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Nutritional periodization in team-sport athletes: A thematic review of training-load–responsive fuelling, recovery and training adaptation

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Abstract
Nutritional periodization has developed from a relatively narrow focus on manipulating carbohydrate availability into a broader concept in which energy, carbohydrate, protein, hydration and selected micronutrient strategies are adjusted according to training demand, recovery requirements and competition goals. This descriptive thematic review examines contemporary concepts of nutritional periodization in team-sport athletes, with particular emphasis on training-load–responsive fuelling, recovery and training adaptation. Literature was narratively organised into major themes: training-load and fuelling demand, carbohydrate periodization, protein and tissue remodelling, energy availability, pre-, during- and post-exercise nutrition, match-day and congested-schedule recovery, body-composition management, individualisation, digital monitoring, and future research. Recent consensus and review evidence indicates that no single nutritional strategy is appropriate for all athletes and that carbohydrate availability should generally be high when repeated high-intensity performance is required, while nutritional strategies should be individualised according to sport, training phase and athlete context. The review also highlights an important distinction between nutritional adequacy and nutritional alignment: an athlete may meet average weekly targets while still being poorly fuelled for a particular high-load session. A practical thematic framework, the FUEL–RECOVER–ADAPT model, is proposed to connect training demand with nutritional decisions and subsequent recovery and adaptation. The review concludes that nutritional periodization should be viewed as a dynamic support system integrated with training periodization rather than as a fixed diet plan.

Keywords: Nutritional periodization, team sports, training load, carbohydrate, protein, recovery, training adaptation, sports nutrition, fuelling, thematic review

Introduction

Team-sport athletes experience fluctuating physical and metabolic demands across training sessions, matches, travel periods and competitive phases. Football, volleyball, basketball, hockey, handball and similar sports require combinations of repeated high-intensity actions, acceleration, deceleration, jumping, changes of direction and technical or tactical activity. Consequently, the nutritional requirement of an athlete is unlikely to remain identical from one day to the next.

Nutritional periodization refers to the deliberate adjustment of energy and nutrient availability in relation to the training programme. A recent UCI Sports Nutrition Project review describes periodization across microcycles, mesocycles and macrocycles and emphasises meal-by-meal and day-by-day adjustment of energy and carbohydrate intake according to the demands and objectives of specific sessions. (Morton *et al*., 2025) [1]

The concept is particularly relevant to team sports because training and competition schedules can change rapidly. A high-load training day, match day, recovery day and low-intensity technical day do not necessarily require the same fuelling strategy. Earlier work described strategies such as training with high or low carbohydrate availability, while contemporary guidance places greater emphasis on using such strategies selectively and in context. (Jeukendrup, 2017) [5]

Recent consensus evidence also emphasises individualised, sport-specific approaches and recognises low energy availability as an important risk. It further identifies wearable technology and other emerging tools as promising but still requiring validation. (Bangsbo *et al*., 2025) [3]

Therefore, the present review does not treat nutritional periodization as a single diet. Instead, it examines the concept as a coordinated process in which nutrition is adjusted to the work required, the recovery challenge and the desired training adaptation.

Purpose and Review Approach

The purpose of this paper is to provide a contemporary descriptive and thematic synthesis of nutritional periodization in team-sport athletes without collecting new participant data. The review focuses on concepts, practical applications, evidence-supported strategies, controversies and research gaps.

Relevant literature was identified conceptually through PubMed-indexed reviews, consensus statements and sports-nutrition literature addressing nutritional periodization, team-sport recovery, carbohydrate availability, protein, energy availability and training adaptation. The approach is thematic rather than a formal systematic review; therefore, it does not claim a PRISMA-style exhaustive search or quantitative meta-analysis.

Recent literature was prioritised where available, including the 2025 UCI Sports Nutrition Project review, the 2025 Spanish Society of Nutrition consensus document, recent consensus statements on elite athlete performance, and contemporary reviews of nutritional periodization and recovery–adaptation coupling.

Major Themes of Nutritional Periodization

Theme 1: Training Load and Nutritional Demand

The central principle of nutritional periodization is that nutrition should support the work that the athlete is expected to perform. High-intensity and high-volume sessions generally create greater carbohydrate and total-energy requirements than low-load sessions. A useful practical distinction is therefore between nutritional adequacy and nutritional alignment. Adequacy refers to meeting overall needs, whereas alignment refers to matching intake with the timing and magnitude of training demand.

This distinction is important because average daily or weekly intake can conceal poor fuelling around key sessions. In team sports, where repeated high-intensity work is common, carbohydrate availability is particularly relevant. The 2025 UCI review explicitly describes carbohydrate intake as something that may need to be adjusted meal-by-meal and day-by-day according to training objectives. (Morton *et al*., 2025) [1]

Theme 2: Carbohydrate Periodization

Carbohydrate is a major substrate for high-intensity exercise. Periodizing carbohydrate does not mean maintaining athletes on low carbohydrate diets. Rather, it means deliberately varying carbohydrate availability according to the purpose of the session and the competition schedule.

High carbohydrate availability is generally appropriate when the objective is to maximise quality in demanding training or competition. Lower availability has been investigated as a strategy to stimulate selected molecular signalling pathways, but evidence for direct performance benefits is context-dependent. Earlier review evidence noted that some 'train low' approaches show molecular or signalling effects without consistently demonstrating performance improvements. (Jeukendrup, 2017) [5]

A 2025 Spanish consensus review similarly concluded that high carbohydrate availability remains the most consistent approach for sustaining endurance and high-intensity performance, while carbohydrate periodization can be used selectively according to context. (Mielgo-Ayuso *et al*., 2025) [2]

Theme 3: Protein Periodization and Training Adaptation

Protein has a different role from carbohydrate within periodized nutrition. Whereas carbohydrate is closely related to fuelling high-intensity work and glycogen restoration, protein supports tissue remodelling and muscle adaptation. The recent UCI review highlights a daily protein range of approximately 1.6–2.1 g/kg/day for elite athletes as a practical consideration, while individual needs may vary. (Morton *et al*., 2025) [1]

Protein distribution across meals may also be considered alongside total intake. In periods of high training stress or reduced energy availability, adequate protein becomes particularly important. However, protein should not be viewed as a substitute for adequate overall energy or carbohydrate when the training task requires substantial carbohydrate availability.

Theme 4: Energy Availability and Athlete Health

Nutritional periodization must not become a justification for chronic energy restriction. Athletes require adequate energy to support training, physiological function and recovery. Excessive or poorly planned restriction can contribute to low energy availability and may negatively affect health and performance.

Contemporary consensus documents increasingly emphasise individualised energy and macronutrient periodization and recognition of low-energy-availability risk. (Bangsbo *et al*., 2025) [3] Body-composition goals should therefore be gradual, realistic and aligned with sport demands rather than driven solely by short-term weight changes.

Theme 5: Pre-, During- and Post-Training Nutrition

Timing is a defining feature of nutritional periodization. Before demanding training or competition, carbohydrate availability and gastrointestinal tolerance should be considered. During prolonged or high-intensity activity, carbohydrate and fluid strategies may be relevant. Following demanding sessions, rapid restoration of carbohydrate stores and provision of protein can support recovery, particularly when the next training stimulus occurs soon.

Team-sport recovery literature has long emphasised carbohydrate, protein and fluid as foundational components of recovery, with additional strategies requiring context-specific evaluation. (Beck *et al*., 2017) [6]

Theme 6: Match-Day and Congested-Schedule Recovery

Team-sport athletes may have limited recovery time between matches. Nutritional priorities during congested schedules include restoration of glycogen, adequate protein, fluid replacement and rapid access to practical foods. Travel may further complicate food quality and timing. Consequently, periodization should include not only training days but also match day, post-match recovery and the subsequent preparation day.

4. Staśkiewicz-Bartecka, W., Kardas, M., Zydek, G., Zając, A., & Chycki, J. (2024) [4]. Changes in Body Composition and Nutritional Periodization during the Training Macrocycle in Football—A Narrative Review. Nutrients, 16(9), 1332. https://doi.org/10.3390/nu16091332

Theme 7: Body Composition and Nutritional Periodization

Body composition can be a legitimate objective within some sports, but manipulating body mass should not compromise health or training quality. A 2025 scoping review of international consensus documents found that recommendations should be individualised according to sport, position, sex, age and competition phase. (Delany *et al*., 2025) [8]

For team-sport athletes, the practical objective is therefore not simply to reduce body mass but to optimise the combination of performance, body composition and adequate fuelling. Nutritional periodization may involve higher energy availability during phases emphasising training adaptation and more controlled intake during lower-load or transition phases.

Theme 8: Recovery–Adaptation Coupling

Nutritional Strategies for Recovery-Adaptation Coupling After Exercise: From Muscle Damage to Performance Remodeling. (2026). PubMed-indexed narrative review. Verify the final bibliographic record before submission.

This perspective is especially useful for team sports. If every training session is treated only as a problem of eliminating fatigue, the nutritional strategy may become overly recovery-focused. Conversely, deliberately creating low availability at inappropriate times may reduce the quality of the next training stimulus. The objective is to balance immediate readiness with longer-term adaptation.

Theme 9: Individualised and Personalised Nutrition

No single nutritional strategy can be universally applied to every athlete. Current consensus evidence supports individualisation according to sport, training phase, competitive schedule and personal context. (Mielgo-Ayuso *et al*., 2025) [2]

Individualisation may consider sex, age, body mass, position, training status, dietary preferences, gastrointestinal tolerance, cultural food patterns, access to food and previous nutrition experience. Thus, two players in the same team may require different practical strategies even when they complete the same training session.

Theme 10: Digital Monitoring and Future Directions

Wearables, digital food logs, training-load dashboards and athlete-monitoring systems create the possibility of integrating training and nutrition information. However, technology should support—not replace—professional judgement. The 2025 elite-athlete consensus identifies wearable sensors and multi-omics as promising emerging technologies but emphasises the need for further validation. (Bangsbo *et al*., 2025) [3]

Future systems may calculate training demand and recommend context-specific nutrition, but such tools must account for uncertainty, individual differences and the risks of excessive monitoring or restrictive eating.

Proposed FUEL–RECOVER–ADAPT Framework

Based on the thematic synthesis, a practical conceptual framework can be proposed:

FUEL → TRAIN → RECOVER → ADAPT → RE-FUEL

Stage	Core question	Practical emphasis
FUEL	What work is required?	Energy and carbohydrate availability matched to session demand
TRAIN	What is the training stimulus?	High/medium/low load, technical or competition focus
RECOVER	What must be restored?	Carbohydrate, protein, fluids, sleep and practical recovery
ADAPT	What longer-term response is desired?	Muscle remodelling, fitness, body composition and resilience
RE-FUEL	What comes next?	Adjust the next meal/day according to the upcoming workload

The model is conceptual rather than a validated clinical tool. Its value lies in providing a simple structure through which coaches, athletes and nutrition professionals can discuss the relationship between training demand and nutritional decisions.

Discussion

The literature supports a shift from static nutrition prescriptions toward dynamic nutritional periodization. The most contemporary interpretation is not that athletes should continuously manipulate nutrients, but that nutrition should be deliberately responsive to the purpose and demand of training.

For team-sport athletes, carbohydrate appears to be the most immediately relevant nutrient for high-intensity performance, while protein supports tissue remodelling and recovery. Energy availability provides the health foundation within which both strategies must operate. The interaction among these components is more important than any isolated nutrient target.

The review also indicates that evidence is stronger for some practical strategies than for others. High carbohydrate availability around demanding exercise has a comparatively consistent performance rationale, whereas some low-carbohydrate or 'train low' strategies have stronger mechanistic than performance evidence. □cite□turn0search7□turn0search9□

Another important issue is the difference between evidence and practice. A strategy can be physiologically interesting but difficult to implement in a university environment where athletes may have limited budgets, hostel food, academic commitments and inconsistent access to sports nutrition professionals. Therefore, practical feasibility should be considered an important part of nutritional periodization.

Nutritional Strategies for Recovery-Adaptation Coupling After Exercise: From Muscle Damage to Performance Remodeling. (2026). PubMed-indexed narrative review. Verify the final bibliographic record before submission.

Practical Implications for Team-Sport Athletes

- Classify the training week into high-, moderate-, low-load, match and recovery days.
- Prioritise carbohydrate availability before and after demanding sessions and matches.
- Maintain adequate daily protein and distribute protein-containing meals across the day.
- Avoid unnecessary chronic energy restriction and monitor for low-energy-availability risk.
- Use hydration and recovery nutrition as part of the planned training cycle.
- Individualise nutrition according to sport, position, body size, training phase and personal context.
- During congested competition, prioritise rapid and practical recovery between events.
- Use digital monitoring only as a support system and verify important recommendations with qualified professionals.

Research Gaps

- More longitudinal studies are needed to examine nutritional periodization across complete competitive seasons.
- Team-sport research should examine day-to-day nutrition–training alignment rather than only average dietary intake.
- Evidence for low-carbohydrate availability strategies requires clearer sport-specific performance outcomes.
- Female athletes and university-level populations remain comparatively underrepresented in parts of the literature.
- Emerging digital and wearable systems require validation before being used to make individual nutrition decisions.
- Future research should integrate training load, nutrition, sleep, recovery and performance within the same framework.

Conclusion

Nutritional periodization in team-sport athletes is best understood as a dynamic process of matching nutrition with training demand, recovery requirements and adaptation goals. Contemporary evidence supports high carbohydrate availability when high-intensity performance is required, adequate protein for tissue remodelling, sufficient energy availability for health, and individualised strategies based on sport and training phase. □cite□turn0search0□turn0search7□

The proposed FUEL–RECOVER–ADAPT framework provides a simple conceptual model for integrating nutrition with training periodization. Rather than treating nutrition as a fixed diet chart, the model places nutrition inside the training system and emphasises continual adjustment according to what the athlete has done and what the athlete needs to do next.

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