

A Comprehensive Analysis of Sports Nutrition Knowledge and Diet Diversity Among South Indian Athletes

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Abstract

Purpose. Athletes can benefit greatly from having knowledge about sports nutrition. However, there are limited studies on athletes' nutritional knowledge and dietary habits in South India. This study aims to assess the athletes' sports nutrition knowledge, analyse their dietary practices and attitudes, and the dietary diversity score.

Material & Methods. A descriptive cross sectional study was conducted in selected areas of Chengalpattu district in Tamil Nadu. Eighty-five athletes aged 10-18 training in different sports academies were interviewed individually using a validated questionnaire to analyse their sports nutrition knowledge, attitude and dietary practices.

Results. The results showed that only 4.7% of the athletes had adequate nutritional knowledge of over 60%. The mean overall knowledge score was 40.2%, with athletes being most knowledgeable about protein and its sources (mean score of 67.9%), but less aware of carbohydrate and fat sources and recommendations (mean score of 15.08% and 14.01%, respectively). The mean score for attitude and dietary practices were 64.4 and 59.5 respectively. A strong and positive correlation was found between the level of nutritional knowledge and attitude ($p=0.0001$). Additionally, we found that the occupation of parents and the monthly income of the family were significantly associated with the athletes' nutritional knowledge. Majority of athletes (74.1%) of the athletes had an adequate dietary diversity score (DDS) of ≥ 5 , and 25.9% of the athletes had a DDS of ≤ 4 .

Conclusions. Nutritional educational interventions at the grass root level can potentially improve athletes' knowledge, dietary practices and sports performance in the future. It is crucial to identify and address knowledge gaps, and use technology to monitor and motivate athletes towards consistency in implementing their knowledge.

Keywords: Athletes, South India, Sports nutrition knowledge, Nutritional attitude, Dietary diversity score, Dietary practices.

Introduction

Nutrition plays a major role in the athlete's health, performance and recovery from injury. An athlete should take extra nutritional care by consuming a well balanced varied diet in appropriate quantities thereby striking a balance between macro and micro nutrients to meet the needs of the respective sport (Thomas et al., 2016). Dietary diversity score (DDS) is a measure of adequacy of macro and micro nutrients irrespective of the level of intake of the foods. DDS indicated the number of food groups consumed in the last 24 hours and a score of 5 or more indicates the consumption of a varied diet (FAO, 2018). Athletes should definitely aim to have a DDS score of 5 or above. By consuming a diverse diet, they can enhance their performance

as well as maintain good health. Nutrient timing and proper hydration are also more important for an athlete to reach their highest potential (Kerksick et al., 2017). But, nutrition is not given due importance in the regular routines of the athletes as compared to their fitness routines and sports practice. It could be attributed to dearth of financial resources and lack of nutritional knowledge of coaches, trainers, parents and athletes themselves (Cherian et al., 2020). On contrary elite athletes are overloaded with nutritional information from various sources and they are also able to afford to consult a sports nutritionist (Kiss et al., 2021). In order to close this gap, there is a need to assess the nutritional knowledge of athletes and provide the access to accurate nutritional information

at all levels (Tam et al., 2022). This can only be accomplished through proper nutritional education interventions across all levels that guide the athletes to reach their maximum potential. Tamil Nadu, is renowned for its thriving sporting community. Nonetheless, there is a discernible dearth of research that evaluates the nutritional acumen and dietary practices of the athletes in the region (Sobana, 2016).

It is crucial to thoroughly examine the understanding of nutrition of athletes belonging to Tamil Nadu and establish a connection between theoretical knowledge and practical application. Hence, this study aims to comprehensively analyze the sports nutrition knowledge of athletes in Tamil Nadu based on socio-demographic variables, identify the areas for nutritional counselling, analyze dietary diversity score and correlate it to their nutritional knowledge.

Material and methods of research

Participants

The present descriptive cross-sectional study aimed to explore the characteristics of athletes who train in various sports academies situated in Chennai, India. The sample size calculated for the study was 85 and the sampling was done using purposive sampling method. The athletes from Chennai belonging to the age group 10-18 years, those who train for a minimum of 8-10 hours/week, those who participate in district and state level matches only were included in the study. The study excluded athletes who had just begun training, those who were irregular in their training, and those who were unwilling to participate.

Methods

The data was collected using a standardized questionnaire tool which included socio-demographic variables of the participants such as age, educational qualification, occupation of parents, the income of the family, and place of residence, the nutritional knowledge, attitude and dietary practices of the athletes and 24-hour dietary recall. The data collected A validated, compact and reliable questionnaire on Nutritional knowledge for young and adult athletes (NUKYA) was used to assess the sports nutritional knowledge of the athletes (Vázquez-Espino et al., 2020). NUKYA was developed based on the recent nutritional recommendations for an athlete and very slight modifications were done with regards to the food sources based on the local food consumption pattern. The nutritional knowledge section included 24 questions with 63 components consisting of different sections such as macronutrients (31 components), micronutrients (21 components), hydration (8 components) and food intake periodicity (3 components). The nutritional attitude and dietary practices of the athletes were assessed based on a questionnaire adapted from a tool previously used on athletes (Nazni and Vimala, 2010). Responses that were accurate were awarded a score of +1, whereas re-

sponses that were incorrect or uncertain received a score of 0. The unsure response was used to discourage guessing. The knowledge, attitude, and practices of each athlete were evaluated and an overall score was calculated. The total score was calculated as percentage and scores above 60% were considered to reflect adequate knowledge, while scores below 60% were considered inadequate (Nor Azizam et al., 2022).

The frequency of consumption of the 11 food groups was assessed using a food frequency questionnaire and the results were tabulated. Furthermore, a 24-hour recall was also acquired from the athletes, which was utilized to compute their Dietary Diversity Score (DDS) for the purpose of evaluating their nutrient sufficiency. DDS is a standard score validated by Food and Agricultural organization (FAO). If an athlete had consumed at least one tablespoon of any of the 10 food groups, they were given a score of 1. However, if they had not consumed a specific food group, they were given a score of 0. The scores for the 10 food groups was summed up to get an overall DDS score which ranged from 1-10. A DDS score below 5 indicates inadequate dietary diversity, while a score of 5 and above indicates sufficient dietary diversity (FAO, 2021).

Procedure

The study was conducted with ethical approval from the institutional ethics committee of IRB Blinded (Reference No. 2969/IEC/2021). Additionally, approval was obtained from the coaches of the cricket academy to conduct the study, and informed consent was obtained from each subject's parents prior to completing the questionnaire. The data was collected using a questionnaire by direct interview method in March-June 2022. It took around 15 minutes to complete the questionnaire for each athlete.

Statistical analysis

The normality of the data was evaluated using the Shapiro-Wilk test. Descriptive statistics were presented in terms of mean and standard deviation, while categorical data were reported as frequency and percentage. The comparison between the nutritional knowledge of athletes and the socio-demographic profiles were done using an independent t-test and ANOVA. A p-value less than 0.05 was considered statistically significant. The Pearson correlation was utilized to examine the correlation between the knowledge, attitude, and practices (KAP) of athletes, as well as the correlation between their nutritional knowledge and diet diversity score (DDS).

Results of the study

Socio demographic characteristics

A total sample of 85 athletes, 76 males and 9 females with a mean age of 13.18 ± 2 years were selected for the assessment of sports nutritional knowledge, attitude and practices (Table 1). Ac-

According to the findings, approximately half of the fathers (50.5%) of the athletes held professional positions, while 15.2% and 16.4% of the fathers were employed as sales workers and technicians, respectively. There were an almost equal proportion of house wives and working mothers (51.7% and 48.25%). 31.7% of the athletes had a family monthly income of Rs.50,000-75000 and an equal percentage of athletes had an income above it. Most of the athletes were studying in secondary/

higher secondary level with only 17.6% pursuing their undergraduate degree. A vast majority of the selected athletes (73) were cricketers and 12 of them were archers with most of them (43.5%) practicing their sport for 5 days a week.

Sports Nutritional knowledge scores

The mean knowledge score for all sections was 40.2 with scores ranging from 3.52% – 78.8% (Table 2). The food intake periodicity had the highest

Table 1. Socio-demographic profiles of the selected athletes (n=85)

	Number (%)	Mean (SD)
Age		13.18 (2)
Sex		
Male	76 (89.4%)	
Female	9 (10.6%)	
Occupation of father		
Agricultural worker/clerk	5 (5.9%)	
Professional	43 (50.5%)	
Sales worker	13 (15.2%)	
Senior official/Manager	10 (11.7%)	
Technician	14 (16.4%)	
Occupation of mother		
Housewife	44 (51.7%)	
Working	41 (48.2%)	
Monthly income of the family		
10,000 – 30,000 Rs	8 (9.41%)	
30,000 – 50,000 Rs	23 (27.05%)	
50,000 – 75,000 Rs	27 (31.7%)	
More than 75,000 Rs	27 (31.7%)	
Number of members in the family		
2-4	61 (71.7%)	
More than 4	24 (28.2%)	
Educational qualification		
Secondary	70 (82.3%)	
Higher secondary/Undergraduate degree	15 (17.6%)	
Type of sport		
Cricket	73 (85.8%)	
Archery	12 (14.11%)	
Days of sports training		
1-2 days per week	26 (30.5%)	
3-4 days per week	8 (9.4%)	
5-6 days per week	37 (43.5%)	
On all 7 days	14 (16.4%)	

Table 2. Nutritional knowledge scores and adequate knowledge level of the athletes (n=85)

Section	Mean Score % (SD)	Adequate knowledge level (>60%) n (%)
All sections	40.2 (7.5)	4 (4.7)
Macronutrients	30 (4.36)	4 (4.7)
Macronutrients – CHO	15.08 (2.20)	5 (5.88)
Macronutrients – Protein	67.9 (1.89)	62 (72.9)
Macronutrients – Fat	14.01 (2.03)	4 (4.7)
Micronutrients	52.6 (3.66)	32 (37)
Hydration	40.5 (1.15)	14 (16.4)
Food intake periodicity	58.4 (0.89)	50 (58.8)

mean score (58.4) and the least mean score was obtained for the sub section on fat and CHO (14.01 and 15.08) indicating a lacunae in the knowledge on sources of CHO and fat. Only a mere 4.7% of the athletes had achieved a knowledge status of more than 60% across all sections. Similarly only 16.4% of athletes had adequate knowledge in hydration indicating the need for educating the athletes in this domain (Table 3).

Comparison of sports nutritional knowledge and socio demographic variables

Based on our research, we found a significant disparity in sports nutritional knowledge scores (Table 4). This disparity was observed among participants whose fathers had different occupations ($p=0.011$), as well as among participants whose mothers had different occupations ($p=0.015$). Additionally, we

found a significant difference in knowledge based on the monthly income of the family ($p=0.003$). However, we did not observe any significant differences in knowledge based on other socio-demographic characteristics.

Sports nutritional attitude

The assessment of sports nutritional attitude of the athletes indicated that 98.8% of the athletes agreed that supplements are alone not enough to be healthy and intake of balanced diet is very important for athletes (Table 5). 89.4% of the athletes had a positive attitude towards the role of good nutrition in improving their performance. Most of the athletes (72.9%) believed that fasting is not the right way to lose weight. Around 28.2% of the athletes only agreed that coaches play a major role on their food choices. Surprisingly only 12.9% of

Table 3. Athlete's responses to sports nutrition knowledge questions (n=85)

S.No.	Questions	Athletes with correct answer N (%)	Mean Score
Macronutrients (CHO)			
1.	Do these foods have a high or low content of complex carbohydrates?		10
2.	Should an athlete who wants to lose weight completely eliminate carbohydrates from his diet?	51(60%)	
3.	Are carbohydrates stored in the muscle as glycogen?	13(15.3%)	
Macronutrients (Protein)			
4.	Does the muscle use protein as main source of energy during exercise?	25(29.4%)	
5.	Do these foods have a high or low content of protein?		72.8
Macronutrients (Fat)			
6.	Do fats play an important role in the body?	53(62.3%)	
7.	Do saturated and unsaturated fats have the same impact on health?	25(29.4%)	
8.	Do these foods have a high or low content of unsaturated fat?		6.9
Micronutrients			
9.	How many servings of fruits and vegetables is recommended to eat per day?	27(31.7%)	
10.	Can humans get most of Vitamin D from sunlight exposure?	67(78.8%)	
11.	Are vitamins and minerals a good source of energy?	23(27.05%)	
12.	Are these foods a good source of iron?		58.8
13.	Are these foods a good source of calcium?		55.1
Hydration			
14.	Your athletic performance will decrease if you lose 2% of your body weight due to water loss.	39(45.8%)	
15.	To be well hydrated during sports training you have to wait until you are thirsty to drink.	54(63.5%)	
16.	To fully rehydrate after exercise, you need to drink a volume of liquid greater than the volume of water lost during exercise.	53(62.3%)	
17.	Fruit juice is a liquid suitable to drink in the training session and in the middle of the match.	11(12.9%)	
18.	Energy drinks like «Red Bull» are recommended for athletes to ingest during exercise.	68(80%)	
19.	What do you think is the most suitable urine colour before starting to train?	16(18.8%)	
20.	During intense or prolonged exercise, what is the best way to replace the water that is lost in the form of sweat.	32(37.6)	
21.	The percentage of CHO in an isotonic sports drink should be?	3(3.52%)	
Food intake periodicity			
22.	What is the optimum time to eat and drink something for kick-starting recovery after exercise or competition?	43(50.5%)	
23.	The most important nutrients to ingest after training	44(51.7%)	
24.	Should the last main meal (breakfast, lunch or dinner) be eaten at least 3-4 hours before a competition / exercise?	62(72.9%)	

Table 4. Comparison of nutritional knowledge score based on socio-demographic variables (n=85)

	Mean score % (SD)	p-value
Sex		
Male	39.5 (11.6)	0.173
Female	45.3 (13.12)	
Occupation of father		
Agricultural worker/clerk	29.8 (8.10)	0.011 *
Professional	42.7 (10.8)	
Sales worker	34.5 (12.7)	
Senior official/Manager	46.3 (11.31)	
Technician	36.7 (12.1)	
Occupation of mother		
Working	43.4 (9.32)	0.015 *
Housewife	37.15 (13.19)	
Monthly income of the family		
10,000-30,000	27.5 (12.22)	0.003*
30,000 - 50,000	37.7 (11.59)	
50,000 - 75,000	43.48 (9.68)	
More than 75,000	42.6 (11.96)	
Number of members in the family		
2-4	41.7 (11.5)	0.057
More than 4	36.25 (11.81)	
Educational qualification		
Secondary	39.17 (11.18)	0.094
Higher secondary / Undergraduate degree	44.8 (13.89)	
Type of sport		
Cricket	39.7 (12.2)	0.471
Archery	42.5 (9.26)	
Days of sports training		
1-2 days/week	39.2 (12.7)	0.289
3-4 days/week	48 (16.08)	
5-6 days/week	39.4 (9.69)	
On all 7 days	39.2 (13.12)	

Table 5. Responses to sports nutritional attitude questions (n=85)

S.No	Questions	Athletes with correct answer N (%)
1.	The nutritional needs of athletes are different from those who are not involved in any sports activities.	66 (77.6%)
2.	Good nutrition is important for better performance in sports activities.	76 (89.4%)
3.	Exercise increases the requirements of proteins.	55 (64.7%)
4.	Expensive sports foods are better in improving performance.	65 (76.4%)
5.	Coaches play a major role on the food choices of athletes.	24 (28.2%)
6.	The food choices of athletes are mostly dependent on friends and media.	9 (10.58%)
7.	Consuming large quantities of water before, during and after the training or performance is very important.	11 (12.9%)
8.	High amount of water consumption can result in weight gain.	71 (83.5%)
9.	It is very important to add electrolytes in sports drinks.	39 (45.8%)
10.	High consumption of ghee, nuts and milk enhances performance.	53 (62.3%)
11.	Fasting is the best method to lose weight.	62 (72.9%)
12.	It is very important to consume nutritional supplements for winning in sports.	71 (83.5%)
13.	Is supplements alone enough to be healthy?	84 (98.8%)
14.	It is essential to have a balanced diet and include more variety of foods for good health.	82 (96.4%)
15.	Dietary pattern of athletes should change with season and climatic conditions.	52 (61.1%)

the athletes had a strong positive attitude towards consuming sufficient water before, during and after training.

Dietary practices of the athletes

The assessment of the dietary practices of the 85 athletes indicated that a vast majority of the athletes (98.8%) did not practice any strict dietary regimen, 97.6% of athletes did not skip their meals to lose weight and 94.1% of athletes did not consume commercial sports supplements/ drinks every day (Table 6). Almost 90% of the athletes had the habit of frequently eating outside at hotels/ restaurants. Only 12.9% of the athletes had the awareness and made few modifications in their diet during competition period to improve their performance. 95% of the athletes were not aware of the term carbohydrate loading and it's not sure if the rest of them who agreed to practice did it the right way.

Correlation between Nutritional knowledge, attitude, dietary practices and dietary diversity scores

There was a significant positive correlation between sports nutritional knowledge and attitude of the athletes ($R=0.404$, $p=0.0001$) but no significant correlation was observed between Attitude Vs Practice and Knowledge Vs Practice (Table 7). Although there was a positive correlation between the knowledge of the athletes and their dietary diversity score, it was not significant at 5% level ($R=0.088$, $p=0.421$).

Frequency of consumption of the various food groups

The assessment of frequency of consumption of foods revealed that cereals, milk, fruits and other vegetables, fats and oils, sugar and jaggery were consumed on a daily basis by most of the athletes

Table 6. Responses to dietary practice questions

S.No	Questions	Athletes with correct answer N (%)
1.	Do you skip meals before the competition?	53 (62.3%)
2.	Do you make any modifications in your diet during your competition period?	11 (12.9%)
3.	Do you practice carbohydrate loading prior to competition?	5 (5.88%)
4.	Do you consume commercial sports supplements / sports drinks everyday?	80 (94.1%)
5.	Do you consume glucose before or during the training?	28 (32.9%)
6.	Do you practice any strict dietary regimen every day?	84 (98.8%)
7.	Do you skip meals in order to lose weight?	83 (97.6%)
8.	Do you take more egg and non – vegetarian foods to improve your protein intake?	47 (55.2%)
9.	Do you eat bananas during exercise?	48 (56.4%)
10.	Do you use performance enhancers that give you a competitive advantage?	83 (97.6%)
11.	Do you have a balanced diet?	66 (77.6%)
12.	Do you consume enough water after the exercise?	80 (94.1%)
13.	Do you consume any light snack before starting to train?	38 (44.7%)
14.	Do you restrict fried foods and junk foods to perform better?	30 (35.2%)
15.	Do you frequently eat outside at hotels/ restaurants?	77 (90.5%)

Table 7. Correlation between nutritional knowledge, attitude and dietary practices

Attribute	Knowledge Mean (SD)	Attitude Mean (SD)	Practices Mean (SD)	Dietary diversity score (DDS) Mean (SD)
	40.17 (11.91)	64.4 (12.78)	59.55 (9.3)	Overall-5.18 (1.14) ≤ 4 – 22 (25.0%) ≥ 5 – 63(74.1%)
Knowledge Vs Attitude	0.0001**			
Attitude Vs Practice	0.2707			
Knowledge Vs Practice	0.074			
Knowledge Vs DDS	0.421			

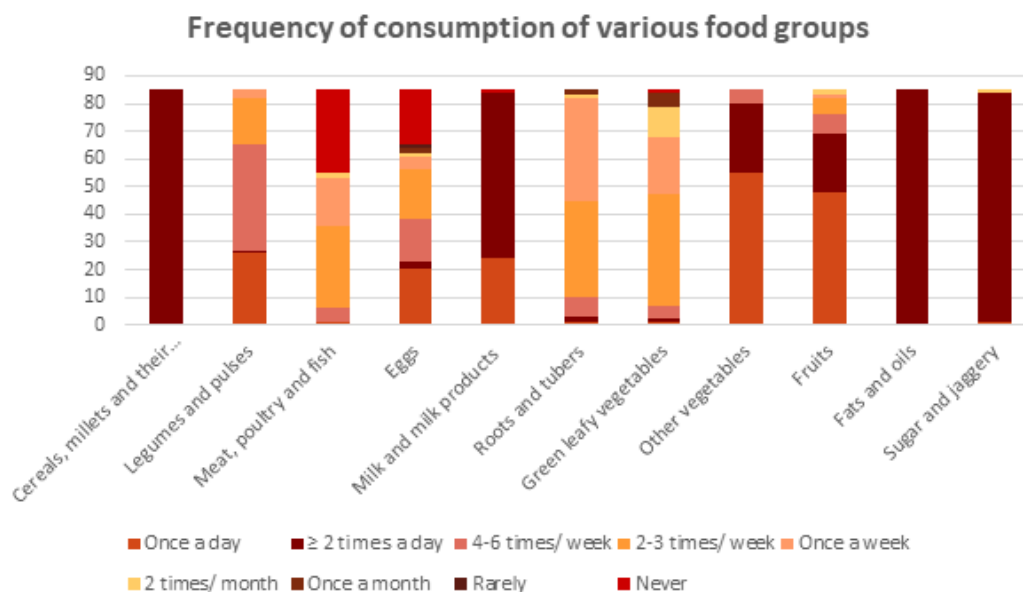


Figure 1. Frequency of consumption of various food groups

(Figure 1). Legumes and pulses were mostly consumed 4-6 times/week. Almost 35% of the athletes did not consume meat, poultry and fish and majority of the athletes who had, consumed it 2-3 times/week. Those who consumed eggs mostly took it once a day and roots and tubers were consumed mostly one a week or 2-3 times/week.

Discussion

This study was designed to evaluate the sports nutritional knowledge of athletes in Chennai and the outcomes of this study will help athletes to realize their goals and also enable the advancement of sports nutrition in Chennai. The knowledge of athletes was assessed in different domains namely macronutrients (CHO, Protein and fat), micronutrients, hydration and food intake periodicity. The overall mean nutritional knowledge score was only 40.2% with only 4 athletes having adequate nutritional knowledge of more than 60%. This clearly demonstrates the poor nutritional knowledge of athletes in Chennai. The results align with another study on KAP of Indian Kabbadi players (Majumder et al., 2022), and a study that assessed the nutritional knowledge of Malaysian University athletes (Mean score = 58.6%) (Nor Azizam et al., 2022). Congolese students who were enrolled in sports courses had even lower scores. (Mean score = 9.17) (Roger et al., 2023). According to a study conducted on Malaysian athletes, interventions in sports nutrition education have been proven to significantly improve athletes' mean KAP scores (Moore et al., 2020; Zaman et al., 2020).

It is evident that athletes have a sound grasp of protein sources, showing the significance they place on protein consumption. Nevertheless, their comprehension of various carbohydrate and fat sources is limited, aligning with a study on the nutritional awareness of Australian football players

(Devlin et al., 2017). This underscores the value attached to proteins in optimizing athletic performance, as well as the misconceptions surrounding the types and origins of fats. Surprisingly, the athletes had a good knowledge on food intake periodicity (Mean score = 58.4%) and hydration (Mean score = 40.5%) which coincided with the findings on nutritional knowledge of elite athletes of Football club Barcelona in comparison with non-athletes (Vázquez-Espino et al., 2022). Performance topics that were considered as essential for nutrition education program by a group of Australian and New Zealand athletes included hydration and food intake periodicity (Solly et al., 2023).

Only 12.9% of the athletes were found to make changes to their diet during competition period. In contrast, 95% of college sportsmen from Tamil Nadu were found to modify their diet during competition (Nazni and Vimala, 2010). This difference may be due to adults making more informed food choices than young adolescents. The current research showed a significant correlation between sports nutritional knowledge and attitude of the athletes which was also confirmed by a study in polish young adults (Tchounwou, 2004). The correlation between nutritional knowledge and practice was significant in a study on undergraduate Nigerian athletes but contrasting results were observed in the current study showing that improving their knowledge and inspiring them to practice it is equally important (Folasire et al., 2015).

The food frequency consumption pattern indicated that meat, poultry and fish and legumes and pulses, roots and tubers and green leafy vegetables were consumed on a weekly basis and all the food groups were consumed on a daily basis indicating the consumption of a varied food. Similar pattern of consumption of green leafy vegetables and eggs was observed in a study with sports faculty stu-

dents from Turkey (Çebi et al., 2020).

The mean DDS was 5.18 ± 1.14 and 74.1% of the athletes had a DDS of ≥ 5 . A better DDS was also observed in football players in Iran in comparison with non-athletes confirming the finding that athletes tend to eat a more diverse diets (Zare et al., 2023). In contrast to above findings, the mean DDS was found to be 4.84 ± 1.51 among adolescents from Bangladesh (Islam et al., 2020). Promoting dietary diversity is one of the major solution for tackling inadequacy in intake of micronutrients (Kennedy, 2009). Though majority of athletes had above minimum DDS, there is still the need for educating the athletes on the intake of a varied diet in appropriate quantities. Nutrition education can go a long way in improving their DDS scores as demonstrated in a study with 1000 school adolescents between 10-18 years (Tamiru et al., 2016; Tanui and Imungji, 2017).

Conclusion

Sports nutritionists stand to gain significant benefits from identifying gaps in athletes' nutritional practices, which can help them to target their educational initiatives and enhance athletes' performance. The sports nutritional knowledge of athletes belonging to Chennai is found to be low. Although nutrition education is essential for all areas, particular attention must be given to the sources and types of carbohydrates and fats, along with hydration guidelines. Young athletes, in par-

ticular, require education that encompasses both themselves and their parents to facilitate the improvement of their dietary behaviors. Coaches and sports nutritionists should inspire athletes to apply their newfound knowledge and improve their dietary practices.

Author's contribution

Conceptualization, S.J. and S.K.; methodology, S.J. and S.K.; software, S.J.; check, S.J. and S.K.; formal analysis, S.J.; investigation, S.J.; resources, S.J.; data curation, S.J.; writing – rough preparation, S.J.; writing – review and editing, S.K.; visualization, S.J.; supervision, S.K.; project administration, S.J. and S.K. All authors have read and agreed with the published version of the manuscript.

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Conflict of interest

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