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The implementation and evaluation of a nutrition education programme for university elite athletes

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Summary
A challenge of providing nutrition education to collegiate athletes lies in the development of an effective method for improving nutrition knowledge and attitudes. This study presents the results of a nutrition education programme, designed to improve nutrition knowledge and dietary intake in a sample of university scholarship athletes coming from different sports settings. The nutrition programme was delivered by a qualified sports nutrition professional and it consisted of six sessions targeted at improving athlete understanding of sports nutrition principles to support training, competition and health. Paired sample t-test detected a significant increase in participants' scores for nutrition knowledge between pre- and post- intervention conditions ($p<0.005$). ANOVA was used to test for variation between males and females but no significant gender differences were noted. Although the nutrition education programme presented was effective in rising nutrition knowledge of the athletes, score increase did not have a significant impact on their dietary practices. Percentages of energy from macronutrients were within current dietary guidelines. The mean diet quality for both males and females was satisfactory: mean intakes of carbohydrate, protein, fat and fluid were into line with dietary recommendations. In contrast, post-test female intakes of calcium, iron, zinc, selenium and iodine were inadequate. While micronutrient intake of male participants revealed no deficiencies. This study reduces the paucity of nutrition education intervention research among university sports scholars and reveals that the nutrition education programme was effective on increasing the participants' nutrition knowledge, but not in improving their dietary intake; these results imply that a controversial relationship links nutrition knowledge and eating patterns, suggesting new spurs for further research.

Riassunto
La principale difficoltà di un valido programma di educazione alimentare è lo sviluppo di un metodo efficace e ripetibile per migliorare lo stile alimentare dei partecipanti. Questo studio presenta i risultati di un percorso educativo finalizzato al miglioramento della conoscenza nutrizionale e delle abitudini alimentari di un gruppo di atleti universitari di alto

livello, provenienti da diversi panorami sportivi. Il programma è stato condotto da dietisti qualificati e si è articolato in sei incontri inerenti i principi della nutrizione sportiva. Conoscenza nutrizionale e abitudini alimentari sono stati valutati prima e dopo l'intervento educativo, rispettivamente attraverso un questionario validato e un diario alimentare settimanale. E' stato evidenziato un significativo incremento della conoscenza nutrizionale dei partecipanti ($p<0.005$) ma non un miglioramento della loro alimentazione. La qualità della dieta dei partecipanti di entrambi i sessi era soddisfacente: gli apporti medi di energia, macronutrienti e acqua rientravano negli intervalli raccomandati. Al contrario, gli apporti post-intervento di calcio, ferro, zinco, selenio e iodio delle donne erano inadeguati. Ad un aumento della conoscenza nutrizionale, dunque, non sempre consegue un miglioramento delle abitudini alimentari. I risultati ottenuti suggeriscono quindi l'esistenza di una controversa relazione tra conoscenza nutrizionale e condotta dietetica, fornendo nuovi spunti per futuri approfondimenti.

Introduction

Nutrition education is becoming increasingly important in the athletic community for teaching athletes how to maximize the benefits of training, avoid injuries and improve both fitness and performance.

Athletes may benefit from nutrition education; however, insufficient nutrition education resources are in place at most college campuses to contribute to the improvement of dietary behaviours (1). A challenge of providing nutrition education to collegiate athletes lies in the development of an effective method for improving nutrition knowledge and attitudes. The present study was conducted on elite level student athletes to evaluate the benefits of a nutrition education programme delivered by a qualified sports nutrition professional related to changes in knowledge, self-efficacy to make healthful choices, and improved dietary intake.

Methodology

For the experimental group seven participants aged 18-23 years were voluntarily recruited from a pool of 105 university sports scholars, who were in receipt of a university sports scholarship. To be a university scholarship athlete was the only selection criterion, which implied that all participants must be considered elite athletes in their sports discipline.

According to the sporting criteria for university scholarship eligibility, elite athletes are defined as athletes that "will be expected to have reached, or have the potential to reach, junior or senior world-class performance level in their sport."

The study was carried out over a five-month period and it consisted of six sessions targeted at improving athlete understanding of sports nutrition principles to support training, competition and health.

Athletes involved in the study received the nutrition education programme through interactive workshops that covered the following main topics: introduction to the topic, introduction to sport nutrition, focus on fuelling, interpreting diet analysis, optimising hydration, recovery nutrition, protein and supplements, and, finally, recap and review.

The education programme was conducted by a performance nutritionist possessing the appropriate qualifications and skills to ensure participants receive highly credible nutrition information, in order to increase both health and sports performance (2, 3).

Efforts were made to increase dietary choice self-efficacy by providing opportunities to gain mastery through in-class activities (i.e. each athlete calculated his own carbohydrate daily requirement using concrete examples of carbohydrate foods and assessed the taste of three different sports drink during an interactive test). In addition, participants were led to tailor and apply the information learned in ways that would be most appropriate and beneficial to them.

Each session was delivered three times a week in order to facilitate participants' attendance; nonetheless participants' presence was very poor, leading to the periodical necessity for the researchers to arrange one-to-one meeting with the athletes to deliver programme session individually. Group email messages were regularly sent out to reiterate following meeting times and further details about the education programme. Although the programme was addressed to scholars coming from different sport fields, each athlete felt that the information was personal to him and the content of the workshops was also presented in an involving, persuasive and interesting way. Each participant was offered to the same treatment to all others, in order to ensure study reliability.

Data collection

All participants were asked to complete a nutrition knowledge questionnaire, which is the only nutrition knowledge questionnaire that had previously undergone extensive validation through test retest reliability measures, and a a seven day semi-quantifies food and fluid diary pre and post the education programme in order to measure changes in knowledge and/or nutritional intake.

At post-treatment, participants completed the same measures to determine the effectiveness of the nutrition education programme. All scholars were encouraged to evaluate their dietary intake in line with principles of optimum performance using data collected from food and exercise records to raise awareness of individual requirements and how to achieve them; individualized feedback and guidance on diet diaries were in the form of a written report.

Anthropometric values of height and weight were measured immediately after individual meetings to collect and revise diet diaries, respectively using a stadiometer and a secca scales.

Diet records were reviewed individually with the athletes post completion to ensure completeness and accuracy; furthermore, participants were contacted by phone or by email if any record entries were unclear. All food diaries were recorded during the same month to avoid seasonal dietary changes, such as fruit, vegetables and typical seasonal products. A total of 16 records were collected, 8 prior to the education programme and 8 after workshop delivery.

Throughout the project researchers registered participants' attendance and regularly filled in overview sheets dealing with session topic, behaviour of participants and further comments, in order to ensure a qualitative analysis of the project. This record of any potential problem areas or limitations might be useful for future research on nutrition education programmes.

Data analysis

For the multiple choice section of the questionnaire correct responses were scored as 1 and incorrect as 0. For the true/false section right answers scored 1 whereas wrong answers scored -1. This method prevented artificially high ratings since random responding would tend to sum to zero rather than 50 per cent (4). All sections of the questionnaire were combined and presented as a percentage of knowledge score, which was then used in subsequent analyses.

NetWISP V.3.0 Dietary Analysis Software was employed to analyze diet diary data. Data were examined for normality of distribution prior to analysis. Descriptive statistics, including the mean and standard deviation, were determined for all variables. Paired t tests were performed between pre- and post-intervention values for each dependent variables and ANOVA was used to test for differences between males and females for nutrition knowledge and dietary intake. To obtain an impression of the magnitude of this difference in scores, Cohen's effect size was used in addition to the use of t-tests. All data were analysed using Statistical Package for the Social Sciences (SPSS) for Windows (version 19.0) and graphed using Excel (Microsoft Corporations) software. Moreover, a graphical representation was present alongside the descriptive analysis of the results. All data were presented as $M \pm SD$, and an Alpha level of 0,05 was adopted to indicate statistical significance.

Micronutrient data results were compared to the recent "Dietary reference values for food energy and nutrients in the United Kingdom" and to the 2002 FAO/WHO "*Recommended Nutrient Intakes* (*RNI*) for Vitamins and Minerals", with values achieving 80% of the recommended value deemed adequate. Whereas macronutrient and fluid intake were related to the "Dietary reference values for food energy and nutrients in the United Kingdom" (COMA, Department of Health, 1991) and the joint position stand of the American College of Sports Medicine (American Dietetic Association, 2009). The choice of taking into account both past and recent dietary recommendations allowed the present investigation to be comparable with all similar studies in the dietary assessment of athletes.

With regards to energy requirements, the activity record was use to determine the most appropriate Physical Activity Level (PAL) in order to gauge the Estimated Energy Requirement (EER). The latter was calculated by multiplying PAL with BMR (Basal Metabolic Rate).

Table 1 shows some demographic and anthropometric information of participants, their sports discipline and PAL values adopted.

All results were summarized in a written report, rich in figures and tables in order to facilitate topic comprehension.

Results

The physical characteristics of the subjects are presented in Table 2. A paired-samples t test revealed that there were no significant differences in anthropometrical values from pre- to post-intervention.

A paired-samples t test was conducted to assess whether there was a change in participants' dietary intake scores from time 1 (pre-intervention) to time 2 (post-intervention). There was no statistically significant difference between the two sets of scores (Table 3).

From the results obtained, it could be seen that the overall dietary intake adhered to the recommendations. The 7-day average energy intake during the pre-test was greater than the post-test average. The pre-season value (39±11.1 kcal/kg of body weight) met the minimum energy recommendation for "active" to "very active" individuals (based on 39-45 kcal/kg body weight), while the post-test value (34,4±9,6 kcal/kg body weight) only corresponded to energy requirements for "sedentary" to "low" activity (32-35 kcal/kg body weight). From time 1 to time 2, no significant changes were observed in energy consumed as car-

Table 1 - Main characteristics of the participants.

Athlete	Gender	Weight (kg)	Height (cm)	BMI	Sport	PAL
1	Female	69.0	176.5	22.1	Basketball	1.7
2	Female	72.0	162.0	27.4	Rugby Union	1.6
3	Female	64.0	164.5	23.7	Rugby Union	1.6
4	Male	87.0	184.5	25.6	American Football	1.8
5	Male	101.0	186.0	29.2	Shot Put	1.9
6	Female	63.0	159.5	24.8	Water polo	1.7
7	Male	78.0	177.0	24.9	Rugby League	1.7

bohydrate, protein and fat neither when expressed in terms of grams/kg of body weight nor as percentage of total kcalories. Furthermore, neither of two conditions met the recommended 7-10 g/kg body weight to accommodate repletion of muscle glycogen stores during repetitive days of training. The pre-programme percentage of energy consumed as fat (30,4±5,0%) was slightly above the recommended 25-30% of total energy intake, conversely the post-programme value fell into the recommended range. Although the protein consumption decreased between pre- and post-test conditions from 1,7±0,5 to 1,5±0,4 g/kg of body weight, the amounts always met the increased protein requirements recommended for strength and endurance athletes (1.2-1.7 g/kg of body weight) (5).

Pre-test fluid consumption (30,8±7,9 ml/kg body weight) was lower than post-test intake (38,7±12,7 ml/kg body weight) but the difference was no statistically significant, nonetheless fluid intakes always met requirements (30-35 ml/kg of body weight). Five athletes reported alcohol ingestion during the pre-test, while six athletes reported consumption during the post-test. Calories from alcohol constituted <3.5% of daily calories consumed for those who reported alcohol use.

Average micronutrient values <75% of the RDA were considered "marginal" for a particular nutrient. Tables and figures represent vitamin and mineral intakes without supplements. The 1989 RDAs and the DRIs for female and male adults were used to compare mean values of female and male participants.

Mean intakes of several vitamins and minerals (Table 4) were higher during the post-test compared to pre-test period, including calcium, phosphorous, iron, selenium, iodine, several B-complex (thiamin, riboflavin, niacin, vitamin B6, vitamin B12) and folate. Copper, zinc and vitamin C are the only micronutrients whose pre-test average intake exceeded that of the post-programme. Selenium was the only micronutrient whose mean intake was marginal (<75% RDA) during both the pre- and post-test periods. The other micronutrients satisfied recommended allowances.

A paired-samples t test was conducted to evaluate the impact of the intervention on participants' scores on the nutrition knowledge questionnaire. There was a statistically significant increase in questionnaire scores from time 1 (M = 18.43, SD = 11.99) to time 2 (M = 39.29, SD = 2.63), t (6) = -5.00, p < .005 (two-tailed). The mean in-

Table 2 - Pre- and post-programme participants' characteristics.

Variable	Pre-Test	Post-Test
	overall mean	overall mean
Age (years)	21.6±2.4	21.9±2.2
Height (cm)	172.9±10.8	172.9±10.8
Weight (kg)	76.3±13.7	77.1±14.8
BMI	25.4±2.3	25.6±2.6

Note. Values expressed as mean ± standard deviation. No pre- to post-season differences were significant (p>.05)

Table 3 - Participants' pre- and post-test intakes of total energy, macronutrients, micronutrients and fluid.

Variable	Pre-Test	Post-Test	p value
	overall mean	overall mean	
Dietary record			
Total kcalories (kcal/kg BW)	39.0±11.1	34.4±9.6	0.070
Carbohydrate (g/kg BW)	5.1±1.4	4.9±1.7	0.535
% of total calorie	49.7±4.7	52.9±5.1	0.237
Fat (g/kg BW)	1.3±0.5	1.0±0.3	0.080
% of total calorie	30.4±5.0	26.1±5.9	0.099
Protein (g/kg BW)	1.7±0.5	1.5±0.4	0.270
% of total calorie	17.0±2.1	17.1±2.9	0.899
Alcohol (g/kg BW)	0.2±0.1	0.2±0.1	0.940
% of total calorie	2.5±2.2	3.1±2.9	0.592
Potassium (mg)	3157.3±963.2	3177.1±1392.6	0.969
Calcium (mg)	924.9±365.1	1112.5±826.2	0.510
Phosporous (mg)	1193.6±383.6	1263.1±632.9	0.768
Iron (mg)	12.8±2.8	14.5±6.2	0.438
Copper (mg)	0.9±0.3	0.8±0.3	0.211
Zinc (mg)	9.9±4.0	9.1±4.2	0.529
Selenium (µg)	45.4±11.8	47.9±16.5	0.749
Iodine (µg)	115.6±63.4	140.7±131.0	0.658
Thiamin (mg)	1.6±0.5	1.9±1.1	0.379
Riboflavin (mg)	1.7±0.7	2.1±1.4	0.485
Niacin equiv. (mg)	26.1±6.1	30.7±12.4	0.488
Vitamin B6 (mg)	2.2±0.6	2.9±1.3	0.307
Vitamin B12 (mg)	4.1±1.9	5.3±3.3	0.476
Folate (µg)	239.9±55.5	304.2±140.7	0.250
Vitamin C (mg)	142.2±73.2	133.4±94.1	0.691
Fluid (ml/kg BW)	30.8±7.9	38.7±12.7	0.279

crease in questionnaire scores was 20.86 with a 95% confidence interval ranging from -31.06 to -10.65.

A mixed between-within subjects analysis of variance was conducted to assess the impact of the intervention on participants' dietary intake, across two time period (pre-intervention and post-intervention). The independent variables included one between groups variable, *gender,* with two levels (male, female) and one within subject variable, *time,* with two levels (time 1=pre-test, time 2=post-test). Dietary intake

Table 4 - Participants' nutrition knowledge questionnaire scores.

Variable	Pre-Test	Post-Test	p value
	overall mean	overall mean	
Questionnaires			
Nutrition knowledge	18.4±12.0	39.3±2.6	0.002*

*Note. *Significantly different from the pre-test value (p<.05).*

variables assessed included: caloric intake, and carbohydrate, protein, fat, alcohol and fluid consumption. There was not a significant difference in dietary intake between males and females.

A *2* (time) x 2 (gender) mixed between-within ANOVA revealed that the main effect for gender was not significant $F(1,5) = 2.93$, $p > .05$, eta-squared = .37. Thus, there was not a significant interaction between the rate of nutrition knowledge improvement and consequently there was no overall difference in the task scores of females (M = 32.13) compared to males (M = 24.50). A significant main effect for time was obtained, $F(1,5) = 33.15$, $p < .01$, furthermore this was a large effect (eta-squared = .87). Task scores after the workshop (M = 39.17) were significantly higher than before the workshop (M = 17.49). Examination of the cell means indicated that although there was a large increase in task skill scores for males from time 1 (M = 10.67) to time 2 (M = 38.33), the workshop did not produce much of a change in the task skill scores of females from time 1 (M = 24.25) to time 2 (M =40.00). Before the workshop females had much higher questionnaire scores (M = 24.25) than did males (M = 10.67), but after the workshop, there was not much of a difference in questionnaire scores between females (M = 40.00) and males (M = 38.33).

Discussion

Athletes' desire for accurate nutrition education is a growing challenge owing to the constant changes resulting from research. Although nutrition knowledge has been measured in athlete populations (6, 7), the influence of nutrition knowledge on athlete eating behaviours has been largely unexplored: this study contributes to fill the gap in the current literature in understanding the effect of nutrition knowledge on dietary intake, and it provides an answer to the question of whether or not university athletes can translate their increased nutrition knowledge into a diet that is in accordance with current dietary guidelines. Meanwhile this investigation aimed to assess whether nutrition knowledge could overcome the influence of other factors (i.e. gender) that affect daily food choices and dietary intake.

The main findings of the current study were that:

- Of the macro- and micronutrient variables used to assess dietary intake, none were significant different between pre-test and post-test conditions, furthermore no difference was found in fluid intake.
- Post-test nutrition knowledge questionnaire scores were significantly higher than pre-test values.
- No gender differences were noted when assessing dietary intake variables.
- Despite high differences in nutrition knowledge scores between males and females, ANOVA tests did not find statistical significance when comparing groups.

These results suggested that students with higher nutrition knowledge do not apply their knowledge in food choice and thus are not more capable of making healthier food choices.

This research study demonstrated that when university athletes are provided with nutrition education intervention in the form of interactive workshops, there can be a significant increase in nutrition knowledge; data obtained from data analysis, indeed, indicated that nutrition education programme was an effective way to improve nutrition knowledge. Mean questionnaire scores increased significantly ($p<0.005$) from 18.4±12.0 at the beginning to 39.3±2.6 at the end of the intervention.

No significant gender differences were noted on mean intakes for pre- and post-intervention periods were

calculated for macronutrients, fluid and main micronutrients. Energy intake was highest for the athletes at the time they were in competition (pre-test period) and percentages of energy from macronutrients were within current dietary guidelines. The mean diet quality for both males and females was satisfactory: mean scores for intake of carbohydrate, protein, fat and fluid were into line with dietary recommendations. In contrast, female mean intake of calcium, iron, zinc, selenium and iodine were inadequate. While micronutrient intake of male participants revealed no deficiencies.

To date, only a paucity of literature exists that have examined the relationship between nutrition knowledge and the dietary intake of university students.

In agreement with responses from this study, nutrition knowledge was not always highlighted as driving appropriate intake (6, 8). Similar findings were reported by Collison and colleagues in a study evaluating the effectiveness of a nutrition education programme on the knowledge, attitudes, and nutrient intake of female athletes and nonathletes (9). Welch and co-workers reported that nutrition counselling was effective in changing the dietary intake of athletes when each counselling session was personally tailored and related to individual needs, interests, experiences, and goals (10).

In contrast with findings of a recent investigation (11), main results of the present study suggest that there is not association existing between nutrition knowledge and dietary intake, and that nutrition knowledge has not got necessarily parallels in the dietary behaviour. According to Kresic and co-workers, nutrition knowledge could act as an effective tool in modifying the influence of eating arrangements on dietary intake, which is of particular importance in university settings. Nonetheless, in the present study no correlation was found between improvement in nutrition knowledge and change in dietary patterns.

In 2004, Walsink suggested that different types of knowledge about a food lead to different levels of consumption likelihood, and knowledge is best translated into consumption when it links food attribute-related knowledge with consequence-related knowledge (12). Therefore, it is important to understand that the relationship between nutrition knowledge and dietary it is neither simple nor self-evident. In other words, if people is educated and prepared on good nutrition basics, their dietary habits could not be consequently improved. Conflicting results have been reported for athletes regarding relationships between nutrition knowledge and dietary intake. Wiita and colleagues (13) found that dietary intake was 27% predictive of nutrition knowledge among runners and thus concluded that runners with greater nutrition knowledge make better food choices. On the other hand, Turner and colleagues (14) reported that osteoporosis knowledge was only 3% predictive of dairy intake among athletes and thus concluded that, among college athletes, there was no significant correlation between knowledge of osteoporosis and intake of dairy products. In the present study, no significant correlations were found between knowledge of specific nutrients and actual dietary intake of the nutrients. Furthermore, the sport athletes were playing did not affect their ability to increase nutrition knowledge or dietary intake, thus leading to the observation that there is not a sport-specific difference on the effects of nutrition education on university athletes.

It is fundamental to underline the role that the university environment may play in the shaping dietary habits and to consider strategies that may encourage students to pursue healthy eating habits and ensure future health benefits, Relocating due to the studying and moving away from parents forces young people to take responsibility for buying and preparing food, and consequently to be responsible for their own diets (15). They are often incapable of meeting these demands, with the results being inadequate dietary intake. In Greece, it was shown that

those students who moved away from home had changed their diet in less healthy direction compared to those who still live with parents (16). According to Heaney and colleagues, student athletes experience significant challenges with time management, financial constraints, food access, nutrition when travelling, and the pressures to achieve a specific physique. In their recent investigation the researchers reported that the major barrier for all athlete groups was lack of time (6). Nutrition professionals, however, conceive this more as a time management issue rather than time shortage (17). Although most dietitians have expert knowledge on planning diets for limited budgets and strategies to streamline shopping and food preparation time (6), student athletes may need more global education to support financial and time management in other areas of their life.

Among 7 participants to the study, there were 4 females, what is of importance because women are still considered to be the "gatekeepers" of the household food supply, and therefore are important in every food-related study (11). In this student female athletes tend to reduce energy intake in a greater amount than males, and have higher nutrition knowledge level. Similar gender specific differences in food choices were shown previously among students (11). Women demonstrated superior knowledge in all areas of nutrition, as has been found in most studies looking at nutritional knowledge (18, 19).

Limitations

The results from this survey should be viewed in light of the limitations of self-reporting and the absence of a control group. Participants may have assumed better diets on the days being recorded or avoided recording days in which they had less discretion over food choices. Furthermore, since the study was performed during the nutrition education programme, athletes could also be more sensitized and under-report or deny their negative dietary habits.

Another potential limitations was that other factors such as price, taste and convenience, which could also influence dietary intake, were not considered. However, as suggested (11, 19) these influences may to some degree be underpinned by knowledge, since knowledge is important even where other barriers and constraints are present.

In addition, the use of a purposive, non-random sample of scholarship athletes should not be considered representative of the student athlete population, so the results of the study cannot be generalized to the student athlete population in United Kingdom. Data from multiply universities, representing greater student diversity, would be easier for generalisation. Probably participant sample selected for this study has better nutrition knowledge than the general population, so it is likely that our results over-estimate the level of nutrition knowledge of the british student population. However, the recruitment process enabled the inclusion of representatives from both genders and a mix of team and individual sports, so diminishing the limit of poor generalisability.

Conclusion and direction for future research

In conclusion, the results of this study reveal that the nutrition education programme was effective on increasing the participants' nutrition knowledge, but not in improving their dietary intake; showing a controversial relationship between nutrition knowledge and eating patterns.

Therefore in the post-test condition, more knowledgeable students were not characterized by better adherence to dietary guidelines and the pursuit of nutritional recommendations.

This does not necessarily mean that educating the athletic population about nutrition could not improve its dietary intakes, but it must be a stimulating invitation to perform further research, learning from the weaknesses and strengths of this study.

Nonetheless, judging from the array of positive and negative findings

that were observed in this relatively short nutrition education programme, there is sufficient evidence to support the need for and the effectiveness of nutrition education intervention to increase nutrition knowledge among university athletes; to bring about more positive changes in dietary behaviours, the nutrition education programme, may need to concentrate more intensely on self-efficacy to maximize opportunities to practice dietary skills acquired. In accordance with previous studies, self-efficacy is a common precursor to behaviour change (20, 21, 22).

Future research is required to assess the complex relationship between nutrition knowledge and dietary intake, as well as evaluate the possibility to develop further nutrition education programmes that may further augment the positive change seen in the current study.

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