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REVIEW

Effectiveness of sports nutrition education on knowledge, attitudes, and practices (KAP) scores, eating behaviours, and energy availability among athletes: A scoping review (2015-2024)

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ABSTRACT

Introduction: Sports nutrition is critical for optimising athletes' performance, recovery, and health. Despite its importance, significant gaps in knowledge, attitudes, and practices (KAP) among athletes often lead to suboptimal dietary habits and impaired energy balance. Sports nutrition education interventions have emerged as a promising strategy to address these deficiencies. This scoping review examined effectiveness of sports nutrition education programmes on KAP, eating behaviours, and energy availability among athletes from 2015 to 2024. **Methods:** A systematic search of PubMed, Google Scholar, and Scopus was conducted using relevant keywords. Out of 394 studies initially screened, 12 met inclusion criteria, comprising intervention-based study designs, including randomised-controlled trials, quasi-experimental studies, and pre-post studies. Studies were considered eligible if they involved athletes, incorporated a nutrition education component, and assessed at least one outcome related to KAP, eating behaviour, or energy availability. **Results:** Most studies reported significant improvements in nutrition knowledge, attitudes, and practices, accompanied by positive changes in dietary behaviours. Interventions delivered via classroom instruction, digital platforms, or blended methods demonstrated varying levels of effectiveness. Key findings included increased energy availability, better dietary adherence, and favourable changes in body composition. Variations in duration of intervention programme delivery and participant characteristics led to the wide range of outcomes observed. **Conclusion:** Sports nutrition education can improve athletes' nutrition knowledge and encourage healthier dietary practices. These interventions may contribute to better energy management, improved health, and enhanced sports performance, although further research is needed to evaluate their long-term effectiveness across different athlete populations.

Keywords: athletes, dietary behaviour, education, knowledge-attitude-practice (KAP), sports nutrition

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INTRODUCTION

Sports nutrition is a fundamental component of optimising athletic performance, enhancing recovery, and supporting overall health in athletes (Amawi *et al.,* 2024). Adequate nutrition is not just about ensuring the intake of essential nutrients to support the physical demands of training and competition but also plays a pivotal role in promoting psychological well-being and long-term health outcomes (Malinowska *et al.,* 2024). It involves the consumption of a balanced and sufficient diet that provides all essential nutrients required for optimal physiological function. Proper nutrition is instrumental in supporting development, daily energy needs, immune function, and overall health (Mitra *et al.,* 2022).

Despite its critical importance, many studies have identified a persistent gap in athletes' knowledge, attitudes, and practices (KAP) regarding sports nutrition. Many athletes lack awareness of the quantity, type, and timing of food intake necessary to support their training and recovery. Often, their nutrition choices are influenced by anecdotal sources, such as word of mouth, social media, or outdated beliefs, rather than evidence-based guidelines.

Some athletes underestimate the importance of nutrition in sports performance, reducing their likelihood of seeking or adhering to evidence-based dietary guidance. Even when appropriate nutrition knowledge is present, they may find it hard to apply due to time, access, peer influence, or cultural habits (Weerasinghe *et al.*, 2025). As a result, athletes may develop poor eating habits, including meal skipping, inadequate energy intake, excessive reliance on low-nutrient, high-calorie foods, or adherence to overly restrictive dietary regimens. These habits can cause energy imbalances, leading to tiredness, injuries, illness, and lower performance. In more severe cases, these behaviours can lead to significant health complications, such as Relative Energy Deficiency in Sport (RED-S), a condition that impairs multiple physiological systems, including metabolic, hormonal, cardiovascular, and immune functions (Gallant *et al.*, 2024).

Structured sports nutrition education is instrumental in addressing and preventing diet-related challenges faced by athletes. By improving their knowledge and practical application of nutritional strategies, athletes can experience gains in performance, health, and longevity in sport. These programmes strive to do more than just deliver content but also to shift mindsets and encourage enduring habits that meet the physiological demands of training and competition (Jayawardena *et al.*, 2025). Research suggests that well-designed educational initiatives can lead to improved dietary quality, optimised energy management, and reduction in nutrition-related deficiencies and injuries (DeJong Lempke, Reece & Whitney, 2025). Nevertheless, such factors as differences in sport discipline, sex, competition level, and sociocultural or dietary practices can affect outcomes. These factors may complicate the assessment of the true impact of these interventions.

Beyond knowledge, attitudes, and practices (KAP), eating behaviours and energy availability are equally critical in determining athletic outcomes. Poor eating behaviours, which are often influenced by misinformation, social pressures, or restrictive body image ideals, can lead to low energy availability, disordered eating patterns, and impaired physical performance (Sueda Boyraz & Göbel *et al.*, 2025). Conversely, athletes who are armed with comprehensive nutrition knowledge can make smarter dietary choices, and this can ensure sufficient energy levels for optimum

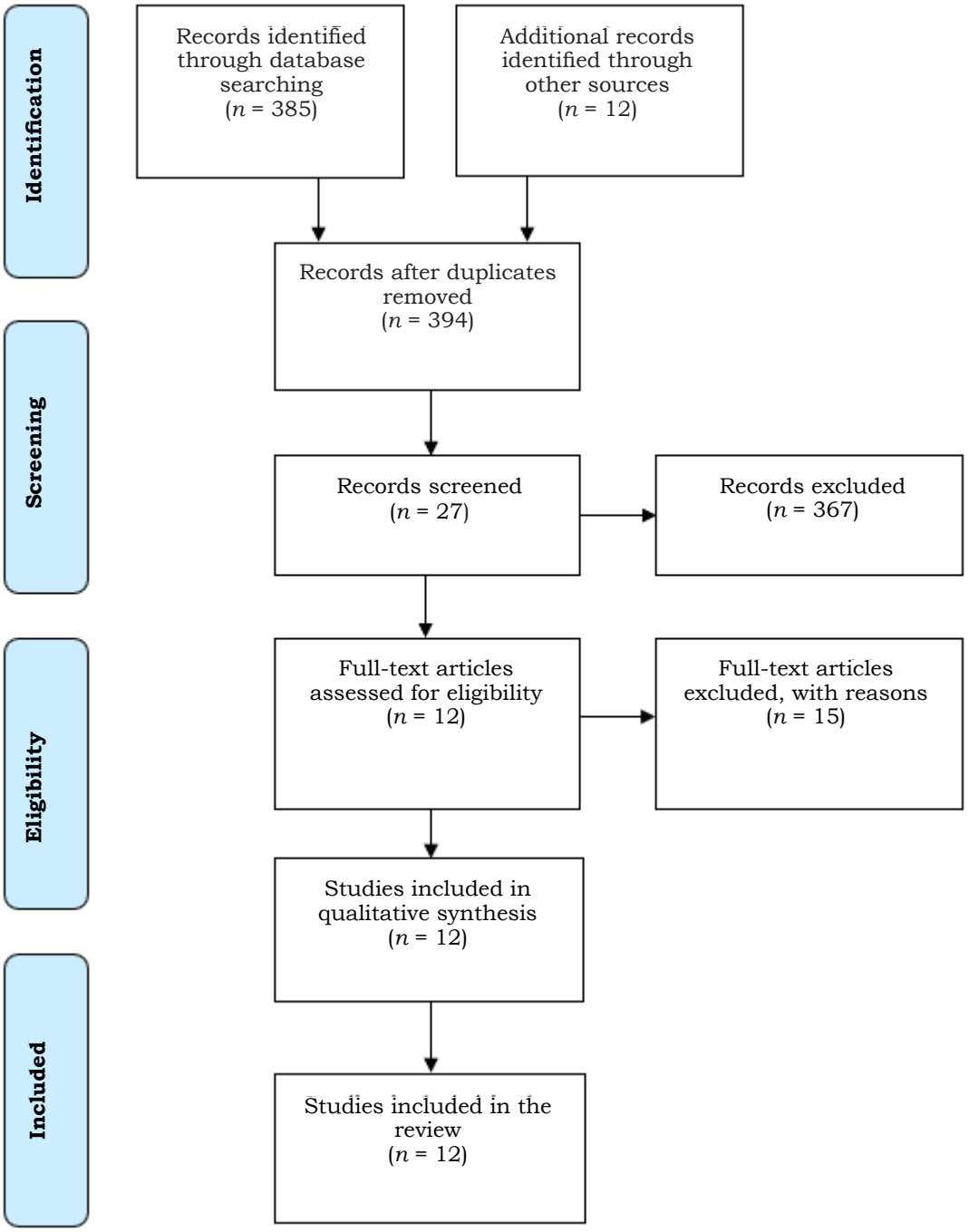

Figure 1. PRISMA flow diagram on the outcomes of the search strategy

Table 1. Effects of sports nutrition education on KAP scores, eating behaviours, and energy availability in previous studies from 2014-2025

No.	*Authors*	*Country*	*Title*	*Study Methods*	*Main Findings*
1	Akman *et al.*, 2024	Turkey	The effect of nutrition education sessions on energy availability, body composition, eating attitude and sports nutrition knowledge in young female endurance athletes	Design: Randomised-controlled trial Participants: Female endurance athletes (n=83), aged 15–18 years Grouping: Intervention (n=45); Control (n=38) Intervention: 6 physical nutrition education lectures for intervention group Outcomes: SNZQ scores, energy availability, body composition	• Energy availability, energy intake, weight, fat-free mass and resting metabolic rate increased in intervention group (p<0.05) • SNZQ scores improved significantly
2	Coccia *et al.*, 2020	USA	Tweeting for nutrition: Feasibility and efficacy outcomes of a 6-week social media-based nutrition education intervention for student-athletes	Design: Quasi-experimental Participants: Student-athletes (n=50), aged 18–24 years Grouping: No grouping Intervention: 6-week Twitter-based nutrition education Outcomes: Nutrition knowledge, dietary intake behaviour	• Improved nutrition knowledge (p=0.035) • Reduced fat intake (p=0.130) • Decrease in BMI (p=0.027)
3	Elias *et al.*, 2018	Malaysia	Effects of sports nutrition education intervention on sports nutrition knowledge, attitude and practice, and dietary intake of Malaysian team sports athletes	Design: Quasi-experimental Participants: Male athletes (n=105) Grouping: Intervention (n=52); Control (n=53) Intervention: 7 weeks of sports nutrition education for intervention group Outcomes: KAP scores	• Significant increase in KAP scores of intervention group compared to control (p<0.001)
4	Enatsu *et al.*, 2024	Japan	Effectiveness of sports nutrition education based on self-determination theory for male university rowing athletes: A randomised controlled trial	Design: Randomised-controlled trial Participants: Male university rowers (n=36) Grouping: Intervention (n=18); Control (n=18) Intervention: Nutrition education based on self-determination theory vs. standard education Outcomes: Dietary knowledge	• Self-determination based programme improved dietary knowledge significantly (p=0.002)

To be continued...

Table 1. Effects of sports nutrition education on KAP scores, eating behaviours, and energy availability in previous studies from 2014-2025 *(continued)*

No.	*Authors*	*Country*	*Title*	*Study Methods*	*Main Findings*
5	Gao *et al.*, 2022	China	Comparison of the effects of different forms of nutrition education on adolescent male soccer players	Design: Quasi-experimental Participants: Male soccer players (n=41), aged 15 years Grouping: Classroom group (n=21); WeChat group (n=20) Intervention: 12-week nutrition education via classroom vs. WeChat Outcomes: KAP scores	• Classroom group showed significantly higher nutrition knowledge and total scores than WeChat group (p<0.05)
6	Heikkilä *et al.* 2019	Finland	The impact of nutrition education intervention with and without a mobile phone application on nutrition knowledge among young endurance athletes	Design: Randomised-controlled trial Participants: Endurance athletes (n=79), aged 16–20 years Grouping: Group 1: nutrition sessions only; Group 2: sessions + mobile food app Outcomes: Nutrition knowledge scores	• Group 2 (app users) showed significant knowledge improvement (p<0.001)
7	Priyadarsini & Ponnalagu, 2015	India	Effect of nutrition education on knowledge, attitude and practices of sports person with special reference to zinc	Design: Quasi-experimental pre-post design Participants: Athletes (n=100), aged 18–30 years Grouping: Single group Intervention: 6-week structured sports nutrition program Outcomes: KAP scores	• Knowledge improved from 42% → 85% • Attitudes improved 38% → 82% • Practices improved 30% → 78%
8	Sadhu & Kotwal, 2018	India	Knowledge–Attitude–Practice (KAP) study and nutrition education of athletic and non-athletic teenagers (13–18 years)	Design: Quasi-experimental pre-post design Participants: Adolescents (n=600), aged 13–18 years Grouping: Athletes (n=300) & non-athletes (n=300) Intervention: PowerPoint + informational booklets Outcomes: KAP scores	• Significant post-intervention improvement in nutritional knowledge (p<0.05)

To be continued...

Table 1. Effects of sports nutrition education on KAP scores, eating behaviours, and energy availability in previous studies from 2014-2025 *(continued)*

No.	*Authors*	*Country*	*Title*	*Study Methods*	*Main Findings*
9	Tan *et al.*, 2022	Australia	The impact of a 'remotely-delivered' sports nutrition education program on dietary intake and nutrition knowledge of junior elite triathletes	Design: Single-arm observational Participants: Junior elite triathletes Grouping: None Intervention: 8-week remotely delivered nutrition education Outcomes: Nutrition knowledge	• Sports nutrition knowledge scores improved by 15% (p<0.001)
10	Ueda *et al.*, 2020	Japan	Nutrition education programme changes food intake and baseball performance in high-school students	Design: Quasi-experimental Participants: Male high-school baseball players (n=50) Grouping: Intervention (n=28); Control (n=22) Intervention: 4 months nutrition education for intervention group Outcomes: Dietary intake, baseball performance	• Improved food intake, dietary balance, and athletic performance • Bat swing speed significantly faster post-intervention
11	Zaman *et al.*, 2021	Malaysia	Knowledge, attitude, practice (KAP) and dietary intake of young university athletes following sports nutrition education	Design: Pre-post single group Participants: University athletes (n=21) Grouping: None Intervention: 1-day sports nutrition education class Outcomes: KAP scores, dietary intake	• Significant increase in KAP scores (p<0.05) • Increased total energy and carbohydrate intake (p<0.05)
12	Zeng *et al.*, 2020	China	Evaluation for the effects of nutritional education on Chinese elite male young soccer players: The application of adjusted dietary balance index (DBI)	Design: Randomised-controlled trial Participants: Soccer players (n=30) Grouping: Intervention (n=15); Control (n=15) Intervention: 4-week program + comic books vs. comic books only Outcomes: KAP scores	• Significant improvement in nutrition knowledge and KAP scores (p<0.01) • No significant difference in dietary attitude/behaviour (p>0.05)

performance and the attainment of their health goals.

While sports nutrition education has been linked to positive results, its effectiveness seems to differ depending on the athlete group. The inconsistency underscores the necessity of a comprehensive overview of existing literature. To address this gap, the present scoping review aims to explore how nutrition education interventions influence athletes' KAP, eating behaviours, and energy availability, focusing on studies published between 2015 and 2024. By examining the scope and quality of current evidence, it seeks to identify common themes, evaluate the design and implementation of educational approaches, and reveal areas where further research is needed. The ultimate goal of the work is to inform the development of nutrition education programmes that are evidence-based, culturally appropriate, and precisely targeted to meet the diverse needs of athletes.

METHODOLOGY

This scoping review summarised the available evidence on the effectiveness of sports nutrition education on KAP, eating behaviours, and energy availability among athletes between 2015 and 2024. The steps followed in this scoping review included identifying the review questions, creating the search strategy, conducting the searches, selecting the studies to be included, data extraction, and interpreting and reporting the findings.

Review questions

This review aimed to answer the following questions: (1) How effective were sports nutrition education programmes in improving athletes' KAP, eating behaviours, and energy availability? (2) How were sports nutrition education programmes implemented for athletes from 2015 to 2024?

Search strategy

Literature search was conducted between November 2024 and January 2025 using search engines PubMed, Google Scholar, and Scopus, covering from 2015 to 2024. Search keywords used were 'knowledge OR attitude OR practice' AND 'nutrition OR sports nutrition' AND 'athletes OR sportsmen'.

Study selection

Only publications from the previous ten years (1st January 2015 to 31st December 2024) were included in the literature search to reflect recent trends and advancements on the topic of interest. The inclusion criteria for the articles were: (1) used sports nutrition education as an intervention; (2) included knowledge, attitude and practice of sports nutrition as outcome measures; (3) athletes as subjects; (4) written in English; and (5) original articles comprising intervention-based study designs, including randomised-controlled trials, quasi-experimental studies, and pre-post studies. Review articles, abstracts, conference proceedings, editorials, letters to editors, research letters, short communications, and opinion articles were excluded.

Data extraction

A total of 397 studies were retrieved during the search. After duplicate studies were removed, 394 studies were screened for their titles, abstracts, and keywords according to the study selection (inclusion and exclusion) criteria. Out of 394 studies, only 27 studies underwent full-text review, where another 3 studies were excluded (Figure 1). Two reviewers carried out an independent examination of the studies. A third reviewer resolved any disagreements.

RESULTS

A total of 12 studies met the inclusion criteria and were included in the final synthesis (Table 1). The studies comprised intervention-based study designs, including randomised-controlled trials, quasi-experimental studies, and pre-post studies. Participants included adolescent and adult athletes across a range of sports, such as endurance running, soccer, rowing, triathlon, and baseball. The interventions offered were diverse, varying from concise, single-day workshops to comprehensive 12-week programmes, and these were accessible through in-person sessions, remote participation, or a blend of both.

Improvements in knowledge, attitudes, and practices (KAP) scores

Across the reviewed studies, nutrition knowledge was the most consistently and significantly improved domain following educational interventions. For example, Elias *et al.* (2018) reported a substantial increase in sports nutrition knowledge among Malaysian team sport athletes after a structured seven-week education programme. Zaman, Salehuddin & Awang (2021) observed a statistically significant improvement ($p<0.05$) in nutrition knowledge following a single-day nutrition workshop for university athletes. Tan, Keong & Yeoh (2022) documented a 15% improvement in nutrition knowledge scores among junior elite triathletes after an 8-week remote education programme. Similar findings were noted in the work of Heikkilä *et al.* (2019), where the addition of a mobile application to in-person sessions further enhanced knowledge outcomes, and in Gao, Lin & Li (2022), where classroom-based interventions led to higher nutrition knowledge scores compared to digital-only formats. Collectively, these results highlighted that both in-person and blended modalities can effectively deliver foundational nutrition education to athletes.

Studies revealed a change in attitudes, but these changes were less consistent compared with the improvements in knowledge. For example, Priyadarsini & Ponnalagu (2015) reported that after an intervention, athletes' perception of essential nutrients, especially zinc, was dramatically improved, with their attitudes shifting from 38% to 82%. Similarly, Sadhu & Kotwal (2018) found significant increases in nutrition-related attitudes across both athletic and non-athletic teenagers following a targeted intervention. In contrast, Zeng, Cheng & Yang (2020) and Gao *et al.* (2022) found no statistically significant improvements in dietary attitudes, even though their related knowledge improved. These inconsistencies might stem from deeper cultural or psychosocial factors, suggesting brief educational sessions were insufficient for significant change.

Behavioural changes in dietary practices were noted in many studies, albeit with mixed results. According to Elias *et al.* (2018), participants in their programme showed an increase in total energy intake and adhered more closely to recommended dietary guidelines. Zaman *et al.* (2021) also found significant increases in daily energy and carbohydrate intakes post-intervention, in which protein and fat intakes remained above recommended levels. According to the work of Akman *et al.* (2024), young female endurance athletes demonstrated increased energy availability and fat-free mass following structured nutrition education, indicating practical application of the knowledge acquired. However, as reported by Zeng *et al.* (2020), despite improvements in knowledge, actual changes in dietary behaviours were limited, suggesting that sustained changes in practice may require longer or more tailored interventions. This discrepancy highlights how important

it is to integrate behaviour change strategies with knowledge delivery to support lasting improvements in dietary habits.

Changes in eating behaviours, dietary intake, and energy availability

Several studies reported improvements in dietary intake quality following intervention programmes. For example, Coccia, Deierlein & Boumtje (2020) observed a reduction in fat intake and a decrease in body mass index (BMI) among student-athletes after participating in a six-week Twitter-based intervention. Similarly, Tan *et al.* (2022) reported increased intakes of energy, carbohydrates, protein, and fat on heavy training days, suggesting improved dietary planning and periodisation. Ueda, Oka & Nakamura (2020) found that enhanced dietary balance and food intake were associated with performance improvements, including increased bat swing speed in high school baseball players. The study additionally highlighted that participants gained weight and improved their swing speed, all without negatively affecting their lean body mass. Improvements in energy availability and physiological parameters were documented only in one study by Akman *et al.* (2024), who reported increased energy availability, fat-free mass, and resting metabolic rate in female endurance athletes after receiving a six-session face-to-face education programme.

Influence of delivery mode

The mode of delivery played a critical role in determining the effectiveness of the intervention. Gao *et al.* (2022) indicated that classroom-based education outperformed mobile app-based learning in improving nutrition knowledge. On the contrary, Heikkilä *et al.* (2019) demonstrated that a blended approach combining education sessions with a mobile app yielded the highest knowledge gains. Digital interventions, such as those documented by Coccia *et al.* (2020) and Tan *et al.* (2022), showed that remote formats could still lead to positive outcomes, particularly when reinforced regularly.

DISCUSSION

The growing body of evidence from the past decade clearly showed that sports nutrition education has a meaningful impact on the knowledge, attitudes, and dietary behaviours of athletes. As revealed in this review, most interventions, regardless of delivery mode, reported significant improvements in KAP domains.

One of the strongest findings across multiple studies is the enhanced understanding of knowledge following education interventions, which likely serves as a key mechanism driving positive dietary changes. For instance, Enatsu, Kobayashi & Nakamura (2024), who applied the principles of Self-Determination Theory (SDT), observed significant gains in nutrition knowledge among university rowing athletes. SDT posits that behaviour change is more likely to occur and sustained when individuals experience autonomy, competence, and relatedness. In this context, the nutrition education approach instilled a sense of independence in athletes by guiding them to make smart choices, improved their capabilities with enhanced nutritional comprehension, and fostered a sense of belonging through supportive interactions with educators and peers. Similarly, Elias *et al.* (2018) reported substantial improvements in both nutrition knowledge and total energy intake after a seven-week intervention among Malaysian team sports athletes. These outcomes are consistent with earlier research, suggesting that well-structured nutrition education enhances

awareness, fosters autonomous motivation, and effectively guides dietary decision-making (Fuller & Bird, 2025). Collectively, it is clear that merging motivational theory with nutrition education for athletes can boost their understanding and actions, ultimately improving health and performance of athletes.

Despite improvements in knowledge acquisition, translating that knowledge into sustained behavioural change and attitudinal shifts remains a significant challenge. Zeng *et al.* (2020) and Gao *et al.* (2022) reported that although nutrition knowledge scores increased substantially following interventions, corresponding changes in dietary attitudes and behaviours were comparatively limited. This gap may stem from the absence of personalised feedback or inadequate reinforcement of learned concepts over time. Behavioural change theories, such as the Transtheoretical Model, emphasise that meaningful change involves progressing through a series of stages such as pre-contemplation, contemplation, preparation, action, and maintenance. It requires repeated exposure, reflection, and motivational support (Kim, Hong & Jung, 2022). These critical elements are often under-represented in brief or one-time educational interventions.

For athletes, effective behavioural change requires more than information-rich, one-off sessions. They benefit from continuous engagement with key concepts, opportunities for self-reflection, and sustained encouragement to stay motivated. Without these supports, even well-intentioned efforts may fail to produce lasting outcomes. While short-term programmes may enhance knowledge, they often fall short in fostering long-term changes in dietary behaviours and attitudes.

Interestingly, the mode of education delivery appears to influence outcomes. Gao *et al.* (2022) found that classroom-based education was more effective than WeChat-based learning, which highlights the importance of interpersonal interaction and direct engagement. This is echoed in the findings of Heikkilä *et al.* (2019), where combining in-person sessions with a mobile app yielded the highest knowledge scores. However, Coccia *et al.* (2020) demonstrated that even remote interventions via X can foster positive changes in dietary habits and knowledge, suggesting that well-designed digital tools can support learning effectively. This finding aligns with recent studies, which emphasise the increasing relevance of digital platforms in health education, particularly in the post-pandemic time (Kelly *et al.,* 2021).

The eating behaviours of athletes are shaped by sport-specific demands and cultural pressures. Akman *et al.* (2024) observed that female endurance athletes benefited significantly from face-to-face sessions, resulting in improved energy availability and fat-free mass. However, eating behaviours are highly susceptible to social influences, especially in aesthetic and weight-sensitive sports. Although athletes may be well-informed about nutrition, disordered eating and RED-S continue to be prevalent issues (Fidyk *et al.*, 2025). Therefore, education programmes must also address the psychological and socio-cultural dimensions of eating, not just nutritional facts.

The significance of age and developmental stage in shaping KAP cannot be overstated. Younger athletes, as demonstrated in the study by Sadhu & Kotwal (2018), showed significant improvements across all KAP domains, underscoring the benefits of early intervention. Adolescents, in particular, may be more receptive to new information and behavioural change when provided with appropriate support. Similarly, the study by Tan *et al.* (2022), which involved

junior elite triathletes, also evidenced that remote, age-tailored interventions can effectively enhance nutrient intake, even among highly active populations.

Adolescence represents a critical developmental window during which habits, routines, and beliefs about health and performance are established. During this phase, the brain is primed for learning, and adolescents are highly susceptible to the influence of significant individuals like coaches, peers, and mentors, who can greatly enhance the effectiveness of well-designed interventions. Younger athletes are still in the process of forming their identities, both as individuals and as competitors. As such, targeted education and consistent support during this formative period can leave a permanent mark on their perceptions of nutrition, training, and recovery.

Energy availability, a critical factor in athletic performance, was not consistently assessed across the reviewed studies. While Akman *et al.* (2024) and Ueda *et al.* (2020) evaluated changes in metabolic rate and physical performance outcomes, respectively, such physiological indicators were generally overlooked in most interventions. This oversight limits the ability to draw definitive conclusions about the extent to which improvements in KAP directly influence energy balance and performance outcomes. Without monitoring objective physiological changes such as alterations in energy availability, metabolic rate, or body composition, it remains unclear whether enhanced nutritional understanding can be effectively translated into improved fuelling strategies and athletic performance.

These measures are particularly important, as although athletes may demonstrate increased nutrition knowledge and improved dietary habits, the practical impact of educational interventions remains uncertain if they do not lead to measurable improvements in energy availability, particularly during periods of intense training. Incorporating direct physiological assessments in future studies would offer the evidence that links cognitive and behavioural changes with tangible performance-related outcomes.

While this review focuses on the last decade, it is important to recognise that many foundational gaps remain. Cultural specificity, for example, is still lacking in many interventions. Recent evidence indicates that female athletes and para-athletes continue to be under-represented in sports nutrition research. McKay *et al.* (2022) noted that current interventions are predominantly drawn from studies in male, able-bodied populations, thus limiting the generalisability of findings. Furthermore, recent research also emphasises that prevailing nutritional guidelines often fail to account for sex-specific considerations, such as menstrual function, as well as the diverse energy expenditure and nutrient requirements observed among para-athletes (Yokoyama, Deguchi, & Hongu, 2022). Collectively, these perspectives underscore the necessity for more inclusive, evidence-driven educational interventions that are tailored to the physiological and contextual needs of diverse athletic populations. Despite consistent knowledge gains, the translation of this understanding into sustained practical applications remains a complex and multifactorial challenge. Addressing this gap will require integrative approaches that combine education with behavioural, cultural, and environmental strategies, complemented by longitudinal evaluations to assess the durability of outcomes.

CONCLUSION

This scoping review suggests that sports nutrition education programmes are

associated with improvements in athletes' knowledge, attitudes, and practices (KAP), and, in some cases, positive changes in eating behaviours and aspects of energy balance. The findings also indicate that tailoring interventions according to sport type, age group, and delivery method may enhance engagement and learning outcomes. Despite widespread reports of increased knowledge, translating that understanding into consistent dietary habits is often hindered by behavioural, cultural, and contextual influences. Further research is needed to examine the longer-term effects of nutrition education and its potential relationship with sustained dietary behaviours and performance outcomes.

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Authors' contributions

Raza MQ, as the principal investigator, conceptualised and designed the scoping review, conducted the literature search, data extraction, and synthesis, and drafted the initial manuscript; Muhamad AS, as the corresponding author, supervised the overall review process, validated data extraction, provided critical input on the interpretation of findings, and substantially revised the manuscript for intellectual content; Ong MLY, contributed to the screening of studies, assisted in data interpretation, and reviewed and refined the final manuscript. All authors read and approved the final version of the manuscript prior to submission.

Conflict of interest

The authors declare no conflict of interest.

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