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PROTEIN INTAKE AMONG HEALTHY ADULTS UNDERTAKING REGULAR MUSCLE STRENGTH TRAINING

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A – study design, **B** – data collection, **C** – statistical analysis, **D** – interpretation of data, **E** – manuscript preparation, **F** – literature review, **G** – sourcing of funding

ABSTRACT

Background: Protein is a basic macronutrient supplied to the body via food intake and one of the key dietary elements of physically-active populations.

Aim of the study: The aim of the study was to analyze the protein intake of healthy adults undertaking regular muscle strength training.

Material and methods: This study was conducted on 168 healthy adults: 84 women (25.9±6.1 years) and 84 men (25.5±5.4 years) performing strength training on a regular basis (~4 times a week). Protein intake was determined using a structured questionnaire to quantify the amount, source, and frequency of protein consumed.

Results: The participants declared an average daily protein intake of 153.8±50.2 g, with women reporting lower intake (115.9±28.3 g) than men (184.8±42.2 g) ($p<0.001$). The main sources of protein were poultry meat, dairy products (e.g. milk, eggs), and protein supplements. 79% of participants declared using protein supplements, but no differences between women (79%) and men (80%) were found ($p> 0.05$). The amount of protein supplied by supplementation was, on average, 37.3±21.5 g with a lesser amount reported by women (28.6±13.2 g) than men (45.5±24.5 g) ($p<0.001$). 62.9% of participants consumed supplements in the form of whey protein concentrate and 42.6% took protein supplements immediately after training.

Conclusions: The study participants consumed an excess amount of protein in comparison to the recommended daily intake. Protein supplementation accounted for a ¼ of daily protein intake, most often consumed immediately after training and generally in the form of whey protein concentrate. Nutritional education is necessary to align the eating habits and supplemental intake of physically active adults, relative to strength-training demands.

KEYWORDS: protein, nutrition, amateur athletes, muscle strength training

Background

Proteins consist of amino acids the building blocks for all body tissue. Protein is the macronutrient supplied to the body with food. It is also one of the key dietary elements of populations with a high level of physical activity (PA), especially among those engaged in regular strength training that activates the major muscle groups.

Muscle protein turnover in the human body is a constant process involving muscle protein synthesis (MPS) and muscle protein breakdown (MPB). Over time, the net balance between MPS and MPB will determine whether an individual experiences a decrease, maintenance and increase in overall muscle mass. PA, especially resistance training, and nutritional intake (e.g. carbohydrate and protein availability), have a significant impact on this process [1,2]. Resistance training stimulates MPS, but also MPB. Depending on the method and quality of protein supplied, MPS may persist for up to 24 hours after training or longer in the case of large training volumes [3]. The time of protein intake, the number of meals containing protein during the day, the intervals between meals and between meals, and training are extremely important [4,5]. Studies show that protein consumed immediately after physical exercise has the greatest impact on muscle hypertrophy [6].

Current recommendations suggest higher protein demands for highly active populations to maximize metabolic adaptation to training [7,8]. The American Dietetic Association (ADA), Dietitians of Canada (DC) and American College of Sports Medicine (ACSM) issued a joint position in 2016, specifying the norms of protein intake for athletes at 1.2–2.0 g/kg of bodyweight (BW)/ day [9]. A similar guideline was offered by the International Society of Sports Nutrition (ISSN), with a daily protein intake of 1.4–2.0 g/kg of BW/ per day for populations engaged in high levels of physical activity [10]. In 2017, Morton in his meta-analysis recommended protein intake for individuals involved in strength training at 1.62 g/kg per day [11]. In a recent meta-analysis, Iraki and colleagues stated that 1.6–2.2 g/kg of BW is a sufficient (daily) amount of protein and should be consumed across 3–6 meals during the day [12]. Larger amounts of protein may be necessary during periods of intensified training [12,13]; thus, the amount of protein consumed every day can differ according to exercising demands. To estimate the protein demands for a given person, it is necessary to consider the amount of time, intensity and frequency of training, training period, availability of energy and other nutrients occurring in the diet [9].

Demand for protein should be covered by a classic, well-balanced diet. The main sources of whole protein are dairy products, meat sources and legume seeds. There is evidence that proteins derived from dairy products, and consumed after resistance training sessions, can lead to increases in muscle strength and mass [6,14,15]. Milk, lean meat, and protein supplements (egg, soy, whey, and casein proteins) are thought to intensify MPS [16]. Studies also show that protein supplements taken by those populations involved in strength training is relatively high [10,17]. However, supplementation with protein preparations is generally recommended for populations with high physical demands, and who are not able to meet their protein needs by consuming conventional meals [9].

Aim of the study

The aim of this study was to analyze the protein intake of healthy adults, currently participating in regular strength training, with a specific focus on the amount of consumed protein, sources of protein, and frequency of consumption.

Material and methods

Participants and study design

The study included 168 healthy adults, aged 18–47 years, who were recruited from sport clubs in Lodz across several strength sports: triathlon, bodybuilding training, weightlifting and crossfit. The criteria for inclusion was regular participation in one of above muscular strength training. Each person voluntarily agreed to participate in this study.

This study was carried out in 2017 and 2018. A structured questionnaire was used to collect the data. The questionnaire contained sixteen closed and short-answer questions about: sex, age, body mass, height, training, basic nutritional habits, protein and protein supplements taken. Each person completed the questionnaire before training starts and the results were sent back to the lead researcher.

Statistical methods

The data collected were analyzed in the Statistica 13.0 software package. The normality of data distribution was checked and verified using the Shapiro-Wilk test. All analyzed variables were normally distributed. Means and standard deviations for the study variables were calculated. Comparisons between women and men on each variable were carried out using an independent student T-test for quantitative variables. P-values of less than 0.05 were considered statistically significant.

Results

Participants

The study cohort comprised of 84 women and 84 men with a mean age of 25.7±5.8 years. The BMI values were 24.1±3.8 kg/m^2 overall, but were higher among men than women. The reported number of training sessions per week was 4.0±1.2 and the duration of a single workout was 79.0±25.2 min. The length of individual training sessions were longer for men (by 13.5 min) than that reported by women ($p < 0.05$). Data is presented in Tab. 1.

Table 1. Characteristic of study group.

Tested parameter	Average values		
	All (n=168)	Women (n=84)	Men (n=84)
Age [years]	25.7±5.8	25.9±6.1	25.5±5.4
Body mass [kg]	73.1±16.4	61.0±8.9	85.3±12.8
Height [cm]	173.4±9.2	166.5±5.8	180.3±6.3
BMI [kg/m^2]	24.1±3.8	22.0±2.8	26.2±3.6
Training sessions per week [number]	4.0±1.2	3.8±1.0	4.1±1.3
Duration of a training session [mins]	79.0±25.2	72.3±21.0*	85.8±27.0

Statistical significance women vs. men: * $p < 0.05$, ** $p < 0.01$

Main results

Overall, 60.12% of respondents declared eating 4 meals/day, including 70.24% of women and 50% of men, whereas only 1 woman (0.60% of all respondents) declared only 1 meal/day. 39.29% women and 27.38% men eat meals regularly, its mean every 3–4 hours (Tab. 2.)

Table 2. Number and regularity of meals during the day in study group.

Tested parameter		All (n=168)		Women (n=84)		Men (n=84)	
		n	[%]	n	[%]	n	[%]
Number of meals during a day	2	1	0.60	1	1.19	0	0.00
	3	20	11.90	5	5.95	15	17.86*
	4	101	60.12	59	70.24**	42	50.00
	≥5	46	27.38	19	22.62	27	32.14
Regularity of meals	Yes	56	33.33	33	39.29	23	27.38
	Partly	56	33.33	26	30.95	30	35.71
	No	56	33.33	25	29.76	31	36.90

Statistical significance women vs. men: * $p<0.05$, ** $p<0.01$

Respondents (n = 131) consumed an average of 153.8±50.2 g of protein per day, but at a lower overall level among women (n = 59) 115.9±28.3 g than men (n = 72) 184.8±42.2g ($p<.001$). Poultry was consumed several times a week for many participants (43.45%) and equally among women and men. Pork and beef, veal and lamb were consumed 1–3 times a month by 34.52% and 49.40% respectively. Fish and seafood, among 37.50%, were consumed 1–3 times a month. 25.60% declared that they do not consume milk, including 32.14% women and 19.05% men, while 22.02% consumed milk daily: 23.81% women and 20.24% men. Dairy products were consumed several times a week. Many participants – 36.31% – declared that they consumed legume seeds 1–3 times a month, while 21.43% did not consume legume seeds. 38.10% of participants ate eggs every day, including 41.67% women and 34.52% men. Data are showed in Tab. 3.

79% of participants reported taking protein supplements: 79% of women and 80% of men. The average amount of protein consumed during the day (n = 130) from supplements was 37.3±21.5 g, which is ¼ of the total amount of daily protein intake. Women (n = 63) consumed 28.6±13.2 g of protein via supplementation, compared to 45.5±24.5 g for men (n = 67) ($p<.001$).

Table 3. Frequency of high protein products intake.

Source of protein		Never		1-3 for a month		1 for a week		A few times for a week		Everyday		A few times for a day	
		n	%	n	%	n	%	n	%	n	%	n	%
Poultry	All	3	1.79	10	5.95	13	7.74	73	43.45	34	20.24	35	20.83
	Women	2	2.38	7	8.33	8	9.52	39	46.43	14	16.67	14	16.67
	Men	1	1.19	3	3.57	5	5.95	34	40.48	20	23.81	21	25.00
Pork	All	19	11.31	58	34.52	38	22.62	45	26.79	5	2.98	3	1.79
	Women	14	16.67	28	33.33	19	22.62	19	22.62	2	2.38	2	2.38
	Men	5	5.95	30	35.71	19	22.62	26	30.95	3	3.57	1	1.19
Beef, veal, lamb	All	32	19.05	83	49.40	25	14.88	25	14.88	1	0.60	2	1.19
	Women	18	21.43	39	46.43	13	15.48	13	15.48	0	0.00	1	1.19
	Men	14	16.67	44	52.38	12	14.29	12	14.29	1	1.19	1	1.19
Fish and seafood	All	15	8.93	63	37.50	61	36.31	24	14.29	5	2.98	0	0.00
	Women	3	3.57	29	34.52	32	38.10	16	19.05	4	4.76	0	0.00
	Men	12	14.29	34	40.48	29	34.52	8	9.52	1	1.19	0	0.00
Milk	All	43	25.60	29	17.26	9	5.36	32	19.05	37	22.02	18	10.71
	Women	27	32.14	12	14.29	1	1.19	15	17.86	20	23.81	9	10.71
	Men	16	19.05	17	20.24	8	9.52	17	20.24	17	20.24	9	10.71
Natural yogurt, kefir, buttermilk	All	26	15.48	32	19.05	23	13.69	42	25.00	34	20.24	11	6.55
	Women	11	13.10	13	15.48	12	14.29	20	23.81	21	25.00	7	8.33
	Men	15	17.86	19	22.62	11	13.10	22	26.19	13	15.48	4	4.76
Cottage cheese	All	20	11.90	21	12.50	23	13.69	58	34.52	32	19.05	14	8.33
	Women	10	11.90	10	11.90	15	17.86	28	33.33	16	19.05	5	5.95
	Men	10	11.90	11	13.10	8	9.52	30	35.71	16	19.05	9	10.71
Pulses	All	36	21.43	61	36.31	39	23.21	26	15.48	5	2.98	1	0.60
	Women	14	16.67	31	36.90	21	25.00	15	17.86	2	2.38	1	1.19
	Men	22	26.19	30	35.71	18	21.43	11	13.10	3	3.57	0	0.00
Eggs	All	4	2.38	12	7.14	15	8.93	59	35.12	64	38.10	14	8.33
	Women	3	3.57	4	4.76	6	7.14	31	36.90	35	41.67	5	5.95
	Men	1	1.19	8	9.52	9	10.71	28	33.33	29	34.52	9	10.71

A small number (20.47%) of participants used protein supplements to accelerate post-workout regeneration, including 22.12% women and 18.63% men. Some men (21.57%) used protein supplements to accelerate muscle growth. Over a third of adults (39.07%) reported taking nutrients for other reasons, including improving the palatability of dishes, a replacement for conventional protein sources or an easy way to meet protein demand.

The most frequently chosen form of protein supplement was whey protein concentrate (WPC) and whey protein isolate (WPI), constituting 62.96% and 29.63% of all respondents' responses. WPC was taken by 56.25% women and 69.51% men, while WPI was taken by 37.5% women and 21.95% men ($p<0.05$).

A large number (42.62%) of adults consumed a protein supplement after training: 42.53% women and 42.71% men, whilst 33.33% consumed protein supplements with meals: 40.23% women and 27.08% men. 40% of our cohort declared taking amino acid supplements. Most individuals were taking creatine (53.13%) and BCAAs (19.79%), whilst a small number (15.63%) used other amino acid supplements, including glutamine, EAA, leucine, arginine and citrulline. Data presented in Tab. 4.

Discussion

The study aim was to analyze self-reported protein intake among healthy adults who, on a regular basis, participated in strength training. The outcomes were quantified in terms of the amount, source, and frequency of protein intake.

The average BMI was 24.1±3.8 kg/m^2, which means that the study group was characterized by a normal body size. However, the BMI values of men were 26.2±3.6 kg/m^2, suggesting an overweight group, whilst the values for women at 22.0±2.8 kg/m^2 are consistent with a normal body size. Of course, BMI is not an appropriate tool for assessing the body composition of active populations, because it does not take into account the amount of muscle and fat tissue, which can differ significantly between highly active and sedentary populations with a similar BMI.

The number of daily meals and time interval between meals are important principals of proper nutrition for the general population, including athletic groups. In the present study, 60.12% of all respondents declared eating 4 meals throughout the day. The amount of meals consumed per day, particularly among highly active groups, can differ [18–23]. In the present study, 33.33% of all respondents declared somewhat regular meals each day.

Table 4. Characteristics of protein supplements intake in study group.

Tested parameter		All (n=132)		Women		Men	
		n	[%]	n	[%]	n	[%]
Purpose of protein supplements intake	regeneration acceleration	44	20.47	25	22.12	19	18.63
	↑ muscles mass	38	17.67	16	14.16	22	21.57
	↓ body mass	23	10.70	14	12.39	9	8.82
	↑ muscles strength	20	9.30	10	8.85	10	9.80
	↑ physical capacity	6	2.79	4	3.54	2	1.96
	other	84	39.07	44	38.94	40	39.22
Type of protein supplements intake	WPC – Whey Protein Concentrate	102	62.96	45	56.25	57	69.51
	WPI – Whey Protein Isolate	48	29.63	30	37.50*	18	21.95
	WPH – Whey protein Hydrolysate	2	1.23	1	1.25	1	1.22
	casein	6	3.70	1	1.25	5	6.10
	other	4	2.47	3	3.75	1	1.22
Duration of protein supplements intake	before training	10	5.46	4	4.60	6	6.25
	after training	78	42.62	37	42.53	41	42.71
	during training	0	0.00	0	0.00	0	0.00
	between meals	13	7.10	3	3.45	10	10.42
	with meals	61	33.33	35	40.23	26	27.08
	before sleep	21	11.48	8	9.20	13	13.54
Tested parameter		**All (n=67)**		**Women**		**Men**	
		n	**[%]**	**n**	**[%]**	**n**	**[%]**
Aminoacid supplements intake	creatine	51	53.13	11	42.31	40	57.14
	BCAA – branch chain amino acids	19	19.79	10	38.46	9	12.86
	B-alanine	11	11.46	3	11.54	8	11.43
	other	15	15.63	2	7.69	13	18.57

Statistical significance women vs. men: * $p<0.05$

Protein requirements should be determined individually for each person, depending on factors like training time, intensity and frequency, degree of advancement, energy availability and other nutrients in the diet. In this work, the amount of protein consumed was 153.8±3.8 g per day overall, but with lower protein consumption among women (115.9±28.3 g) than that seen for men (184.8±42.2 g). Women and men consumed 1.9 g/kg and 2.2 g/kg of protein (normalized for BW/day), respectively. Since the study involved active adults, but not highly active athletes, protein intake was deemed too high in relation to current recommendations [9–12]. Other data reflect these results, including Gondek et al. [24] who showed that men taking part in strength training consumed 187.52 g of protein per day. In a study by Chappell [25], the amount of protein ingested was 254 +/- 92.7 g/day among males and 172 +/- 28.3 g/day among females, with others reporting similar differences between men (276.7 +/- 82.1 g/day) and women (209.4 +/- 38.4 g/day) [26]. Pilis et al. [27] found that protein intake among powerlifters was 171.93 g/day, which coincides with the current results. In the study by Całyniuk et al. [28], protein intake among powerlifters and weightlifters was 197.48 g and 197.91g, being successively higher than our observations Gogojewicz et al. [29] assessed the amount of protein consumed by women participating in fitness classes, which was 54.8±15 g, being half the amount consumed by women in this work. Oliver et al. [30] conducted a study outside of the starting season, among other strength-training disciplines, and found that protein consumption was 1.18 g/kg of BW/day, which is insufficient based on current guidelines. Ismael [31] showed that protein intake amongst bodybuilders was 163.4 +/- 70.4 g/day.

The demand for protein should be covered by a conventional diet. It is extremely important to choose the appropriate food products and source of complete protein. Wholesome animal products will provide wholesome protein. In this research, those products containing protein most often were poultry, milk, natural yogurt, kefir, buttermilk, cottage cheese and eggs, while the consumption of fish and milk were less frequent. Both fish and milk should be included in the diet, as natural sources of wholesome protein, but also other vital nutrients that have a positive effect on exercise capacity and post-workout regeneration [32].

In studies conducted by other authors [21,23,25], meat appeared in the diet of populations almost every day, whilst our results showed that 43.45% respondents ate poultry several times a week and consumed pork (34.52%) and beef (49.40%) 1–3 times a month.

Contrary to the present study, where 37.50% consumed fish 1–3 times a month and 36.31% once a week, other studies noted that fish products were consumed daily or several times a week [21,23,25]. Current recommendations suggest at least 2 servings of fish a week [33]. Legume seeds are a particularly good substitute for animal products and good source of wholesome protein. Indeed, 36.31% of our respondents consumed legume seeds 1–3 times a month. Other studies have reported similar intake levels [23,25].

Studies show that milk enhances protein synthesis and thus, should be adopted as part of a balanced diet amongst physically active people [16,34]. We found that 25.60% of adults tested herein did not drink milk at all, while 22.02% consumed milk every day. In other studies, milk and dairy products are consumed daily [23] or several times a week [21]. Eggs are also a good source of protein. Therefore, it should be present in the diet for highly active individuals [33]. Not surprisingly, 38.10% of our participants consumed eggs daily, while 35.12% ate eggs several times a week, similar to other research in this area [25,35].

Morton et al. [11] indicated that protein supplementation can replenish a conventional diet and thus, have a positive effect on the development of muscle strength and mass. In 2016, Thomas et al. [36] draw a different conclusion in their meta-analysis, whereby protein supplementation did not significantly augment the beneficial effects of resistance exercise training. In present study, 79% of all respondents declared taking protein supplements, 79% of all women and 80% of all men. The number of people using protein supplements is similar to other studies [37–38]. In the present study, the amount of protein taken via supplementation was 37.3±21.5 g overall, but less for women 28.6±3.2 g versus men 45.5±24.5 g. In other work, the amount of protein taken by supplementation was highly variable; 38 g [27], 74.38 g [29], 46.71 g [39] among men undertaking strength training. The values obtained coincide somewhat with the present results.

Respondents justified the use of protein-based supplements to ensure, amongst other factors, faster regeneration (20.47% of all respondents), increase muscle mass (17.67%) and muscle strength (9.30%).

Our results showed that the most frequently chosen protein supplement is whey protein hydrolysate (WPH) and whey protein isolate (WPI) 62.96% and 29.63% respectively. Among amino acid supplements, respondents most often declared creatine (53.13%) and brain chain amino acids (BCAAs) (19.79%) intake. Respondents declared that they took supplements after training (42.62%) and with meals (33.33%). In other studies, the most frequently chosen protein supplement was creatine, protein nutrients, BCAA and other amino acids [37,38,40].

Both the present work and previous studies have shown that the use of protein supplements is popular among populations who regularly engage in strength training. The most used supplements include protein supplements, creatine and BCAAs.

The study results are limited by subjective reporting of protein intake, which may underestimate or overestimate actual consumption of this, and other, dietary factors. In addition, we did not dissect the nature of protein needs across different types of athletes or between groups employing different strength training protocols.

Conclusions

The balance between protein demand and supplementation is often mis-matched, as we saw in the current study. The main sources of protein are poultry, dairy products, and eggs. They also supply protein from protein supplements which constitute ¼ of the amount of total protein delivered daily. Whey protein concentrate, creatine and BCAA are the most common supplements. Nutrition-based educational programs are necessary to modify eating habits and better align supplement intake among healthy, physical active adults involved in strength training.

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