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ORIGINAL RESEARCH

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Measuring the sports nutrition knowledge of elite Australian athletes using the Platform to Evaluate Athlete Knowledge of Sports Nutrition Questionnaire

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Abstract

Aims: To evaluate the nutrition knowledge of elite Australian athletes, and to obtain feedback from sports dietitians on the Platform to Evaluate Athlete Knowledge of Sports Nutrition Questionnaires' (PEAKS-NQ) suitability.

Methods: Sports dietitians from the National Institute Network across Australia recruited athletes to complete the online, 50-item PEAKS-NQ which contained two sections (General Nutrition and Sports Nutrition). Sports dietitians provided feedback on the PEAKS-NQ using a 14-item questionnaire (with two open-ended items). The main outcome measures were nutrition knowledge score and tool suitability (usefulness, acceptability and feasibility) scores. For knowledge scores, independent *t*-tests, ANOVA and Chi-square tests were used to evaluate differences between groups. Suitability was evaluated using descriptive statistics.

Results: Twelve sports dietitians from the National Institute Network in Australia recruited a convenience sample of 240 athletes (21.3 ± 4.3 years, 63.5% female, 63.3% competed internationally). Athletes scored 70.7 ± 10.5%, with better general vs sports nutrition knowledge. Females had higher overall scores ($P < .001$) with no differences for age or sport played. University-educated athletes scored higher than non-tertiary educated athletes ($P = .004$). Knowledge gaps were identified in fats (role and food sources), recovery nutrition and managing body composition. Sports dietitians rated suitability of PEAKS-NQ positively with complete agreement on 8 of 12 items.

Conclusions: Athletes have greater understanding of general nutrition compared to sports nutrition concepts and may benefit from education on applying nutrition in sports-specific contexts. Sports dietitians' responses showed PEAKS-NQ was a highly acceptable, feasible and useful measure.

KEYWORDS

assessment, nutrition, knowledge, attitudes, practice, nutritional surveys, process evaluation, sports nutrition sciences

† Deceased on January 13, 2020

1 | INTRODUCTION

Elite athletes have special nutrition requirements to optimally fuel, recover and adapt to their strenuous training demands.[1] High levels of nutrition knowledge encompassing both general nutrition and sports nutrition domains provide the understanding to alter dietary intake to meet these needs. Australian athletes have previously indicated their preference for receiving nutrition information from dietitians,[2] and therefore nutrition knowledge assessment can provide valuable insight into knowledge gaps, provide a way to appropriately "pitch" the difficulty of education interventions to maximise understanding, and allow practitioners to assess the effectiveness of education.[3]

Adequate knowledge levels in athletes have previously been reported to be 75%,[4] as such knowledge levels in athletes are often described as deficient in a number of recent studies that have reported assessment scores between 40% and 60%.[5–7] Moreover, the effect of demographic variables associated with nutrition knowledge such as sex and sporting calibre[8] remain unclear as the assessment of sports nutrition knowledge in athletes has been limited by the availability of comprehensively validated and reliable questionnaires.[9,10] Additionally, the use of these assessment instruments may be hindered by the associated administrative burden,[11] such as follow-up to ensure completion, and the time spent scoring and providing feedback. An electronic assessment instrument known as the Platform to Evaluate Athlete Knowledge of Sports Nutrition Questionnaire (PEAKS-NQ) has recently been developed to address these gaps.[11] The PEAKS-NQ has demonstrated good construct and content validity, and reliability,[12] but has not been used to evaluate the knowledge levels of elite athletes. Additionally, the usefulness, feasibility, acceptability and potential for enhancing practice have not been established by sports dietitians working with these athletes.

Therefore, the primary aim of the present study was to evaluate the sports nutrition knowledge level of elite Australian athletes across a range of sports using the PEAKS-NQ. A secondary aim was to assess the feasibility, usefulness and acceptability of the PEAKS-NQ with sports nutrition professionals.

2 | METHODS

Initial development of the PEAKS-NQ was informed by focus groups with high-level sports dietitians and nutritionists and a modified Delphi process to refine items,[11] with qualitative analysis confirming content validity. Known-groups testing[13] was used to establish construct validity by comparing athletes from a national sports institute with sports dietitians. Reliability was assessed using test-retest by the same athletes 2 weeks apart and Rasch analysis was undertaken to further refine items.[12]

The PEAKS-NQ contains 50-item electronic questionnaire with a total score of 75 across two sections: (a) General Nutrition (29 items, maximum score = 34) and (b) Sports Nutrition (21 items, maximum score = 41). Correct answers were awarded one mark. Incorrect and "not sure" responses were scored zero. Items with multiple correct answers scored one mark per correct answer and were deducted one mark per incorrect option selected. Negative scores (ie, multiple incorrect answers) were adjusted to zero.

An automated one-page feedback report informed by initial focus groups[11] detailing total score, section scores and strengths and weaknesses in knowledge was developed using Filemaker Pro 16.[14]

A cross-sectional design was used for the present study. The PEAKS-NQ was delivered online within a suite of three questionnaires that could be completed independently of each other: (a) Demographics, (b) PEAKS-NQ and (c) Athlete Diet Index[15] (Figure 1). This is collectively referred to as the "Accelerated Sports Nutrition Assessment Platform (ASNAP)". This paper focuses only on the PEAKS-NQ results and the associated demographics.

Elite athletes within Australia are those recognised by the Australian Institute of Sport, National Sporting Organisations and/or have a scholarship within the National Institute Network.[16] A link to ASNAP was disseminated to sports dietitians within the National Institute Network across Australia, which includes eight state academies/institutes of sport, and national sporting organisations, encompassing approximately 3000 athletes and 40 dietitians. Interested sports dietitians contacted the researchers for access to the platform. Sports dietitians disseminated study details to their own athletes and/or teams to recruit a convenience sample between November 2019 and July 2020. Because athletes were invited through their sports dietitians, the potential pool of athletes reached could not be accurately established.

Athletes completed the questionnaires and received individualised feedback via the online platform or email. Feedback reports were sent to consenting athletes' sports dietitians.

Sports dietitians that helped recruit athletes were asked to complete a process evaluation to review both ASNAP questionnaires and their associated feedback sheets. The process evaluation was deployed by Qualtrics[17] and contained 14 items developed by the authors. The same items were used to separately evaluate each questionnaire. Twelve items used a 5-point Likert

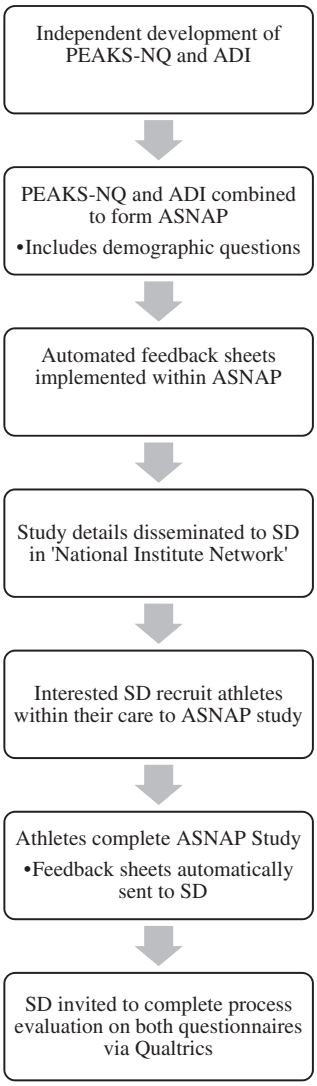

FIGURE 1 Study design. PEAKS-NQ, Platform to evaluate athlete knowledge of sports nutrition questionnaire; ADI, Athlete diet index; ASNAP, Accelerated sports nutrition assessment platform; SD, sports dietitian

scale to assess the usefulness of the questionnaire for screening and prioritisation, the utility of feedback received and intention for ongoing use. The remaining two open-ended questions captured type of athletes recruited and any additional written feedback. Only the results for the PEAKS-NQ are presented.

Descriptive statistics summarised sample characteristics and Chi-squared tests for trend or independence were used to assess differences in categorical variables (sport played, education and calibre). Sports were categorised as endurance, prolonged high-intensity intermittent (PHIT), skill, anaerobic-power and other (sports that could not be classified) based on their main energy demands in training. PHIT sports are characterised mostly by team sports such as rugby which involve repetitive high-intensity efforts followed by periods of lower intensity.[18]

Independent *t*-tests were used to examine differences between sex, age, education and knowledge scores. One-way ANOVA was used to assess knowledge by calibre and sport type with a post-hoc Tukey's test to identify differences. A two-way ANOVA was used to further investigate these differences by sex. Pearson's correlation was used to assess the relationship between age and knowledge. Data are presented as mean ± standard deviation. Questionnaire scores are presented as percentages. The proportion of athletes that scored no marks and full marks on specific questions was reported to identify knowledge strengths and weaknesses.

The study was approved by the University of Sydney Human Research Ethics Committee as protocol number 2019/800. Athletes received separate participant information sheets and consent forms from their sports dietitians and provided secondary consent within the ASNAP.

3 | RESULTS

Over 9 months, 240 athletes (mean age 21.5 ± 4.5 years, median 20 years) completed the PEAKS-NQ (Table 1). Athletes were predominantly female (n = 150, 62.5%) with European backgrounds (n = 208, 86.3%). The majority had completed high school (n = 211, 87.9%) and had competed at international level (n = 152, 63.3%). Almost all athletes had previously received some nutrition education (n = 218, 90.8%). Athletes were predominantly in PHIT (n = 100, 41.7%) and anaerobic-power sports (n = 96, 40.0%).

Overall, athletes scored 70.7% ± 10.5% with higher general nutrition knowledge (GNK) scores (74.8 ± 9.5%) compared to sports nutrition knowledge (SNK) (67.3 ± 13.5%) (Table 2). Females scored higher than males across each section and overall ($P < .001$). University educated athletes had higher scores across all sections ($P = .004$). No differences were observed when grouped by age (above and below mean). There was no correlation between age and knowledge score ($r = 0.08$). Median completion time of PEAKS-NQ was 17:21 minutes.

There were no knowledge differences in scores across sport types in GNK ($F[4235] = 1.678$, $P = .156$), SNK ($F[4235] = 1.456$), $P = .216$) or total score ($F[4235] = 1.106$), $P = .354$). Further two-way ANOVA to consider sex differences by sport type found no interactions for total score, GNK or SNK.

No knowledge differences were observed across athlete calibre for SNK ($F[4, 235] = 0.385$, $P = .82$) and total score ($F[4, 235] = 1.597$, $P = .18$), however there was a difference in GNK score ($F[4, 235] = 4.858$, $P = .001$). Tukey's post-hoc analysis indicated athletes competing at open international level scored 77.8% ± 8.8% compared to those competing at age-group international (72.2%

TABLE 1 Demographic and sport information of athlete participants (n = 240)

	Total n (%)	Male n (%)	Female n (%)	*P*-value
	240 (100)	**90 (37.5)**	**150 (63.5)**	
Age (y)	21.3 ± 4.3	22.3 ± 4.8	21.0 ± 4.3	.67[a]
Sport Played				
Endurance	7 (2.9)	1 (1.1)	6 (4.0)	<.005[c]
PHIT	100 (41.7)	21 (23.3)	79 (52.7)	
Anaerobic/Power	96 (40.0)	53 (58.9)	43 (28.7)	
Skill	16 (6.7)	7 (7.8)	9 (6.0)	
Other	21 (8.8)	8 (8.9)	13 (8.7)	
Competitive level				
Open international	69 (28.7)	24 (26.7)	45 (30.0)	.926[b]
Junior international	29 (12.1)	12 (13.3)	17 (11.3)	
Age group international	54 (22.5)	22 (24.4)	32 (21.3)	
National	81 (33.8)	30 (33.3)	51 (34.0)	
Other (Regional, School, University)	7 (2.9)	2 (2.2)	5 (3.3)	
Previous nutrition education				
Yes	218 (90.8)	80 (88.9)	138 (92.0)	.419[c]
No	22 (9.2)	10 (11.1)	12 (8.0)	
Education level				
University	57 (23.8)	20 (22.2)	37 (24.7)	.935[b]
TAFE	10 (4.2)	3 (3.3)	7 (4.7)	
Year 12	144 (60.0)	61 (67.8)	83 (55.3)	
Year 11	18 (7.5)	3 (3.3)	15 (10.0)	
Year 10	11 (4.6)	3 (3.3)	8 (5.3)	
Ethnicity				
European	208 (86.7)	75 (83.3)	134 (88.7)	.742[c]
Asian	6 (2.5)	3 (3.3)	3 (2.0)	
Mixed ethnicities	17 (7.1)	7 (7.8)	10 (6.7)	
Other	7 (2.9)	4 (4.4)	3 (2.0)	
Middle Eastern/Latin American/African	2 (0.8)	1 (1.1)	1 (0.7)	

Abbreviations: TAFE, Technical and Further Education; Endurance—athletics—endurance, rowing; PHIT, Prolonged high-intensity intermittent—hockey, netball, basketball, water polo; Anaerobic/Power—tennis, cricket, canoe, kayak, athletics—track and field, athletics—power; Skill—synchronised swimming, golf; Other—cycling, winter sports, equestrian.

[a]Independent samples *t*-test (differences between sex).

[b]Chi-squared test for trend (differences between sex).

[c]Chi-squared test of independence (difference between sex).

± 9.9%) and national (73.0% ± 9.6%) levels, a difference of 5.65% (95% CI, 1.07, 10.23, $P = .007$) and 4.80% (95% CI 0.67, 8.93, $P = .014$), respectively. No other group differences were observed. No differences were observed when sex was considered alongside calibre.

Items were ranked by the proportion of athletes that scored zero for the item (Figure 2). Within GNK, the items that scored most poorly pertained to identifying the main macronutrient of kidney beans (76% incorrect), foods that enhance iron absorption (53% incorrect), classifying butter into a food group (46% incorrect), and identifying the main macronutrient in cashews (39% incorrect). In SNK, the worst performing items were related to post-exercise rehydration (54% incorrect), foods for fuelling competition (50% incorrect), selection of recovery meals (question 1%-48% incorrect, question 2%-47% incorrect), and athlete protein requirements (41% incorrect). A more detailed list of item rankings is available as online supplementary material (Appendices 1 and 2).

TABLE 2 Comparison of scores across sex, age, calibre and sport played

Category (n)	General nutrition (%)	*P* value	Sports nutrition (%)	*P* value	Total (%)	*P* value
Total (240)	74.8 ± 9.5		67.3 ± 13.5		70.7 ± 10.5	
Sex[a]						
Male (90)	73.0 ± 11.0	.03	62.2 ± 14.7	<.001	67.1 ± 11.7	<.001
Female (150)	75.8 ± 8.3		70.3 ± 11.8		72.8 ± 9.0	
Age[a]						
Below mean age (<21 y) (151)	74.2 ± 8.7	.24	67.3 ± 12.5	.98	70.4 ± 9.7	.60
Above mean age (>21 y) (89)	75.8 ± 10.7		67.3 ± 15.2		71.2 ± 11.6	
Education level[a]						
University (57)	77.5 ± 10.0	.01	71.4 ± 15.0	.01	74.2 ± 11.4	.004
Non-tertiary (183)	73.9 ± 9.1		66.0 ± 12.8		69.6 ± 9.9	
Sport played[b]						
Endurance (7)	77.3 ± 8.2	.16	73.7 ± 15.2	.24	75.1 ± 11.1	.35
PHIT (100)	75.1 ± 8.0		68.8 ± 11.6		71.7 ± 8.7	
Anaerobic power (96)	73.7 ± 10.6		66.6 ± 15.2		69.8 ± 11.9	
Skill (16)	79.7 ± 8.0		64.6 ± 14.2		71.4 ± 10.5	
Other (21)	73.3 ± 11.4		63.3 ± 12.4		67.9 ± 10.8	
Calibre[b]						
Open international (69)	77.8 ± 8.8	.001	68.1 ± 14.9	.89	72.5 ± 10.5	.18
Junior International (54)	75.7 ± 7.4		67.8 ± 11.0		71.4 ± 8.3	
Age group international (29)	72.2 ± 9.9		66.3 ± 13.7		68.9 ± 11.0	
National (81)	73.0 ± 9.6		66.8 ± 13.0		69.6 ± 10.5	
Regional (7)	81.9 ± 9.5		70.7 ± 16.0		75.9 ± 11.6	

Note: Non-tertiary includes Year 10, 11, 12 and TAFE.
Abbreviation: PHIT Prolonged high-intensity intermittent.
[a]Independent samples t-test.
[b]One-way ANOVA with post-hoc Tukey's test.

Feedback that was received from 12 dietitians (~30% response rate) who completed the ASNAP feedback questionnaire was mostly positive (Table 3). Of the 12 rated questions, there was unanimous positive agreement ("strongly agree" or "agree") on eight items. From the remaining four items, there was 75% agreement that the tool "provided information on knowledge areas and eating behaviours of concern", and 92% agreement that the tool "helped prioritise athletes to support", "was useful in providing overall and section scores" and "was practical and time-efficient for athletes to complete". Written comments suggested the display of questions alongside feedback sheets (n = 2), altering question wording (n = 2), and the possibility that the questionnaire was too easy as an athlete known to have poor dietary intake scored well (n = 1).

> "Thank you. These assessment tools have been a great way to get a snapshot of a new group of athletes to help me tailor the nutrition program to their needs, as well as provide relevant individually tailored advice." SD1

> "This has been absolutely amazing and very helpful. I have limited time to extract all this info from my players with so many to look after in limited time." SD11

4 | DISCUSSION

The PEAKS-NQ deployed via the ASNAP platform evaluated the sports nutrition knowledge of elite Australian athletes. Athletes scored 70.7% ± 10.5%, performing better in the GNK section compared to SNK section. Female athletes scored higher than males and university-educated athletes scored higher than non-tertiary

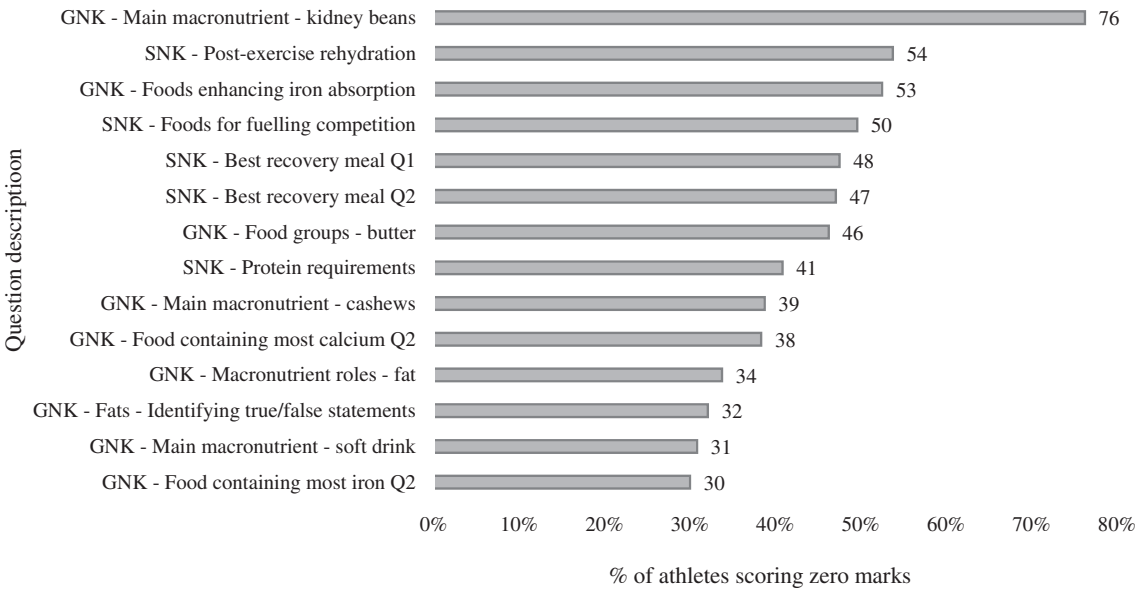

FIGURE 2 Questions ranked by largest proportion of athletes scoring zero marks. A higher percentage of zero marks indicates that a larger proportion of athletes incorrectly answered the item. GNK, general nutrition knowledge; SNK, sports nutrition knowledge

educated athletes across all sections and overall. No differences were observed for age or for type of sport played. A difference was detected when analysed by calibre with athletes competing at open international level scoring better than those competing at age-group international or national level in GNK.

Findings of the study were consistent with the pilot results of the PEAKS-NQ where athletes scored 67.1% ± 10.5% and better in GNK than SNK.[12] Direct comparison with previous research is difficult due to variability in questionnaires and their validity, athlete types and calibre[9]; however, most studies conclude that athletes exhibit insufficient levels of nutrition knowledge.[5–7]

Females had higher nutrition knowledge scores than males, which is consistent with some,[7,19] but not all studies.[10] Previous research suggests that female athletes have higher diet quality[19] and dietary habits than males.[20] Studies in non-athlete populations conclude that this discrepancy may be because females place a higher importance on overall health, and the healthfulness and nutritiousness of food, so are more motivated in being informed about nutrition.[21]

University-educated athletes scored higher than non-tertiary educated athletes, supporting recent studies suggesting that education level is associated with nutrition knowledge.[10] This may be related to a greater ability to understand complex concepts, and to access, recall and interpret information than those without tertiary education.[22]

It can be hypothesised that nutrition knowledge should increase with calibre and training age, as athletes at sporting institutions are likely to have more exposure to nutrition education, with higher-level athletes receiving more individual interaction with sports dietitians. However, recent studies have found no difference in knowledge associated with calibre, and one reported inverse findings.[5,19,23] In the present study, the open international level athletes scored better in GNK, but not overall, suggesting that further research examining the relationship between these two variables is necessary.

Previous research has suggested that sports nutrition concepts build upon general nutrition concepts,[11] therefore it should be expected that athletes have greater GNK. The PEAKS-NQ contains a higher proportion of GNK questions that assessed declarative knowledge (knowledge of facts), compared to procedural knowledge (application of knowledge),[24] which was prominently assessed in the SNK section.[11] This suggests difficulty in translating nutrition knowledge to sports-specific contexts, possibly explained by the varied scenarios experienced during training, recovery and in competition. Small numbers of dietitians compared to the number of athletes in elite sport may explain the preference for group-based nutrition education, which may limit delivery of harder SNK concepts compared to GNK because of the need to cater to the range of knowledge within groups.[9,20]

Weaknesses were identified in knowledge of fats, with a large proportion of athletes incorrectly classifying the food group for butter and the main role of fat as a macronutrient (Figure 2). Athletes incorrectly classified the main macronutrient in cashews, mostly as a protein instead of fat, and soft drinks as a fat instead of carbohydrate. In identifying healthy sources of fat (ie, poly- or monounsaturated), olive and coconut oil were often misclassified. Similar knowledge gaps have been reported by

TABLE 3 Process evaluation results by individual rater, that is, sports dietitians

	Gave useful information to provide better nutrition support	Provided information on knowledge areas and eating behaviours of concern	Helped to prioritise athletes to support	Helpful for screening and identifying gaps	Helpful for identifying athletes with poor knowledge	Would use to justify and advocate for nutrition services to athletes	Useful to have section and overall scores	Automated scoring and feedback were helpful	Feedback report was informative and useful	The report provided a useful way for me to follow-up with the athletes	Practical and time-efficient for athletes to complete	Would use the PEAKS-NQ again
Rater	Usefulness		Enhances practice				Feedback				Feasibility	Acceptability
1	SA	A	SA	SA	SA	A	A	SA	A	A	SA	SA
2	A	N	A	SA	A	A	D	SA	A	A	A	A
3	SA	N	A	A	SA	SA	SA	SA	SA	A	SA	SA
4	SA	SA	A	SA	SA	SA	SA	SA	A	SA	SA	SA
5	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
6	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
7	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
8	A	A	A	A	A	SA	A	SA	SA	A	SA	A
9	A	D	N	SA	SA	SA	SA	SA	A	SA	SA	A
10	A	A	A	A	A	SA	SA	SA	A	SA	N	SA
11	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
12	SA	SA	A	SA	SA	SA	SA	SA	SA	SA	SA	SA
Total												
SA	8	6	5	9	9	10	9	12	7	8	10	9
A	4	3	6	3	3	2	2	0	5	4	1	3
N	0	2	1	0	0	0	0	0	0	0	1	0
D	0	1	0	0	0	0	1	0	0	0	0	0

Abbreviations: A, agree; D, disagree; N, neither agree nor disagree; SA, strongly agree.

Andrews et al. in soccer (football) players[23] which could be related to increasing interest in high-fat or ketogenic diets, especially in endurance athletes as a performance enhancing dietary strategy.[25]

Recovery nutrition was identified as a knowledge gap, with many athletes not identifying carbohydrates or fluid as essential components of recovery after high-intensity training or strenuous exercise. These findings suggest athletes may not understand carbohydrate function in exercise contexts, supporting the numerous studies reporting that carbohydrate intakes of athletes are below recommendations for their sport.[5,6,26] The variety of carbohydrate manipulation strategies available to athletes (eg, periodisation, train low-compete high, carbohydrate loading)[27] may be causing athletes confusion and low carbohydrate diets, such as Atkins, ketogenic and Paleolithic diets,[28] may also be influencing athletes' beliefs about the benefits of carbohydrate for performance. Clear education addressing the appropriate inclusion, negative connotations and debunking popular thinking around carbohydrates is recommended.

The majority of athletes did not classify energy surplus as necessary for increasing lean muscle mass, however most identified protein-rich diets, protein spacing throughout the day and protein in the post-exercise period as essential. Incorrect knowledge such as drinking more water and increasing vegetable intake as strategies for gaining lean body mass were also identified. Athletes appear to understand the importance of protein with previous studies reporting that protein is often adequately consumed[5,6] and is possibly related to greater nutrition knowledge.[29] Athletes may benefit most from education around optimising protein consumption for recovery and body composition and addressing misinformation.

Feedback on the use of the PEAKS-NQ was very positive, with high acceptability, usefulness and feasibility for implementation into practice. The evaluation of nutrition knowledge questionnaires by "end-users" (sports dietitians) is seldom completed which means applicability to settings outside of research is unknown. Dietitians indicated that the tool was helpful for enhancing the delivery of their services and the feedback sheet was positively received, which may improve the uptake by sports dietitians for screening and assessment in practice.

A strength of the study was the large sample size of high-level athletes recruited. Recruitment through the National Institute Network ensured that athletes were of high calibre; however, this limited the ability to recruit large numbers of athletes in sports where the programs are smaller, such as synchronised swimming. This resulted in greater recruitment of team-sport athletes, with effects flowing onto sex (eg, netball, predominantly played by females). Demographic questions did not capture type within sport (eg, cycling—sprint/endurance) meaning some sports could not be categorised. The convenience sampling methodology used meant it was not possible to ascertain the number of athletes reached. While most athletes had previously received nutrition education, the amount was not captured, meaning it was not possible to compare the quality and quantity of nutrition education received with knowledge level. It is difficult to determine predictors of nutrition education in this population as age, calibre and education are inter-related. Future studies utilising the PEAKS-NQ questionnaire should more accurately capture sport type, consider seeking more detailed information about previous nutrition education and further investigate differences within subgroups.

The present study is one of few to examine nutrition knowledge across a range of sports using a reliable and valid electronic nutrition knowledge questionnaire. It is also the first to provide automatically generated, personalised feedback sheet and scores, which allows users to understand strengths and weaknesses in their nutrition knowledge. For practitioners, this allows the tailoring of group education and individualisation of consultations to effectively address knowledge gaps. Since the present study was limited to elite Australian athletes and their sports dietitians, further studies with different athlete calibres and evaluation from a broader range of nutrition practitioners outside of the National Institute Network is necessary to establish the generalisability of findings. Another strength of the present study was the high level of acceptability and feasibility for the use of the PEAKS-NQ to enhance the practice of sports dietitians. Future research should assess athletes' opinions on the usefulness of the PEAKS-NQ and the feedback received. PEAKS-NQ presents a time-efficient screening tool that overcomes the additional burden of scoring responses, which has previously limited use in practice.[11] It also makes it viable to deliver remote services and support to athletes without consistent face-to-face access to a sports dietitian.

The PEAKS-NQ delivered via ASNAP effectively evaluated the sports nutrition knowledge of elite Australian athletes across a range of sports, providing specific and targeted feedback to athletes and sports dietitians. Athletes performed better in GNK than SNK, possibly due to difficulties applying nutrition knowledge to the various scenarios experienced. Knowledge gaps were identified in the understanding of fats, and recovery nutrition, related particularly to carbohydrates. PEAKS-NQ was evaluated as a feasible, useful and practical nutrition knowledge assessment tool that enhances the practice of sports dietitians.

CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest. No financial support was received for the present study.

AUTHORS' CONTRIBUTIONS

All authors contributed to the study question, design and methodology. Ryan Tam was responsible for the drafting and preparation of the manuscript, collection of the data and data analysis. Victoria M. Flood contributed to the data analysis. Kathryn L. Beck contributed to the preparation of the manuscript. Janelle A. Gifford assisted with the analysis of data and preparation of the manuscript. All authors (except Helen T. O'Connor) are in agreement with the manuscript. The work is original and is not under consideration for publication elsewhere.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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