1.89	0.171
Caffeine	0	0.00	2	1.67	1.89	0.171
Vitamin A	7	5.47	1	0.83	4.26	0.039
Vitamin E	5	3.91	1	0.83	2.48	0.116
Mineral salts	0	0.00	1	0.83	1.07	0.303
Biotin	4	3.13	1	0.83	1.65	0.201
Alanine, L-Citrulline, Berberine, Guarana, Silymarin, Carbohydrate (energy) bars	2	1.56	5	4.17	1.53	0.218

1	2	3	4	5	6	7
Iron	7	5.47	0	0.00	6.75	0.009
Potassium	3	2.34	0	0.00	2.85	0.092
Vitamins for those planning a pregnancy	2	1.56	0	0.00	1.89	0.171
Folic Acid	2	1.56	0	0.00	1.89	0.171
Other micro/macro elements (Calcium, Selenium)	1	0.78	0	0.00	0.94	0.334
Horsetail, Royal jelly, Piperine, Curcumin	4	3.13	1	0.83	1.65	0.201

In the Fitness Group, 52.50% of the women had been training for over a year, with most of them, 87.50%, training between 1 and 2 hours a day, 3–4 times a week (72.50%) (Table 2). The main forms of training are strength training (95.83%) and cardio training on equipment such as a treadmill or bike (62.50%).

Sweets and fast food were eaten usually only once or twice a week by the women who were training (62.50%). Vegetables and fruit were consumed daily by 79.19% of women from the Fitness Group, while fish was eaten much less frequently with only 56.66% eating fish either less than once a week or never. The processed products were consumed by only 17.50% of the women who trained, and frying, as a meal preparation method, was occasionally used by 55.00% of the respondents, and not at all by 25.00% of them. Calories were counted during meals by 60.00% of women from the Fitness Group.

The Internet was the source of knowledge on healthy eating for 95.83% of the women who trained, while 42.50% of them used the advice of a dietitian.

Table 2. Time and type of training, sources of knowledge about nutrition and nutritional behaviour in the Fitness Group

Question	Answer	n (%)
1	2	3
How long have you exercised at a fitness club?	Less than 1 month	7 (5.83)
	1–3 months	20 (16.67)
	3–6 months	12 (10.00)
	6 months–1 year	18 (15.00)
	Longer than a year	63 (52.50)
How long do you workout for?	Less than one hour	10 (8.33)
	From 1 to 2 hours	105 (87.50)
	More than 2 hours	5 (4.17)
How many times a week do you go to the fitness club?	1–2	16 (13.33)
	3–4	87 (72.50)
	5–7	17 (14.17)
What type of training do you do?	Weight training	115 (95.83)
	Crossfit	10 (8.33)
	Calisthenics	7 (5.83)
	Yoga	7 (5.83)
	Cardio machines (treadmill, bicycle)	75 (62.50)
	Organised classes at the club	21 (17.50)
	Is your training supervised by a personal trainer?	31 (25.83)

1	2	3
What is your main source of information about healthy eating?	Internet	107 (89.17)
	Specialist literature	54 (45.00)
	Advice of a dietitian	51 (42.50)
	Advice of friends	26 (21.67)
	Magazines	21 (17.50)
How many times a week do you consume sweets, fast food, etc?	0	13 (10.83)
	1–2	75 (62.50)
	2–3	0 (0.00)
	3–4	20 (16.67)
	5–7	12 (10.00)
How many times a week do you eat fruit and vegetables?	Hardly ever	2 (1.67)
	A few times a week	23 (19.17)
	Every day	95 (79.17)
How often do you eat fish?	Never	25 (20.83)
	Less than once a week	43 (35.83)
	Once a week	40 (33.33)
	More than once a week	12 (10.00)
Do you eat fried foods?	Never	30 (25.00)
	Occasionally	66 (55.00)
	Often	0 (0.00)
	Very often	24 (20.00)
Do you eat processed foods?	Yes	21 (17.50)
Do you count calories?	Yes	72 (60.00)

An analysis of the correlation between age, BMI, time and type of training, sources of knowledge about diet in sport, eating behaviours along with the consumption of protein products, dietary supplements and creatine, carried out in the Fitness Group, showed the following relationships. The older the woman, the more often she took supplements ($R = 0.28$, $p < 0.01$) and creatine ($R = 0.22$, $p < 0.05$) (Appendix A). The longer she had been attending the Fitness Club, the more often she used supplements ($R = 0.36$, $p < 0.01$), protein products ($R = 0.33$, $p < 0.01$) and creatine ($R = 0.32$, $p < 0.01$). Obtaining information from magazines was associated with a more frequent use of protein products ($R = 0.20$, $p < 0.05$), while a dietary consultation increased the frequency of supplements in general ($R = 0.21$, $p < 0.05$). The consumption of vegetables was positively correlated with the general use of supplements ($R = 0.18$, $p < 0.05$) and protein products ($R = 0.26$, $p < 0.01$). Fish consumption was positively correlated with protein supplements ($R = 0.18$, $p < 0.05$). Calorie counting was associated with more frequent general supplementation ($R = 0.26$, $p < 0.01$), and creatine ($R = 0.20$, $p < 0.05$).

Logistic regression confirmed most of the dependencies shown in the correlations. A positive predictor of the use of protein products was the higher frequency of consumption of vegetables (Table 3).

Table 3. Multiple logistic regression analysis for the use of protein product predictors

	B	p	OR	95% C.I. for OR	
				lower	upper
Age (years)	0.00	0.961	1.00	0.84	1.18
BMI (kg/m^2)	–0.17	0.069	0.84	0.70	1.01
How long have you exercised at a fitness club?	0.36	0.065	1.43	0.98	2.09
How long do you workout for?	0.19	0.791	1.21	0.29	5.06
Weight training	1.70	0.280	5.49	0.25	120.28
Crossfit	–0.29	0.770	0.75	0.11	5.20
Calisthenics	0.05	0.960	1.05	0.14	8.12
Yoga	0.30	0.788	1.35	0.15	11.76
Cardio machines (treadmill, bicycle)	–0.17	0.726	0.84	0.32	2.24
Organised classes at the club	–0.03	0.965	0.97	0.26	3.59
Internet	–0.17	0.839	0.85	0.17	4.20
Magazines	1.01	0.161	2.76	0.67	11.37
Specialist literature	0.10	0.853	1.10	0.39	3.15
Advice of a dietitian	0.49	0.347	1.63	0.59	4.54
Advice of friends	–0.18	0.778	0.84	0.24	2.86
How many times a week do you consume sweets, fast food, etc?	0.32	0.094	1.37	0.95	1.99
How many times a week do you eat fruit and vegetables?	1.26	0.029	3.53	1.13	11.01
How often do you eat fish?	0.43	0.166	1.54	0.84	2.84
Do you eat processed foods?	0.74	0.311	2.11	0.50	8.89
Do you eat fried foods?	–0.53	0.073	0.59	0.33	1.05
Do you count calories?	0.29	0.574	1.34	0.48	3.74

Positive predictors of the use of general supplementation, excluding protein products, were: age, number of months of training, using the advice of a dietitian and calorie counting (Table 4).

Table 4. Multiple logistic regression analysis of general supplementation predictors

	B	p	OR	95% CI. for OR	
				lower	upper
1	2	3	4	5	6
Age (years)	0.27	0.004	1.32	1.09	1.59
BMI (kg/m^2)	–0.15	0.168	0.86	0.70	1.06
How long have you exercised at a fitness club?	0.59	0.009	1.80	1.15	2.81
How long do you workout for?	0.91	0.284	2.48	0.47	13.13
Weight training	–1.50	0.395	0.22	0.01	7.10
Crossfit	–1.30	0.266	0.27	0.03	2.70
Calisthenics	–1.38	0.221	0.25	0.03	2.28
Yoga	–0.59	0.609	0.56	0.06	5.25

1	2	3	4	5	6
Cardio machines (treadmill, bicycle)	0.14	0.800	1.15	0.39	3.41
Organised classes at the club	–1.02	0.170	0.36	0.09	1.54
Internet	–1.08	0.247	0.34	0.06	2.11
Magazines	0.26	0.713	1.30	0.32	5.22
Specialist literature	–0.19	0.743	0.83	0.27	2.52
Advice of a dietitian	1.50	0.009	4.49	1.45	13.87
Advice of friends	0.59	0.364	1.81	0.50	6.49
How many times a week do you consume sweets, fast food, etc?	0.02	0.935	1.02	0.68	1.51
How many times a week do you eat fruit and vegetables?	0.84	0.201	2.33	0.64	8.50
How often do you eat fish?	–0.22	0.477	0.80	0.44	1.47
Do you eat processed foods?	0.30	0.712	1.35	0.28	6.52
Do you eat fried foods?	–0.10	0.742	0.90	0.49	1.65
Do you count calories?	1.54	0.008	4.65	1.49	14.53

Positive predictors of the use of creatine supplements were age and calorie counting (Table 5).

Table 5. Multiple logistic regression analysis of the use of creatine predictors

	B	p	OR	95% CI.for OR	
				Lower	Upper
1	2	3	4	5	6
Age	0.54	0.002	1.71	1.21	2.42
BMI	–0.40	0.072	0.67	0.43	1.04
How long have you exercised at a fitness club?	0.87	0.062	2.39	0.96	5.94
How long do you workout for?	1.38	0.137	3.98	0.64	24.54
Weight training	13.96	0.999#	1,150,805.94#	0.00#	#
Crossfit	–1.72	0.300	0.18	0.01	4.62
Calisthenics	0.96	0.441	2.62	0.23	30.43
Yoga	–22.56	0.998#	0.00#	0.00#	0.00#
Cardio machines (treadmill, bicycle)	–0.62	0.362	0.54	0.14	2.03
Organised classes at the club	–1.83	0.130	0.16	0.01	1.72
Internet	–0.71	0.582	0.49	0.04	6.20
Magazines	0.47	0.616	1.60	0.25	10.08
Specialist literature	–0.53	0.522	0.59	0.12	2.98
Advice of a dietitian	–0.01	0.988	0.99	0.24	4.13
Advice of friends	–0.51	0.564	0.60	0.10	3.42
How many times a week do you consume sweets, fast food, etc?	0.50	0.148	1.64	0.84	3.22
How many times a week do you eat fruit and vegetables?	0.02	0.985	1.02	0.20	5.10
How often do you eat fish?	–0.84	0.081	0.43	0.17	1.11
Do you eat processed foods?	0.68	0.557	1.98	0.20	19.29

1	2	3	4	5	6
Do you eat fried foods?	0.13	0.743	1.14	0.52	2.53
Do you count calories?	2.09	0.022	8.09	1.35	48.32

[#] For strength training, calculating the confidence intervals is impossible as the result for the number of people who do not practice strength training and who, at the same time, use creatine supplementation was zero (strength training no – creatine yes). Similarly, the result for the number of people who are both practising yoga and using creatine at the same time was also zero (yoga yes – creatine yes).

Discussion

Dietary supplements have become a common and convenient form of supplementing the diet with nutrients. The use of modern technologies in the production of food for special purposes can guarantee a combination of all the nutrients needed to support the achievement of a specific training goal in any given dietary source (bar, drink) (Gavrilova et al., 2020). Supplements for athletes are easy to consume, have hygienic packaging, are convenient to transport, for example, to the gym, so they are easily accessible before, during, and after training. Dietary supplements are a practical way to deliver a specific combination of key nutrients when they are needed. However, only a proper diet can provide the athlete with all the nutrients necessary to maintain top sporting condition. However, selecting food products containing all the necessary nutrients and preparing well-balanced meals from them requires extensive knowledge of their nutritional value and such knowledge is not available to a person uneducated in these matters (Burke, Hawley, 2018).

Supplements that are allowed to be used in sports can be divided into those that increase muscle mass, those that accelerate fat burning, those that increase the immune system of the body and regenerate joints and those that improve mental performance (Frączek, Gacek, Grzelak, 2012; Fielding, Riede, Lugo, Bellamine, 2018) The Australian Sports Commission (*Supplements* | *Australian Institute of Sport* (*ais.gov.au*)) have divided dietary supplements, intended for athletes, into 4 groups based on scientific research and evidence of their effectiveness, usefulness, and safety. It is worth mentioning only the first group of these preparations, because they include those with scientifically proven positive effects for athletes, they are: sports food (sports drinks (isotonic drinks), bars, gels, confectionery, liquid meals, whey protein and electrolyte replacement), medical supplements (iron, calcium, multivitamin/mineral, vitamin D, probiotics), performance supplements (caffeine, β-alanine, bicarbonate, beetroot juice, and carnitine) (*Supplements* | *Australian Institute of Sport* (*ais.gov.au*)).

This study showed that 40.83% of women who trained in fitness clubs used dietary supplements, compared to 35.48% of the group of physically inactive women. However, this difference was not statistically significant. Positive predictors of general supplement use were age, number of months of training, use of advice from a dietitian, and calorie counting. The age of the women who trained in fitness clubs ranged from 16 to 31 years. The more frequent use of supplements by older female athletes could result, for example, from the very process of education and the general acquisition of knowledge on various topics that occur during daily functioning in society. Often, this is how women find out a lot about nutrients and gain the basis for their independent research on nutrition in sports. Perhaps slightly older respondents have also begun to feel the onset of changes related to a decrease in overall efficiency of the body, inevitably connected with age. As their general knowledge about nutrition was higher, they were more likely to use supplements.

It seems that women who train longer strive to maximise the effects of their training and, hence, take steps to support their dietary needs. Additionally, in order to count calories, it is necessary to have at least a basic knowledge about the caloric value of the food eaten, which shows that the women surveyed have a greater interest in sports nutrition. A positive phenomenon in the women training in fitness clubs is more frequent use of supplements after consulting a dietitian. Certainly, consulting a dietitian does not guarantee sound supplementation. However, it is more likely to be consistent with the needs of an exercising woman's body.

In the Fitness Group, 60.00% of the women supplemented their diet with protein supplements, but this was not observed in the Control Group. A positive predictor of the use of protein supplements was the higher frequency of vegetable consumption. This could be due to the fact that the women were aware that only some vegetables are rich in protein and they therefore concluded that when consuming a lot of vegetables, they should additionally supplement their protein with protein products. The literature on the subject states that physically active people should supplement their daily diet with protein in the amount of approximately 1.4 to 2.0 g of protein per kilogram of body weight per day to maintain nitrogen balance (Maughan et al., 2018; Kerksick et al., 2018). The lack of a sufficient amount of protein in an athlete's diet may contribute to slower adaptation of the body to physical exertion and reduced post-exercise regeneration. Protein products, designed for athletes, provide the opportunity to consume high-quality protein when needed. If insufficient protein is obtained from the diet, the athlete will maintain a negative nitrogen balance, which can increase protein catabolism in the body and, over time, lead to muscle wasting and training intolerance. In addition, increasing protein intake during weight loss, which is often a motivation for young women to exercise in fitness clubs, helps to maintain muscle mass. For those involved in a general fitness program, protein needs can generally be met with a consumption of 0.8–1.0g of protein/kg/day. The best sources of high-quality protein found in dietary supplements are: whey, colostrum, casein, milk proteins and egg white (Nemet, Eliakim, 2007; Poulios et al., 2019; Whitehouse, Lawlis, 2017; Rusu, Popa, 2016).

The group of dietary supplements used by the women exercising in fitness clubs also included: creatine, L-carnitine, fat reducers (thermogenics), ashwagandha, collagen and β-alanine. Creatine, which is currently the most popular supplement used by athletes in the world, turned out to be the most popular dietary supplement among the sportswomen (Andres et al., 2017; Butts, Jacobs, Silvis, 2018; Mielgo-Ayuso et al., 2019; Awgul, Głąbowski, Kopeć, Sroczyński, 2017; Kreider et al., 2017). The results of this research confirmed that creatine was consumed the most frequently of all the dietary supplements used by the women exercising in a fitness club with 17.50% of them using this supplement. In the Control Group, this supplement was not used at all. Age and calorie counting were positive predictors of creatine use in the Fitness Group. The reasons for the positive effect of age and calorie counting on creatine use are certainly related to the reasons for the use of general supplements. A creatine molecule is the basic energy carrier in muscle cells and therefore contributes to increasing the intensity and efficiency of muscle activity, boosting their strength, promoting faster muscle mass growth and their efficiency and regeneration, and hence improving physical efficiency. This increase in muscle mass is the result of an improvement in the muscle's ability to perform high-intensity exercise, thus allowing the athlete to exercise harder, thereby promoting greater training adaptations and muscle hypertrophy. Supplementing the diet with creatine monohydrate and/or creatine seems to be a safe and effective method of increasing muscle mass and preventing sports injuries (Andres et al., 2017; Butts et al., 2018; Mielgo-Ayuso et al., 2019; Awgul at al., 2017; Kreider et al., 2017). The position of the International Society of Sport Nutrition (ISSN) (Kerksick et al., 2018) on the use of creatine is positive and confirms that creatine monohydrate is currently the most widely researched and clinically effective form of creatine used in dietary supplements for athletes and is therefore the most effective ergogenic aid. It facilitates an increase in the exercise capacity of muscles and lean body mass during exercise. Supplementation in young athletes is acceptable and can constitute a nutritional alternative to potentially dangerous anabolic drugs. The fastest method to increase creatine stores appears to be to consume around 0.3g/kg/day of creatine monohydrate for at least 3 days, followed by 3–5 g/day (Kerksick et al., 2018).

Vitamin complexes and vitamin D, i.e., a group of compounds supplying the body in an exogenous way and fulfilling an important role in every aspect of the body's functioning (Maughan et al., 2018; Kerksick et al., 2018; Williams, 2004; Bojanić, Radović, Bojanić, Lazović, 2011) came after creatine. They were the most frequently used dietary supplements among the female athletes surveyed. Both the vitamin complexes, which, unfortunately, were not named by the women surveyed and therefore their exact composition cannot be verified, and vitamin D were used by 10.00% of the women who trained. In comparison, in the physically inactive Control Group, significantly fewer women (3.13%) used vitamin complexes, and only slightly more (14.84%) used vitamin D. Vitamin D regulates the balance of calcium and phosphorus and, together with these elements, is responsible for bone remodelling. Vitamin D deficiency leads to calcium malabsorption and consequently to deterioration of bone mineralization and bone fractures. It also has an effect on the correct performance of the musculoskeletal and nervous systems and mobilises the immune system (Maughan et al., 2018; Kerksick et al., 2018; Williams, 2004; Bojanić et al., 2011).

The exogenous amino acids BCAAs which include: valine, leucine and isoleucine, took next place in terms of the popularity of use by the women exercising in fitness clubs but not used at all in the Control Group. BCAAs are key amino acids that stimulate protein synthesis (Maughan et al., 2018; Kerksick et al., 2018; Waldron et al., 2017; Van Dusseldorp et al., 2018). Generally, supplementation with Essential Amino Acids (EAAs), which also includes BCAAs, should be at levels of 3–6 g of amino acids after exercise. This can increase protein synthesis, muscle mass, and training adaptations, and also delay the effects of fatigue. Consumption of BCAA alone (6–10 g per hour) before, during and after exercise is recommended as safe and effective for athletes. The recommendations for this type of preparation are related to the fact that these amino acids act as an energy substrate, are easily digestible, help build muscle mass, contribute to the inhibition of muscle catabolism, show strong anabolic properties, delay the occurrence of fatigue after long and intense training, and have a positive effect on the immune system (Maughan et al., 2018; Kerksick et al., 2018; Waldron et al., 2017; Van Dusseldorp et al., 2018).

Women who practise sports usually avoid fat in their daily diet. In this study, there was some supplementation with fish oil and omega acids – used by 7.50% of the respondents. When discussing fat consumption in the daily diet, it should be mentioned that athletes are recommended to consume a moderate amount of fat, that is, approximately 30% of their daily caloric intake, and up to 50% with heavy load training.

For athletes trying to reduce body fat, an intake of 0.5–1.0 g/kg/day of fat is recommended. Fats help replenish intramuscular triacylglycerol and maintain circulating testosterone levels (Maughan et al., 2018; Kerksick et al., 2018). However, what is important is that the athletes must be knowledgeable about the existence of various types of fats with different saturation levels, so they should be able to choose the best and most valuable of them for themselves (Venkatraman, Leddy, Pendergast, 2000). Omega 3, 6 and 9 fatty acids, as well as docosahexaenoic acid (DHA) and eicosapantaenoic acid (EPA) are extremely important for the health of the entire body, including the cardiovascular system. For general health, dosing guidelines range from 3,000 mg to 5,000 mg daily (Thielecke, Blannin, 2020). When comparing the fish oil/omega acids supplementation in the Fitness Group and the Control

Group, it can be seen that their use is significantly higher among the women who exercise (7.50% vs 1.56%), so it may be considered that some physically active women know about the benefits of such supplementation.

A small percentage of the sportswomen took vitamin C (2.50%), compared to the Control Group, where the consumption of this vitamin was slightly higher (6.25%). Vitamin C increases the body's immunity and has a beneficial effect on the states of fatigue and overtraining. It also acts as a biocatalyst in indirect carbohydrates metabolism and exerts a specific effect on stress responses by participating in adrenal hormone synthesis (Williams, 2004; Bojanić et al., 2011). Antioxidants, including vitamins C and E (Higgins, Izadi, Kaviani, 2020), have been identified as possible substances to improve athletic performance. In this study, a few women used these vitamins, 2.50% and 0.83%, respectively, of the women surveyed. Increased oxidative stress during training causes the production of free radicals, leading to muscle damage, fatigue, and a decrease in body performance. However, it has been shown that the above-mentioned vitamins also tend to block anabolic signalling pathways and thus impair adaptation to resistance training, so special care should be taken when using them. It is recommended that athletes eat a diet rich in fruit and vegetables that provide vitamins, minerals and other bioactive compounds to meet the recommended intake of vitamins C and E (Higgins et al., 2020).

The next supplements used by the women training in fitness clubs are the B vitamins. They were taken by 3.33% of women from the Fitness Group and 6.25% of women from the Control Group. The B vitamins are necessary for the production of energy and the synthesis and production of hormones. A lack of them interferes with the proper functioning of the body, contributing to the formation of diet-related diseases (Maughan et al., 2018; Kerksick et al., 2018; Williams, 2004; Bojanić et al., 2011). Furthermore, the B vitamins contribute to the accumulation of glycogen in the liver, take part in reduction and oxidation reactions as components of respiratory enzymes, participate in the indirect metabolism of carbohydrates, fats and proteins, increase the use of oxygen by tissues and accelerate the synthesis of glycogen in the liver and muscles. Several women from the Fitness Group reported taking vitamins A (0.83%), E (0.83%) and K (2.50%). In the Control Group, the use of vitamin A was considerably higher (5.47%), vitamin E slightly higher (3.91%) and vitamin K slightly lower (0.78%). These are fat-soluble vitamins that help prevent infections, regenerate soft tissues, vitamin A, protect against free radicals, vitamin E, and have an impact on proper muscle function, vitamin K. In addition, regular use of vitamins A and E, which belong to the group of antioxidant vitamins that protect the body against oxidative stress induced by intense physical effort, contributes to increasing the antioxidant potential of cells and prevent tissue damage after exercise (Maughan et al., 2018; Kerksick et al., 2018; Williams, 2004; Bojanić et al., 2011). Presumably, the relatively high frequency of vitamin A and E use in the physically inactive group is associated with the positive effect of these vitamins on hair, skin and nails (Bojarowicz, Płowiec, 2010). It should also be noted that two respondents from the Fitness Group (1.7%) used probiotic bacteria, which help to maintain the proper composition of the intestinal flora, which brings many health benefits, including a positive effect on the immune functions of the body (Jäger et al., 2019; Zeppa et al., 2020). In the Control Group, none of the women made use of the properties of this "good" bacteria. Probiotics, often referred to as "friendly" or "good" bacteria, are living microorganisms that, when administered in appropriate amounts, contribute to the health benefits of their host. It is estimated that 70% of a person's immune system is in the digestive system, indicating the importance of a balanced intestinal microflora (Jäger et al., 2019; Zeppa et al., 2020).

During training, the athlete is exposed to the loss of significant amounts of mineral salts, mainly sodium, potassium, magnesium, calcium, and iron, which are inorganic elements necessary for the formation of many metabolic processes. In response to long training sessions, athletes are exposed to a significant shortage of minerals lost by the body in sweat. When the mineral status of the body is insufficient, exercise capacity can be significantly impaired. Supplementing the athlete's diet with minerals is important to restore the body's efficiency to the state before the training session, or to increase the exercise capacity of, for example, muscles. Minerals are important components of enzymes and hormones. They serve as structural elements for tissues and are regulators of the nervous system (Maughan et al., 2018; Kerksick et al., 2018). These elements are involved in the regulation of water-electrolyte and acid-base balance and neuromuscular excitability. They also impact the proper functioning of the heart and skeletal muscles and stimulate hematopoietic processes. Furthermore, as an activator of many enzymes, magnesium is involved in the metabolism of carbohydrates and fats (Maughan et al., 2018; Kerksick et al., 2018; Valenta, Dorofeeva, 2018). Iron, thanks to which oxygen is transported to all cells, ensures the proper functioning of the body under physical exertion. Several of the proposed nutritional ergogenic aids including: Calcium (1,000 mg/day (ages 19–50), stimulate fat metabolism, are beneficial in combating premature osteoporosis, help maintain bone mass and nerve transmission, but provide no ergogenic effect on exercise performance (Maughan et al., 2018; Kerksick et al., 2018; Valenta, Dorofeeva, 2018). It was used by 0.78% of the Control Group and 0.00% of the Fitness Group. Magnesium (males 420mg/day, females 320 mg/day) affects the activation of enzymes involved in protein synthesis and may improve energy metabolism (ATP availability). Supplementation with magnesium (500 mg/day) does not affect exercise performance in athletes unless there is a deficiency (Maughan et al., 2018; Kerksick et al., 2018; Valenta, Dorofeeva, 2018). It was used by 5.47% of women in the Control Group and 2.50% in the Fitness Group. Iron (males 8mg/day, females 18 mg/day – age 19–50) is a component of haemoglobin and iron supplementation is especially important in increasing aerobic capacity, although, most research shows that iron supplements do not appear to improve aerobic performance unless the athlete is iron-depleted and/or has anaemia (Maughan et al., 2018; Kerksick et al., 2018; Valenta, Dorofeeva, 2018). It was used by 5.47% of the respondents from the Control Group and 0.00% of the Fitness Group and it was a statistically significant difference. Potassium (2,000 mg/day) plays a role in nerve conduction and helps regulate acid-base balance and regulates body fluid balance. Potassium loss during intense exercise in the heat has been anecdotally associated with muscle cramping, but no ergogenic effects have been reported. It was used by 2.34% of people from the Control Group and 0.00% of the Fitness Group. Zinc (males 11mg/day, females 8mg/day) possesses properties which reduce upper respiratory tract infections. Studies have shown that supplementation (25 mg/day) minimised exercise-induced changes in immune function (Maughan et al., 2018; Kerksick et al., 2018; Valenta, Dorofeeva, 2018). It was used by 0.78% of women in the Control Group and 1.67% of the Fitness Group.

A deficiency of key minerals can lead to painful, sudden, and involuntary contractions of the skeletal muscles, as well as exhaustion and increased acidification of the body caused by a high-protein diet and hard training sessions (Maughan et al., 2018; Kerksick et al., 2018; Valenta, Dorofeeva, 2018). This research has shown that women who trained in fitness clubs do not supplement with single mineral salts. It was found that 10% of the women used vitamin complexes, which possibly contained these salts. However, it should be remembered that the consumption of vegetables and fruit by sportswomen was at a satisfactory level, therefore, it can be assumed that the diet of the women training in the fitness clubs is not deficient in these elements.

L-carnitine was another example of support for the body system that sportswomen used. It was used by 2.50% of women from the Fitness Group, but it was not used at all in the Control Group. The job of L-carnitine is to transport long-chain fatty acids. These acids are the main source of energy for the muscles of a person who performs moderate-intensity exercise. L-carnitine increases the rate of fatty acid oxidation in working muscles and delays the use of glycogen and the development of fatigue (Fielding, Riede, Lugo, Bellamine, 2018; Durazzo et al., 2020; Burrus, Moscicki, Matthews, Paolone, 2018). L-carnitine is one of the most common nutrients in weight loss supplements. Preliminary studies have reported that L-carnitine supplementation has a minimal effect on reducing biomarkers of exercise-induced oxidative stress. Although these results are not promising, there is some recent evidence that supplementation with L-carnitine tartrate during increased periods of training may help athletes endure training to a greater degree. In connection with the presented research, it can be concluded that there are probably other advantages of L-carnitine supplementation than just the promotion fat metabolism (Fielding et al., 2018; Durazzo et al., 2020; Burrus et al., 2018).

Some women from the Fitness Group (2.50%), unlike the Control Group, also used thermogenics, i.e., substances that increase the metabolic rate by increasing body temperature, and thus stimulating fat metabolism and enabling a reduction in the level of adipose tissue through increased fat burning (Maughan et al., 2018; Kerksick et al., 2018).

Caffeine supplements used by 1.67% of women training and 0.00% of the Control Group are a “stimulant” of natural origin. It stimulates the body relatively quickly to greater physical and mental performance. The energising effect of caffeine is manifested by stimulating the central nervous system, helping to overcome fatigue and training stagnation. Moreover, it reduces glycogen breakdown and, at the same time, increases fat metabolism (Bruce et al., 2000). Scientific research has shown that although caffeine can have a positive effect on energy expenditure and weight loss by reducing body fat, in people who regularly consume drinks containing caffeine the benefits are limited. Studies have also shown (Bruce et al., 2000; Okuroglu et al., 2019; Burke, 2008), that caffeine consumption (eg 3–9 mg/kg body weight consumed 30–90 minutes before exercise) can reduce carbohydrate use during exercise and thus improve physical endurance. Caffeine doses greater than 9 mg/kg body weight in a competitor’s urine exceed the doping threshold for many sports organisations. It has also been shown that caffeine doses <9 mg / kg do not increase the effect on body performance (Bruce et al., 2000), but carry a greater risk of negative side effects, such as increased heart rate, nausea, restlessness, and insomnia. In addition, caffeine consumption before exercise has been found to dehydrate the body, although these reports contradict the scientific literature (Burke, 2008).

β-alanine was used very rarely by women in this study. β-alanine has ergogenic properties, demonstrated in scientific research based on its relationship with carnosine, which is an organic compound composed of the amino acids β-alanine and histidine, which naturally occur in large amounts in skeletal muscles (Carvalho et al., 2018). Carnosine, an endogenously water-soluble dipeptide with antioxidant properties, is the main non-protein nitrogen-containing compound in vertebrate skeletal muscles. It acts as a water-soluble equivalent of lipophilic antioxidants (e.g., α-tocopherol), inhibits lipid peroxidation, thus preventing damage to protein-lipid membranes, and plays a specific and very important role in tissues that use free radicals in the regulation of biological processes and plays a role in protection against oxidative stress. Carnosine acts as a mobile pH buffer for tissue which, due to the preferred glycolytic path of energy generation, is particularly vulnerable to acid-base imbalance (mainly striated muscles). In addition, it “buffers” reactive oxygen species in tissue, but does not completely inhibit its regulatory and signalling functions. Studies have shown that taking β-alanine orally over a period of 28 days was effective in increasing carnosine levels, and thus improving tolerance to maximal intensity exercise. Supplementation with β-alanine reduces muscle fatigue rate, shortens regeneration time, and thus increases work efficiency and muscle strength (Carvalho et al., 2018; Saunders et al., 2017; Trexler et al., 2015). The dosing guidelines for β-alanine typically includes the consumption of 3.2 to 6.4 g / day, taken in a divided dose regimen of 0.8 to 1.6 g, every 3 to 4 hours over a period of 4 to 12 weeks (Saunders et al., 2017).

In the last few years, many studies (Maughan et al., 2018; Kerksick et al., 2018; Jeukendrup, 2014; Williams, Rollo, 2015) have also shown that carbohydrates are one of the best ergogenic aids for athletes. Consumption of carbohydrates and protein immediately after exercise may increase carbohydrate storage and protein synthesis in the body and lead to greater training adaptations. Athletes and physically active people should maintain a high-carbohydrate diet (55–65% of calories or 5–8 g/kg/day) to maintain muscle and liver carbohydrate reserves (Maughan et al., 2018; Kerksick et al., 2018; Jeukendrup, 2014; Williams, Rollo, 2015). Ideally, the majority of dietary carbohydrates should come from complex carbohydrates with a low or moderate glycemic index (e.g., whole grains, vegetables, and fruit), and, if such products are not included in the diet, the athlete should take them as dietary supplements to meet the body's needs. Research shows that the body can oxidise 1.0–1.1 g of carbohydrate per minute, or about 60 g per hour (Jeukendrup, 2014; Williams, Rollo, 2015). The American College of Sports Medicine (ACSM) recommends an intake of 0.7 g/kg/hr when exercising in a 6–8% solution (i.e., 6–8 g per 100 ml of fluid) (*ACSM | The American College of Sports Medicine)*. Only one woman from the Fitness Group declared that she used carbohydrate bars.

Isotonic drinks and water are undoubtedly the most important ergogenic aids for athletes (Urdampilleta, Gómez-Zorita, 2014; Lee, Nio, WeeHon; Law, Lim, 2011; Ramos-Jiménez et al., 2014). Training performance is considered to deteriorate when body weight is reduced by 2% or more as a result of a loss of water through sweat, while a weight loss of 4% during training can lead to heat stroke and even death of the athlete (Urdampilleta, Gómez-Zorita, 2014). It is important that athletes maintain the necessary hydration for the body, which, in practice, means drinking an average of 200g of water or an isotonic drink every 5 to 15 minutes during exercise. In order to maintain fluid balance and prevent dehydration, athletes must drink 0.5 to 2 l/hr of fluid depending on the length of the training (Urdampilleta, Gómez-Zorita, 2014; Lee et al., 2011; Ramos-Jiménez et al., 2014). Importantly, fluid intake cannot depend on the perceived thirst, because only when the athlete loses a significant amount of water from the body is there a feeling of thirst. It is believed that during a training session of more than an hour, athletes should consume glucose and electrolyte drinks to maintain blood glucose levels, prevent dehydration, and reduce the immunosuppressive effects of intense exercise (Urdampilleta, Gómez-Zorita, 2014; Lee et al., 2011; Ramos-Jiménez et al., 2014). None of the women surveyed declared the use of isotonic drinks. Unfortunately, the survey did not directly ask about isotonic drinks, and women only associated supplementation with taking solid supplements. This aspect should be considered a limitation of the study.

Certainly, the selection of dietary supplements should be a well-thought-out decision made after consultation with a qualified dietitian or sports doctor. Sometimes a person, especially a recreational sportsperson, does not need any additional supplements because it is not necessary for the intensity of training and any nutritional deficiencies can be corrected from daily food sources. It is not recommended to buy supplements from unknown sources, especially with labels that offer quick effects, including those with slogans such as: stimulating, energising, enhancing, and a rapid effect. Consumers should always be informed and cautious when purchasing and consuming supplement products (Volf et al. 2020; Meng, Sun, Wu, 2015; Wójcicki, 2020).

Limitations of the study. Supplementation in sport, both competitive and amateur, is a complex, multidisciplinary scientific issue. This study only shows a general picture of supplementation taken by women training in fitness clubs on an amateur basis in comparison with women from the same population, who are physically inactive. For this reason, a number of questions remain unanswered and many points need clarification. The authors of the study know neither exactly what the training load of the amateur sportswomen was or how long it lasted, nor in what doses and in what form the supplements were taken and to what extent they corresponded to the real needs of the women's bodies. Additionally, some respondents entered "vitamin complex" in the questionnaire, which made it impossible to interpret the data. The women did not keep a dietary diary so the quantity of nutrients supplied to the body through the diet was not known. Also, specific micro- and macronutrients in their organisms were not determined. The authors did not know the general health condition of the fitness or control group and whether supplementation had been recommended by a doctor. All these limitations show what an extensive issue the subject of nutrition and supplementation in sport is and how much information is needed to ensure proper nutrition of the body during increased physical activity. However, the authors of the publication have forged a path for other researchers by revealing the issues that should be taken into account when researching the topic of supplement intake in humans. The statements of the women training in fitness clubs clearly indicate that they take supplements and nutrients, so, further research is necessary to first organise what is known and then translate it into guidelines for amateur sportswomen. Moreover, it needs to be presented in such a way that is understandable to people without any specialised education in this area.

Conclusions

In the Fitness Group, 60.00% of the women used protein products, 40.83% other dietary supplements. The most popular supplements among women exercising were creatine, vitamin complexes, vitamin D, BCAA, and fish oil/omega acids. Women in the Fitness Group, compared to women who lead a sedentary lifestyle, used more creatine, BCAA, vitamin complexes, fish oil/omega acids, and less often vitamin A and iron.

In the fitness group, protein supplements were consumed more frequently by those women who also ate vegetables more frequently. Overall consumption of supplements in the fitness group was more frequent in women who were older, exercised longer, saw a dietitian and counted calories. Creatine, on the other hand, was used more often by older women and those counting calories.

Compared to the Control Group, the supplementation of female athletes was aimed at enhancing the effects of exercise, including reducing body fat and/or increasing muscle mass. In the Control Group, the women also used dietary supplements and vitamins, but their choice was more focused on a broadly understood general strengthening of the body and improvement in the condition of the skin and hair.

As can be concluded from the above premises, a significant percentage of women, who train on an amateur basis in fitness clubs, use dietary supplements and nutrients. Is it good for their health? Are the supplements they take selected in accordance with the needs of their body? In order to answer the above questions, it makes sense to conduct further, more detailed research on supplementation used with various training loads, and then to develop some guidelines for amateur sportswomen.

Appendix A. Correlations between predictors related to supplements, protein products, creatine and training, sources of knowledge about healthy eating and eating habits. For estimated variables: Spearman's rho, for dichotomous variables: phi coefficient; *: p <.05; **: p <.01.

	Supplements	Protein products	Creatine
1	2	3	4
Age [years]	0.28**	0.07	0.22*
BMI [kg/m^2]	–0.12	–0.13	–0.09
How long have you exercised at a fitness club?	0.36**	0.33**	0.32**
How long do you workout for?	0.15	0.14	0.12
Weight training	0.09	0.17	0.10
Crossfit	–0.01	0.00	–0.06
Calisthenics	–0.06	0.06	0.07
Yoga	0.01	0.06	–0.11
Cardio machines (treadmill. bicycle)	0.01	0.04	–0.10
Organised classes at the club	–0.07	0.02	–0.10
Internet	–0.09	–0.01	–0.05
Magazines	0.06	0.20*	0.02
Specialist literature	0.03	0.12	–0.06
Advice of a dietitian	0.21*	0.15	0.05
Advice of friends	0.10	–0.02	0.02
How many times a week do you consume sweets. fast food. etc?	0.02	0.15	0.09
How many times a week do you eat fruit and vegetables?	0.18*	0.26**	0.02
How often do you eat fish?	0.04	0.18*	–0.05
Do you eat processed foods?	–0.03	–0.03	0.08
Do you eat fried foods?	–0.04	–0.04	0.03
Do you count calories?	0.26**	0.10	0.20*

References

ACSM | The American College of Sports Medicine (www.acsm.org).

Andres, S., Ziegenhagen, R., Trefflich, I., Pevny, S., Schultruich, K., Braun, H., Schanzer, W., Hirch-Ernst, K.I., Schafer, B., Lampen, A. (2017). Creatine and creatine forms intended for sports nutrition. *Molecular Nutrition & Food Research*, 61 (6), 1600772. DOI: 10.1002/mnfr.201600772.

Andrews, A., Wojcik, J.R., Boyd, J.M., Bowers, Ch.J. (2016). Sports nutrition knowledge among Mid-Major Division I university student-athletes. *Journal of Nutrition and Metabolism*, 3172460. DOI: 10.1155/2016/3172460.

Awgul, K., Głąbowski, D., Kopeć, M., Sroczyński, T. (2017). The potential benefits and side-effects resulting from creatine supplementation. *Bromatologia i Chemia Toksykologiczna*, *2*, 122–127.

Baume, N., Hellemans, I., Saugy, M. (2007). Guide to over-the-counter sports supplements for athletes. *International Journal of Sports Medicine*, *8* (1), 2–10.

Bojanić, V., Radović, J., Bojanić, Z., Lazović, M. (2011). Hydrosoluble vitamins and sport. *Acta Medica Mediterranea*, *50* (2), 68–75. DOI: 10.5633/amm.2011.0213.

Bojarowicz, H., Płowiec, A. (2010). Influence of vitamin A on skin condition. *Problemy Higieny i Epidemiologii,* 91, 352–356.

Brożyna, K., Tkaczyk, J., Rutkowska, A. (2019). Dietary supplements in sport – side effects. *Journal of Education, Health and Sport*, *9* (8), 779–782. DOI: 10.5281/zenodo.3407953.

Bruce, C.R., Anderson, M.E., Fraser, S.F., Stepto, N.K., Klein, R., Hopkins, W.G., Hawley, J.A. (2000). Enhancement of 2000-m rowing performance after caffeine ingestion. *Medicine & Science in Sports & Exercise*, *32* (11), 1958–1963. DOI: 10.1097/00005768-200011000-00021.

Burke, L.M. (2008). Caffeine and sports performance. *Applied Physiology, Nutrition and Metabolism*, *33* (6), 1319–1334. DOI: 10.1139/H08-130.

Burke, L.M., Hawley, J.A. (2018). Swifter, higher, stronger: What's on the menu? *Science*, *362* (6416), 781–787. DOI: 10.1126/science.aau2093.

Burrus, B.M., Moscicki, B.M., Matthews, T.D., Paolone, V.J. (2018). The effect of acute L-carnitine and carbohydrate intake on cycling performance. *International Journal of Exercise Science*, *11* (2), 404–416.

Butts, J., Jacobs, B., Silvis, M. (2018). Creatine use in sports. *Sports Health*, *10* (1), 31–34. DOI: 10.1177/1941738117737248.

Carvalho, V.H., Oliveira, A.H.S., de Oliveira, L.F., da Silva, R.P., Di Mascio, P., Gualano, B., Artioli, G.G., Medeiros, M,H.G. (2018). Exercise and β-alanine supplementation on carnosine-acrolein adduct in skeletal muscle. *Redox Biology*, *18*, 222–228. DOI: 10.1016/j.redox.2018.07.009.

Durazzo, A., Lucarini, M., Nazhand, A., Souto, S.B., Silva, A,M., Severino, P., Souto, E.B., Santini, A. (2020). The nutraceutical value of carnitine and its use in dietary supplements. *Nutrients*, *25* (9), 2127. DOI: 10.3390/molecules25092127.

Fielding, R., Riede, L., Lugo, J.P., Bellamine, A. (2018). L-Carnitine supplementation in recovery after exercise. *Nutrients*, *10* (3), 349. DOI: 10.3390/nu10030349.

Frączek, B., Gacek, M., Grzelak, A. (2012). Nutritional support of physical abilities in a professional athletes' group. *Problemy Higieny i Epidemiologii*, *93* (4), 817–823.

Gavrilova, N., Chernopolskaya, N., Rebezov, M., Schetinina, E., Dogareva, N., Likhodeevskaya, O., Knysh, I., Sankova, Z. (2020). Specialized sports nutrition foods: review. *International Journal of Pharmaceutical Research*, *12*, 998–1003. DOI: 10.31838/ijpr/2020.12.02.0152.

Harty, P.S., Zabriskie, H.A., Erickson, J.L., Molling, P.E., Kerksick, Ch.M., Jagim, A.R. (2018). Multi-ingredient pre-workout supplements, safety implications, and performance outcomes: a brief review. *Journal of International Society of Sports Nutrition*, *15* (1), 41. DOI: 10.1186/s12970-018-0247-6.

Higgins, M.R., Izadi, A., Kaviani, M. (2020). Antioxidants and exercise performance: with a focus on vitamin E and C supplementation. *International Journal of Environmental Research and Public Health*, *17* (22), 8452. DOI: 10.3390/ijerph17228452.

Housman, J.M., Dorman, S.M. (2008). Diatery and sports supplements: the need for a systematic tracking system. *American Journal of Health Studies*, 23, 35–40.

Jäger, R., Mohr, A.E., Carpenter, K.C., Kerksick, Ch.M., Purpura, M., Moussa, A., Townsend, J.R., Lamprecht, M., West, N.P., Black, K., Gleeson, M., Pyne, D.B., Wells, S.D., Arent, S.M., Smith-Ryan, A.B., Kreider, R.B., Campbell, B.I., Bannock, L., Scheiman, J., Wissent, C.J., Pane, M., Kalman, D.S., Pugh, J.N., A Ter Haar, J., Antonion, J. (2019). International Society of Sports Nutrition Position Stand: Probiotics. *Journal of the International Society of Sports Nutrition*, *16* (1), 62. DOI: 10.1186/s12970-019-0329-0.

Jeukendrup, A.A. (2014). Step towards personalized sports nutrition: carbohydrate intake during exercise. *Sports Medicine*, 44 (Suppl. 1), 25–33. DOI: 10.1007/s40279-014-0148-z.

Jîtcă, G., Tero-Vescan, A., Miklos, A., Vari, C-E., Ősz, B.E. (2018). Differences in dietary supplements used by performance athletes and recreationally active individuals. Campiono Italiano Velocita. *Sport*, *19* (3), 153–157. DOI: 10.26659/pm3.2018.19.3.153.

Kerksick, Ch.M., Wilborn, C.D., Roberts, M.D., Smith-Ryan, A., Kleiner, S.M., Jäger, R., Collins, R., Cooke, M., Davis, J.N., Galvan, E., Greenwood, M., Lowely, L.M., Wildman, R., Antonio, J., Kreider, R.B. (2018). ISSN exercise & sports nutrition review update: research & recommendations. *Journal of International Society of Sports Nutrition*, *15* (1), 38. DOI: 10.1186/s12970-018-0242-y.

Kotnik, K.Z., Jurak, G., Starc, G., Puc, M., Golja, P. (2018). Use of dietary supplements in differently physically active adolescents. *Journal of Food and Nutrition Research*, *57* (8), 231–241.

Kreider, R.B., Kalman, D.S., Antonio, J., Ziegenfuss, T.N., Wildman, R., Collins, R., Candow, D.G., Kleiner, S.M., Almada, A.L., Lopez, H.L. (2017). International Society of Sports Nutrition position stand: safety and efficacy of creatine supplementation in exercise, sport, and medicine. *Journal of International Society and Sports Nutrition*, *14*, 18. DOI: 10.1186/s12970-017-0173-z.

Krejpcio, Z., Skwarek, K., Hyżyk, A.K., Dyba, S. (2011). Evaluation of prevalence of dietary supplements intake in a selected group of sports people. *Problemy Higieny i Epidemiologii*, *92* (4), 935–938.

Lee, J.K.W., Nio, A.Q.X., WeeHon; A., Law, L.Y.L., Lim, Ch.L. (2011). Effects of ingesting a sports drink during exercise and recovery on subsequent endurance capacity. *European Journal of Sports Science, 11* (2), 77–86. DOI: 10.1080/17461391.2010.487115.

Martinovic, D., Tokic, D., Vilovic, M., Rusic, D., Bukic, J., Bozic, J. (2021). Sport dietary supplements and physical activity in biomedical students. *International Journal of Environmental Research and Public Health*, *18* (4), 2046. DOI: 10.3390/ijerph18042046.

Maughan, R.J., Burke, L.M., Dvorak, J., Larson-Meyer, D.E., Peeling, P., Phillips, S.M., Rawson, E.S., Walsh, N.P., Garthe, I., Geyer, H., et al. (2018). IOC consensus statement: dietary supplements and the high-performance athlete. *British Journal of Sports Medicine*, *52* (7), 439-455. DOI: 10.1136/bjsports-2018-099027.

Maughan, R.J., Shirreffs, S.M. (2018). Making decisions about supplement use. International Journal of Sport Nutrition and Exercise Metabolism, *28* (2), 212–219. DOI: 10.1123/ijsnem.2018-0009.

Meng, X., Sun, J., Wu, M. (2015). Market structure and case analysis of sport nutrient food industry. *Journal of Food Science and Technology*, *7*, 82–87.

Mielgo-Ayuso, J., Calleja-Gonzalez, J., Marqués-Jiménez, D., Caballero-García, A., Córdova, A., Fernández-Lázaro, D. (2019). Effects of creatine supplementation on athletic performance in soccer players: a systematic review and meta-analysis. *Nutrients*, *11* (4), 757. DOI: 10.3390/nu11040757.

Mujika, I., Burke, L.M. (2010). Nutrition in Team Sports. *Annals of Nutrition and Metabolism*, *57* (Suppl 2), 26–35. DOI: 10.1159/000322700.

Nemet, D., Eliakim, A. (2007). Protein and amino acid supplementation in sport. *International Journal of Sports Medicine Journal*, *8* (1), 11–23. DOI: 10520/EJC48606.

Okuroglu, E., Tekin, T., Kuloglu, M., Mercan, S., Bavunoglu, I., Acikkol, M., Turkmen, Z. (2019). Investigation of caffeine concentrations in sport supplements and inconsistencies in product labelling. *Journal of Chemical Metrology*, *13* (1), 21–28. DOI: 10.25135/jcm.25.19.04.1252.

Peeling, P., Castell, L.M., Derave, W., de Hon, O., Burke, L.L. (2019). Sports foods and dietary supplements for optimal function and performance enhancement in track-and-field athletes. *International Journal of Sport Nutrition and Exercise Metabolism*, *29* (2), 198–209. DOI: 10.1123/ijsnem.2018-0271.

Poulios, A., Georgakouli, K., Draganidis, D., Deli, Ch.K., Tsimeas, P.D., Chatzinikolaou, A., Papanikolaou, K., Batrakoulis, A., Mohr, M., Jamurtas, A.Z., Fatouros, IG. (2019). Protein-based supplementation to enhance recovery in team sports: what is the evidence? Journal of Sports Science and Medicine, *18* (3), 523–536.

Ramos-Jiménez, A., Hernández-Torres, R.P., Wall-Medrano, A., Torres-Durán, P.V., Juárez-Oropeza, M.A., Viloria, M., Villalobos-Molina, R. (2014). Gender- and hydration-associated differences in the physiological response to spinning. *Nutriction Hospitalaria*, *29* (3), 644–651. DOI: 10.3305/nh.2014.29.3.7017.

Rawson, E.S., Miles, M.P., Larson-Meyer, D.E. (2018). Dietary supplements for health, adaptation, and recovery in atheltes. *International Journal of Sport Nutrition and Exercise Metabolism*, *28* (2), 188–199. DOI: 10.1123/ijsnem.2017-0340.

Rusu, M.E., Popa, D.S. (2016). Protein food and amino acid supplements in athletes' diet. Campiono Italiano Velocita. *Sport*, *17* (2), 146–152.

Santesteban Moriones, V., Ibáñez Santos, J. (2017). Ergogenic aids in sport. *Nutrition Hospitalaria*, *34* (1), 204–215. DOI: 10.20960/nh.997.

Saunders, B., Elliott-Sale, K., Artioli, G.G., Swinton, P.A., Dolan, E., Roschel, H., Gualano, B. (2017). Beta-alanine supplementation to improve exercise capacity and performance: A systematic review and meta-analysis. *British Journal of Sports Medicine*, *51* (8), 658–669. DOI: 10.1136/bjsports-2016-096396.

Savino, G., Valenti, L., D'Alisera1, R., Pinelli, M., Persi, T., Trenti, T. (2019). Dietary supplements, drugs and doping in the sport society. *Annali di igiene: medicina preventica e di comunita*, *31* (6), 548–555. DOI: 10.7416/ai.2019.2315.

Sparks, I.M., Janse van Rensburg, D.C., Fletcher, L., Jansen van Rensburg, A. (2018). A cross-sectional study of 2550 amateur cyclists shows lack of knowledge regarding relevant sports nutrition guidelines. *The South African Journal of Sports Medicine*, *30* (1), 1–6. DOI: 10.17159/2078-516X/2018/v30i1a2963.

Supplements | Australian Institute of Sport (ais.gov.au).

Thielecke, F., Blannin, A. (2020). Omega-3 fatty acids for sport performance—are they equally beneficial for athletes and amateurs? A narrative review. *Nutrients*, *12* (12), 3712. DOI: 10.3390/nu12123712.

Trexler, E.T., Smith-Ryan, A.E., Stout, J.R., Hoffman, J.R., Wilborn, C.D., Sale, C., Kreider, R.B., Jäger, R., Earnest, C.P., Bannock, L., Campbell, B., Kalman, D., Ziegenfuss, T.N., Antonio, J. (2015). International society of sports nutrition position stand: Beta-Alanine. *Journal of International Society of Sports Nutrition*, *12*, 30. DOI: 10.1186/s12970-015-0090-y.

Urdampilleta, A., Gómez-Zorita, S. (2014). From dehydration to hyperhidration isotonic and diuretic drinks and hyperhydratant aids in sport. *Nutriction Hospitalaria*, *29* (1), 21–25. DOI: 10.3305/nh.2014.29.1.6775.

Valenta, R., Dorofeeva, Y.A. (2018). Sport nutrition: the role of macronutrients and minerals in endurance exercises. *Foods and Raw Materials*, *6* (2), 403–412. DOI: 10.21603/2308-4057-2018-2-403-412.

Van Dusseldorp, T.A., Escobar, K.A., Johnson, K.E., Stratton, M.T., Moriarty, T., Cole, N., McCormick, J.J., Kerksick, Ch.M., Vaughan, R.A., Dokladny, K., Kravitz, L., Mermier, Ch.M. (2018). Effect of branched-chain amino acid supplementation on recovery following acute eccentric exercise. *Nutrients*, *10* (10), 1389. DOI: 10.3390/nu10101389.

Venkatraman, J.T., Leddy, J., Pendergast, D. (2000). Dietary fats and immune status in athletes: clinical implications. *Medicine & Science in Sports & Exercise*, *32* (Suppl 7), 389–395. DOI: 10.1097/00005768-200007001-00003.

Vitale, K., Getzin, A. (2019). Nutrition and supplement update for the endurance athlete: review and recommendations. *Nutrients*, *11* (6), 1289. DOI: 10.3390/nu1106128.

Volf, E., Simakova, I., Eliseev, Y., Perkel, R., E. Malyshev, E., Zinin, A. (2020). Quality and safety problems of sports nutrition products. *Agronomy Research*, *18* (3), 1888–1896. DOI: 10.15159/AR.20.092.

Waldron, M., Whelan, K., Jeffries, O., Burt, D., Howe, L., Patterson, S.D. (2017). The effects of acute branched-chain amino acid supplementation on recovery from a single bout of hypertrophy exercise in resistance-trained athletes. *Applied Physiology, Nutrition and Metabolism*, *42* (6), 630–636. DOI: 10.1139/apnm-2016-0569.

Ward, W.E., Chilibeck, F.D., Comelli, E.M., Duncan, A.M., Phillips, S.M., Lindsay E. Robinson, L.E., Stellingwerf, T. (2019). Research in nutritional supplements and nutraceuticals for health, physical activity, and performance: moving forward. *Applied Physiology, Nutrition and Metabolism*, *44* (5), 455–460. DOI: 10.1139/apnm-2018-0781.

Whitehouse, G., Lawlis, T. (2017). Protein supplements and adolescent athletes: A pilot study investigating the risk knowledge, motivations and prevalence of use. *Nutrition & Dietetics*, *74* (5), 509–515. DOI: 10.1111/1747-0080.12367.

Williams, C., Rollo, I. (2015). Carbohydrate nutrition and team sport performance. *Sports Medicine*, *45* (Suppl 1), 13–22. DOI: 10.1007/s40279-015-0399-3.

Williams, M.H. (2004). Dietary supplements and sports performance: introduction and vitamins. *Journal of International Society and Sports Nutrition*, *1* (2), 1–6. DOI: 10.1186/1550-2783-1-2-1.

Wójcicki, K. (2020). FTIR spectroscopy for quality evaluation of sports supplements on the Polish market. *Foods and Raw Materials*, *8* (1), 177–185. DOI: 10.21603/2308-4057-2020-1-177-185.

Zeppa, S.D., Agostini, D., Gervasi, M., Annibalini, G., Amatori, S., Ferrini, F., Sisti, D., Piccoli, G., Barbieri, E., Sestili, P., Stocchi, V. (2020). Mutual interactions among exercise, sport supplements and microbiota. *Nutrients*, *12* (1), 17. DOI: 10.3390/nu12010017.

Cite this article as: Witkoś, J., Hartman-Petrycka, M. (2022). The use of Dietary and Protein Supplements by Women Attending Fitness Clubs on a Recreational Basis and an Analysis of the Factors Influencing their Consumption. *Central European Journal of Sport Sciences and Medicine*, *3* (39), 27–47. DOI: 10.18276/cej.2022.3-03.