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COMPARATIVE ANALYSIS OF DIETARY INTAKE BETWEEN VEGETARIAN AND OMNIVOROUS STRENGTH TRAINING PRACTITIONERS: PROTEIN CONSUMPTION DISPARITY

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ABSTRACT

The interaction between a vegetarian diet and strength training remains an area lacking substantial information. However, it is recognized that both vegetarian and omnivorous practitioners require adequate energy and nutrient intake to optimize performance and muscle recovery. This study aimed to compare the dietary intake of omnivores versus vegetarian practitioners of resistance training. Dietary intake was assessed via 24-hour recall and analyzed using the WebDiet® software. A total of 79 (44.6%) vegetarians and 98 (55.4%) omnivores participated in this study, with a majority being female (81.0%) among vegetarians, while the sample among omnivores was equally distributed between genders. The mean energy intake was 27.8±10.5 kcal/kg/day and 29.0±9.4 kcal/kg/day in vegetarian and omnivorous women, respectively, while in men, it was 28.7±10.6 kcal/kg/day and 29.6±8.6 kcal/kg/day in vegetarians and omnivores, respectively. There was no significant difference in average carbohydrate and fat consumption between groups. Protein intake was significantly lower among vegetarians [(female veg=1.3±0.8g/kg/day vs Omniv.=1.7±0.7g/kg/day, p<0.001); (male veg=1.2±0.7g/kg/day vs Omniv.=1.7±0.6g/kg/day, p=0.001)]. In conclusion, vegetarians and omnivores displayed similar dietary intake, but vegetarians tend to consume less protein, which may impair muscle recovery and mass gain.

Key words: Vegan diet. Plant-based diet. Strength training. Food consumption.

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RESUMO

Análise comparativa da ingestão alimentar entre praticantes de treinamento de força vegetarianos e onívoros: disparidade no consumo de proteínas

A interação entre a dieta vegetariana e a prática de musculação é um campo que ainda carece de informações substanciais. Contudo, é reconhecido que tanto os praticantes vegetarianos quanto os onívoros necessitam de uma ingestão adequada de energia e nutrientes para otimizar o desempenho e a recuperação muscular. O objetivo deste estudo foi comparar o consumo alimentar de onívoros versus vegetarianos praticantes de musculação. A alimentação foi avaliada por recordatório de 24h e analisada no WebDiet®. Participaram deste estudo 79 (44,6%) vegetarianos e 98 (55,4%) onívoros praticantes de musculação, sendo a maioria do sexo feminino (81,0%) entre os vegetarianos; enquanto entre os onívoros a amostra estava igualmente distribuída entre os sexos. A ingestão energética média foi 27,8±10,5 kcal/kg/dia e 29,0±9,4 kcal/kg/dia nas mulheres vegetarianas e onívoras, respectivamente, enquanto nos homens vegetarianos foi 28,7±10,6 kcal/kg/dia e em onívoros 29,6±8,6 kcal/kg/dia. Não houve diferença significativa no consumo médio de carboidratos e gorduras entre os grupos. O consumo proteico foi significativamente menor entre vegetarianos [(mulheres veg=1,3±0,8g/kg/dia vs Oniv.=1,7±0,7g/kg/dia, p<0,001); (homens veg=1,2±0,7g/kg/dia vs Oniv.=1,7±0,6g/kg/dia, p=0,001)]. Conclui-se que vegetarianos e onívoros apresentam consumo alimentar semelhante, entretanto os vegetarianos tendem a consumir menos proteínas o que pode prejudicar a recuperação e o ganho de massa muscular.

Palavras-chave: Dieta vegana. Dieta a base de plantas. Treino de força. Consumo alimentar.

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INTRODUCTION

Physical exercise plays a crucial role in promoting health, well-being, and quality of life (Westcott, 2012).

In this context, strength training has gained prominence due to its growing number of enthusiasts (Gonçalves, Alchieri, 2010; Ministério da Saúde, 2022).

The goals of strength training practitioners range from increasing muscle mass to improving overall health and body aesthetics (Lima-Junior, Santos, 2022).

To achieve these goals and optimize adaptations to strength training, individuals must consume adequate amounts of energy and nutrients, particularly proteins (Mariuzza, Vogel, Bertani, 2021).

Amino acids from proteins play a fundamental role in synthesizing contractile and metabolic proteins, essential for strength training practitioners. Inadequate protein intake can impair protein synthesis and negatively impact muscle mass gain and recovery between workouts (Pinckaers et al., 2021).

In addition to quantity, protein quality is also relevant, as high-quality sources, such as animal proteins, have better bioavailability and higher essential amino acid content, influencing adaptations to strength training (Hevia-Larraín et al., 2021).

In this context, vegetarians, who follow a diet in which the consumption of animal proteins is partially or totally excluded (Slywitch, 2022), deserve special attention regarding their dietary intake. Among them, strict vegetarians, who exclude all sources of animal proteins, are at greater risk of protein deficiency (Couceiro, Slywitch, Lenz, 2008).

There is a lack of information on the effects of vegetarian diets on adaptations and performance to strength training (Craddock, Probst e Peoples, 2016, Hernández-Lougedo et al., 2023).

A recent study conducted by Hevia-Larraín et al., (2021), investigated the effects of a plant-based diet compared to an omnivorous diet on adaptations to strength training over 12 weeks. The results indicated that the plant-based diet was as effective as the omnivorous diet in promoting strength and muscle mass gains.

However, both groups (vegans and omnivores) received protein supplementation to ensure a daily intake of approximately 1.6g/kg/day.

Despite the increasing popularity of vegetarianism worldwide, Information on the dietary intake of vegetarian strength training practitioners is scarce, especially compared to omnivores.

Given the increasing number of both strength training practitioners and vegetarians, it is crucial to investigate the dietary patterns of these groups and assess differences in dietary intake between vegetarians and omnivores. Certainly, this information could contribute to the development of nutritional education and intervention strategies for this population.

Therefore, this study aimed to analyze and compare the dietary intake of vegetarian and omnivorous strength training practitioners.

MATERIALS AND METHODS

This is a cross-sectional study aimed at assessing the dietary intake of male and female, vegetarian, and omnivorous individuals. Subjects aged 18 years or older with at least three months of experience in strength training were included in the research.

For vegetarians, individuals who had been following this type of diet for at least three months were included. Volunteers were recruited through informative posters placed in gyms, colleges, and social media platforms, as well as through direct invitations by researchers.

Data were collected both online and in-person, with all volunteers having access to and providing informed consent through an Informed Consent Form (ICF) before providing any data. Participants were informed of their right to withdraw from the study at any time without any consequences. The research was approved by the Research Ethics Committee of the Federal University of Lavras under CAAE: 20221419.7.0000.5148.

Data collection occurred in two ways: online via Google Forms and in person at the Department of Nutrition of the Federal University of Lavras. Anthropometric data including weight and height were self-reported by participants who completed the online questionnaire with their most recent data for these variables. In-person data collection utilized a digital platform scale Líder®, model P-300C, with an accuracy of 0.1g, and a Sammy® stadiometer with an accuracy of 0.1cm for anthropometric data collection at the Department of Nutrition.

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Sociodemographic information (educational level, gender, age, city, and state of residence) was also collected. Vegetarian participants were asked about the type of vegetarian diet practiced (lacto-vegetarian, ovo-vegetarian, lacto-ovo-vegetarian, strict vegetarian, or vegan) and the duration of adherence to this dietary pattern. All participants were asked about the duration of their strength training practice, the use of nutritional supplements, and whether they had received or were currently receiving nutritional counseling.

Dietary intake was assessed using a 24-hour dietary recall for a typical day that included strength training.

Participants were instructed to detail the foods consumed at each meal, including portion sizes, preparation methods, and brands when necessary. The 24-hour recalls were analyzed using the WebDiet® software, with preference given to foods listed in the Brazilian Table of Food Composition (Food Research Center (FoRC), 2023).

To determine the percentage of energy intake adequacy, the recommendation from the Brazilian Society of Sports Medicine (BSSM, 2009) was used, which advocates for a consumption of 30 to 50 Kcal/kg/day.

For protein intake, the recommendation from the American College of Sports Medicine (Thomas et al., 2016) was used, which recommends a consumption of 1.2 to 2g/kg/day of protein.

Additionally, an analysis of apparent optimal intake (1,6g/kg) proposed by Morton et al., (2018), was conducted. Carbohydrate and fat intake were assessed based on the recommendations of (Iraki et al., 2019), which advocate for a consumption of 3-5g of carbo/kg/day and 0.5-1.5g of fat/kg/day. Daily fiber intake (25g for women and 38g for men) was evaluated according to the recommendations of the Institute of Medicine (2005).

All data were presented as mean ± 1 standard deviation and analyzed using SigmaPlot version 2012. Data normality was tested using the Shapiro-Wilk test.

To compare the means of anthropometric variables (weight, height, and BMI), and dietary variables (energy, carbohydrates, proteins, and lipids) between vegetarians and omnivores, the Student's t-test for independent samples or Mann-Whitney test was used.

The comparison of protein intake between vegans, lacto-ovo vegetarians, and omnivores was performed using analysis of variance or the Kruskall-Wallis test. The proportion of protein adequacy between vegetarians and vegans was compared using the chi-square test. A significant level of 5% was adopted for all analyses.

RESULTS

A total of 113 (63.4%) women and 64 (36.6%) men participated in this study. Overall, 79 (44.6%) subjects were vegetarians and 98 (55.4%) were omnivores.

Among vegetarians, female subjects predominated (81.0%), while there was an equal distribution of sexes among omnivores (50% men and 50% women).

Omnivores had significantly higher weight, height, and BMI than vegetarians (Table 1).

However, there was no significant difference in anthropometric variables between vegetarians and omnivores of the same sex.

This result may be explained by the predominance of women in the vegetarian group, as women generally have lower average weight and height than men.

Table 1 - Anthropometric characterization of vegetarian and omnivorous strength training practitioners.

Variables	Female		Male		All	
	Veg.	Oniv.	Veg.	Oniv.	Veg.	Oniv.
Age (years)	29,2±8,3	23,2±3,9#	30,5±7,8	23,2±4,2#	29,2±8,2	23,2±4,0#
Weight (kg)	58,6±6,9	61,0±10,5	75,0±9,5	78,9±12,9	61,7±9,8	70,1±14,8*
Height (m)	1,61±0,05	1,62±0,06	1,76±0,06	1,78±0,06	1,64±0,08	1,70±0,10*
BMI (kg.m^2)	22,3±2,3	23,09±3,6	24,16±2,5	24,78±3,4	22,6±2,4	23,9±3,6**

Data are presented as mean ± SD. Veg. = vegetarians, Oniv. = omnivores. #p<0,001 vegetarians greter than omnivores; *p<0.001, **p<0.01 omnivores greater than vegetarian.

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The majority of participants were either enrolled in or had completed higher education, engaged in strength training, and had been vegetarians for over 2 years. Approximately two-thirds of the participants reported using dietary supplements, with a significantly higher proportion in the vegetarian group (veg=81% vs oinv=53%, p=0.0001). Most vegetarians and omnivores reported having received or currently receiving nutritional counseling (Table 2).

Table 2 - Sociodemographic Characteristics, Physical Activity Practice Duration, Supplement Use, and Nutritional Counseling.

Groups	Vegetarian n=79	Omnivores n=98	All n=177
Sex			
Female	64(81%)	49(50%)	113(63,8%)
Male	15(19%)	49(50%)	64(36,6%)
Educational level			
≤ High school completed.	10(12,5%)	8(8,2%)	18(10,2%)
≤ College completed	69(87,5%)	90(91,8%)	159(89,8%)
Exercise experience (yrs.)			
< 6 mo.	15(18,98%)	30(30,6%)	45(25,4%)
6 mo. <1 yrs.	14 (17,7%)	15(15,3%)	29(16,3%)
1 ≤ 2 yrs.	15(18,98%	17(17,3%)	32(18%)
Supplement use			
Yes	64(81%)*	52(53%)	116(65,5%)
No	15(19%)	46(47%)	61(34,5%)
Nutritional counseling			
Yes	47(59,5%)	52(53%)	99(55,9%)
No	32(40,5%)	46(47%)	78(44,1%)

Data are presented as mean ± SD. Veg. = vegetarians, Oniv. = Omnivores. *P=0.0001. Vegetarians are greater than Omnivores.

Table 3 - Mean energy and macronutrient intake of vegetarian and omnivorous strength training practitioners.

Energy and nutrients	Female		Male	
	Veg. (n=64)	Oniv. (n=49)	Veg. (n=15)	Oniv. (n=49)
Energy (kcal)	1605,6±564,3	1723,1±484,4	2084,4±595,9	2297,7±656,9
Energy (kcal.kg/d)	27,8±10,5	29,0±9,4	28,7±10,6	29,6±8,6
Carbo (g)	217,1±92,0	223,8±80,0	286,5±105,4	308,5±103,4
Carbo (g/kg/d)	3,7±1,6	3,7±1,5	3,9±1,7	3,9±1,3
Carbo (%)	54,9±12,9	51,4±10,1	54,8±8,3	53,6±7,5
Protein (g)	77,3±43,6	101,4±35,0*	87,1±42,8	132,3±45,2**
Protein (g.kg/d)	1,3±0,8	1,7±0,7*	1,2±0,7	1,7±0,6**
Protein (%)	19,1±6,7	24,0±7,3*	16,6±6,6	23,2±5,8*
Fat (g)	51,3±26,4	52,1±27,3	68,7±25,8	66,2±27,3
Fat (g.kg/d)	0,89±0,5	0,86±0,4	0,9±0,39	0,85±0,3
Fat (%)	28,3±10,2	27,9±18,3	30,1±9,3	25,8±6,94

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Fiber (g)	36,3±23,5	29,6±12,0	47,2±11,0	27,7±12,7*

The data are presented as mean ± SD. Veg. = vegetarians, Oniv. = Omnivores. *p<0.001, **p=0.001 Omnivores greater than vegetarians.

Due to the disparity in sex distribution within the omnivorous and vegetarian groups, with a high predominance of women in the vegetarian group, dietary data were compared within each sex separately (Table 3).

There was no significant difference (p>0.05) in energy, carbohydrate, and lipid intake between vegetarians and omnivores within each sex.

The mean energy intake was lower than the minimum recommended by the Brazilian Society of Sports Medicine (30-50 Kcal/kg/day). Conversely, the mean carbohydrate and lipid intake in g/kg/day of body weight were within the ranges recommended by Iraki et al., (2019).

Omnivores had a significantly higher protein intake than vegetarians in both sexes (p<0.01). Dietary fiber intake was significantly higher in male vegetarians compared to omnivores (p<0.001), but there was no significant difference among women.

The average protein intake per kilogram of body weight (g/kg/day) was significantly higher in omnivores compared to vegans and lacto-ovo vegetarians (Figure 1).

However, there was no significant difference between lacto-ovo vegetarians and vegans (Vegans = 1.22 ±0.50 g/kg vs lacto-ovo = 1.44 ±0.90 g/kg, p=0.39).

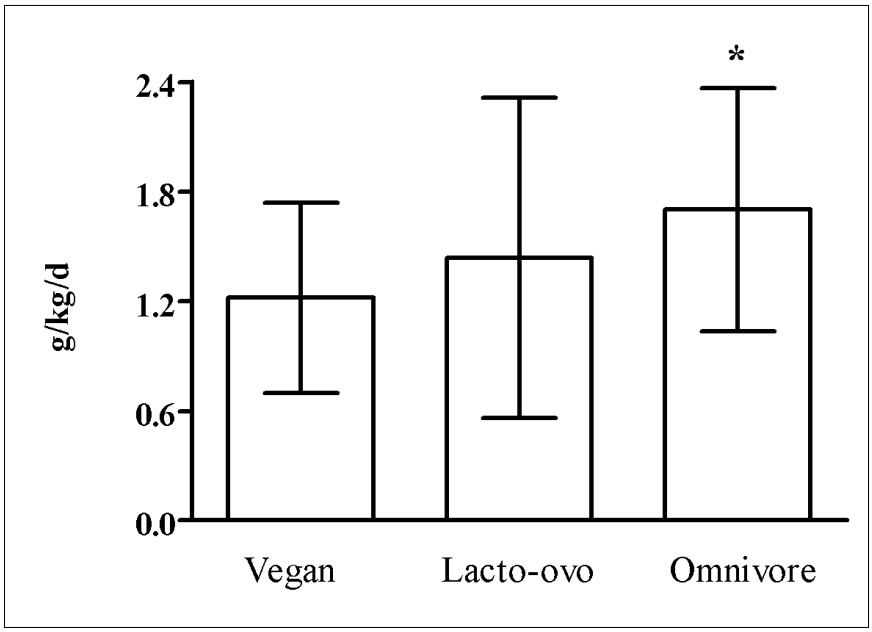

Figure 1 - Protein consumption per kilogram of body weight of vegetarian and omnivorous strength training practitioners. *p<0.05 omnivores is significantly higher than ovo-lacto vegetarians and vegans
Source: Own elaboration

The percentage of lacto-ovo vegetarians and vegans with protein intake below 1.2g/kg/day and 1.6g/kg/day was significantly higher when compared to omnivores (p<0.01) (Figure 2).

This highlights that although the average protein intake per kilogram of body weight was within the recommended range, there were individuals who did not reach the minimum recommended intake (1.2g/kg/day) or the ideal intake (1.6g/kg/day), especially among vegans, where 60.7% and 82.1% of the sample had protein consumption below 1.2g/kg/day and 1.6g/kg/day, respectively.

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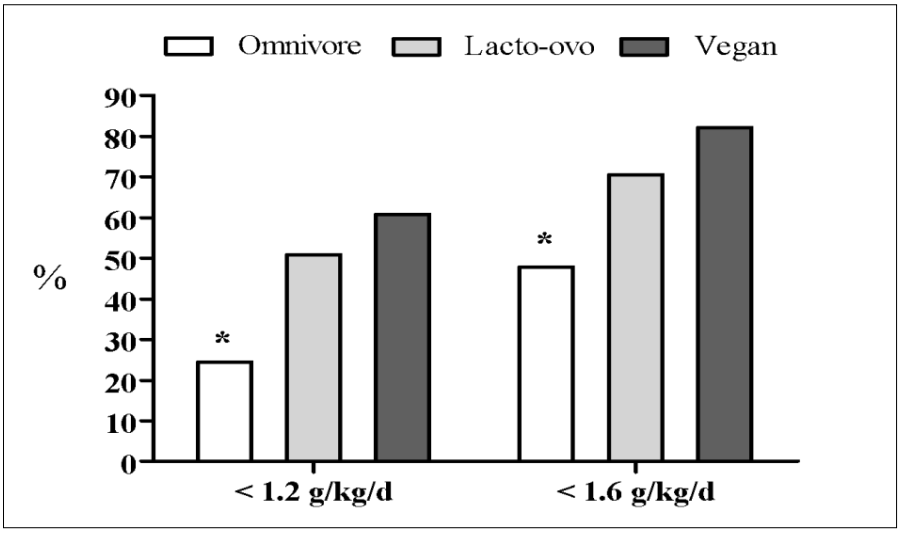

Figure 2 - Percentage of vegetarian and omnivorous strength training practitioners with protein intake below the minimum or "optimal" intake. *p<0.01 omnivores' percentage was significantly lower than ovo-lacto vegetarians and vegans. Source: own elaboration.

The sources of protein consumed by participants varied significantly (Figure 3). As expected, vegetarians predominantly consume protein from plant sources (77.8%), while omnivores primarily ingest protein from animal sources (69.3%).

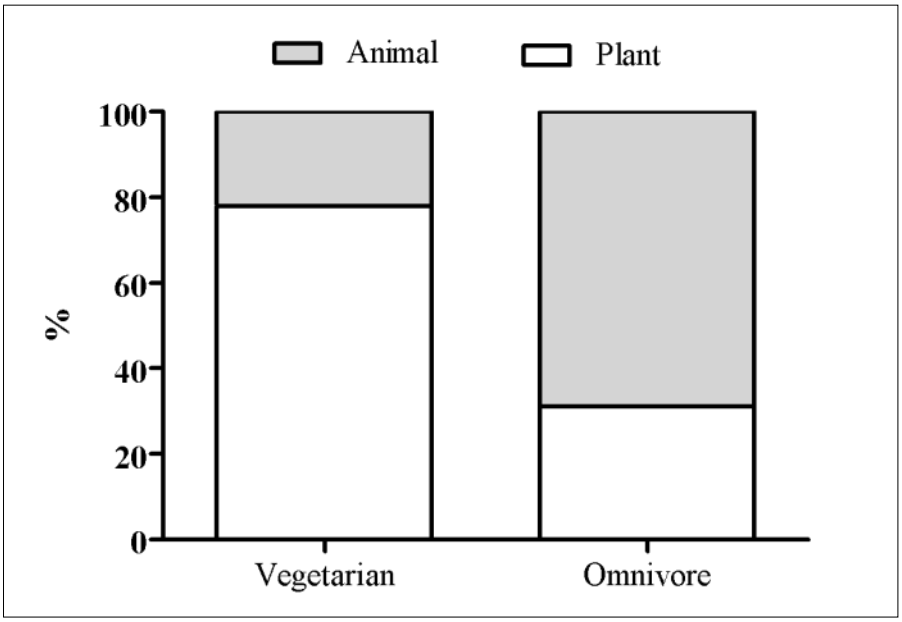

Figure 3 - The proportion of animal and plant proteins consumed by vegetarian and omnivorous strength training practitioners. Source: own elaboration.

Protein intake per meal was analyzed by considering meals consumed by all participants (Figure 4).

Omnivorous and vegetarian women reached the recommended minimum intake (20g per meal) only at lunch and dinner. Omnivorous men achieved the minimum protein intake at lunch, afternoon snack, and dinner, while male vegetarian subjects only reached the recommended minimum intake range at lunch. Furthermore, in both sexes, omnivores had significantly higher protein consumption at

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lunch and dinner compared to vegetarians ($p<0.001$).

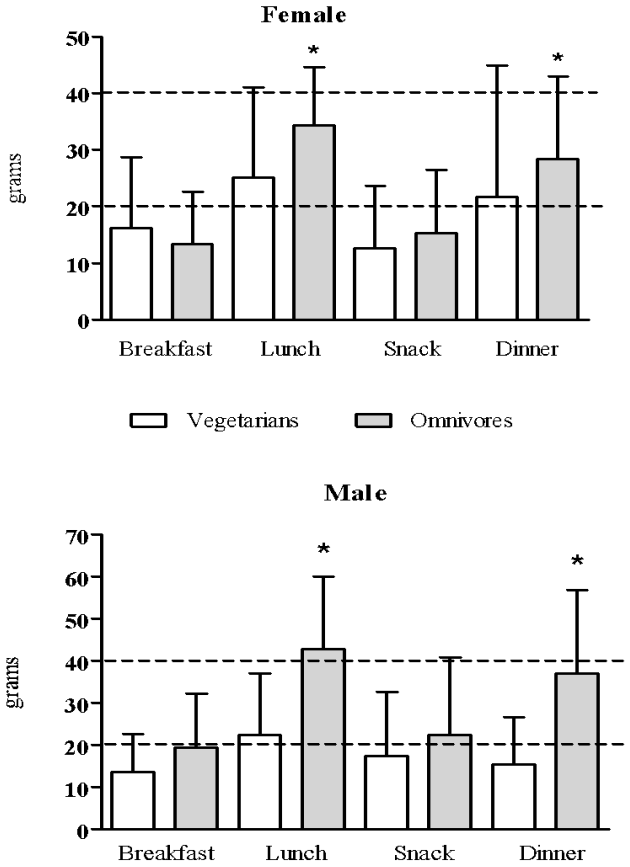

Figure 4 - Protein consumption per meal of vegetarian and omnivorous strength training practitioners. *p<0.001 omnivores is significantly higher than vegetarians. Source: own elaboration.

DISCUSSIONS

To our knowledge, this is the first study to compare the dietary intake of vegetarians and omnivores practicing strength training.

The main findings revealed a disparity in protein consumption between the two dietary groups. It was found that, regardless of gender, omnivorous individuals had a significantly higher protein intake per kilogram of body weight compared to vegetarians. Only omnivorous men met the minimum protein intake at all meals (20g at breakfast, lunch, snack, and dinner).

On the other hand, there was a trend of lower fiber intake among omnivorous individuals, especially males. Additionally, it was observed that energy intake fell below recommended levels in both population groups.

The lower protein intake in vegetarian athletes was also observed in the systematic review by Hernández-Lougedo et al., (2023). Although vegetarians have a significantly lower protein intake compared to omnivores, their average consumption (≥1.2g/kg/day) would be considered sufficient for strength training practitioners, according to the guidelines established by the American College of Sports Medicine (Thomas et al., 2016).

However, it was observed that 54.4% of vegetarians had a daily protein intake per kilogram of body weight below the recommended minimum (1.2g/kg/day). Therefore, it is relevant to individually assess each subject to ensure adequate protein intake.

Scientific guidelines have recommended a wide range of protein intake (1.2 to 2.0 g/kg/day) for athletes in any sports discipline (Jäger et al., 2017; Thomas et al., 2016).

However, studies suggest that a protein intake of around 1.6 g/kg/day appears to be

effective in maximizing muscle mass and strength gains in healthy adults engaged in resistance training programs (Hevia-Larraín et al., 2021; Morton et al., 2018). In the present study, only 17.9% and 29.5% of vegans and lacto-ovo vegetarians had protein consumption equal to or greater than 1.6 g/kg. In contrast, the majority of omnivores (52.1%) consumed more than 1.6 g/kg/day.

Therefore, considering the optimization of protein synthesis, recovery, and muscle mass gain, the vegetarian dietary pattern and even more so the vegan one, if not well planned, may impair and reduce adaptations to training and recovery in athletes and strength exercisers.

The even distribution of protein throughout meals has been recognized as an important aspect of optimizing muscle protein synthesis and, consequently, promoting positive adaptations to resistance training (Hudson, Iii, Campbell, 2020; Morton et al., 2018).

The International Society of Sports Nutrition has advocated for a minimum protein intake of 20g per meal to optimize protein synthesis (Jäger et al., 2017).

In the present study, protein consumption was concentrated at lunch and dinner. Both vegetarian and omnivorous women had a mean protein intake equal to or greater than 20g only at lunch and dinner.

However, vegetarian men reached this range only at lunch. The best distribution of protein consumption was observed in omnivorous men who reached the recommended range in three meals: lunch, snack, and dinner.

Comparable results were found in the study by Andrade et al., (2021), where the average protein intake per meal was within the recommended range only at lunch, dinner, and supper, with male subjects consuming a higher quantity at dinner compared to females.

Increasing protein intake to at least 20g per meal can help optimize adaptations to strength training. In the study by Martini et al., (2023) lacto-ovo-vegetarians and non-vegetarians were encouraged to increase their protein intake to at least 20g/meal.

After 12 weeks, vegetarians and non-vegetarians had similar changes in body composition, muscle size, and strength adaptations.

Animal proteins are typically considered superior to plant proteins due to their higher content of essential amino acids and better digestibility. However, the true effects of protein sources on resistance training adaptations are still not clear (Lim et al., 2021).

As expected, in the present study, vegetarians consumed proteins predominantly from plant sources (77.8%), while the majority of proteins (69.3%) ingested by omnivores originated from animal sources.

In the study by Hevia-Larraín et al., (2021), no differences were found in the gain of strength and muscle mass in the lower limbs of vegans and omnivores undergoing resistance training for 12 weeks. It is worth noting that the authors increased protein intake for vegans and omnivores to about 1.6 g/kg/day and distributed proteins in 4 meals more evenly. However, to achieve this amount, vegans had to consume approximately half of their daily protein in the form of supplementation (soy protein isolate), which does not reflect the reality of this population group.

To assist strength training practitioners and other vegetarian athletes in meeting the daily protein recommendation, we suggest encouraging them to consume plant-based foods with high protein content, such as textured soybeans, lentils, almond milk, and flax seeds, among others (Hernández-Lougedo et al., 2023).

Dietary fibers have been shown to enhance microbiota diversity, thereby enhancing nutrient and energy metabolism, inflammation, oxidative stress, and immunological responses (Donati Zeppa et al., 2019).

Conversely, high consumption of red meat and animal fat negatively affects these parameters. In the present study, the mean intake of dietary fibers was significantly higher in male vegetarians ($p<0.001$) and tended to be higher in female vegetarians ($p=0.08$) compared to omnivores.

Only male omnivores had a mean intake of dietary fiber below the recommendation (38g/day). The low consumption of fiber by resistance-trained individuals was also observed by (Souza et al., 2021), who found that 100% of men and 92.3% of women did not meet the dietary fiber intake proposed by the Institute of Medicine (2005).

In the present study, the average energy intake of both groups was found to be below the recommendations established by the Brazilian Society of Sports Medicine (BSSM,

2009), which advocates for a range of 30 to 50 kcal/kg/day.

This observation of low energy intake was also supported by other investigations (Silva Junior, Abreu, Silva, 2017; Souza et al., 2021). It is worth noting that energy intake below the recommended levels can increase the risk of developing Relative Energy Deficiency in Sport (RED-S) syndrome, contributing to immunological, hormonal, metabolic dysfunctions, compromised bone health, muscle recovery, and physical performance, among other issues (Fagerberg, 2018; Mountjoy et al., 2023).

Additionally, the results of the study conducted by Ribeiro et al., (2019) indicated a positive correlation between energy intake and muscle strength gains in bodybuilders, suggesting potential negative effects for the participants of the present study aiming to increase muscle mass. It is relevant to point out that bodybuilders often adopt energy-restricted diets for varying periods, typically between 2 to 6 months, intending to reduce fat mass and increase muscle definition, which could justify the observed low energy intake in the present study. However, this issue was not addressed in the current investigation.

Although some studies show no differences in performance between vegetarians and omnivores in strength sports, there is still a lack of evidence (Craddock, Probst, Peoples, 2016; Hernández-Lougedo, 2023).

Further studies are warranted to investigate the impacts of these dietary patterns on vegetarians and omnivores among resistance-trained individuals. Future research should address the association of both vegetarian and omnivorous dietary patterns with long-term strength training adaptations (>12 weeks).

Additionally, it is suggested that vegans and lacto-ovo vegetarians be evaluated separately, as the latter maintains a considerable intake of animal protein.

CONCLUSION

In summary, the present investigation revealed a significant disparity in protein consumption between the groups, with omnivorous individuals typically ingesting higher quantities.

However, vegetarians demonstrated the ability to attain adequate levels of protein intake, albeit in lower proportions. These findings underscore the importance of a meticulous dietary approach to meet the nutritional needs of resistance-trained individuals, irrespective of their dietary preferences.

Strategies such as diversifying plant protein sources and, when necessary, appropriate supplementation may be considered to fulfill the protein demands of vegetarian resistance-trained individuals, particularly vegans.

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