DOI: https://doi.org/10.4038/jnfs.v3i1.18

The Journal of Nutrition and Food Sciences

Journal Home Page: https://nutritionsocietyofsrilanka.org/the-journal-of-nutrition-and-food-sciences-2/

Optimising Nutrition and Performance: Insights from National-Level Athletes in Sri Lanka

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ARTICLE INFO

Article history:
Received:
19.12.2023
Revised version received:
30.09.2024
Accepted:
01.10.2024
Available online:
21.02.2025

Keywords:
Sports Nutrition
National-level athletes
Body composition
Energy balance
Nutritional assessment

Citation:
Wickramarathna H.P.T.D., Weerasooriya H.A.M.U., Senanayake D., Dahanayake U.N.J., Silva K.D.R.R. & Chandrasekara A. (2024). Optimising Nutrition and Performance: Insights From National Level Athletes In Sri Lanka. *The Journal of Nutrition and Food Sciences*, 3(1), 89-106.

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ABSTRACT

Background: Optimal athletic performance is closely linked to proper and balanced nutrition yet limited information exists on the dietary practices of Sri Lankan national-level athletes, especially those aspiring to win international medals.

Objectives: This study evaluates nutritional behaviours, perceptions, and beliefs as well as the body composition, and energy balance of the athletes in the national athletic pool in Sri Lanka.

Materials & Methods: Conducted as two sub-studies, the first involved 40 athletes from various sports (badminton, boxing, judo, weightlifting, track and field, and para-athletics), who participated in a questionnaire survey adapted from validated questionnaire. The second sub-study included 29 athletes from power/speed, endurance, and para-athletic groups, some overlapping from the initial sample, whose dietary intake and physical activity were assessed via 24-hour recall during training.

Results: Survey results indicated that "performance enhancement" (85%) was the primary driver of food choice, followed by considerations of "food quality/price" (70%), "weight gain concerns" (67%), and "brand names" (55%). Knowledge of dietary protein was limited, with 60% of athletes believing higher protein is essential for muscle development across sports, while only 40% were aware of "peri-workout" dietary supplementation. Coaches (75%), medical doctors (60%), and nutritionists (50%) were the main sources of nutritional advice. Supplement use was high, with 93% of athletes reporting intake of vitamins (83%), minerals (70%), branched-chain amino acids (68%), whey protein (60%), fish oil (55%), and creatine (53%). The dietary assessment adequate macronutrient intake among most athletes, but 59% experienced a negative energy balance. Body composition analysis revealed that approximately one-third (9/27) of the tested athletes exhibited lower-than-recommended body fat levels, while almost all athletes (26/27) displayed "normal" or "high" levels of muscle mass relative to their respective sports.

Conclusion: These findings underscore the need to enhance athlete awareness on protein requirements and peri-workout supplementation, with targeted nutrition counseling to improve energy balance and support international competitive success.

INTRODUCTION

Being more physically active with intensive training programs and competitions, professional athletes are significantly different from the general population. The athletic performance of the athletes is influenced by different factors such as genetic predisposition, time available for training, physical, psychological, and physiological characteristics, and nutrition (Boullosa et al., 2020). Among these contributing factors, adequate nutrition is one of the significant factors that differentiate athletes with good genetic endowment and proper training, to ensure peak performance, adaptation, and recovery during intensive training effectively avoiding health risks and injury (Kang, 2013; Wardenaar, 2017).

In recent decades, although extensive research has been carried out worldwide to investigate whether athletes meet the nutrition requirements recommended by the guidelines. They reveal that athletes have difficulty in achieving the recommended nutrient intakes (Arachchi et al., 2015). Multiple cross-sectional studies consistently reveal that a significant percentage of athletes fail to meet recommended levels of energy and certain macronutrient intakes. Insufficient energy intake has been observed among various athlete populations including female collegiate cross-country and lacrosse players in the U.S., elite athletes from Brazil, and athletes of South Asian descent (Jagim et al.,2019; Rodrigues et al.,2017). For instance, a study examining the nutritional adequacy of elite athletes in Sri Lanka has reported shortcomings in energy and protein intake among male and female swimmers (Arachchi et al., 2015). Another recent research has identified less diverse dietary intake, low BMI, and iron deficiency in professional hockey players (Peiris et al., 2018). Furthermore, research focusing on national-level volleyball players has demonstrated sub-optimal and inadequate nutrient intake during competition days when compared to established nutritional recommendations (Gamage et al., 2014).

The factors influencing athlete dietary behaviours are narrowly focused on nutrition knowledge but the nutrition behaviour of athletes is part of an interacting system because athletes are embedded within social and physical environments. Perceptions, beliefs, and attitudes related to nutrition have a direct influence on athletes' dietary behaviour. Despite the availability of internationally endorsed dietary guidelines specifically tailored for athletes, there remains a persistent tendency among athletes to adopt inadequate, counterproductive, and potentially harmful nutritional practices in pursuit of improved performance (Kang, 2013; Gogojewicz et al., 2020). Numerous harmful nutritional practices and factors contribute to the challenges athletes face in achieving optimal dietary intake. These practices and factors include time constraints, financial limitations, social and demographic influences, lack of cooking skills and access to cooking equipment, insufficient support from sporting authorities, cultural influences, food preferences, and nutrition knowledge (Trakman et al., 2016). Moreover, the individual heterogeneity among athletes, encompassing differences in physical and psychological attributes, type of sport, training intensity, sport-specific rules, and physiological limitations, can further complicate the pursuit of personalised nutrition goals (Kang, 2013).

The consequences of inadequate nutrition in professional athletes can be far-reaching. Insufficient energy intake can compromise the body's adaptive response to physical activity, leading to declines in lean body mass, muscle strength, and endurance, as well as impairing immune function, and increasing susceptibility to injuries and other health complications (Gogojewicz et al., 2020). Therefore, ensuring appropriate quantity, composition, and timing of food intake in line with nutritional guidelines is fundamental to optimise the physical performance of athletes (Kang, 2013; Burke et al., 2019). Recently, the Ministry of Youth and Sports in Sri Lanka in conjunction with the National Sports Council has initiated a long-term, progressive approach; a national high-performance strategy and sport tier system for

high-performance athletes on a professional basis contract. Significant consideration has driven the nutrition of the athletes to improve their performance levels. As mentioned previously, several investigations have been conducted in the past regarding the nutritional status and micronutrient adequacy of different national-level sportsmen and the dietary supplementation of national-level athletes. However, a comprehensive and up-to-date dataset relating to the nutrition behaviour, nutrition status, body composition, and energy balance of the athletes within the national athletic pool is currently lacking. Thus, the primary aim of the study was to assess the body composition, energy balance, and macronutrient intake of the athletes. Furthermore, it was aimed to determine the self-reported nutrition behaviours, perceptions, and beliefs relating to pre-, during, and post-exercise nutrition intake among them. Based on the information, it was expected to provide suggestions for nutrition interventions to uplift their performance in upcoming international athletic events.

MATERIALS & METHODS

Study design and setting

The research was developed as a combination of two quantitative and qualitative sub-studies.

Ethical aspects

The ethical approval for the study was obtained from the Ethics Review Committee, Faculty of Livestock, Fisheries and Nutrition, Wayamba University of Sri Lanka, Makandura, Gonawila, 60170, Sri Lanka (ERC Approved Decision for Application No. 202309H13).

Participants

The study group originally consisted of all the 60 high-performance athletes under tier 1 including male and female individuals in the national pool in Sri Lanka who were training under the Ministry of Youth and Sports in 2021. All the athletes were informed about this project using letters from the Institute of Sports Medicine, online Zoom meetings, and telephone calls. The athletes who had been participating in at least three intensive training workouts per week for six months participated in the telephone questionnaire survey. These athletes are from different sports groupings including athletic and para-athletic sports.

To collect comprehensive data related to nutritional behaviours, perceptions, beliefs, body composition, and energy balance, a multi-faceted approach was adopted.

Nutritional behaviours, perceptions, and beliefs

A pilot test was conducted to pre-test the two modules of the questionnaire with 6 national-level athletes. The questionnaire consists of two modules was an adapted and combined version of previously validated questionnaires (Walsh et al., 2011; Khan et al., 2017; Guina et al., 2020). The two modules included information on (1) demographic, athletic event-related, and nutrition behaviour and (2) nutrition perceptions and beliefs related to and factors affecting nutrition behaviour. A telephone interview was carried out with each athlete to collect information and in parallel to it, an online Google questionnaire form was used by the interviewer to enter the information. This was carried through a virtual platform due to the prevailed restrictions during the Covid-19 pandemic in 2021.

Body composition analysis

Body composition assessment was conducted by using the bioimpedance method with the bio-electrical impedance analyzer (Tanita SC 240 - BIA Analyzer), strictly adhering to the recommended measurement conditions. To categorize the body fat mass percentage, body muscle mass percentage, and body water percentage of participants, the Asian classification based on age and gender was followed, as outlined in the health monitor GMON customer administration software internal reference manual (Deurenburg et al., 2004; Beaudart et al., 2014; GMON administrative software Version 3.4.4, 2020).

Assessments of dietary intake and energy expenditure

For the dietary intake assessment, a standardised 24-hour dietary recall was used. A standardised 24-hour physical activity recall was used to assess the total energy expenditure of athletes.

Data analysis

In dietary analysis, household measurements of portions in 24-hour dietary recalls were converted to grams for solid foods and milliliters for liquid foods, and dietary intakes were analysed using Foodbase 2000 computer software (version 2.0, Institute of Brain Chemistry and Human Nutrition, UK) to get energy intake.

In physical activity analysis, BMR was calculated using the Harris-Benedict equation (Harris et al., 1919). The total energy expenditure was calculated based on BMR, scientifically determined metabolic equivalents (METs) values for each activity, and the duration of the activity in hours (Ainsworth et al., 2000). PAL values were calculated. The difference between dietary energy intake and daily energy expenditure was taken to obtain the body's energy balance.

Statistical analysis

All descriptive statistical analyses were performed using SPSS 16.0 statistical software, ensuring accurate data analysis and interpretation.

RESULTS

Socio-demographic characteristics of the athletes; Substudy I

Although the original study group was consisted of 60 athletes from tier I, during the study, 20 athletes were refused to participate as they were training abroad, far away, and due to time constraints. However, only 40 athletes participated in the substudy I; telephone questionnaire survey.

Table 1. Socio-demographic characteristics of the athletes of the national athletic pool who participated in substudy 1; telephone questionnaire survey

Characteristics	Category	Number (%)
Gender	Male	28(70%)
	Female	12(30%)
Sport category	Badminton	1(3%)
	Boxing	4(10%)
	Weight lifting	10(25%)
	Track and field events	11(27%)
	Para-athletics	13(32%)
	Judo	1(2%)
Educational level	Up to GCE O/L	19(47%)
	Up to GCE A/L	17(43%)
	Undergraduate/ Degree holder	4(10%)
Employed	Employed	29(73%)
	Unemployed	11(27%)

Note: Results are presented as counts and percentages. GCE O/L = General certificate of education ordinary level, GCE A/L = General certificate of education advanced level

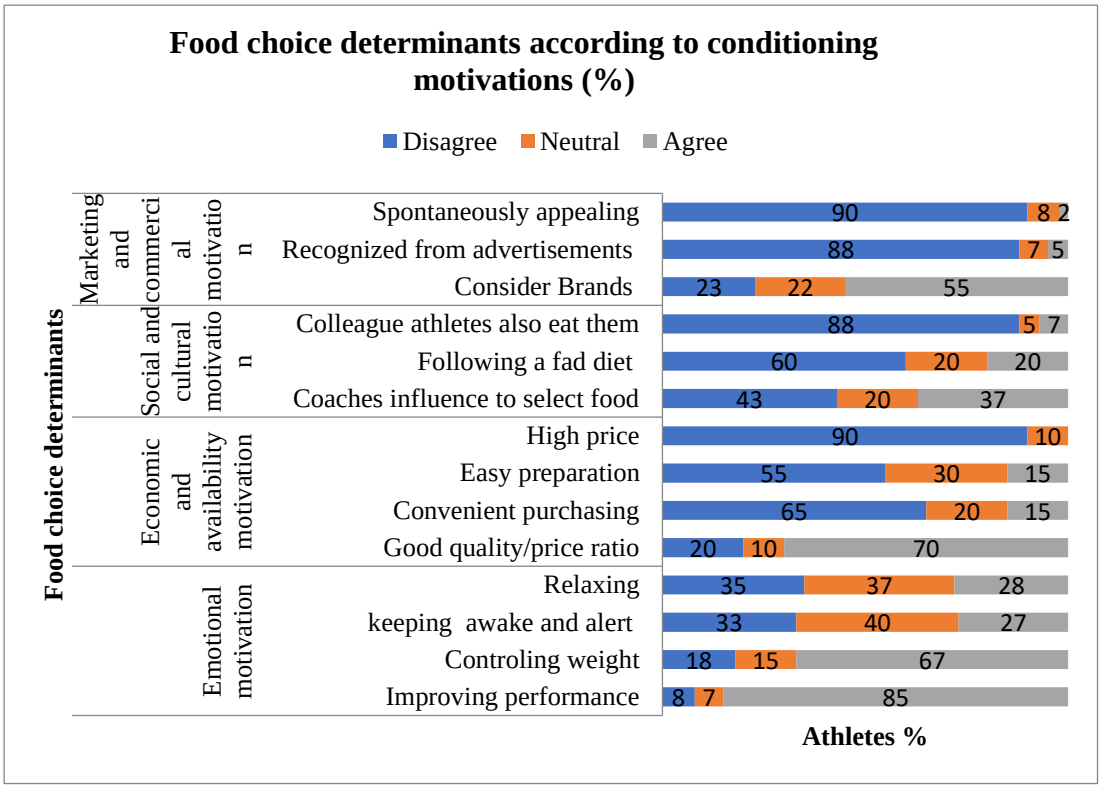

Figure 1. Food choice determinants according to conditioning motivations

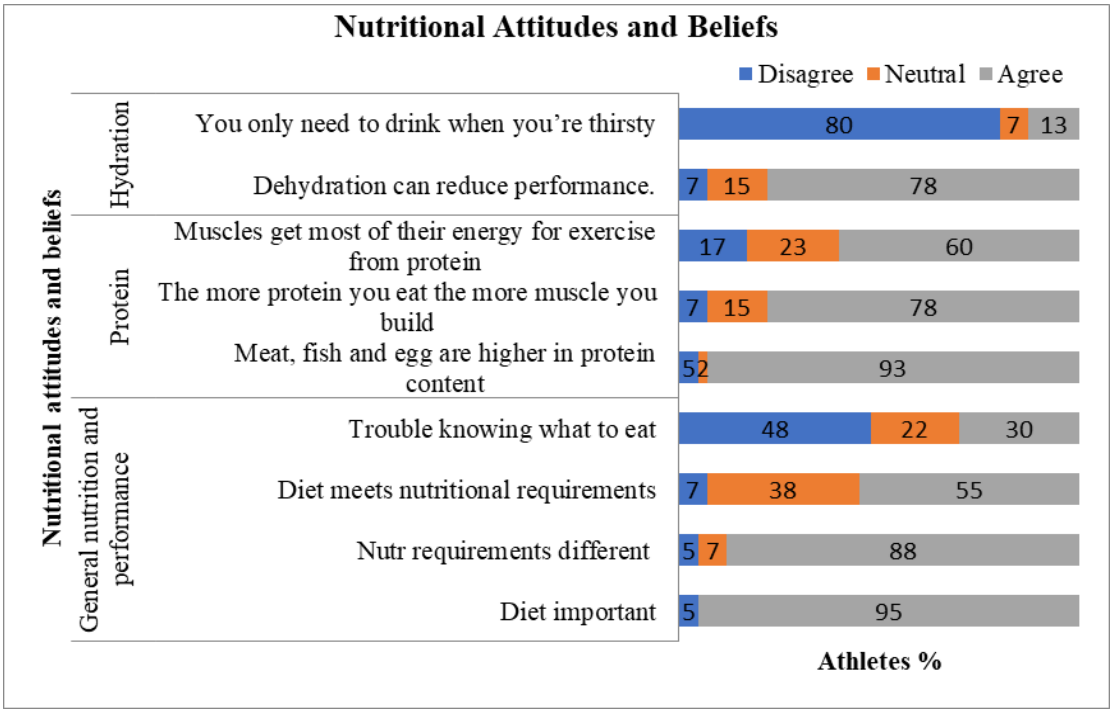

Figure 2. Self-reported nutritional attitudes and beliefs relevant to sports performance

Factors affecting nutritional behaviour

Motivations that affect the food choices of athletes were captured by the agreement level of the majority (> 50%) of these athletes. The highest ratings indicated that emotional motivation to "improve performance" was regarded as the most important factor to athletes overall. "Controlling weight, good quality /price ratio" (n=28, 70%), and "brand names" (n=22, 55%) were considered to be highly influential to athletes' food choices.

Attitudes and beliefs relevant to sports nutrition

Common beliefs among national-level athletes were identified by the agreement level of the majority (> 50%) of these athletes per each statement in the belief section. For the nutrition and performance subcategory, they believe there is an effect of food they consume on their performance (n=38, 95%) and they have specific nutritional requirements than other people of their age (n=35, 87.5%). Nearly a third of athletes don't know what they should eat (n=12, 30%). Moreover, one-third of them were confused regarding whether their diet meets their nutritional requirements (n=15, 37.5%).

In the protein subcategory, a majority believed that meat, fish, and egg are higher in protein content (n=37, 93%), and eating more protein leads to building more muscle (n=31, 78%). Virtually most of them believe that muscles get most of their energy for exercise from protein (n=24, 60%). In the hydration subcategory, about 80% (n=32) believe that they shouldn't wait until feel thirsty and 80% believe dehydration can reduce performance.

Perceptions on pre/during/ post event meal- highlights

Overall, about 40% of athletes showed awareness on the importance of having pre-, during, and post-event meals. Carbohydrate was found as a basic food nutrient that was provided during sports competitions (n=12, 30%) according to the perception of athletes. Furthermore, only 28% were known about carbohydrate loading, and most of them were confused (48 %) regarding this concept.

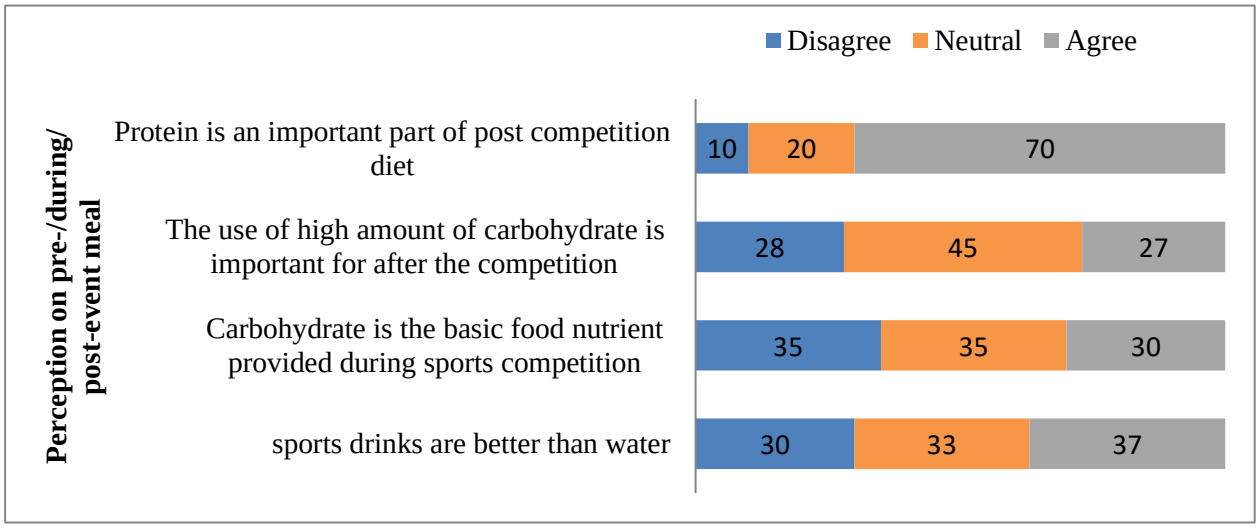

Figure 3. Perceptions on pre-/during/ post-event meal- highlights

Current sources of nutrition information

Currently, 70% of participants (n=28) were following a diet plan. The majority reported receiving nutrition information primarily from their coaches (n=30, 75%), followed by doctors (n=24, 60%) and nutritionists (n=21, 52.5%). Most participants (n=34, 85%) considered this information to be both reliable and important. They expressed interest in learning about meal planning for pre-, during-, and post-event periods, as well as dietary guidance for training days through future nutrition programmes. Regarding body weight, more participants aimed to lose weight (n=13, 32.5%) than to gain it (n=7, 17.5%).

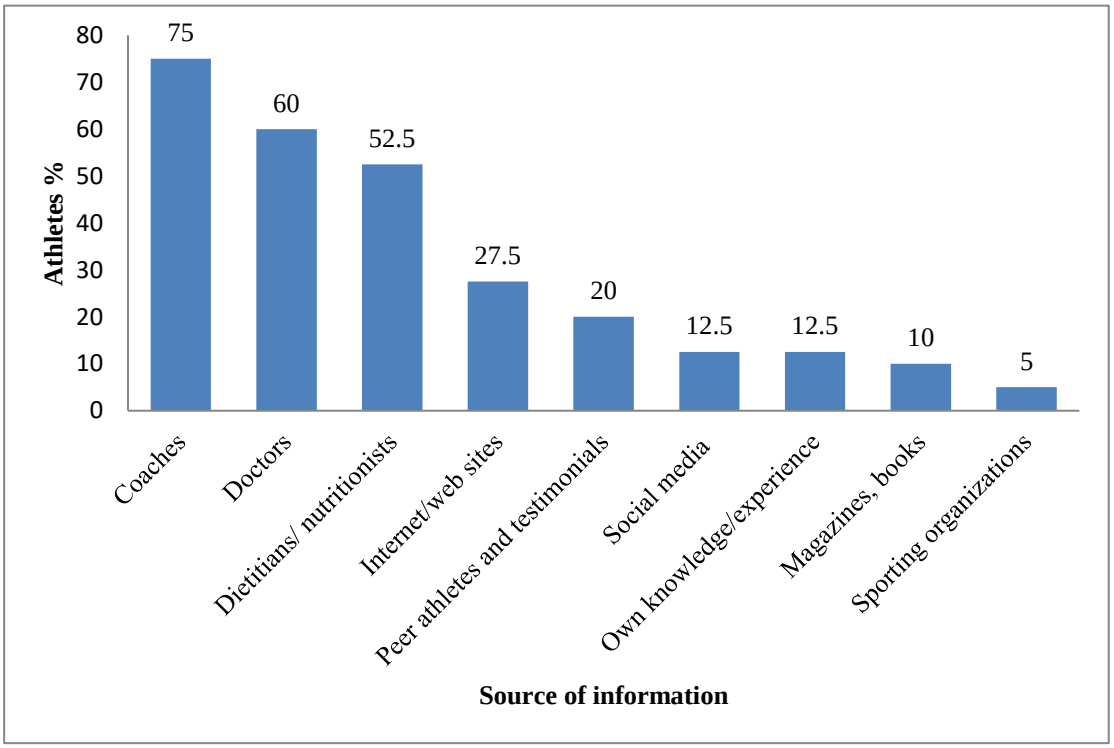

Figure 4. Current sources of nutrition information

Current supplement usage

The most common supplement types used within the past month are shown in Figure 5. Whey protein, Branch Chain Amino Acid (BCAA), Creatine, Vitamins/ Multivitamins, Minerals – (e.g., Calcium, Iron), and Fish oil supplements (e.g., Seven seas cod liver oil) were major supplement types within the population.

Socio-demographic characteristics of the athletes; Substudy II

During the substudy II, a total of 29 athletes from both the tier I and tier II national-level athletes participated when conducting the physical interviews for dietary intake assessments. In the same sub-study, although 29 athletes attended, 2 para-athletes were excluded during body composition measurements due to physical obstacles in measuring. Notably, there were two athletes below the age of 20, with one female athlete being 16 years old, indicating the inclusion of younger athletes in national-level athletes.

Distribution of athletes in different categories of body composition parameters

Table 3 presents the distribution of athletes in various categories of body composition

parameters, including body fat mass percentage, measured using the bio-electrical impedance analyser (BIA), muscle mass percentage, and body water percentage. Moreover, there were no athletes, male or female, in the increased/high body fat mass percentage category for this method. No athletes, male or female, were classified as having low body water percentage, and all athletes had good body water percentage.

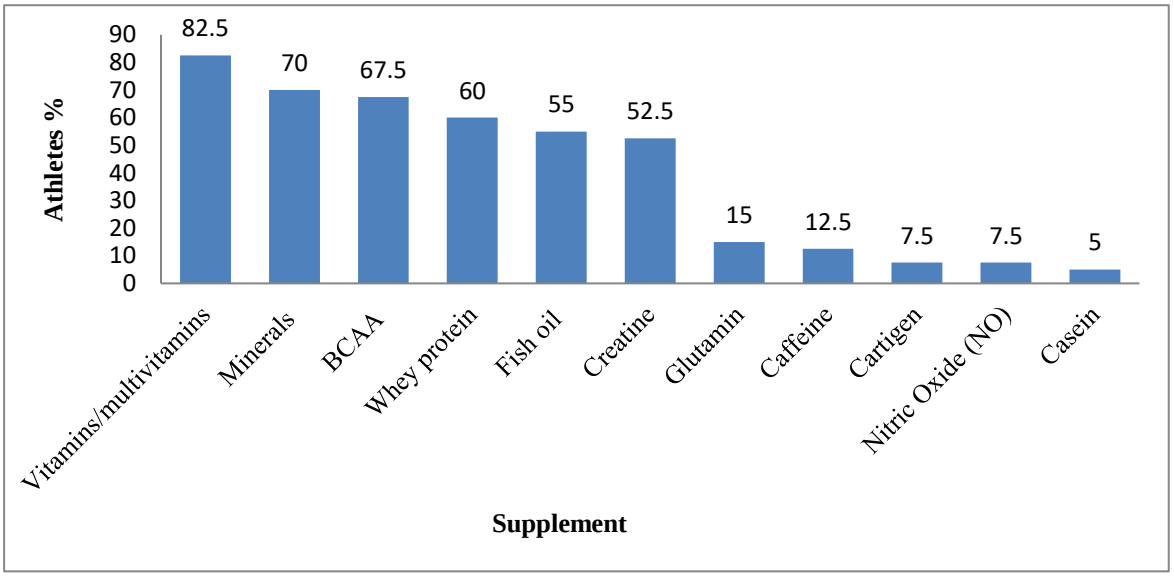

Figure 5. Current supplement usage

Table 2. Socio-demographic characteristics of the athletes of the national athletic pool who participated in substudy II; dietary, physical activity, and body composition assessments

Characteristics	Category	Number (%)
Gender	Male	17(58.6%)
	Female	12(41.4%)
Age (Years)	<20	2(6.9%)
	20-30	16(55.2%)
	>30	11(37.9%)
Sport category	Athletic power & speed events	17(58.6%)
	Athletic endurance	2(6.9%)
	Para-athletic power & speed events	10(34.5%)
Educational level	Up to GCE O/L	13(44.8%)
	Up to GCE A/L	11(37.9%)
	Undergraduate/ Degree holder	5(17.2%)
Employed	Employed	24(82.8%)
	Unemployed	5(17.2%)

Note: Results are presented as counts and percentages. GCE O/L = General certificate of education ordinary level, GCE A/L = General certificate of education advanced level

Table 3. Distribution of the athletes in different categories of body composition parameters

Body composition parameter	Gender	No. of athletes	Categories		
			Low	Good	Increased/ High
Body fat mass percentage (BIA analyser)	Male	15	6	8	1
	Female	12	3	9	0
	Total	27	9	17	1
Muscle mass percentage	Male	15	1	8	6
	Female	12	0	10	2
	Total	27	1	18	8
Body water percentage	Male	15	0	15	0
	Female	12	0	12	0
	Total	27	0	27	0

Note: Values are expressed as counts, BIA = Bioelectrical impedance analyzer Source, Categorization was adapted from (GMON administrative software; Beaudart et al., 2014; Deurenburg et al., 2004)

Dietary intake, energy expenditure, energy balance, and macronutrient intake of the athletes

Figure 6 illustrates the individual energy balance distribution of the athletes where a majority depicted a negative energy balance.

Energy intake, energy expenditure, and energy balance

Table 4 presents the mean values (± SD) of energy intake, energy expenditure, and energy balance among the athletes in the national athletic pool of Sri Lanka.

These values were compared to the recommended ranges by the International Society of Sports Nutrition (ISSN) for athletes during exercise, which suggest a range of 600 – 1200 kcal/h energy expenditure only during exercise, indicating that both male and female athletes' energy expenditure generally aligned with the recommended guidelines.

Regarding energy intake, the values fell within the recommended ranges by ISSN for athletes during exercise. Energy balance, which represents the difference between energy intake and energy expenditure, showed that male athletes had a mean energy balance of 327 ± 1661 kcal/day, while female athletes had a mean energy balance of 1405 ± 1161 kcal/day. These values suggest that female athletes generally had a higher energy balance than male athletes, indicating that their energy intake might have exceeded their energy expenditure.

Macronutrient intake

The table 4 presents the mean values (± SD) of macronutrient intake among male and female athletes. For carbohydrates, male athletes had an average percentage of energy intake from carbohydrates of 53 ± 7%, while female athletes had a slightly higher percentage of 54 ± 8%. These values were within the recommended range of 55-60% of energy intake from carbohydrates. In terms of grams of carbohydrates consumed per day, male athletes had an average intake of 407 ± 130 g, and female athletes had an average intake of 403 ± 121 g. These values were within the recommended range of 250-1200 g/day for athletes weighing 50-150 kg.

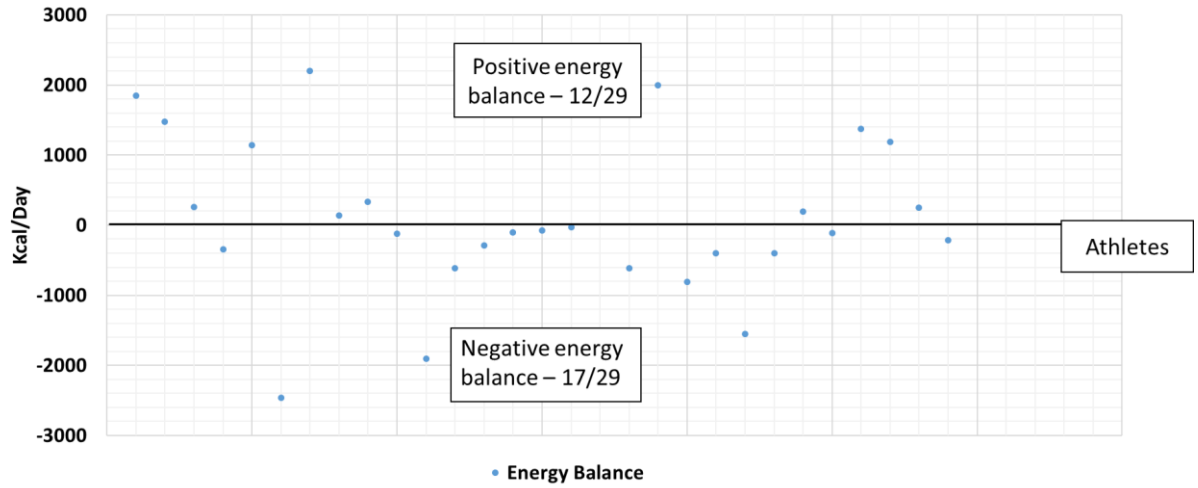

Figure 6. Individual energy balance (kCal/day) of athletes

Table 4. Mean (±SD) values of energy intake, energy expenditure, energy balance, and macronutrient intake of athletes

Variable	Unit	Male (n=17)	Female (n=12)	ISSN recommendations
Energy expenditure	kcal/day	3200 ± 765	2310 ± 246	600 – 1200 kcal/h during exercise
Energy intake	kcal/day	2872 ± 910	2845 ± 891	2500 – 8000 kcal/day
Energy balance	kcal/day	327 ± 1661	1405 ± 1161	
Carbohydrates	% energy	53 ± 7	54 ± 8	55 – 60 %
	g	407 ± 130	403 ± 121	250 – 1200 g/day
				50 – 150 kg athlete
Protein	g/kg/day	5.9 ± 2.3	8.2 ± 3.3	5 – 8 g/kg/day
	% energy	16 ± 3	15 ± 4	
	g	113 ± 48	108 ± 56	75- 300 g
	g/kg/day	1.6 ± 0.8	2.1 ± 1.1	1.4 – 2.0 g/kg/day
Fat	% energy	31 ± 6	31 ± 7	30%
	g	99 ± 38	99 ± 42	
	g/kg/day	1.5 ± 0.7	1.9 ± 0.8	0.5 – 1 g/kg/day
Dietary fiber	g	12.8 ± 6.2	14.0 ± 5.3	25 g

Note: Values are expressed as means ± SD, SD = Standard deviation, n = Number of athletes, ISSN = International society of sports nutrition

For protein intake, male athletes had an average percentage of energy intake from protein of 16 ± 3%, and female athletes had a slightly lower percentage of 15 ± 4%. Both values were within an acceptable range. Regarding grams of protein consumed per day, male athletes had an average intake of 113 ± 48 g, and female athletes had an average intake of 108 ± 56 g. These values fell within the recommended range of 75-300 g/day.

For fat intake, both male and female athletes had an average percentage of energy intake from fat of 31 ± 6% and 31 ± 7%, respectively. These values were within the recommended range of 30% of energy intake from fat. In terms of grams of fat consumed per day, male athletes had an average intake of 99 ± 38 g, and female athletes had an average intake of 99 ± 42 g. Both values were within the acceptable range.

Finally, dietary fiber intake was measured in grams, and male athletes had an average intake of 12.8 ± 6.2 g, while female athletes had an average intake of 14.0 ± 5.3 g. The values were slightly below the recommended intake of 25 g. Overall, the macronutrient intake of high-performance athletes in the national athletic pool of Sri Lanka appeared to be in line with the ISSN recommendations, with some minor variations observed in specific nutrient categories.

Current dietary adequacy of athletes

Figure 7 presents the current dietary adequacy of the athletes in the national athletic pool of Sri Lanka. The figure illustrates the adequacy of athletes' macronutrient intake;the percentage of energy intake from carbohydrates (CHO), protein, and fat in comparison to the ISSN recommendations in number of athletes.

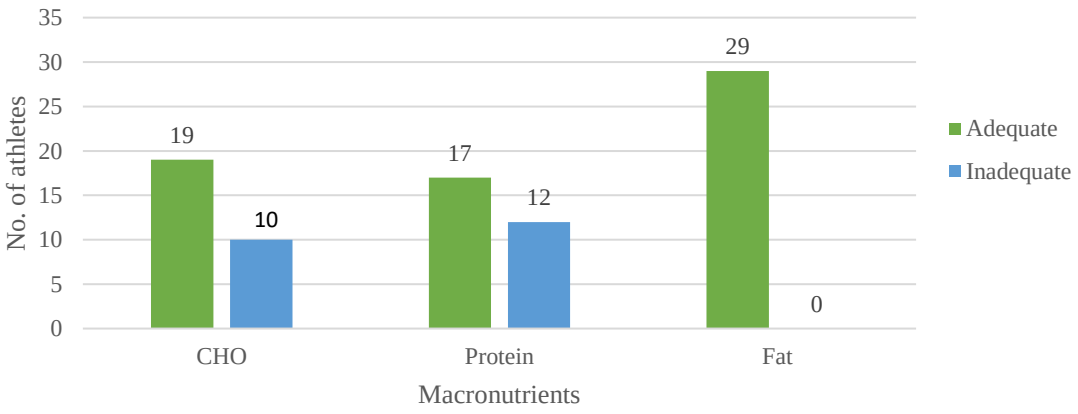

Figure 7. Current dietary adequacy of athletes

DISCUSSION

Nutritional behavior; attitudes, beliefs, and perceptions of athletes

The results indicate that improving performance, controlling weight, good quality/ price ratio, and brand names were the major determinants of the nutritional behaviour of national pool athletes. Overall nutritional perception and beliefs among athletes were not up to the level of satisfaction. It was found that their coaches were the main source of nutrition information followed by medical doctors and nutritionists. The majority believe that muscles get energy from protein and their perceived protein needs were greater compared to carbohydrates. Around 93% of athletes used dietary supplements, vitamins (83%), minerals (70%), BCAA (68%), whey protein (60%), fish oil (55%), and creatine (53%) were the most common.

Findings show that improving performance was rated highest of all factors agrees with recent international studies (Thurecht and Pelly,

2020). This is in contrast to the literature on general populations that report sensory factors such as taste as one of the highest-ranking influences on food choice (Markovina et al., 2015). Additionally, controlling weight, good quality/ price ratio, and brand names were reported as the most prevailing factors that affect their food choice. The findings of the recent studies serve to highlight that emotions play a pivotal role in influencing athletes' adherence to nutritional guidelines. Similar to our findings they also showed that athletes' self-identities appeared to be constructed within a 'performance' and 'slim to win' (Bentley et al., 2021). Building on this, we can confirm that 'body image' is a defining feature of athletic identity, whereby athletes spoke of the sociocultural pressures to achieve and maintain the 'ideal' body shape and size for their sport. Previous research also has shown that the majority of the athletes were rated "provides me with energy", "does not cause me gastrointestinal discomfort" and, "are nutritious" as important (Blennerhassett et al., 2019). Our study shows that they were less influenced by colleague athletes and commercial advertisements.

The study population has believed that muscles get most of the energy from protein. Contradictorily to the present findings athletes answered correctly about the use of carbohydrates as primary fuel (Chandrasekara et al., 2017). However, it was not surprising that the athletes recognized that their protein needs were higher than that of the general population and consumed significantly more protein than recommended in the RDI. (Fox et al., 2011) The findings highlight the confusion among athletes about the importance of carbohydrates during and after the event/ training sessions. They underestimate the carbohydrate needs which may lead to low attention on the carbohydrate content of their diet compared to protein. Similarly, the literature shows that the carbohydrate intake (% of total calories) was significantly less than the lowest recommended level (Fox et al., 2011).

Current usage of supplements

It was found that Sri Lankan high-performance athlete's supplement usage was high, which agrees with the recent studies where 91.5% of elite athletes reported using at least one supplement (Rashani et al., 2020). Meanwhile, many athletes use supplements without having an idea about their real benefits. Some athletes use supplements on an "ad hoc basis", unaware of what the active ingredients are or of the amount of those ingredients (Garthe and Maughan, 2018). These findings highlight the confusion among athletes about whether the supplements have side effects. Consuming multiple supplements may increase the risk of exposure to harmful levels of specific substances or interactions causing adverse health outcomes (e.g., calcium and interference of iron uptake) (De Silva et al., 2010). Most athletes are inclined to supplement use with the intention of enhancing performance. Similarly, recent studies have reported that major motivational perceptions were related to gaining energy /strength and enhancing performance (Rashani et al., 2020). Vitamins (83%), minerals (70%), BCAA (68%), whey protein (60%), fish oil (55%), and creatine (53%) were observed as the most preferred supplement types among the population accessed. Additionally, a recent study has reported multivitamins (57%), rehydration drinks (49.7%), and protein supplements (43.5%) as the most frequently used supplements among Sri Lankan elite athletes. Contradictorily to the present findings, sports drinks have been reported as the most frequently used supplements in the studies conducted in Sri Lanka (Silva et al., 2010). However, according to the reported literature, athlete performances have not merely increased due to supplement consumption while only a few have given positive outcome (Garthe and Maughan, 2018). Therefore athletes' enthusiasm should be further developed through awareness programs, explaining the role of sports doctors and nutritionists within the field of doping in sports.

Current source of nutrition information

In the present study, the most common nutrition information source was their coaches. This observation collaborates with the previous findings of the study conducted with rugby players in Ireland (Walsh et al., 2011). Still, 52% of athletes are likely to seek information about nutrition from nutritionists. Unlike the current research findings, sports doctors (45%), team coaches (40%), or friends (15%) were reported as mostly using nutrition information sources among Sri Lankan athletes (De Silva et al., 2010). Although the accuracy of sports nutrition advice taken from coaches may be questionable, athletes (63%) expect future nutrition advice from coaches. Similar to the previous research, this study highlighted that coaches require education on sports nutrition, efforts to educate this group may facilitate improvements in the quality of nutritional advice given to athletes and, therefore, help dispel many of the misconceptions identified in this study (Walsh et al., 2011). Frequent contact between players and their coaches presents an ideal opportunity for nutritional advice, appropriate interventions, and monitoring of the nutritional behaviours of young players.

Body composition

Body composition assessments revealed that most athletes had normal fat levels, with some variations observed based on gender and sports category. The majority of the athletes had a normal fat level, whereas other athletes had low (sprints, field) except one athlete who had increased (field) fat levels according to the Asian classification. Most of the sprinters had good fat percentage values and higher muscle mass was observed. The increased fat value was found in a male javelin player. However, according to (Jeukendrup and Gleeson, 2010) track events, athletes are considered to have low body fat percentage since they have to work against body weight. In contrast, in this case, series one increased fat value was found in a male javelin player. The suitable fat composition of a field player can be indicated as 16-20 % (male), and 20-28 % (female). The javelin player mentioned in the sample had a 22.8% fat percentage in the body. Therefore, it is clear that although some athletes had higher fat composition percentages compared to common Asian cutoff values, they were at an optimal level in each sport category. According to the common Asian cutoff values, 8 athletes had low-fat values. But when considering their ideal fat composition for the sport (Sprinters – Male -8-10%, Female -12-20%) the fat composition is adequate concerning the sprinting sports category. The muscle mass percentage of a person also indicates the body composition and nutritional status of an athlete. The majority of the athletes were in a “Good” and “Increased” level of muscle mass percentage except for one athlete who had a low muscle mass percentage. Here the person who had a low level of muscle mass percentage is the same male javelin player mentioned before who had a higher fat percentage. Bioelectrical impedance level also provides information regarding the total body water level of the body. Here almost all the athletes had good body water levels. However, the information cannot be alone considered to conclude their hydration level.

Energy balance

Irrespective of sports activity status, energy expenditure is higher during training and performance. In the literature, studies have shown that athletes have failed to meet their energy requirements in general. In a study on runners, sprinters, and handball athletes, it was determined that the athlete’s energy intake was lower than their energy expenditure (Garcin et al., 2009). In this study mean energy intake of female athletes was nearly similar to that of male athletes (Table 4). However, the mean energy expenditure of male athletes was higher than that of females (Table 4). In terms of mean dietary intake and mean energy expenditure, although the female athletes had a positive energy balance, male athletes who could not meet their energy expenditure had a negative energy balance. However, these results may not be accurate enough to conclude, because some of the athletes are in different seasons of

training. For example, few male athletes in the para-athlete category were passing the off-season, thus they are not following a heavy meal. That may be a reason that the mean energy intake of male athletes was lower than that of female athletes. In the sports center where the study was conducted, the lack of individual dietary counseling and nutrition education could be a reason for inadequacies among athletes. Most probably the reasons for the negative energy balance may be due to high intensive workouts. Normally most of the players who were in the pre-competition period were engaged in high intensive two training sessions in the morning and evening. The heavy workload, limited time to get a proper diet with the busy working schedules, and inadequate dietary intake can be the reasons for the negative energy balance. Low energy intake has a harmful effect on many body systems, including the cardiovascular system, several hormonal pathways, the muscular-skeletal system, fluids and electrolytes, thermoregulation, growth, and development. Thus, overall performance is also negatively affected. Since some athletes had to be prepared for the meet, they intentionally restricted caloric intake and engaged in weight control activities to achieve their required weight category. As well as, they did their training without taking the required amount of fluid and adequate amounts of meals, thus it causes to meet the highest negative energy balance. Several studies have indicated that maintenance of positive energy balance and lean mass per day causes disturbances to hormonal, metabolic, and immune function (Burke et al., 2006). However, endurance athletes, female athletes, and those participating in sports requiring strict control over body composition and size often experience a negative energy balance due to dietary restrictions (Arachchi et al., 2015). Weight-class sports athletes, in particular, may engage in weight control activities to achieve specific weight categories, affecting their energy balance.

Macronutrient intake

Both the exercise performance in speed and power events, and endurance sports depends on the maintenance of blood glucose during exercise and muscle glycogen renewal after exercise, and a high carbohydrate diet is required due to the long exercise periods. According to the athletic event, time duration, and the intensity of the training program, the target for carbohydrate intake ranges from 3 – 12 g/kg body mass per day (IOC, 2003; Wardenaar, 2017). For those who are in moderate exercise training, the targeted carbohydrate intake should be 5 – 8 g/kg BW/ day. Excluding other supplement intake and considering only the dietary intake, the mean energy intake of both male and female athletes from carbohydrates was adequate compared to the recommended intake. However when considering individual dietary intake as a case series, although a majority of the athletes got adequate carbohydrates amount per day, few athletes were unable to meet the requirements (Figure 7). This may be due to the same reason as mentioned previously; few male athletes in the para-athlete category were passing the off-season, thus they are not following a heavy meal. However, a study that evaluated the macronutrient adequacy of elite Sri Lankan swimmers showed consumption of higher carbohydrate amounts than the recommended values (Arachchi et al.,2015). Moreover, a study on CrossFit-trained athletes evidenced a low consumption of carbohydrates (Gogojewicz et al.,2020).

Protein consumption is considered a key nutrient for good performance, especially for recovery after training. The daily protein requirement of the athletes varies according to endurance and power training. According to the ISSN recommendations, for those who are in moderate exercise training, the targeted protein intake should be between 1.4 – 2.0 g/kg BW/ day. In a study, it was evidenced that the athletes' protein consumption was higher than the recommendation (García-Rovés et al., 2014). Similarly, in this study the male and female protein intakes were adequate. In terms of individual cases, the majority of the athletes got an adequate protein amount per day, while other athletes got an inadequate amount of

protein per day. The protein sources in the athletes' diet were high-quality protein resources such as meat, beef, eggs, and milk. In the study on elite Sri Lankan athletes, a lower intake of protein and fat resulted (Arachchi et al.,2015). According to the ISSN recommendations, the targeted and recommended fat intake should be between 0.5 – 1.0 g/kg BW/ day. In this study, the mean energy intake from dietary fat was adequate and slightly higher compared to the recommended values. In terms of individual cases, all the athletes got an adequate fat amount per day. It should be specifically stated that all this dietary information was analysed without considering the supplement intake of these athletes. During the dietary recalls, quantity estimations and conversions, overestimation and underestimation errors may have happened.

Limitations and recommendations

The study had some limitations, including a small sample size and convenience sampling, leading to a lower response rate. A larger and more representative sample is recommended for future studies to enhance the generalisability of the findings.
Additionally, the inclusion of para-athletes, while important, may have introduced some complexities due to the lack of specific reference values for their nutritional assessments. Future studies could explore tailored approaches for assessing para-athletes' nutritional needs.

To optimise the athletes' performance, individualised dietary counseling, tailored diet plans, and nutritional intervention and awareness programmes are suggested. Athletes should receive proper guidance to meet their nutrient requirements, especially those engaged in weight-class sports, to avoid negative energy balance and its adverse effects on their overall health and performance.

CONCLUSIONS

This study revealed that improving performance, controlling weight, good quality/price ratio, and brand names significantly influenced food choices among high-performance athletes. There is a need for improved nutritional education and guidance, as athletes' perception and beliefs regarding supplements and macronutrient needs were not up to satisfactory levels. Although the majority of athletes had appropriate body composition for their respective sports, addressing the issue of negative energy balance remains crucial to optimise overall athletic performance.

ACKNOWLEDGMENT

We acknowledge all the athletes, the Department of Applied Nutrition, Faculty of Livestock, Fisheries and Nutrition, Wayamba University of Sri Lanka, the National Institute of Sports Medicine, and the Ministry of Sports for providing facilities and funding to conduct the research.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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