Mal J Nutr 24(1): 103-116, 2018

Effects of sports nutrition education intervention on sports nutrition knowledge, attitude and practice, and dietary intake of Malaysian team sports athletes

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ABSTRACT

Introduction: The purpose of this study was to determine the effects of sports nutrition education intervention on improvements in sports nutrition knowledge, attitude and practice (KAP), and dietary intake among Malaysian team sports athletes. **Methods**: A total of 105 male participants representing four team sports under the elite sports programme were recruited based on a name list provided by National Sports Council of Malaysia. Teams were assigned by stratified random sampling to either the experimental group (EG) (n=52) or the comparison group (CG) (n=53). The EG received seven weeks of education intervention programme based on a validated booklet covering basic sports nutrition for team sports. A self-administered sports nutrition KAP questionnaire and dietary intake assessment of total energy, carbohydrates, proteins and fats based on three-day food records was conducted before and after the intervention. **Results:** There were significant increments (p<0.001) in the EG's post-intervention mean scores for knowledge (6.21±2.95), attitude (9.04±6.65) and practice (4.39±4.27) compared to decrements in the respective mean scores of the CG (-2.15±1.45; -1.72±5.06; -0.74±2.32). Significant improvements were found in the EG's total energy intake, total carbohydrate and total protein intake compared to those of the CG. **Conclusion:** The sports nutrition education intervention was useful in improving the sports nutrition KAP scores, total carbohydrate and total protein intake of team sports athletes.

Keywords: Athletes, intervention study, dietary intake, sports nutrition, knowledge

INTRODUCTION

Sports nutrition can be defined as the application of nutrition knowledge to practical daily diet plan in order to provide energy for physical activity, repairing process in the body, optimising sports performance in competitions and to ensure health and well-being (Contento, 2007). Researchers have reported that physical activity, athletic performance and recovery from exercise were enhanced by optimal nutrition

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(American Collage of Sport Medicine, American Dietetic Association & Dietitians of Canada, 2009).

Delivering optimum nutrition practice is important for all sports, regardless of individual sports or team sports since sports and nutrition are directly related to each other (Supriya & Ramaswami, 2013). In individual sports, the dynamics that govern success is the athlete himself. Individual athletes achieve success through high self-reliance, high discipline in training, with other application of sports science including sports nutrition. Meanwhile, in team sports, two or more athletes work together on a common playing area to defeat an opposing group of competitors (Fink & Mikesky, 2015). Team sports are based on intermittent high-intensity activity patterns, but experience marks the variability of the game characteristics among sports, playing positions and playing styles. Such differences create a diversity of physiological challenges and nutritional needs of team sports athletes (Mujika & Burke, 2010). Position-specific tasks and physique requirements, playing level, gender and age issues further affect nutrient requirements (Holway & Spriet, 2011). In team sports, athletes rely on teammates to achieve team success, it is most important for every team members in team sports to have basic nutritional knowledge and disseminate the correct sports nutrition practice.

Sports nutrition knowledge is important in assessing the knowledge of those athletes who practice sports nutrition and spread information about it. This evaluation is intended to avoid myths and misinformation, as well as to ensure that accurate information is obtained and optimal sports nutrition is practiced by athletes (Zinn, Schofield & Wall, 2005). However, the level of general and sports-specific nutrition knowledge of athletes has been a popular question for researchers. Athletes lack knowledge in nutrition, healthy food choices and the components of a well-balanced diet (Davar, 2012), and these factors have implications on athletes' performance. Hornstorm *et al.* (2011) found a significant inverse relationship between female softball players' nutrition knowledge scores and the quality of their food selections, indicating that the players with less nutrition knowledge had poorer eating habits.

Athletes have special nutritional needs compared to the general population. Burke *et al.* (2001) reported that athletes' diets were often nutritionally inadequate when compared with sports nutrition and general population recommendations. Only 15% of male athletes and 26% of female athletes had adequate carbohydrate and protein intake, respectively (Hinton *et al.*, 2004). One of the strategies to help athletes consume an adequate diet is nutrition education (Spendlove *et al.*, 2012), and the transition from theory to practice usually requires an educational programme (Trabucco *et al.*, 2013). Therefore, the objective of this study is to determine the effects of sports nutrition education intervention on KAP regarding sports-related nutrition and dietary intake among Malaysian elite team sports athletes.

MATERIALS AND METHODS

Study design

In this quasi-experimental intervention study, two groups of participants were recruited, consisting of one experimental group (EG) and one control group (CG) for comparison purposes. The EG attended a seven-week intervention programme on sports nutrition education, while no programme was provided to the CG. The data was collected; at week 0 (i.e.,

the baseline or pre-intervention), and at week eight (post-intervention) after the seven-week intervention.

Participants

Representatives of four elite team sports out of seven listed by the National Sports Council of Malaysia were selected for this study. The participants were grouped into either the EG or the CG, using stratified random sampling. Stratified random sampling was used because of the small number of certain groups that might cause representatives from those groups not to be selected if a simple random sampling was used (McKenzie *et al.*, 2005). Two team sports that stays and train at National Sports Complex Bukit Jalil were grouped into the EG while the other two team sports that stay and train away from Bukit Jalil were grouped into CG, this was done to avoid respondent contamination during the intervention. In total, 110 participants from four team sports were recruited in the study and 105 respondents completed the study. The players representing two team sports (field hockey and football) were assigned to the EG (n=52), and the representatives of the other two (cricket and rugby) were assigned to the CG (n=53) (Figure 1). The inclusion criteria were as follows: (i) male, (ii) engaged in intermittent team sports, (iii) an elite athlete in a training squad, (iv) between 18 and 35 years old (young adult), (v) never received any formal sports nutrition education before this study and (vi) not at a competition phase. The exclusion criteria were as follows: (i) not an elite athlete and (ii) an athlete with an injury. The sample size calculation was based on Chan (2003) formula for calculating the intervention group size, as follows:

Size per group,

$$M = c \times \frac{\pi 1 (1 - \pi 1) + \pi 2 (1 - \pi 2)}{(\pi 1 - \pi 2)^2},$$

where c is constant $[z(1-\alpha/2) + z(1-ß)]^2$ = 7.9, $z(1-\alpha/2)$ = standardised value for 95% confidence interval = 1.96 and $z(1-ß)$ = 80% power = 0.842. Proportion estimates were derived from the effect size of 1.2 (Sharifirad *et al.*, 2009). Based on interpretation by Cohen (1988), an effect size of 1.2 equals to 88% of the treatment group will be above mean of the control group (62%) of having successful outcome. Proportion estimates $\pi 1$ = 0.88 (88% of the EG would be above the mean of the CG that had a successful outcome), and $\pi 2$ = 0.62 (62% of the CG would have a favourable outcome). Therefore, the calculated sample size per group comprised of 50 participants (after considering an 80% response rate), and totals 100 participants in both groups.

Procedure for the intervention

The intervention activities consisted of distribution of the educational booklets, lecture sessions, group discussions and group activities. The intervention programme was conducted in small group sessions, with each group consisting of five to six participants. The EG attended one to two hours of educational sessions on a weekly basis. Each session comprised a one-hour lecture based on one of the sports nutrition topics from the educational material (booklet), followed by a half-hour discussion, including a question-and-answer segment. Some topics in the booklet required the respondents to perform some calculation activities for about half an hour. Table 1 presents the intervention activities. The principal researcher, who had a sports nutrition background, delivered the lecture sessions. Before the educational sessions began, the EG was given a one-hour explanation regarding the booklet and the activities that would be conducted during the intervention. No intervention programme was provided to the CG as it served the purpose of comparison only.

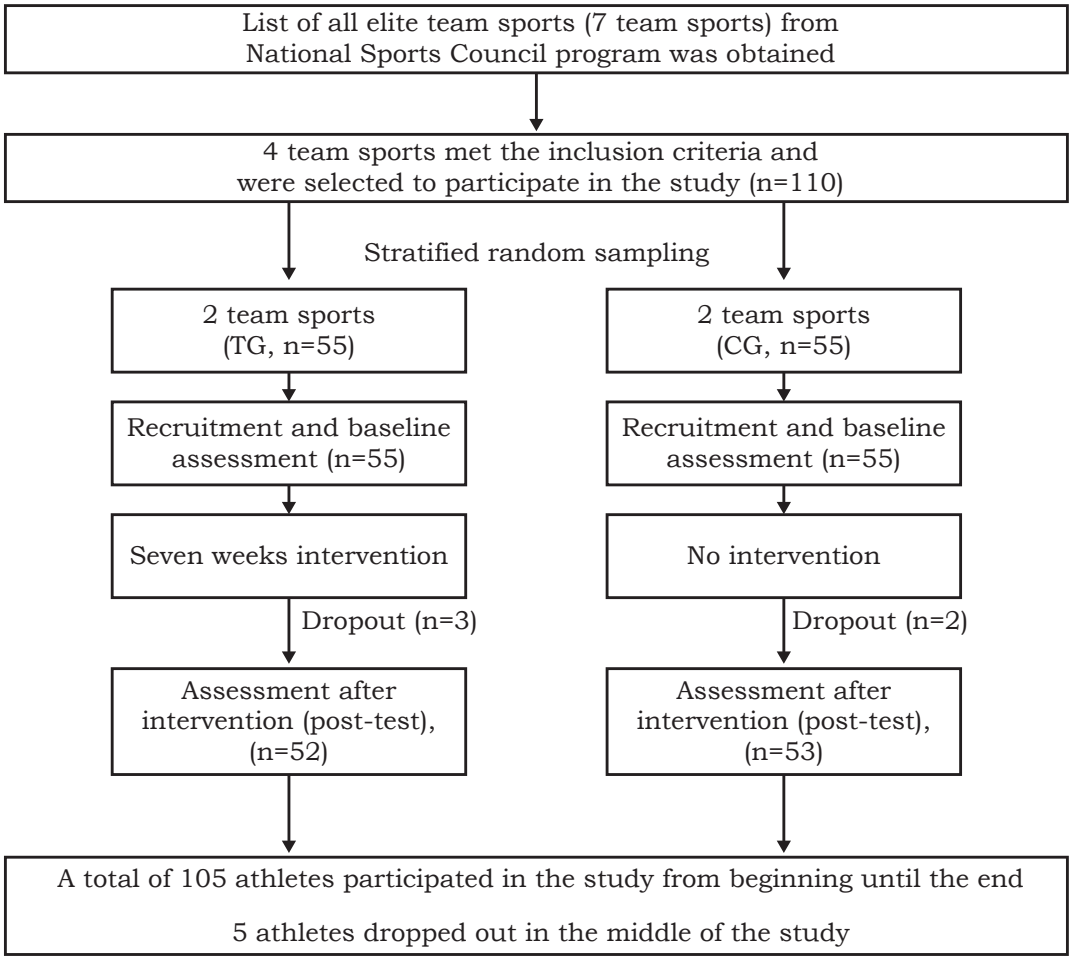

Figure 1. Flow of recruitment, data collection and intervention conducted

There were seven education sessions, and attendance for EG participants was compulsory. Participants who attended the session signed the attendance list. Participants were considered to have dropped out if they did not complete or attend the education session more than two times and did not complete the baseline and post-intervention assessment. Participants who withdrew from the study due to unwillingness to participate were also considered to have dropped out.

Measurement outcomes

The baseline data and the post-test results were collected from the participants in both groups. The data were collected from sports nutrition KAP questionnaires and three-day food records. The socio-demographic section of the questionnaire was used only at the baseline, while similar methods and instruments were applied again at the post-test phase (after the intervention) to collect the data.

Socio-demographic information
In the self-administered questionnaire, each participant was asked about his age, date of birth, ethnicity, educational level, sports category and number of years as an athlete.

Sports nutrition questionnaire
The athletes' sports nutrition KAP levels were determined using a validated questionnaire developed by Hornstrom *et al.* (2011). The sports nutrition questionnaire was first translated using the forward translation method (from English to Bahasa Malaysia) and was translated again using the backward translation method (from Bahasa Malaysia to English) to ensure the accuracy and the clarity of the questionnaire's language, meaning and content. The questionnaire consisted of the following three sections:

(i) Knowledge on basic sports nutrition included 25 questions. Each answer was coded as "correct" and given one mark or "incorrect" and given a zero. The total score was calculated by summing up the marks obtained for all items. A higher score indicates a higher level of knowledge on sports nutrition.

(ii) The second section comprised nutrition choices and nutrition practice, consisting of seven questions on usual food choices and proper nutrition. The respondents were required to choose one out of four answer options. The positive statements about nutrition choices were assigned numbers in a reverse way for scoring purposes. The items were reversed from 1 = every day, 2 = most days, 3 = occasionally and 4 = rarely to 1 = rarely, 2 = occasionally, 3 = most days and 4 = every day. The nutrition practice subsection included five questions about the respondents' nutrition practice based on the Malaysian food pyramid. The participants were required to choose one out of four answer options (1 = four times or more per day, 2 = two or three times per day, 3 = once per day and 4 = less than once per day). The total score was calculated by adding the mark obtained for each of the 12 items in the nutrition choices and the nutrition practice subsections. A higher score indicates healthier nutrition practice.

(iii) Questionnaire on attitude towards nutrition and sports-enhancing diet consisted of 20 questions. The participants were required to choose one out of four options (1 = strongly agree, 2 = agree, 3 = disagree and 4 = strongly disagree). The positive statements in this section were assigned numbers in a reverse way. The total score was calculated by summing the marks obtained from items 1 to 20. A high score indicates higher or more positive attitude towards sports-enhancing diets.

Three-day food records
The three-day food records were self-administered by the participants. To ensure the accuracy of the contents, the researcher interviewed the participants after they handed their completed forms. These dietary records were used to obtain the respondents' dietary and energy intake information. The participants were required to record their entire food and beverage intake, including supplements, during two weekdays on training days and one weekend on rest days. The respondents can choose any two weekdays and any weekend for their dietary intake records. Their total energy and macronutrient intake was examined. The participants' dietary intake was analysed using the Nutritionist Pro software.

Development of educational material
A booklet on basic sports nutrition for team sports was developed, based on information gathered from various learning materials, including scientific

journals, books, websites, fact sheets and pamphlets from local and international publications. After the information was collected, an expert panel of two senior lecturers from the Department of Nutrition and Dietetics and three sports nutritionists from the Sports Nutrition Department, National Sports Institute of Malaysia revised the contents of the booklet. Simple questionnaires about the booklet were distributed to the expert panel and the sports nutritionists to assess the content validity of the instrument. Comments and suggestions from the expert panel and the sports nutritionists were used to improve the booklet's content, images, font types and appearance so that it would be precise and attractive to use as the intervention instrument.

The booklet entitled *Asas Pemakanan Sukan untuk Sukan Berpasukan* (ISBN 978-983-2408-27-7) was written in Bahasa Malaysia as the teaching material to be used during the intervention programme. The booklet consisted of seven topics on basic sports nutrition, as follows: (i) food and healthy nutrition; (ii) macronutrients; (iii) micronutrients; (iv) fluid and hydration; (v) nutritional intake before, during and after training or competition; (vi) energy balance and body weight management, and (vii) dietary supplements.

Data collection

The study was carried out for a total of nine weeks, including one week for the pre-intervention data collection (baseline), seven weeks for the intervention programme and another week for the post-intervention data collection. The participants received an information sheet prior to the data collection to enhance their understanding of this study's objectives. Each respondent signed and returned a consent form, indicating his agreement to participate in the study.

Ethics approval

The Ethics Committee for Research Involving Human Subjects, under the Research Management Centre of Universiti Putra Malaysia, approved this study (Approval No. UPM/TNCPI/RMC/1.4.18.1(JKEUPM)/F2 dated 17 April 2015). Permission to involve the Malaysian elite team sports athletes was obtained from the National Sports Council of Malaysia, related sports associations and team sports managers and coaches.

Data analysis

Descriptive statistical analysis was used to determine the mean, standard deviation, frequency and percentage. Chi-square test was performed to determine associations between categorical variables, while paired *t*-test was used to determine the differences in the means of continuous data within each group before and after the intervention. Independent *t*-test was conducted to determine the significant differences in the means of continuous data between the EG and the CG at the baseline. A general linear model, repeated-measure ANOVA for the two groups at the baseline and the post-test phases was used to determine if any significant differences existed between the groups at each time point. If a significant difference between the groups was found at the baseline, ANCOVA was performed, using the baseline data as covariates. The analysis was based on the intention to treat the EG, and the statistical significance was assigned at $p<0.05$. The data was analysed with the SPSS 22.0.

RESULTS

Initially, 110 eligible respondents were included in the study. At the end of the seven-week intervention, five respondents dropped out, and 105 continued to the post-intervention

Table 2. Socio-demographic characteristics of experimental and comparison groups

Characteristics	*Experimental group (n=52) n (%)*	*Comparison group (n=53) n (%)*	*Overall n (%)*	*Chi-square** (p-value)*
Ethnicity				0.851 (0.356)
Malay	48 (92.3)	46 (86.8)	94 (89.5)	
Indian	0 (0.0)	6 (11.3)	6 (5.7)	
Chinese	2 (3.8)	0 (0.0)	2 (1.9)	
Others	2 (3.8)	1 (1.9)	3 (2.8)	
Type of Sports				6.191 (0.013)*
Cricket	0 (0.0)	14 (26.4)	14 (13.3)	
Football	26 (50.0)	0 (0.0)	26 (24.8)	
Hockey	26 (50.0)	0 (0.0)	26 (24.8)	
Rugby	0 (0.0)	39 (73.6)	39 (37.1)	
Years Being Athletes				0.826 (0.363)
< 5 years	0 (0.0)	4 (7.5)	4 (3.8)	
5 - 10 years	43 (82.7)	36 (67.9)	79 (75.2)	
> 11 years	9 (17.3)	13 (24.5)	22 (21.0)	
Education Level				28.806 (<0.001)*
Secondary	39 (75.0)	12 (22.6)	51 (48.6)	
Pre University	7 (13.5)	6 (11.3)	13 (12.4)	
University	6 (11.0)	35 (66.0)	41 (39.0)	

*significant difference between groups
**Chi-square based on 2x2 contingency table

phase. Of the 105 participants, 52 were from the EG, and 53 were from CG. The programme continuation rates for the EG and the CG were 94.5% and 96.4%, respectively. After the intervention, the final sample's programme completion rate averaged 95.5%. Age of participants was between 18-32 years old and mean age for EG was 18.69 (*SD*=0.88) while mean age for the CG was 23.26 (*SD*=3.81). There was significant difference between mean age for EG and CG, $t(58)=-8.513$, $p<0.001$. The EG and the CG were similar in terms of ethnicity and number of years as an athlete. However, the two groups differed significantly ($p<0.05$) in the type of sports and educational level. The participants in the EG were football (24.8%) and hockey (24.8%) players, while the participants in the CG engaged in cricket (13.3%) and rugby (37.1%) sports ($\chi^2=6.191$, $p<0.05$). For educational level, 75.0% of the respondents in the EG and 22.6% of the respondents in the CG had completed secondary education. Meanwhile, 66.0% of respondents in CG and 11.0% respondents in EG completed their tertiary education ($\chi^2=28.806$, $p<0.001$) (Table 2).

Table 3 presents the pre-test and the post-test mean scores for the sports nutrition KAP of the EG and the CG. At the baseline, the CG's mean score for knowledge was significantly higher than that of the EG, but there was no significant difference in the mean scores for attitude and practice between the two groups. There were significant increments in the EG's KAP mean scores after the intervention, as indicated by the mean changes in the knowledge ($\Delta M=6.21$, $p<0.001$), attitude ($\Delta M=9.04$,

Table 1. Outline of sports education intervention activities

Week	*Activities*	*Content*	*Period*
1	Lecture session	Topic 1: Food and healthy nutrition	1 hour
	Group discussion		½ hour
2	Lecture session	Topic 2: Macronutrient	1 hour
	Group discussion		½ hour
3	Lecture session	Topic 3: Micronutrient	1 hour
	Group discussion		½ hour
4	Lecture session	Topic 4: Fluid and hydration	1 hour
	Activity	Calculation of percent body weight loss during training and volume of fluid to be replaced	½ hour
	Group discussion		½ hour
5	Lecture session	Topic 5: Nutrition before, during and after training or competition	1 hour
	Group discussion		½ hour
6	Lecture session	Topic 6: Energy balance and weight management	1 hour
	Activity	Calculation of BMI and estimation of energy requirement	½ hour
	Group discussion		½ hour
7	Lecture session	Topic 7: Dietary supplement	1 hour
	Group discussion		½ hour

$p<0.001$) and practice ($\Delta M=4.39$, $p<0.001$) scores between the baseline and the post-test phases. The increments in the post-test KAP mean scores contributed to the significant difference ($p<0.001$) in the KAP mean scores between the EG and the CG. Meanwhile, there was a significant decrease in the CG's KAP scores after the intervention.

Table 4 presents the pre-test and the post-test mean total energy and macronutrient intake of the EG and the CG. At the baseline, there was a significant difference in the total energy intake between the two groups. For the macronutrient intake at the baseline, the two groups showed significant differences in carbohydrate intake, in g/kg of body weight, percentage of total carbohydrate intake, total protein intake, percentage of total protein intake, total fat intake and percentage of total fat intake ($p<0.001$). No significant difference was found in total carbohydrate intake and protein intake (in g/kg of body weight). After the intervention, the mean total energy intake was significantly higher in the EG than in the CG, as indicated by the mean change between the groups ($\Delta M=401$ versus -104, $p<0.001$). Meanwhile, there were significant increments in certain macronutrient variables in the EG, as indicated by the mean changes in their total carbohydrate intake ($\Delta M=38.13$ g, $p<0.001$), carbohydrate intake (in g/kg of body weight; $\Delta M=0.57$, $p<0.001$), total protein intake ($\Delta M=30.45$, $p<0.001$) and total fat intake ($\Delta M=18.36$, $p<0.001$).

Table 4. Mean differences of total energy and macronutrient intake between the experimental and comparison groups

Variable	*Experimental group (n=52) Mean±SD*	*Comparison group (n=53) Mean±SD*	*F-value*	*p-value*
Total energy (kcal)				
Pre	2478±364	2801±541		
Post	2879±385 [c]	2697±600 [c]	24.517[a a]	<0.001[*]
Difference	401±486	-104±338		
Total carbohydrate (g)				
Pre	342.15±59.96	332.24±52.96		
Post	380.28±62.72 [c]	319.39±59.80 [c]	13.025[b]	<0.001[*]
Difference	38.13±74.54	-12.85±45.49		
Carbohydrate g/kg body weight				
Pre	5.25±1.05	4.37±0.88		
Post	5.82±1.24 [c]	4.12±0.57 [c]	49.990[a]	<0.001[*]
Difference	0.57±1.15	-0.25±0.66		
Carbohydrate percentage (%)				
Pre	55.13±4.84	48.05±4.53		
Post	52.79±5.54 [c]	48.11±4.89	0.905[a]	0.344
Difference	-2.33±5.46	0.06±4.91		
Total protein (g)				
Pre	108.68±23.32	142.62±38.54		
Post	139.14±22.22 [c]	141.34± 41.40	15.822[a]	<0.001*
Difference	30.45±29.33	-1.28±22.93		
Protein g/kg body weight				
Pre	1.68±0.43	1.83±0.39		
Post	2.13±0.47 [c]	1.79±0.39	1.748[b]	0.189
Difference	0.46±0.47	-0.04±0.31		
Protein percentage (%)				
Pre	17.63±2.97	20.11±2.71		
Post	19.41±2.46 [c]	20.63±2.46	0.349[a]	0.556
Difference	1.77±3.14	0.51±2.49		
Total fat (g)				
Pre	75.94±16.22	101.68±26.42		
Post	94.30±19.80 [c]	96.21±26.76	9.973[a]	0.003[*]
Difference	18.36±23.01	-5.58±20.01		
Fat percentage (%)				
Pre	27.58±4.03	32.29±3.36		
Post	29.50±4.27 [c]	31.68±3.44	1.502[a]	0.233
Difference	1.92±5.40	-0.62±3.96		

[*] significant difference between groups, $p<0.05$

[a] result from ANCOVA with baseline data as covariates

[b] result from GLM repeated measures ANOVA

[c] significant difference within-group between baseline and post-intervention as determined by paired sample *t*-test

The significant increments in the post-test results for these variables contributed to the significant difference (p<0.001) between the EG and the CG. After the intervention, no significant difference was found in the percentage of carbohydrate intake, percentage of protein intake, protein intake (in g/kg of body weight) and percentage of protein intake between the two groups.

DISCUSSION

This study was conducted to examine the effects of sports nutrition education intervention on Malaysian team sports athletes. After the intervention, the time and the group effects on the KAP scores showed significant interactions between the two groups of respondents over the two periods. The main effect of time on the KAP scores showed significant increments in the EG's KAP test scores and decreases in the CG's KAP test scores at the post-test phase. The EG (with intervention programme) and the CG (no intervention programme) showed statistically significant results, indicating differences in the KAP scores of both groups, with the EG demonstrating better outcomes after the intervention compared to the CG. These findings are consistent with those of Abood, Black & Birnbaum (2004), Valliant *et al.* (2012) and Rossi *et al.* (2017), which showed significant improvements in the athletes' nutrition knowledge and dietary practice after an education intervention programme. Another study found a positive relationship between nutrition knowledge and attitude; higher knowledge and attitude scores were associated with athletes that had more nutrition education (Hornstrom *et al.*, 2011).

The mean KAP scores for EG shows increment after the intervention, while the CG decreased in their mean KAP scores after the intervention. Within-group comparison revealed that there was statistically significant effect of time for pre- and post-KAP scores for both groups, with EG showing increment in their post-test KAP scores, while the CG decreased their test score at post-test. The effect comparing the two types of intervention between EG which received seven weeks of sports nutrition education and CG who do not receive any education programme was significant suggesting there was differences in KAP scores for both groups with the EG showing better result of sports nutrition knowledge, attitude and practice compared to the CG. The differences in the scores between the EG and the CG is assumed to be due to the input given to the EG which comprise comprehensive approach on basic sports nutrition during the intervention program while no information given to the CG on the importance of sports nutrition knowledge, attitude and practice of sports nutrition.

At baseline, the significant differences in the type of sports were due to the differences in the training regime, training volume, training environment, rest time, daily life activity and sports culture of the different team sports involved in this study. Moreover, the players' body physique depended on the type of sports that they were playing.

Athletes' energy requirements depend on the scheduled training and the competition cycle and vary from day to day throughout the yearly training plan relative to changes in volume and intensity (ACSM, 2016). This study found a significant improvement in the EG's mean energy intake at the post-test phase. This result indicated good practice because the total calorie intake showed an improvement, with more energy intake to balance the athletes' energy requirements. Additionally, the EG's energy intake (2879 kcal) after the intervention exceeded the value of the

energy intake (2784 kcal) reported in Ismail and colleagues' (1995) local study among selected sportsmen.

The recommended nutrient (e.g., carbohydrates and proteins) and energy intake should be expressed by using guidelines per kilogram of body weight to allow scaling to a large range of the body sizes of athletes (ACSM, 2016). The mean intake of total carbohydrate and carbohydrate (in g/kg of body weight) were significantly increased in the EG after the intervention. The EG's carbohydrate intake (in g/kg of body weight) showed improvement over the two periods, but the value (5.6 g/kg of body weight) did not reach the recommended range for actively training athletes (6-10 g/kg of body weight). Although the EG's total carbohydrate intake increased (from 342.15 g to 380.28 g) at the post-test phase, converting this amount from gram to percentage showed a decrease with 53% of the total carbohydrate intake, and this value did not meet the recommended total energy requirement from carbohydrate intake. The EG's failure to meet the adequate percentage of carbohydrate intake indicated that the improvement in their total energy intake was due to their consumption of high-protein and high-fat foods instead of carbohydrate-rich foods. These findings are similar to those of Villiant *et al.* (2012), who reported an improvement in the participants' dietary intake and an increased percentage of their fat intake after the intervention programme. In the present study, the respondents would need to reduce their fat intake and increase their carbohydrate intake to meet the dietary intake recommendations for athletes. According to Loucks (2004), the limiting factor for performance is energy intake, especially carbohydrate intake, below the recommended total energy requirement. In contrast, Villiant *et al.* (2012) study showed an increase in the participants' carbohydrate intake from 48% to 66% before and after the intervention, respectively.

The EG had significant increases in their total protein intake, protein intake (in g/kg of body weight) and percentage of total protein intake after the intervention. Their protein intake was within the recommended range for athletes (1.2–1.7 g/kg of body weight) (Jeukendrup & Cronin, 2011) at the pre-test phase and exceeded the recommended protein intake for athletes (2.13 g/kg of body weight) at the post-test phase. Their percentage of total protein intake slightly increased from 18% at the pre-test phase to 19% at the post-test phase, remaining within the recommended range for the total energy intake. The EG's total fat intake and percentage of total fat intake increased significantly at the post-test phase. Although their percentage of total fat intake increased, the value was just acceptable and less than 30% of the recommended range for the total energy requirement from fat intake.

One of the functions of nutrition education is to facilitate voluntary adoption of eating and other nutrition related behaviour conductive to health and well-being (Contento, Randell & Basch, 2002). Nutrition education programmes are designed to improve nutrition knowledge, with the aim of supporting sound dietary practice within the community or specific target population (Worsely, 2002). In this research, results of increased KAP scores in the EG after the intervention programme shows that nutrition education given to EG was useful to facilitate the participants in EG to apply a good dietary practice and this shows from their positive dietary intake increments after the intervention. Meanwhile, in CG the dietary intake data shows either significant decreased or no significant difference within group after the intervention since no education programme given to this comparison

group to guide them on practicing good nutrition habits.

Limitations

Several limitations could have affected this study's findings. The study involved players from only four team sports. Hence, the results might not be representative of all the other team sports athletes in Malaysia. The study was conducted among team sports athletes only, which might not be generalised to other sports athlete populations. The nutrition education programme used was only limited to the team sports in the experimental group only, while athletes in the comparison group did not receive the nutrition education program. No comparison could be made to female athletes since this study only involved male athletes. The participants' types of sports might have biased this study's results because the respondents in the EG and the CG played different sports. This variety reflected the differences in both groups' sports culture, body physique, training regime, training time, training volume and intensity, and all of these factors could have affected the study's results.

During the data collection, self-bias might have occurred because each participant's diet was unobserved. The dietary intake information used in this study was based on the subjects' self-reports, and the collected data depended on their honesty in documenting their three-day food records. Under- or over-reporting on the three-day food records might have led to an underestimation or an overestimation of the participants' total caloric intake in this study. Furthermore, the questionnaire used in this study was self-administered. Hence, the reliance on the self-reported data depended on the participants' honesty and ability to understand the questionnaire.

CONCLUSION

The sports nutrition education intervention increased the sports nutrition KAP scores, improved athletes' intake of total energy and macronutrients. This study's findings support the need for programmes to improve the dietary intake of team sports athletes for optimal performance.

Acknowledgement

We wish to thank all sport organisations that involved in this research for their support: National Sports Council of Malaysia, National Sports Institute of Malaysia, participants, coaches, managers and physical trainers from Malaysia Hockey Confederation, Football Association of Malaysia, Rugby Union of Malaysia and Malaysia Cricket Association. Special thanks to Faculty of Sport Science and Recreation, Universiti Teknologi MARA Shah Alam and Ministry of Higher Education Malaysia for the provision of scholarship throughout this research.

Authors' contributions

Siti Soraya ME, principal investigator, conceptualized and designed the study, led the data collection, prepared the draft of the manuscript and reviewed the manuscript; Hazizi AS, conceptualized and designed the study, led the data collection, advice on the data analysis and interpretation, assisted in drafting of the manuscript and reviewed the manuscript; Mohd Nasir MT, conceptualized and designed the study and reviewed the manuscript; Zubaidah J, conceptualized and designed the study and reviewed the manuscript.

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