BMC Nutrition

RESEARCH

Open Access

Validation of a sports nutrition knowledge questionnaire for Sri Lankan track and field athletes

Ranil Jayawardena[1,2*], Kalani Weerasinghe[3], Gina Trakman[4], Terrence Madhujith[5], Andrew P. Hills[6] and Nishan Sudheera Kalupahana[7]

Abstract

Background While several validated sports nutrition knowledge questionnaires exist, none are specifically designed to assess the sports nutrition knowledge (SNK) of Sri Lankan track and field athletes. This study aims to validate the Sri Lankan Sports Nutrition Knowledge Questionnaire (SLn-SNKQ), tailored for this athlete group, to provide more accurate and meaningful insights for research and practice. This will enable health professionals and coaches to confidently assess athletes' nutrition knowledge, which directly influences their food choices.

Methods The validity of the questionnaire was established through a multi-step approach. Content validity was achieved via ratings from nutrition experts, all of whom had specialized training in human nutrition and experience of working with athletes. Face validity was evaluated through in-depth telephone interviews with elite or highly trained athletes, using a retrospective think-out-loud protocol to gather feedback on the clarity and relevance of the questions. Construct validity involved nutrition-trained doctors (NTG), non-nutrition-trained professionals (NNTG), and elite-level athletes' groups (AG). Internal consistency was assessed using Cronbach's alpha, and test-retest reliability was evaluated.

Results The final tool comprised 123 individual statements or prompts (items) that were organized into 32 broader questions, spanning 12 sub-sections. Content validity was confirmed by fully integrating 49 out of 70 comments and partially integrating four comments received from nutrition experts for each sub-section. Face validity was established by fully integrating 33 out of 40 comments received from 16 elite and highly trained athletes. Construct validity was confirmed, indicating significant differences in the total scores achieved as a percentage of the SLn-SNKQ among the NTG (462.5, 92.5%), NNTG (223.5, 44.7%), and AG (235, 47.0%; $p < 0.001$). Reproducibility was established by strong test-retest reliability between individuals' scores on two test attempts, three weeks apart (spearman's correlation; $\rho = 0.99$, $p < 0.05$). Internal reliability for each sub-section met psychometric reliability requirements (Cronbach's $\alpha > 0.7$).

Conclusions The SLn-SNKQ has been validated and demonstrates robust psychometric properties, offering a reliable tool for assessing SNK among Sri Lankan track and field athletes.

Keywords Sports nutrition knowledge, Track and field, Athlete, Questionnaire, Validation

*Correspondence:
Ranil Jayawardena
ranil@physiol.cmb.ac.lk

Full list of author information is available at the end of the article

Introduction

Sports nutrition plays a crucial role in optimizing the performance of athletes at all levels [1]. Adequate energy intake and an appropriate balance of macronutrients ensure that athletes meet the energy demands of their training programs, enhance adaptations to training, and allow rapid recovery between sessions [2]. Despite the strong evidence supporting the importance of proper nutrition for enhancing health and performance, the literature suggests that many athletes have nutritionally inadequate diets [3]. Furthermore, dietary practices among athletes often fall short of sport-specific nutritional recommendations [4].

Poor dietary habits among athletes are influenced by various factors, with a significant contributor being the lack of current, evidence-based sports nutrition knowledge (SNK) [5]. Although professional sports personnel recognize the importance of nutrition knowledge and its potential impact on athletes' performance [6], many athletes continue to struggle with implementing appropriate dietary practices [7]. A study involving 128 student-athletes from eight sports disciplines revealed that they possess low nutrition knowledge (57.6% ± 18.6%), which places them at risk of making inappropriate dietary choices that could hinder their ability to perform optimally and increase their risk of injury [7]. Conversely, another study [8] indicates that enhancing nutrition knowledge through educational interventions can improve dietary intake following athlete recommendations. According to the findings of this review, while 14 out of 22 trials ($n=5$ single-blind and $n=9$ double-blind) reported significant changes in at least one nutritional parameter, the observed dietary changes were inconsistent [8]. Moreover, there was no direct assessment of diet quality; instead, the focus was on aligning the diet with specific requirements [8]. Observations from coaches and nutrition experts suggest that athletes who are confident in their nutritional knowledge are more likely to apply this knowledge by adopting dietary practices that meet their sports-related needs [9]. Ultimately, adherence to nutritional guidance can enhance performance and overall health for athletes [10].

Assessing baseline SNK is essential for identifying knowledge gaps among athletes and tailoring sports nutrition education programs. To ensure accuracy and relevance, sports nutrition knowledge questionnaires (SNKQs) must be developed and validated within specific cultural contexts, as athletes' dietary practices are often influenced by varying socioeconomic factors [11]. Considering the existing literature, SNKQs have either been adapted from existing tools or specifically developed and validated for various countries, age groups, and sports disciplines [12]. Trakman and colleagues developed an updated questionnaire based on recent reviews of sports nutrition practices, which was validated using a robust methodology that combines classical test theory (CTT) and item response theory (IRT), including Rasch analysis [13]. While this tool applied robust methodology, its cultural specificity is limited, potentially reducing its applicability outside its original context. Similarly, a questionnaire developed to assess endurance athletes' beliefs and knowledge about carbohydrates focused narrowly on a specific nutrient, limiting its comprehensiveness in assessing broader sports nutrition knowledge [14]. Tam and colleagues developed the Platform to Evaluate Athlete Knowledge of Sports Nutrition Questionnaire (PEAKS-NQ), an electronic tool and validated it with developmental athletes in New Zealand [15]. Though proven reliable through Rasch analysis, its length (94 items) may pose practical challenges, particularly in non-Western contexts where lengthy questionnaires might reduce participant engagement [16]. Zinn and colleagues used input from an expert panel to develop a questionnaire tailored to the New Zealand context, ensuring content validity [17]. The results indicated that the questionnaire was sufficiently valid and reliable for use in research and practice to assess SNK [18]. However, the tool may not adequately address the diverse socioeconomic factors influencing dietary practices in other regions. These limitations underscore the need for a context-specific tool like the SLn-SNKQ, which is culturally adapted for the Sri Lankan athletic population.

Hence, developing and validating such questionnaires involves numerous complex and time-consuming steps, making it a costly process where important measures are often overlooked [19]. A systematic review conducted in 2015 of sixty studies using questionnaires to assess nutrition attitudes and knowledge among athletes and coaches, found that nearly 70% of the studies used tools with unclear validity and reliability, and 67% relied on unpiloted methods [20]. The review also identified flaws in statistical analysis, such as the absence of power calculations, confidence intervals, and effect sizes [20]. Using low-quality SNKQs limits the insights that can be drawn from nutrition knowledge research [12]. While various SNKQs have been developed and validated globally, none have been specifically tailored to the unique cultural and socioeconomic context of the Sri Lankan athletic population. Given the influence of these factors on dietary practices, there is a significant need for a well-validated SNKQ that can accurately assess the knowledge of individuals who practice or disseminate sports nutrition information in Sri Lanka. This research aims to validate the Sri Lankan Sports Nutrition Knowledge Questionnaire (SLn-SNKQ), a tool previously developed [21] and specifically adapted for Sri Lankan track and field athletes. The validation of this tool will not only provide an accurate measure of general nutrition knowledge (GNK)

and SNK within the Sri Lankan sports community but also facilitate the development of targeted nutrition education programs to enhance nutrition knowledge and practices.

Methods

Ethics approval and consent

Ethical approval for the study was obtained from the Ethics Review Committee, Faculty of Medicine, University of Peradeniya, Sri Lanka (Ref No. 2023/EC/48), and all methods were performed in accordance with the Declaration of Helsinki. Informed written consent was obtained from each participant after giving them adequate time to ask questions and clarify doubts about the research.

Recruitment

Panellists ($n=10$) were selected using purposive sampling to assess content validity. These panellists had qualifications and expertise in human nutrition, dietetics, and sports nutrition (Step I). For face validity, elite and highly trained level [22] track and field athletes were recruited through purposive sampling ($n=16$) (Step II).

To assess construct validity, voluntary participants were recruited from three distinct groups, each with 18 members, using purposive sampling: NTG (Nutrition-trained group): Participants in this group had at least a postgraduate qualification in human nutrition and prior training in sports nutrition. NNTG (No nutrition-trained group): This group comprised banking professionals without prior SNK. AG (Athletes' Group): This is a separate group of athletes consisting of male and female track and field athletes at the elite and highly trained level [22] (Step III).

The SLn-SNKQ was then administered online to the NTG and NNTG groups from Step III, twice, with a three-week interval between administrations (Step IV). Additionally, the AG group ($n=18$) from Step III assessed the questionnaire's duration (Step V; Fig. 1).

Five-step validation process of the tool

The SLn-SNKQ tool is an online questionnaire developed using Google (Google LLC, California, USA, version 2016) [23] and is available in all three official languages of Sri Lanka: English, Sinhala, and Tamil, ensuring inclusivity for participants from different linguistic backgrounds. The procedures followed during the development have been published elsewhere [21]. To establish validity and reliability, five steps were employed based on established protocols outlined in the literature [4]. These steps included: (I) Assessment of Content Validity, (II) Assessment of Face Validity, (III) Assessment of Construct Validity, (IV) Assessment of Reproducibility and Internal Consistency, and (V) Assessment of Questionnaire Duration (Fig. 1).

Sample size calculation

Content validity was assessed based on feedback from a panel of experts related to sports nutrition recruited via purposive sampling. Calculating a Content Validity Index (CVI) requires the involvement of three to ten experts [24]. In the context of telephonic in-depth interviews to assess face validity, a recommended range of six to ten participants is often cited to capture a diverse set of perspectives effectively [25]. However, based on the research team's prior experience and understanding of cultural nuances, it was anticipated that Sri Lankan athletes might express their opinions with restraint. Therefore, to enhance the robustness of the data collected and ensure a wider representation of views, the sample size was increased, resulting in a target of 16 elite or highly trained athletes. To determine the appropriate sample size for assessing construct validity, a power analysis for an independent sample t-test was conducted using G-POWER [26]. This analysis considered an alpha level of 0.05, a power of 0.80, a substantial effect size ($d=0.8$), and adopted a two-tailed approach. Based on the above-mentioned criteria, the recommended sample size for each group—NTG, NNTG, and AG—was determined to be 18 [27].

Content validity

Upon the formulation of individual statements or prompts (items) of the questionnaire and determination of suitable response formats, invitations were sent to ten potential panellists who were recognized experts in the field of nutrition. All panellists possessed advanced qualifications, including a minimum of a Master's degree in Human Nutrition or a related field. Additionally, several panellists had completed specialized certifications in sports nutrition, and each panellist also had substantial experience working with athletes, which included roles such as sports dietitians or nutrition consultants for professional sports teams. Those who agreed to participate engaged in individualized telephonic conversations during which relevant materials were shared via email, and the content validation form specifically developed for this study is given as Supplementary Material 1.

Accompanying the validation materials was an information sheet providing comprehensive instructions to guide the experts, including the most recent version of the questionnaire, with the correct response marked. Each expert was tasked with evaluating the questions within each subsection of the questionnaire and their assessment encompassed considerations of relevance, appropriateness, accuracy, and clarity. The evaluation employed a 4-point Likert scale, ranging from 1 ('Not

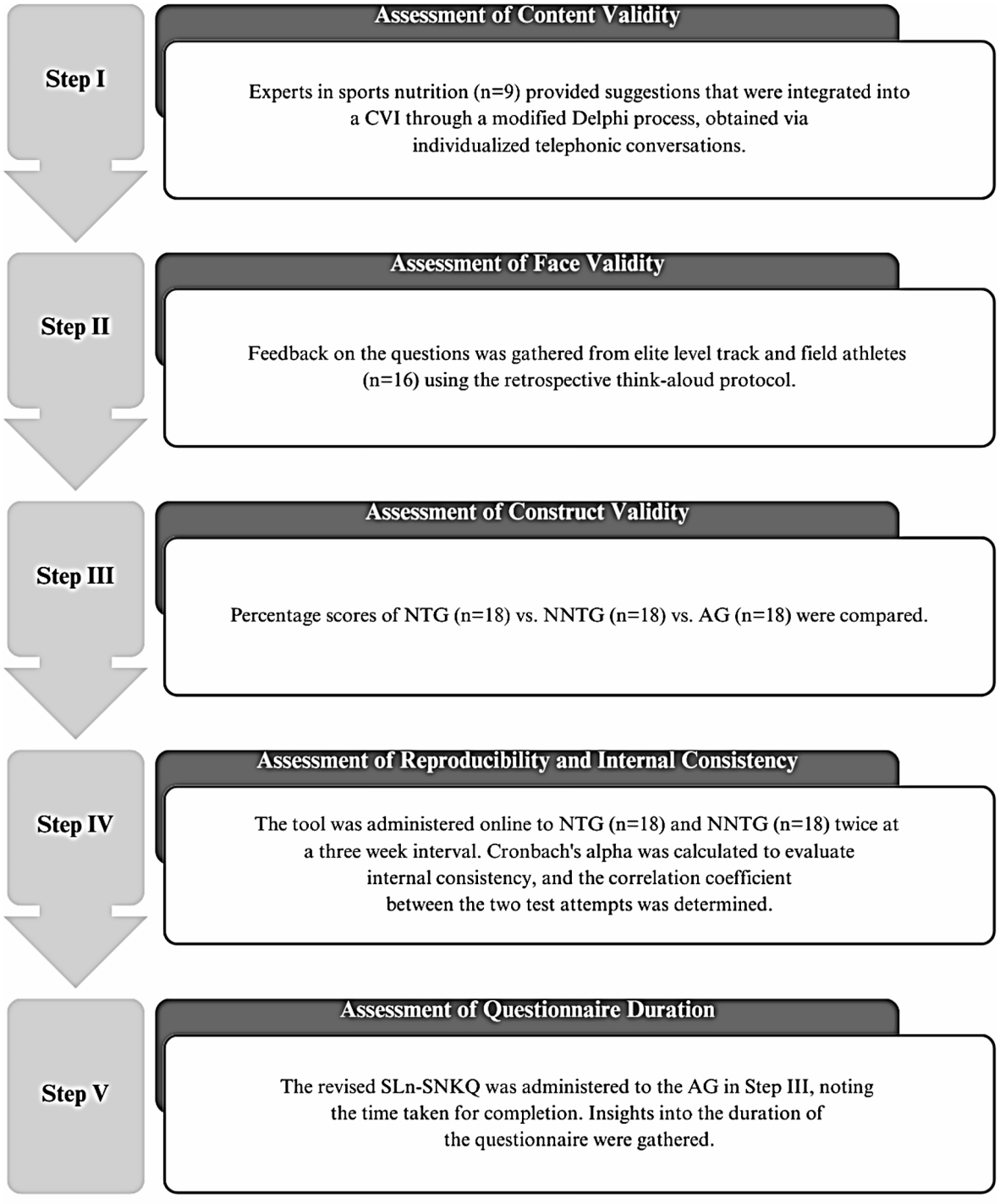

Fig. 1 Flow chart of 5-step validation and assessment of the reliability of the SLn-SNKQ. AG: Athletes' Group, SLn-SNKQ: Sri Lankan-Sports Nutrition Knowledge Questionnaire, CVI: Content Validity Index, NNTG: No Nutrition-Trained Group, NTG: Nutrition-Trained Group

relevant, Not appropriate, Not accurate, Not clear') to 4 ('Highly relevant, Very appropriate, Very accurate, Very clear'), with accompanying written comments for each sub-Sect. [12].

The CVI for each sub-section was calculated by dividing the cumulative score assigned to that sub-section by all raters, and then dividing by the total number of raters. Index scores exceeding 3.2/4.0 (≥0.8) were considered adequate for ratings related to relevance, accuracy, clarity, and appropriateness [24]. Sub-sections with a mean score below 3.2 were precisely reviewed, and the individual comments provided by experts were incorporated

to modify each question qualitatively. Following these revisions, experts who had initially assigned lower scores (1 or 2 out of 4) were contacted and asked to review and provide new ratings on the revised questions. This iterative Delphi process was repeated multiple times until the mean scores for each sub-section reached ≥3.2 for the categories of relevance, appropriateness, accuracy, and clarity.

Face validity

To evaluate face validity, feedback was solicited from a separate cohort of 16 male and female track and field athletes who were recruited using the purposive sampling technique. The recruited athletes represent the following tiers according to McKay et al. [22]: 'Elite athletes (Tier 4)' are defined as those competing at the international level, such as members of national teams; 'Highly trained athletes (Tier 3)' are defined as those competing at the national level. A retrospective think-out-loud protocol was used. The athletes were provided with the questionnaire ahead of time, but its precise nature was not disclosed. Subsequently, an in-depth telephone interview was conducted with the research team using a guided questionnaire specifically developed for this study (Supplementary Material 2). This interactive session aimed to address inquiries such as the purpose behind specific sections, the appropriateness of questions for evaluating the SNK of Sri Lankan athletes, and the relevance of subsections. Participants were also asked about their satisfaction with the clarity and formulation of the questions. In cases where dissatisfaction arose, alternate approaches to phrasing were explored. Additionally, participants were questioned about the comprehensibility of terms, the clarity of images, and whether any terms appeared unfamiliar. Further, the discussion addressed the potential confusion or misleading nature of any question.

These sessions were audio recorded. While we did not use a formal analytical approach, feedback was collected through a separate questionnaire, and the responses were carefully noted. Adjustments to the questionnaire were made based on this feedback. A table summarizing the feedback and the corresponding revisions is available if needed.

Construct validity

To assess construct validity, a comparative analysis was undertaken by administering the questionnaire to three distinct groups NTG (n=18), NNTG (n=18), and AG (n=18). Participants were contacted via WhatsApp messages from Meta Platforms, Inc., to facilitate communication and ensure engagement. The use of WhatsApp was solely for logistical purposes.

The administration of the questionnaire to an equivalent number (n=18) of elite-level [22] track and field athletes served two purposes: to evaluate the questionnaire's effectiveness in measuring the intended construct, specifically SNK, and to ensure precision.

Internal consistency and reproducibility

To assess internal consistency, Cronbach's alpha was applied to each of the five sub-sections separately, as each sub-section addressed a different area of knowledge. A minimum Cronbach's alpha requirement of $\alpha > 0.7$ was accepted to demonstrate sound internal consistency [28].

To assess reproducibility, the questionnaire was administered online to the NTG (n=18) and NNTG (n=18) groups twice, at a three-week interval, to evaluate test-retest reliability. This interval was selected to ensure an adequate time lapse for participants' recall of their previous responses to diminish, while also minimizing the likelihood of significant changes in their nutrition knowledge during the period [29]. Both data sets were collected during different phases to evaluate the questionnaire's reliability over time.

Assessment of the duration of the questionnaire

The revised version of the SLn-SNKQ was administered to a new cohort of participants, specifically the AG group from Step III, which consisted of 18 elite-level [22] track and field athletes recruited through purposive sampling. These participants conscientiously completed the questionnaire, noting the time taken for its completion and providing insights into the duration of the questionnaire.

Statistical analysis

Data was assessed for normality using the Kolmogorov-Smirnov Test and the significance level was set at $P < 0.05$. Data were considered non-parametric. A Kruskal-Wallis test was conducted to determine if there were differences in total and subsection nutrition knowledge scores between three groups (NTG, NNTG, and AG) that varied in their expected nutrition knowledge levels. Where differences were statistically significant, pairwise comparisons were performed using the Mann-Whitney test with a Bonferroni correction for multiple comparisons. A Spearman's correlation was conducted to examine the correlation between nutrition knowledge scores of NTG and NNTG groups at two distinct time points.

Results

The final questionnaire content, structure and scoring

The final validated SLn-SNKQ comprised 32 questions across 12 sub-sections, including 123 individual items (Supplementary material 3). The included questions had three options - 'agree,' 'disagree,' and 'unsure,' while others had five responses carrying the most accurate answer. A plus mark (+1) was awarded for correct answers, each item without any weightage, and a negative mark (-1) for

Table 1 Summary of the newly validated SLn-SNKQ

Section	Sub-sections	Questions (*n*)	Items (*n*)	Question format
1. GNK	Macronutrients	04	27	SBRQs
	Micronutrients	03	08	SBRQs
	Energy balance	04	09	SBRQs
	Hydration	03	11	SBRQs
	Weight management	01	01	SBRQs
2. SNK	Carbohydrate loading	01	01	SBRQs
	Pre-training meals	01	04	SBRQs
	Training meals	01	06	MCQs
	Post-training meals	02	11	MCQs, SBRQs
	Sports supplements	06	25	SBRQs
	Supplement label reading, alcohol, isotonic drink, and doping	04	18	SBRQs
	Energy intake and food habits	02	02	SBRQs
Total	12	32	123	NA

GNK=General nutrition knowledge, MCQs=Multiple-choice questions, SBRQs=Single-best response questions, SNK=Sports nutrition knowledge, SLn-SNKQ: Sri Lankan-Sports Nutrition Knowledge Questionnaire

Table 2 CVI values

Sub-section (number of questions)	1st attempt				2nd attempt	
	Accuracy V_1	Appropriateness V_1	Clarity V_1	Relevance V_1	Accuracy V_2	Clarity V_2
1. Macronutrients (*n*=27)	3.4	3.6	3.3	3.7	3.4	3.3
2. Micronutrients (*n*=7)	3.2	3.7	3.4	3.8	3.2	3.4
3. Energy balance (*n*=9)	3.4	3.6	3.3	3.7	3.4	3.3
4. Hydration (*n*=11)	3.2	3.7	3.6	3.8	3.2	3.6
5. Weight management (*n*=1)	3.2	3.2	**2.7**	3.6	3.2	**3.2**
6. Carbohydrate loading (*n*=1)	3.2	3.8	3.6	3.8	3.2	3.6
7. Pre-training meals (*n*=4)	3.6	3.8	3.9	4.0	3.6	3.9
8. Training meals (*n*=4)	**2.2**	3.4	3.3	4.0	**3.3**	3.3
9. Post-training meals (*n*=15)	**2.6**	3.6	3.3	3.5	**3.4**	3.3
10. Sports supplements (*n*=6)	**2.7**	3.2	3.2	3.8	**3.6**	3.2
11. Supplement label reading, alcohol, isotonic drink, and doping (*n*=10)	3.2	3.8	3.4	4.0	3.2	3.4
12. Energy intake and food habits (*n*=2)	3.3	3.6	3.4	3.8	3.3	3.4
Total (*n*=97)	3.0	3.6	3.3	3.8	3.3	3.4

CVI: Content validity index, V_1: Version 1, V_2: Version 2

wrong answers; zero marks (0) were given for an unsure response, based on author consensus [30]. This covered the GNK section containing 15 questions with sub-sections covering macronutrients (*n*=4), micronutrients (*n*=3), energy balance (*n*=4), hydration (*n*=3), and weight management (*n*=1), and the SNK section with 17 questions, under 17 sub-sections (Carbohydrate loading, Pre-training meals, Training meals, each contains 1 question, Post-training meals: *n*=2, Sports supplements: *n*=6, Supplement label reading, alcohol, isotonic drinks, and doping: *n*=4, Energy intake and food habits: *n*=2) [21]. A comprehensive overview of the newly validated SLn-SNKQ is presented in Table 1, and the revised version of the tool with the correct answer marked is provided as supplementary material 3.

Findings of the five-step validation process of the tool

Content validity

Nine experts (5 males and 4 females) participated in the content validity assessment, with a mean age of 43.7 years (range: 30–60 years). Their years of experience ranged from 3 to 20 years. The response rate was 90%. In the initial attempt, the experts affirmed that the sub-sections of the questionnaire were relevant and appropriate for assessing the SNK, thus confirming content validity. Table 2 provides the calculated CVI values, based on the experts' ratings for the relevance, appropriateness, accuracy, and clarity of each sub-section. Items that received low ratings for accuracy and clarity and did not meet the CVI values were subsequently modified in accordance with the comments and suggestions provided by the experts. Out of the total comments (*n*=70) received for each sub-section, 49 were fully integrated,

Table 3 Total scores achieved as a percentage of the SLn-SNKQ by the NT, NNT and AG

Sub-section (*n*)	Marks of NTG (%)	Marks of NNTG (%)	Marks of AG (%)	NTG vs. NNTG *p* value	NNTG vs. AG *p* value	NTG vs. AG *p* value
1. Macronutrients ($n=20$)	92.5	56.3	60.5	$p=0.027$	$p=0.005$*	$p=0.012$*
2. Micronutrients ($n=5$)	91.1	38.2	45.8	$p=0.016$*	$p=0.00$*5	$p=0.003$*
3. Energy balance ($n=6$)	90.7	16.6	25.0	$p=0.016$*	$p=0.007$*	$p=0.002$*
4. Hydration ($n=5$)	92.2	61.1	73.4	$p=0.004$*	$p=0.023$	$p=0.031$
5. Pre-training meals ($n=4$)	97.2	20.8	30.6	$p=0.012$*	$p=0.005$*	$p=0.020$
Total ($n=40$)	462.5 (92.5%)	223.5 (44.7%)	235 (47.0%)	$p<0.001$*	$p<0.001$*	$p<0.001$*

NTG: Nutrition-trained group, NNTG: No nutrition-trained group, AG: Athletes' Group

*Statistically significant when Bonferroni correction applied

Table 4 Internal reliability, test-retest reliability, and identical response rates of the SLn-SNKQ across two data collection periods separated by a 3-week interval using Spearman's correlation

Sub-section (*n*)	Internal reliability[a] (α)	Test-retest correlation[b] (*r*)	Identical responses from both tests (all participants) (%)	Identical responses from both tests (NTG) (%)	Identical responses from both tests (NNTG) (%)
1. Macronutrients ($n=20$)	0.85	0.81	90.6	92.1	89.2
2. Micronutrients ($n=5$)	0.85	0.93	91.8	93.7	90.0
3. Energy balance ($n=6$)	0.78	0.97	93.3	93.3	93.4
4. Hydration ($n=5$)	0.84	0.87	89.7	92.2	87.2
5. Pre-training meals ($n=4$)	0.77	0.99	88.3	90.4	86.2
Total ($n=40$)	NA	0.99	90.7	92.3	89.2

SLn-SNKQ: Sri Lankan-Sports Nutrition Knowledge Questionnaire, NTG: Nutrition-trained group, NNTG: No nutrition-trained group, NA: Not applicable

[a]Chronbach's alpha (α)

[b]Spearman's correlation (ρ) is significant at $p<0.05$

4 were partially addressed, and 17 were not incorporated into the questionnaire because they were considered irrelevant/not commensurate to be included in the questionnaire.

The CVI values for each sub-section were recalculated based on their ratings from the second attempt. The values for accuracy, appropriateness, clarity, and relevance were 3.6, 3.8, 3.3, and 3.4, respectively (Table 3). Details of the comments provided for each sub-section and how expert feedback was integrated are included in Supplementary Table 1.

Face validity

Sixteen elite and highly trained athletes (11 males, and 4 females, with a mean age of 27.5 years; range: 22–32 years) participated to assess face validity. All athletes successfully identified the underlying purpose of each questionnaire section. The majority (13 out of 16) concurred that the questions and sub-sections in the questionnaire were appropriate for evaluating the sports nutrition knowledge of Sri Lankan track and field athletes and that the questions and instructions were clear. Where concerns regarding question-wording arose, the comments and suggestions were carefully considered to confirm face validity. Particularly, three athletes requested the inclusion of commonly used English terms alongside the local language to enhance comprehension and clarity (e.g., "recovery," "pre-workout") (Supplementary Table 2). Furthermore, one athlete proposed dividing the questionnaire into several steps (e.g., 3–4 steps) to prevent the Google Form from becoming excessively lengthy. These comments were seamlessly integrated into the questionnaire.

Out of the total of 40 comments received for each sub-section, 33 were fully integrated. Furthermore, seven comments were not incorporated into the questionnaire, as the experts believed them inappropriate for inclusion. Examples of changes made based on athletes' feedback and how they were integrated are included in supplementary Table 2.

Construct validity

Tables 3 and 4 present construct validity and reliability statistics for the final set of questions. In the 1st phase,

all 36 participants from both the NT and NNT groups (100%) responded. For the re-test phase, the response rate was 100% for the NT group and 88% (16/18) for the NNT group.

On average, athletes scored higher than the NNTG group but lower than the NTG group across all sub-sections. There was a statistically significant difference in total correct response percentages among the groups, with athletes scoring higher than the NNTG group and lower than the NTG group (NTG: 92.5% vs. AG: 47.0% vs. NNTG: 44.7%, $p<0.05$) (Table 4). Post-hoc tests, with Bonferroni correction applied, revealed significant differences between all groups ($p<0.001$). A similar trend was observed within the sub-sections.

In the Macronutrients sub-section, significant differences were found between NTG and AG ($p=0.005$) and NNTG and AG ($p=0.012$). In the Micronutrients sub-section, significant differences were observed between NTG and NNTG ($p=0.016$), NNTG and AG ($p=0.016$), and NTG and AG ($p=0.003$). In the Energy Balance sub-section, differences were found between NTG and NNTG ($p=0.016$), NNTG and AG ($p=0.007$), and NTG and AG ($p=0.002$). In the Hydration sub-section, a significant difference was found between NTG and NNTG ($p=0.004$). Finally, in the Pre-training Meals sub-section, differences were noted between NTG and NNTG ($p=0.012$) and NTG and AG ($p=0.005$).

Reliability

A strong test-retest reliability was observed, as indicated in Table 4, with a correlation of 0.99 for the total score (Spearman's correlation is significant at $p<0.05$). The correlation coefficients for individual sub-sections ranged from 0.81 to 0.99 (Table 4). Participants provided identical responses to the same question 90.7% of the time. The NTG showed an identical response rate of 92.3%, while the NNTG exhibited a rate of 89.2%. The micronutrient sub-section had the highest number of identical responses in the NTG at 93.7%, whereas the energy balance sub-section achieved the highest identical response rate for the NNTG at 93.4%. The pre-training meals subsection had the lowest number of identical responses, with rates of 90.4% and 86.2% for the nutrition and non-nutrition groups, respectively (Table 4).

Questionnaire duration

The average completion time of the final sports nutrition questionnaire for the athletes was 16.5±4.4 min.

Discussion

The questionnaire

The present study aimed to validate a previously developed SNKQ, specifically to assess the sports nutrition knowledge of Sri Lankan track and field athletes, filling a gap that existing tools do not cover. This questionnaire provides a culturally relevant and validated assessment, ensuring more accurate and meaningful insights for research and practice. The newly validated tool, the SLn-SNKQ, includes 123 individual items, consisting of 32 questions (some with multiple parts) across 12 distinct sub-sections. The average completion time for the final sports nutrition questionnaire was 16.5±4.4 min. This duration is comparable to the Nutrition for Sport Knowledge Questionnaire (NSKQ) by Trakman et al. [13], which has 89 items, the Nutrition Knowledge Questionnaire for Athletes (NKQA) with 85 questions by Furber et al. [31], and the SNKQ developed by Zinn et al. [17], containing 88 items. However, it is important to note that while these other tools were referenced for comparative purposes, our SLn-SNKQ was developed independently and not adapted from these or any other pre-existing questionnaires. The SLn-SNKQ is unique in that it was specifically validated for Sri Lankan track and field athletes, making it one of the few sports nutrition knowledge questionnaires validated within this population globally [32] in the global context. More importantly, this is also the first such tool developed and validated specifically in Sri Lanka.

Validity and reliability

The key finding of this study is the establishment of the psychometric properties of the SLn-SNKQ tool via comprehensive and structured validation and reliability assessments. This robust methodology supported the content, face, and construct validity, as well as the reliability and internal consistency, of the SLn-SNKQ. While the tool shows the ability to assess the nutrition knowledge of Sri Lankan track and field athletes, further research is needed to confirm its applicability across other athletic populations. Health professionals and coaches may consider using the SLn-SNKQ within the context of Sri Lankan athletes.

Recruiting sports nutrition experts plays a major role in obtaining essential feedback on the content validity Sect. [33]. In developed countries, sports dietitians have been identified as discrete and well-developed professionals for the content validity assessment of SNKQs [12, 17]. However, in Sri Lanka, sports nutrition advice is mainly provided by doctors who have training in the field of nutrition and experience with the sports population. In the current study, we recruited clinicians, academics, and researchers with extensive experience in sports nutrition and a strong track record of working with athletes. These panellists were selected for their specialized knowledge and expertise, making them well-suited to provide valuable feedback on the content of the questionnaire in the Sri Lankan context. While previous studies [16], have included sports nutrition experts from the industry in

content validity assessments, the sports nutrition industry in Sri Lanka is still developing, with most supplements and food products being imported. As a result, the expert panel for this study did not include sports nutrition experts from related industries, which is a distinction from previous validation tools.

Furthermore, in most previously developed SNKQs [17, 31], content validity has been assessed qualitatively by incorporating experts' comments and suggestions into the questionnaire. But, being consistent with the methodology followed by Trakman et al. [12] Tam et al. [15], Karla et al. [18], and Scrivin et al. [14] in the content validity assessment, in the current study, content validity was assessed quantitatively using a CVI. This robust revision of the content of the questionnaire by adhering to the individual comments of each expert should have improved the clarity and accuracy of the questionnaire.

When evaluating face validity, it is important to note that the majority of studies in this area have involved college-level athletes. Even though this study aimed to have a diverse sample, including both genders and individuals at elite and highly trained levels, only 13 out of the 16 participants provided substantial feedback to improve the questionnaire items. This contrasts with similar studies conducted by Trakman et al., [12], Furber et al., [31], Tam et al., [15], Karla et al., [18], and Scrivin et al., [14] athletes played a significant role in making the questionnaire clearer, more applicable, and easier to read. The unique socio-cultural and educational context of Sri Lankan athletes might influence this discrepancy. Observations suggest that Sri Lankan athletes often have ties to the national army forces, which may influence their education and social environment differently compared to athletes in more developed countries. Additionally, cultural norms in Sri Lanka may emphasize respect for authority and conformity, potentially making athletes less likely to express diverse opinions. However, it is important to note that these are observations and hypotheses based on the research team's experience and not derived from direct empirical data. This is reflected in the observation that only four out of the 16 participants in our face validity assessment, who had a relatively stronger educational background, provided meaningful comments to improve the clarity of the questionnaire.

In contrast, Trakman et al., [12] engaged student-athletes who were college graduates in their study in assessing face validity, and this demographic played a crucial role in refining their developed and validated questionnaire. In evaluating construct validity and reliability, most studies have enlisted a cohort comprising individuals with and without nutritional qualifications. These investigations typically employ two divergent groups to scrutinize this facet of the assessment tool. Conversely, some studies have opted for a more homogeneous participant population. Following recruitment, a nutrition education intervention is exclusively administered to one group, allowing for the longitudinal evaluation of construct validity and test-retest reliability. In our approach, we adhered to the former method, selecting a sample of doctors possessing a minimum post-graduate qualification in human nutrition and some prior sports nutrition training for the NT group. In contrast, a disparate set of professionals from the banking sector constituted the NNT group. This approach was intended to highlight the differences in nutrition knowledge between those with specific training in the field and those without, thus confirming the construct validity of the tool.

Upon analysis of the results of construct validity and test-retest reliability, it is noteworthy that both the NTG and NNTG scored highly in GNK sub-sections such as Macro-nutrients and Hydration. However, in the case of the SNK sub-sections, specifically pre-training meals, the NTG exhibited a higher percentage of correct responses compared to the NNTG, indicating a significant difference. Although this difference was more noticeable than in the GNK sub-sections, the findings should be interpreted with caution due to potential limitations, such as sample size and context-specific factors. These results suggest that the assessment tool has the potential to distinguish individuals with varying levels of nutrition knowledge and experience in sports nutrition. Nonetheless, further validation is needed to fully establish the construct validity and reliability of the tool across different sub-sections.

Additionally, a subsequent step was taken wherein the SLn-SNKQ tool was administered to a sample of track and field athletes. Their scores, expressed as percentages, were then compared with those of the NTG and NNTG. The findings from this phase revealed that, on average, athletes scored higher than the NNTG and lower than the NTG across all sub-sections. This serves to further confirm the construct validity of the tool, proving its efficacy in distinguishing between individuals with varying levels of nutrition knowledge, particularly within the context of athletic nutrition.

A key strength of the present study lies in the comprehensive and structured validation procedure employed for validating the newly developed SLn-SNKQ, utilizing the modified Delphi process. Additionally, this tool has confirmed content, face, and construct validities, along with demonstrating adequate reliability and strong reproducibility. Moreover, the administration of this questionnaire is facilitated by its online format, enhancing accessibility for athletes through their smart devices. This approach aligns with the integration of novel technology, making the questionnaire more user-friendly and feasible for widespread use.

However, this method of validation has a few limitations. We did not consider all the items in the questionnaire due to the complexity and difficulty of comparing the two cohorts: NT and NNT. Additionally, the study's small sample size, limited to a specific population of Sri Lankan track and field athletes, may not be representative of the broader athletic population or applicable to different settings or countries. Consequently, the results should be interpreted with caution as they might not generalize beyond the studied sample. Future research should aim to include a larger and more diverse sample to enhance the generalizability of the findings. Therefore, future studies should be planned in a way that the validation procedure covers all sub-sections of the SNKQ. Additionally, interventions should be designed and administered to the athletic population based on the SNK assessed by properly developed and well-validated tools like this one. This approach may provide insights into improving SNK and, consequently, enhancing sports performance and overall well-being.

Conclusions

Following the development of the SLn-SNKQ, five steps were employed to establish validity and reliability. Content validity was confirmed by integrating comments and suggestions from a panel of sports nutrition experts received for each sub-section. Face validity was established by feedback from elite or highly trained athletes. Construct validity was confirmed by administering the tool to two distinct groups: NTG, NNTG, and AG using a comparative analysis. Internal reliability was established by administering the tool to the NTG and NNTG twice in a test-retest manner, with a three-week interval separating the administrations. The SLn-SNKQ meets all psychometric measures, providing a new, valid, and reliable tool to assess GNK and SNK among Sri Lankan track and field athletes. The utilization of the tool in the long term will allow for a more accurate evaluation of SNK and sports nutrition interventions for sports personnel, enhancing their overall sporting performance outcomes.

Abbreviations

SLn-SNKQ	Sri Lankan-Sports Nutrition Knowledge Questionnaire
GNK	General Nutrition Knowledge
MCQs	Multiple Choice Questions
SNK	Sports Nutrition Knowledge
SNKQ	Sports Nutrition Knowledge Questionnaire

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40795-024-00944-9.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Supplementary Material 4

Supplementary Material 5

Acknowledgements

We express our gratitude to all the authors who granted permission to adopt the questions from their previous questionnaire tools, as well as to all the other contributors who contributed to the improvement of the study.

Author contributions

RJ conceived and designed the study. RJ, GT, and KW participated in the finalization of the questionnaire. RJ, KW, and GT contributed to drafting the manuscript. NSK, TM, and APH, as supervisory team members participated in the revision of the paper. All authors provided valuable feedback on the manuscript. Additionally, all authors carefully reviewed and approved the final version of the manuscript.

Funding

No funding was received for conducting this study.

Data availability

Raw data supporting the findings of this study are available upon reasonable request from the corresponding author to ensure participant anonymity and comply with data protection regulations.

Declarations

Ethics approval and consent to participate

The qualitative study used in the multi-modal approach during the development of the questionnaire was conducted in accordance with the standards set by the Declaration of Helsinki. Ethical approval was obtained from the Ethics Review Committee of the Faculty of Medicine, University of Peradeniya, Sri Lanka, prior to conducting the study (Ref No. 2022/EC/66). All participants provided written informed consent to participate in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

[1]Department of Physiology, Faculty of Medicine, University of Colombo, Colombo, Sri Lanka
[2]Department of Physiology, Faculty of Medicine, University of Peradeniya, Kandy, Sri Lanka
[3]Health and Wellness Unit, Faculty of Medicine, University of Colombo, Colombo, Sri Lanka
[4]Department of Sport, Exercise and Nutrition Sciences, La Trobe University, Melbourne, Australia
[5]Department of Food Science and Technology, Faculty of Agriculture, University of Peradeniya, Kandy, Sri Lanka
[6]School of Health Sciences, College of Health and Medicine, University of Tasmania, Launceston, Australia
[7]Department of Nutrition and Health, College of Medicine and Health Sciences, United Arab Emirates University, Al Ain, United Arab Emirates

Received: 25 June 2024 / Accepted: 3 October 2024
Published online: 10 October 2024

References

1. Burke LM, Castell LM, Casa DJ, Close GL, Costa RJ, Desbrow B, et al. International association of athletics federations consensus statement 2019: nutrition for athletics. Int J Sport Nutr Exerc Metab. 2019;29(2):73–84.
2. Fritzen AM, Lundsgaard AM, Kiens B. Dietary fuels in athletic performance. Annu Rev Nutr. 2019;39:45–73.
3. Spronk I, Kullen C, Burdon C, O'Connor H. Relationship between nutrition knowledge and dietary intake. Br J Nutr. 2014;111(10):1713–26.

4. Jenner SL, Buckley GL, Belski R, Devlin BL, Forsyth AK. Dietary intakes of Professional and Semi-professional Team Sport athletes do not Meet Sport Nutrition Recommendations-A Systematic Literature Review. Nutrients. 2019;11(5).
5. Carbone A. How nutrition knowledge of coaches, athletic trainers, and strength and conditioning specialists translates to their athletes. East Tennessee State University; 2021.
6. Boumosleh JM, El Hage C, Farhat A. Sports nutrition knowledge and perceptions among professional basketball athletes and coaches in Lebanon-a cross-sectional study. BMC Sports Sci Med Rehabil. 2021;13(1):53.
7. Werner EN, Guadagni AJ, Pivarnik JM. Assessment of nutrition knowledge in division I college athletes. J Am Coll Health. 2022;70(1):248–55.
8. Boidin A, Tam R, Mitchell L, Cox GR, O'Connor H. The effectiveness of nutrition education programmes on improving dietary intake in athletes: a systematic review. Br J Nutr. 2021;125(12):1359–73.
9. Alaunyte I, Perry JL, Aubrey T. Nutritional knowledge and eating habits of professional rugby league players: does knowledge translate into practice? J Int Soc Sports Nutr. 2015;12:18.
10. Bentley MR, Mitchell N, Sutton L, Backhouse SH. Sports nutritionists' perspectives on enablers and barriers to nutritional adherence in high performance sport: a qualitative analysis informed by the COM-B model and theoretical domains framework. J Sports Sci. 2019;37(18):2075–85.
11. O'Brien L, Collins K, Amirabdollhian F. Exploring sports Nutrition Knowledge in Elite gaelic footballers. Nutrients. 2021;13(4).
12. Trakman GL, Forsyth A, Hoye R, Belski R. Developing and validating a nutrition knowledge questionnaire: key methods and considerations. Public Health Nutr. 2017;20(15):2670–9.
13. Trakman GL, Forsyth A, Hoye R, Belski R. The nutrition for sport knowledge questionnaire (NSKQ): development and validation using classical test theory and Rasch analysis. J Int Soc Sports Nutr. 2017;14:26.
14. Scrivin R, Costa RJ, Pelly F, Lis D, Slater G. Development and validation of a questionnaire investigating endurance athletes practices to manage gastrointestinal symptoms around exercise. Nutr Diet. 2021;78(3):286–95.
15. Tam R, Beck K, Scanlan JN, Hamilton T, Prvan T, Flood V, et al. The platform to Evaluate Athlete Knowledge of sports Nutrition Questionnaire: a reliable and valid electronic sports nutrition knowledge questionnaire for athletes. Br J Nutr. 2021;126(4):561–71.
16. Capling L, Gifford JA, Beck KL, Flood VM, Slater GJ, Denyer GS, et al. Development of an Athlete Diet Index for Rapid Dietary Assessment of Athletes. Int J Sport Nutr Exerc Metab. 2019;29(6):643–50.
17. Zinn C, Schofield G, Wall C. Development of a psychometrically valid and reliable sports nutrition knowledge questionnaire. J Sci Med Sport. 2005;8(3):346–51.
18. Vázquez-Espino K, Fernández-Tena C, Lizarraga-Dallo MA, Farran-Codina A. Development and validation of a short Sport Nutrition Knowledge Questionnaire for athletes. Nutrients. 2020;12(11).
19. Frary RB. A brief guide to questionnaire development. Va Polytechnic Inst State Univ Retrieved Oct. 2003;9:2003.
20. Kouvelioti R, Vagenas G. Methodological and statistical quality in research evaluating nutritional attitudes in sports. Int J Sport Nutr Exerc Metab. 2015;25(6):624–35.
21. Jayawardena RWK, Trakman G, Madhujith T, Hills AP, Kalupahana NS. Development of a sports nutrition knowledge questionnaire for elite track and field athletes. World Nutr J. 2024;8(i1):104–28.
22. McKay AKA, Stellingwerff T, Smith ES, Martin DT, Mujika I, Goosey-Tolfrey VL, et al. Defining training and performance caliber: a participant classification Framework. Int J Sports Physiol Perform. 2022;17(2):317–31.
23. LLC G. Google Forms California, USA[cited 2024 Jan 16] [Available from: https://policies.google.com/terms?hl=en-US
24. Polit DF, Beck CT, Owen SV. Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. Res Nurs Health. 2007;30(4):459–67.
25. Poliandri D, Perazzolo M, Pillera GC, Giampietro L. Dematerialized participation challenges: methods and practices for online focus groups. Front Sociol. 2023;8:1145264.
26. Kang H. Sample size determination and power analysis using the G*Power software. J Educ Eval Health Prof. 2021;18:17.
27. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007;39(2):175–91.
28. Aithal A, Aithal P. Development and validation of survey questionnaire & experimental data–a systematical review-based statistical approach. Int J Manage Technol Social Sci (IJMTS). 2020;5(2):233–51.
29. Cappelleri JC, Jason Lundy J, Hays RD. Overview of classical test theory and item response theory for the quantitative assessment of items in developing patient-reported outcomes measures. Clin Ther. 2014;36(5):648–62.
30. Parmenter K, Wardle J. Evaluation and design of nutrition knowledge measures. J Nutr Educ. 2000;32(5):269–77.
31. Furber MJW, Roberts JD, Roberts MG. A valid and reliable nutrition knowledge questionnaire for track and field athletes. BMC Nutr. 2017;3:36.
32. Edmonds C, Tam R, Madigan S, Gubb L, Beck KL, Gifford JA, et al. Validation of a sports nutrition knowledge questionnaire for athletes in the United Kingdom and Ireland. J Nutr Sci. 2023;12:e2.
33. MacKenzie SB, Podsakoff PM, Podsakoff NP. Construct measurement and validation procedures in MIS and behavioral research: integrating new and existing techniques. MIS Q. 2011:293–334.

Publisher's note