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ORIGINAL ARTICLE

Nutrition status of elite Jiu-Jitsu athletes during training season

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ABSTRACT

Optimizing high-intensity Jiu-Jitsu requires careful nutritional consideration, impacting body composition and performance. Balancing dietary intake with expenditure enhances athlete performance. This study, conducted with ten healthy Jiu-Jitsu athletes from the Jiu-Jitsu Association of Thailand, scrutinized their dietary intake compared to recommendations and its correlation with body composition to enhance performance and training adaptations. Participants completed three days of 24-hour dietary recalls. body composition was assessed using bioelectrical impedance analysis. Across both genders, total energy intake is inadequate, with carbohydrate consumption falling significantly below the recommended levels ($p < .05$). Female athletes showed significant positive correlations between dietary intake and body composition, notably with protein intake and skeletal muscle mass percentage and the skeletal muscle mass index (r = .895, and .963, respectively, $p < .05$). Conversely, male athletes displayed no significant correlations, but a broader analysis across genders revealed a strong positive correlation between protein consumption and muscle mass (r = .685, $p < .05$). The study highlights inadequate dietary intake, particularly in carbohydrates, among Jiu-Jitsu athletes during training, potentially compromising competition performance due to insufficient energy sources. Addressing these nutritional deficiencies is crucial to optimizing performance and body composition, emphasizing the need for dietary practice improvements among Jiu-Jitsu athletes.
Keywords: Sport medicine, Sports nutrition, Combat sports, Body composition.

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INTRODUCTION

Dietary intake among athletes is important. Inadequate dietary intake or over-consumption among athletes can result in alterations to body composition and body weight. These changes, stemming from insufficient or excessive food intake, may adversely affect a player's ability to perform and sustain activity during competition. An imbalance between energy expenditure and dietary intake, marked by a surplus of expenditure over dietary intake, has the potential to lead to the depletion of muscle mass, reduced performance, or an increased susceptibility to injury (Madison et al., 2023). Therefore, maintaining energy balance through appropriate energy consumption is crucial to ensure the correct intake of nutrients necessary for optimal athletic performance (Afrifa et al., 2020).

The high-intensity and intermittent nature of play and training for Jiu-Jitsu athletes necessitate a strategic approach to harnessing their potential to meet increased energy demands (Artioli et al., 2013). From meticulous pre-competition preparations to the culmination of events, nutrition emerges as the principal determinant influencing the health and performance outcomes of athletes. To sustain optimal health and robust physical fitness, athletes must be mindful of special nutritional considerations, given the metabolic and energy demands required for both practice and competition (Jagim et al., 2021). The estimated energy requirement (EER) for athletes is determined based on their physical activity levels (Nepocatych et al., 2017). Adequate nutrition not only enhances an athlete’s training, performance, and recovery but also plays a crucial role in maintaining appropriate body composition, immune function, and musculoskeletal health (Heaton et al., 2017). The judicious selection of food, ensuring both appropriate quality and quantity, is deemed paramount. This aspect holds particular significance for athletes and is recognized as a pivotal factor contributing to the enhancement of their health and overall effectiveness in competitive endeavours (Papadopoulou, 2020).

The primary source of energy for Jiu-Jitsu athletes is carbohydrates (Januszko & Lange, 2021). Carbohydrate recommendations are crucial to maintaining exercise, as they are directly linked to muscle glycogen content. Scientific evidence supports the notion that an appropriate level of carbohydrate intake is associated with increased strength and enhanced muscle glycogen storage (Artioli et al., 2013; Greene et al., 2017; Murray & Rosenbloom, 2018; Januszko & Lange, 2021). In "*grappling*" Jiu-Jitsu sports, there is a heightened reliance on anaerobic lactic metabolism (Andreato et al., 2017; Almeda et al., 2023). The protein intake recommendation in Jiu-Jitsu athletes' diets is notably higher compared to non-training individuals, aiming to ensure consistent muscle protein synthesis (Januszko & Lange, 2021). In the realm of sports, it is well established that the loss of muscle mass can significantly impact an athlete's performance, affecting strength and power capacity (Artioli et al., 2013). This holds particular significance for Jiu-Jitsu athletes, where competitive performance heavily relies on strength and power.

Hence, the purpose of this study was to scrutinize the dietary intake and body composition of healthy Jiu-Jitsu athletes affiliated with the Jiu-Jitsu Association of Thailand and study potential associations between dietary intake and body composition. The hypothesis posited was that athletes maintain an adequate diet, a factor that is expected to manifest in their body composition.

MATERIAL & METHODS

Study design

This cross-sectional study was collected in 10 training facilities of the Jiu-Jitsu Association of Thailand at Rajamangala National Stadium, adhered to the principles outlined in the Declaration of Helsinki and received approval from the Kasetsart University Research Ethics Committee (COA No. COA66/030). The sample size determination involved a power calculation utilizing an effect size of 2.53, an alpha error of 0.05, a power of 0.95, and 95% coefficient limits, conducted using G*Power 3.1.9.7. software from Dusseldorf, Germany. Dietary intake and body composition evaluations were conducted during the initial stages of the general preparation phase, taking place within the training facilities of the Jiu-Jitsu Association of Thailand at Rajamangala National Stadium during the same week.

Participants

Ten healthy Jiu-Jitsu athletes, comprising five males and five females, were recruited for this study. Participants were affiliated with the Jiu-Jitsu Association of Thailand. The inclusion criteria mandated that participants be current Jiu-Jitsu athletes with at least one year of training experience and no history of heart disease. During the general preparation phase for the national competition, participants adhered to a consistent training regimen, involving five days per week with three and a half hours of training per day, characterized by a moderate to high level of physical activity. Informed consent was obtained from each participant before their engagement in the study.

Assessment of dietary intake

Dietary intake among the athletes was evaluated through a 24-hour dietary recall. This assessment was conducted over two weekdays and one weekend day. The evaluation utilized 3-day estimated food diaries obtained during the training phase, concurrent with the body composition assessment. The total energy (kcals) and macronutrient intake (g and %) were analysed using the INMUCAL-Nutrients V.4.0 software program. To account for variations in body mass, relative energy and macronutrient intakes were normalized to body mass (g/kg/d).

Resting Metabolic Rate (RMR)

The Resting Metabolic Rate (RMR) represents the total calories expended by the body when in a state of complete rest. The RMR was determined using the Mifflin St. Jeor Equation: (Mifflin et al., 1990).

Male: 10 x weight (kg) + 6.25 x Height (cm) - 5 x Age (year) + 5
Female: 10 x Weight (kg) + 6.25 x Height (cm) - 5 x Age (year) – 161

Estimated Energy Requirement (EER)

The Estimated Energy Expenditure (EER) for all participants was determined through a comprehensive 5-day exercise record. This record documented all structured physical activities, detailing the modality, duration, and intensity of each activity. To quantify the energy expenditure, the exercise records were cross-referenced with The Compendium of Physical Activities to ascertain the metabolic equivalents (METs) associated with each type of exercise. The EER was then calculated using the following equation: (Klein et al., 2023).

EER = Resting Metabolic Rate (kcal) × Activity Factor (1 kcal/kg/day)

Dietary intake recommendations

The recommended energy consumption was determined by employing the Mifflin St. Jeor formula, as outlined by Frankenfield et al. (2005), which involves multiplying the resting metabolic rate by a fixed activity factor of 1.82, as deemed appropriate for the utilized formula. Macronutrient recommendations in grams were computed using the following equation:

$$\frac{\text{Estimated Energy Requirement (kcal)} \times \text{Acceptable Macronutrient Distribution Range (\%)}}{100 \times \text{Energy from Each Macronutrient}}$$

The recommended macronutrient distribution range suggests that 60-70% of the total caloric intake should come from carbohydrates, with the specific amount of protein, ranging from 10-35%, being dependent upon the mode and intensity of the exercise. Additionally, 20-35% of the caloric intake is recommended to be derived from fats. These guidelines align with the nutritional recommendations put forth by respected authorities such as The International Society of Sports Nutrition (ISSN) (Jäger et al., 2017; Kerksick et al., 2017) and Nutrition in Combat Sports (Manore, 2005; Zello, 2006; Artioli et al., 2013; Januszko & Lange, 2021; Shaw, 2022).

Body composition assessment

Body composition assessments were conducted utilizing Bio-Impedance Analysis (BIA) with the TANITA MC-780 device. All measurements were performed in the morning following an overnight fast of 8-12 hours. Participants were instructed to wear shorts and abstain from vigorous exercise on the day preceding the measurement. The outcomes of the BIA scan were employed to estimate various parameters, including Body Mass (kg), Body Mass Index (BMI, kg/m²), Body Fat Percentage (%), Body Fat Mass (kg), Lean Body Mass (kg), and Muscle Mass (kg), Skeletal Muscle Mass (kg and %). The Skeletal Muscle Mass Index (SMI) is determined by dividing the sum of the appendicular muscle mass (AMM) in kilograms by the square of the body height in meters (Oshita & Myotsuzono, 2021).

Statistical analysis

Descriptive statistics were computed and presented as means and standard deviations (SD). The Shapiro-Wilk's normality test was applied to each variable individually to assess the normal distribution of the data. In cases of normal distribution, the Paired T-test was employed to compare the mean difference between two corresponding samples. Conversely, for non-normally distributed data, the nonparametric Wilcoxon signed rank-test was utilized. Pearson correlation coefficients were conducted to examine the relationship between dietary intake and body composition, analysed separately. Statistical significance was accepted at a *p*-value of < .05. The strength and direction of the linear relationship were presented with Pearson's correlation coefficients (R). Statistical analysis was conducted using R program version 3.4.1.

RESULTS

The characteristics of the 10 athletes are detailed in Table 1. 5 females and 5 males Jiu-Jitsu athletes exhibited similarities in age, body mass, and body mass index. However, a statistically significant difference between females and males in terms of body height, body fat (kg and %), lean body mass, muscle mass, skeletal muscle mass (kg and %), skeletal muscle mass index, and resting metabolic rate ($p < .05$).

The statistical details of dietary intake and a comparison with recommendations for both female and male athletes can be found in Table 2 and Table 3. In both female and male athletes, total energy intake is inadequate, wherein carbohydrate consumption falls significantly below the recommended levels ($p < .05$).

The results indicate that the dietary intake of both female and male athletes falls below the recommended total energy requirements. Additionally, a comparative analysis of carbohydrate consumption, a key macronutrient, reveals that both female and male athletes are significantly below the recommended daily intake, as evidence. Despite the Jiu-Jitsu athlete's energy intake being less than recommended, their body weight remained constant. This contrasts with the consumption patterns observed in the protein and fat groups, where both female and male athletes adhere closely to the recommended daily amounts.

Table 1. Descriptive characteristics of the entire sample have been categorized based on gender.

Variables	Female (n = 5)	Male (n = 5)	*p*-value
Age (years)	22.80 ± 4.27	22.80 ± 2.68	1.000
Body mass (kg)	63.20 ± 10.49	61.54 ± 5.41	.761
Body height (cm)	160.20 ± 4.32	168.20 ± 3.03	.010*
BMI (kg/m²)	24.54 ± 3.25	21.74 ± 1.39	.114
Body fat (kg)	19.98 ± 5.64	5.56 ± 2.04	.001*
Body fat (%)	31.16 ± 3.28	8.92 ± 2.65	.000*
Lean body mass (kg)	43.22 ± 4.93	55.98 ± 3.75	.002*
Muscle mass (kg)	40.58 ± 4.49	53.08 ± 3.55	.001*
Skeletal muscle mass (kg)	24.18 ± 3.55	32.34 ± 3.00	.004*
Skeletal muscle mass (%)	38.40 ± 1.72	52.26 ± 3.75	.000*
Skeletal muscle mass index (kg/m²)	7.93 ± 1.17	9.35 ± 0.48	.037*
Resting metabolic rate (kcal)	1348.60 ± 187.97	1592.60 ± 115.59	.039*

*Note. Data presented as means ± SD. * p < .05, significantly different.*

Table 2. Dietary intake of female athletes compared with dietary intake recommendations. (n = 5)

Variables		Dietary intake	Recommendations	*p*-value
Carbohydrate	g	202.40 ± 20.10	368.17 ± 51.31	.021*
	g/kg/day	3.30 ± 0.71	5.48 ± 0.20	.000*
Protein	g	88.21 ± 19.42	92.04 ± 12.83	.250
	g/kg/day	1.40 ± 0.23	1.46 ± 0.05	.264
Fat	g	65.34 ± 11.80	68.18 ± 9.50	.250
	g/kg/day	1.05 ± 0.20	1.08 ± 0.04	.345
Total energy intake	kcal/day	1750.45 ± 146.40	2454.45 ± 342.11	.021*

*Note. Female athletes' ingestion data is computed as the mean ± SD from 3-day nutrition protocols. * p < .05.*

Table 3. Dietary intake of male athletes compared with dietary intake recommendations. (n = 5)

Variable		Dietary intake	Recommendations	*p*-value
Carbohydrate	g	205.31 ± 43.99	433.58 ± 32.67	.000*
	g/kg/day	3.36 ± 0.81	7.05 ± 0.15	.000*
Protein	g	116.61 ± 24.62	108 ± 8.17	.262
	g/kg/day	1.91 ± 0.46	1.76 ± 0.04	.259
Fat	g	101.35 ± 29.87	80.29 ± 6.05	.118
	g/kg/day	1.67 ± 0.57	1.31 ± 0.03	.112
Total energy intake	kcal/day	2199.87 ± 469.29	2890.52 ± 217.81	.031*

*Note. Male athletes' ingestion data is computed as the mean ± SD from 3-day nutrition protocols. * p < .05.*

The correlation between dietary intake and body composition among female athletes is delineated in Table 4, whereas the corresponding information for male athletes is provided in Table 5.

In the examination of the correlation coefficient (Table 4), it is evident that carbohydrate intake, measured in grams per kilogram per day, exhibits extreme negative correlations with various anthropometric measures, including body mass (kg), BMI (kg/m²), body fat (kg and %), muscle mass (kg), and skeletal muscle mass (kg) (r = -.966, -.885, -.987, -.992, -.929, -.880, respectively). Moreover, a significant extreme positive correlation is evident between protein intake and both skeletal muscle mass percentage and the skeletal muscle mass index (r = .895, .963, respectively), underscoring statistical significance ($p < .05$).

Table 4. Correlation analysis between dietary intake and body composition of female athletes. (n = 5)

Dietary Intake	Body Composition							
	Body Mass (kg)	BMI (kg/m²)	Body Fat (kg)	Body Fat (%)	MM (kg)	SMM (kg)	SMM (%)	SM (kg/m²)
CHO (g)	-0.863	-0.780	-0.911*	-0.968**	-0.798	-0.746	0.722	-0.563
CHO (g/kg/d)	-0.966**	-0.885*	-0.987**	-0.992**	-0.929*	-0.880*	0.652	-0.703
PRO (g)	0.714	0.849	0.645	0.456	0.782	0.863	0.265	0.963**
PRO (g/kg/d)	-0.077	0.159	-0.169	-0.380	0.030	0.170	0.895*	0.453
FAT (g)	0.422	0.426	0.392	0.314	0.453	0.452	-0.033	0.446
FAT (g/kg/d)	-0.383	-0.332	-0.408	-0.449	-0.343	-0.318	0.380	-0.207
Total energy intake (kcal/d)	0.210	0.331	0.127	-0.062	0.306	0.376	0.513	0.526

*Note. CHO = carbohydrates, PRO = protein. BMI = Body Mass Index, MM = Muscle Mass, SMM = Skeletal Muscle Mass, SMI = Skeletal Muscle Mass Index. ** Correlation is significant at the .01 level (2-tailed). * Correlation is significant at the .05 level (2-tailed). Strength of correlation very weak: <0.20; weak: 0.20–0.39; moderate: 0.40–0.59; strong: 0.60–0.79; very strong: >0.80.*

The analysis of correlations between dietary intake and body composition in male athletes (Table 5) revealed that none of the correlations reached statistical significance. However, in the examination of the correlation coefficient, it became apparent that carbohydrate intake, measured in grams per kilogram per day, exhibits weak to moderate negative correlations with various anthropometric measures, including body mass (kg), BMI (kg/m²), body fat (kg and %), muscle mass (kg), and skeletal muscle mass (kg) mirroring the findings in female athletes (r = -.491, -.254, -.421, -.354, -.481, -.396, respectively).

Table 5. Correlation analysis between dietary intake and body composition of male athletes. (n = 5)

Dietary Intake	Body Composition							
	Body Mass (kg)	BMI (kg/m²)	Body Fat (kg)	Body Fat (%)	MM (kg)	SMM (kg)	SMM (%)	SMI (kg/m²)
CHO (g)	-0.154	0.087	-0.130	-0.108	-0.153	-0.127	-0.137	-0.174
CHO (g/kg/d)	-0.491	-0.254	-0.421	-0.354	-0.481	-0.396	-0.069	-0.393
PRO (g)	-0.062	0.275	-0.410	-0.526	0.135	0.332	0.457	0.221
PRO (g/kg/d)	-0.397	-0.067	-0.681	-0.747	-0.201	0.053	0.504	0.004
FAT (g)	-0.580	-0.203	-0.559	-0.527	-0.429	-0.344	0.032	-0.450
FAT (g/kg/d)	-0.646	-0.359	-0.677	-0.628	-0.564	-0.440	0.089	-0.502
Total energy intake (kcal/d)	-0.361	-0.026	-0.455	-0.453	-0.275	-0.175	0.063	-0.277

*Note. CHO = carbohydrates, PRO = protein. BMI = Body Mass Index, MM = Muscle Mass, SMM = Skeletal Muscle Mass, SMI = Skeletal Muscle Mass Index. ** Correlation is significant at the .01 level (2-tailed). * Correlation is significant at the .05 level (2-tailed). Strength of correlation very weak: <0.20; weak: 0.20–0.39; moderate: 0.40–0.59; strong: 0.60–0.79; very strong: >0.80.*

The examination of the relationship between dietary intake and body composition among Jiu-Jitsu athletes (refer to Table 6) reveals that protein intake, measured in grams, demonstrates extreme positive correlations with muscle mass (kg), skeletal muscle mass (kg and %), and skeletal muscle mass index (kg) (r = .685, .746, .658, .762, respectively). Importantly, these observed correlations are statistically significant at a level of $p < .05$.

Table 6. Correlation analysis between dietary intake and body composition of Jiu-Jitsu athletes. (n = 10)

Dietary Intake	**Body Composition**							
	Body Mass (kg)	BMI (kg/m²)	Body Fat (kg)	Body Fat (%)	MM (kg)	SMM (kg)	SMM (%)	SMI (kg/m²)
CHO (g)	-0.385	-0.251	-0.226	-0.134	-0.132	-0.143	0.049	-0.175
CHO (g/kg/d)	-0.734*	-0.544	-0.379	-0.207	-0.308	-0.329	0.094	-0.369
PRO (g)	0.235	0.082	-0.415	-0.574	0.685*	0.746**	0.658*	0.762*
PRO (g/kg/d)	-0.219	-0.297	-0.645*	-0.698*	0.491	0.538	0.734*	0.519
FAT (g)	-0.132	-0.308	-0.602	-0.683*	0.530	0.504	0.627	0.436
FAT (g/kg/d)	-0.372	-0.490	-0.684*	-0.703*	0.384	0.355	0.627	0.279
Total energy intake (kcal/d)	-0.147	-0.255	-0.561	-0.624	0.470	0.465	0.582	0.416

*Note. CHO = carbohydrates, PRO = protein. BMI = Body Mass Index, MM = Muscle Mass, SMM = Skeletal Muscle Mass, SMI = Skeletal Muscle Mass Index. ** Correlation is significant at the .01 level (2-tailed). * Correlation is significant at the .05 level (2-tailed). Strength of correlation very weak: <0.20; weak: 0.2–0.39; moderate: 0.40–0.59; strong: 0.60–0.79; very strong: >0.80.*

DISCUSSION

In the current investigation, the average energy intake was documented to be below the recommended levels. According to the Estimated Energy Requirements (EER), the caloric demands for Jiu-Jitsu athletes engaging in training sessions of moderate or high intensity training sessions may range from 40 to 70 kilocalories per kilogram per day, contingent upon the intensity and frequency of their training sessions. (Januszko & Lange, 2021) Moreover, the energy intake observed was lower than anticipated based on their energy expenditure. It was also observed that the athletes maintained a suboptimal diet characterized by low carbohydrates. With carbohydrate consumption at 3.3 g/kg/d for both female and male athletes during the training phase (recommended range: 5 to 7 g/kg/d), their intake was deemed adequate following the recommended levels for their physical activity (Jeukendrup, 2004; Artioli et al., 2013; Andreato et al., 2016; Al Mahmud et al., 2019; Mata et al., 2019; Januszko & Lange, 2021). High-intensity sports are associated with an increased need for carbohydrate intake (recommended range: 8 to 12 g/kg/d). Carbohydrates, being the primary macronutrient, play a crucial role in pre-exercise meals. Scientific evidence supports the notion that consuming carbohydrates before training enhances endurance and augments the replenishment of muscle and liver glycogen stores. (Cermak & C. van Loon, 2013; Greene et al., 2017; Murray & Rosenbloom, 2018; Mata et al., 2019).

The protein intake of 1.4-1.9 g/kg/d for female and male athletes, respectively, was within the recommended range. Protein intake is crucial for facilitating the metabolic adaptation process and promoting the recovery of damaged muscular fibres. However, it is advised to increase protein intake in larger quantities only during short periods of intensive training or when total energy and carbohydrate intake are reduced. (Weinert, 2009; Artioli et al., 2013; Simmons et al., 2016; Januszko & Lange, 2021).

Fat intake, at 1-1.6 g/kg/d, aligned with the recommended levels (1 to 1.8 g/kg/d, training phase) for the athletes' activity (Artioli et al., 2013; Januszko & Lange, 2021). However, upon examining the fat intake in grams among male athletes (101 g), the findings indicate a slightly higher consumption than the recommended threshold of 80 g. Nevertheless, this difference did not reach statistical significance. However, the analysis revealed that fat intake, in both females and males, did not exhibit a statistically significant correlation with body fat. This finding is consistent with the data presented in Table 6, which demonstrates an extremely negative correlation (r = -.684) between fat intake and body fat in Jiu-Jitsu athletes, reaching statistical significance. Fat plays a vital role in meeting the endurance demands of Jiu-Jitsu. Given these requirements, athletes may need approximately 2 grams of fat per kg body weight per day to replenish intramuscular triglycerides and support sustained performance (Shaw, 2022).

The isolated analysis of BMI categorizes athletes as within the normal weight range, though it reveals a slight elevation in female athletes that could potentially classify as overweight. However, relying solely on this classification for athletes is suboptimal, as it considers only body mass and stature without accounting for body composition constituents. Notably, predominant values indicative of high muscle mass and low body fat levels suggest that the observed elevated BMI in females in this study is a consequence of significant muscle mass development (Andreato et al., 2012; Franchini et al., 2014; Almeda et al., 2023).

The assessment of body composition holds paramount importance as a pivotal indicator of physical fitness and performance within the realm of Jiu-Jitsu sports. In this classification system, athletes are stratified according to their respective weights. The present study has demonstrated that Jiu-Jitsu athletes exhibit a commendable body fat percentage. Specifically, the body fat content observed in our sample falls within the recommended range of ≥11.6–17.0% for Jiu-Jitsu athletes (Cerqueira et al., 2022). These findings are consistent with earlier research on Jiu-Jitsu athletes, which also reported body fat content ranging from 9% to 15% (Andreato et al., 2016). Even within these specified body fat levels, the athletes under examination demonstrated the potential for substantial muscle development. The recorded muscle mass for the participants in this study ranged from 40.58 kg to 53.08 kg. Notably, a prior investigation by Andreato et al. (2016) detailed a comparable range of muscle mass, specifically between 40.4 kg and 60.9 kg, in Jiu-Jitsu athletes, closely aligning with the findings of the current study.

Skeletal muscles play a pivotal role in the execution of movements, encompassing challenging sequences necessitated by combat training and competition. Consequently, the frequently taxed skeletal muscles of combat sport athletes offer valuable insights into an individual's overall health status. The research on Judo athletes, a combat sport akin to Jiu-Jitsu, revealed a skeletal muscle mass percentage and skeletal muscle mass index of 50.94% and 13.01, respectively (Dopsaj et al., 2017). The recorded values for participants in this study were notably lower at 45.33% and 8.64, respectively, falling below the typical range observed in combat sports. This discrepancy arises because the Skeletal Muscle Mass Index (SMI) utilized by Dopsaj et al. (2017) is determined by dividing the sum of the skeletal muscle mass in kilograms by the square of the body height in meters. The difference in the formula employed in this study involves using the sum of the appendicular muscle mass (in the four limbs) in kilograms. Enhancing or preserving skeletal muscle mass and strength is crucial not only for optimizing athletic performance but also for improving overall quality of life. Conversely, a decline in muscle mass and strength is linked to an elevated risk of multi-morbidity (Dopsaj et al., 2017; Kerksick et al., 2017; Jäger et al., 2017).

The hypothesis positing that individual dietary intake could account for athlete body composition variations was investigated. The results revealed that only in the case of female athletes, protein intake demonstrated a notably strong positive correlation with both skeletal muscle mass and skeletal muscle mass index. This lack of significant correlation may be attributed to the relatively small sample size and the high interindividual variability present in the analysed data. The correlation between dietary intake and body composition yielded incongruent results. This discrepancy may be attributed to the fact that food intake was recorded in the current situation, encompassing a brief period, and did not exert a discernible impact on the measured body composition. As previously noted, athletes were in the training preparation phase for a national competition. Consequently, they consciously reduced their dietary intake, particularly carbohydrates, due to concerns about its potential impact on their weight. This dietary approach may have contributed to body composition values and altered dietary habits. Simultaneously, athletes expressed apprehension about potential muscle loss, prompting them to increase their protein consumption. However, certain protein sources also contain fat, such as certain cuts of meat or cooking methods.

CONCLUSIONS

In summary, the study findings indicate insufficient energy and carbohydrate intake among Jiu-Jitsu athletes during the training period. Conversely, protein and fat intake aligned with recommended levels. Notably, the correlation between dietary intake and body composition was observed predominantly in female athletes, revealing a robust positive correlation between protein intake in both skeletal muscle mass percentage and the skeletal muscle mass index. The study's findings underscore specific areas within nutrition that could be improved to optimize the performance and body composition of Jiu-Jitsu athletes.

AUTHOR CONTRIBUTIONS

Research design and data collection were carried out by Paiyarat, K.; Techakriengkrai, T.; Jamphon, A.; Penglee, N.; and Polyai, N. The analysis of data, interpretation of results, and composition of the manuscript were undertaken by Paiyarat, K.; Techakriengkrai, T.; and Techakriengkrai, W. All authors contributed to the article and have approved the final submitted version.

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