EC NUTRITION
Review Article

A Review of the Physical Demands, Physiological Profile and the Role of Nutrition in Cricket

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Abstract

Relatively little research has been carried out investigating the role that nutrition may have on the performance, recovery and body composition of cricketers. This review aims to summarize the current knowledge available to investigate the role of nutrition in maximizing performance, optimizing body composition and minimizing the impact of illness and injury in professional cricket and identify areas of further research. Fast bowlers have the greatest workload compared to their counterparts with multi-day cricket being the most demanding of the formats. The optimum body composition of cricketers is unknown with little epidemiology relating to the anthropology of cricketers existing in the current literature. Cricketers have an increased injury risk with stress fractures being the most time costly injury and hamstring injuries the most common. Cricket is often played in hot environments, however a paucity of literature exists investigating the impact on performance. More research is required across all of aspects of nutrition, physiology and anthropology to determine the impact they may have on cricket performance and injury prevention.

Keywords: *Team Sport; Male and Female Athletes; Injury; Nutrition; Ergogenic Aids*

Background

The modern game of cricket is played both competitively and recreationally in both hemispheres, with varied match formats, differing specialist positions and different environments of play requiring players to adapt to varying physiological pressure [1] (Table 1). This diversity presents multifactorial challenges for players, coaches and practitioners such as physiotherapists, doctors, nutritionists and strength and conditioning coaches. These challenges include international travel, performance in hot environments and prolonged playing schedules.

Format	Innings duration	Match duration	Match start times (UK)
Multi-day	2 innings per team, unlimited overs per innings	3-5 days	11.00 am
One Day	1 innings per team, 50 overs per innings	Approx. 6 hours	10.30 am
			2.30 pm (Day night fixture)
Twenty-Twenty (T20)	1 innings per team, 20 overs per innings	Approx. 3 hours	7.00 pm

Playing Position	Description
Batsmen	Scores runs of the balls bowled by the bowler.
Bowlers	Bowls and attempts to get the batsmen dismissed. (Bowlers are classed as either spin or pace bowlers).
Wicket Keeper	Positioned behind the stumps to assist the bowler's attempts to dismiss the batsmen.
Fielder	Players who assist the bowler and prevent the batsmen from scoring runs.

Table 1: *Summary of the various forms and playing positions in modern day cricket.*

It is commonly accepted that athletes need to consume adequate energy during periods of high-intensity and/or long-duration training to maintain body weight and health and maximize training effect [2]. However, there is a paucity of scientific studies that investigate the impact of nutrition and the impact it may have on cricket performance. This review aims to summarize the current knowledge available to investigate the role of nutrition in maximizing performance, optimizing body composition and minimizing the impact of illness and injury in professional cricket and identify areas of further research.

Physical demands of cricket

Cricket, is a prolonged, variable-intensity team sport [3]. Research has investigated the physiological demands of position specific cricket match play (Summarized in table 2).

Publication	N	Mean age (yrs)	Study aims	Summary of key findings
Peterson., *et al.* (2011)	42 Male professional	22.1 ± 2.8	To quantify the physiological demands of selected cricket training activities and compare these to known match demands.	• Conditioning drills twice as long in duration as skills drills. • HR and lactate levels higher in conditioning drills vs. skills drills. • Training replicates or exceeds match demands.
Peterson., *et al.* (2011)	Male Elite = 12 Male State = 42	Elite, 29.8 ± 3.6 State, 27.1 ± 3.3	To quantify differences between formats and playing level in the movement patterns of international- and state-level cricketers.	• Cricketers generally cover similar distance in both formats. • Test fielders cover greater distances at higher intensity.
Peterson., *et al.* (2009)	42 Male professional	22.1 ± 2.8	To quantify the movement patterns undertaken by players in different positions and formats of cricket.	• Fast bowlers have the greatest workload of any position. • More sprinting in 1 day and T20 vs. multiday cricket. • Multiday has greater overall physical load.
Duffield., *et al.* 2008	6 Male professional	23 ± 3	To investigate the relationship between physiological and performance responses during repeated 6-over fast bowling spells.	• Minimal performance decrement in well trained fast bowlers. • Faster bowlers had faster final 5m run-up speeds.
Johnstone., *et al.* (2007)	15 Male professional	25.0 ± 5.0	To highlight the anthropometric and physiologic profile of a professional cricket team and identify differences between on-field playing positions, before the start of a competitive first class season.	• Elite cricketers have superior fitness parameters than the general population. • Fitness parameters comparable with other professional athletes. • Fitness differences exist between playing positions.
Christie., *et al.* 2007	10 Male professional	22.0	Assess selected physiological responses of batsmen during simulated high intensity batting work bout.	• 1^{st} over carried a lower energy cost than remaining 6 overs. • HR increased significantly during 1^{st} 3 overs. • Mean energy expenditure = 2536kjh-1 during work bout.
Noakes., *et al.* (2000)	N/A	N/A	A review of the physiological requirements of cricket.	• Elite cricketers have fitness parameters comparable with professional rugby players.

Table 2: *Summary of studies investigating the physical demands of cricket.*

Elite cricketers participate in a mixture of one-day and multiday games at either domestic or national level during a long competitive season [3].

For all on-field positions, especially fast bowlers, the repetitive high-intensity acceleration-deceleration element can lead to cricket-specific fatigue due to altered muscle action in players [3].

Bowling

Fast bowlers are generally accepted to have the greatest physical demands [3]. During 20 over cricket (T20), fast bowlers can reach peak heart rates of 181 beats per minute (bpm) and 191 bpm during high intensity conditioning sessions. In addition, fast bowlers can cover up to 5.5 ± 0.4 km during a T20 innings and 22.6 ± 2.1 km during a full days play of multi-day cricket. Fast bowlers record the most sprints per hour than any other position across all game formats in contrast to spin bowlers who cover distances of up to 3.3 km and complete less than 100 sprints per hour in both one day and T20 cricket [4].

Batting

A batsmen's workload is directly associated to the time spent at the crease. In theory, batsmen could bat for an entire innings and cover up to 13.0, 8.7, and 3.5 km in multi-day (6h), one day, and T20 cricket respectively [4].

The average energy expenditure during one day cricket is approximately 2536 kilojoules per hour (KJ/h) [5], with the average energy expenditure of a batsmen playing multiday cricket being 650 KJ/h [6].

Furthermore, heavy anaerobic work performed by batsmen during the sprinting of singles, was shown by Christie., *et al.* who evaluated the respiratory exchange ratio (RER) (CO_2 eliminated vs O_2 consumed; an indicator of what fuel is supplying the body with energy (carbohydrate or fat). The RER increased to > 1.00 from the second over onwards suggesting carbohydrate was the preferred energy source in this instance [5].

Wicket keeping and fielding

Wicket keepers cover more distance per day in multi-day cricket (16.6 km) compared to one-day cricket (9.5 km) and T20 (3.3 km), however a greater proportion of the total distance covered in the shorter match formats is performed at higher intensity compared to multiday cricket [4].

Nutrition and body composition

At present, there is little evidence to determine what the optimal body morphology and composition should be for an elite cricketer (Table 3). It has been shown that batsmen tend to be smaller and lighter than their bowling counterparts [5,7,8], but data suggests they have a similar body composition with both batsmen and bowlers averaging approximately 12-14% body fat [7,8]. There is less data relating to the body morphology of female cricketers. One study showed that that female fast bowlers where more endomorphic and less monomorphic, have more subcutaneous adipose tissue and less skeletal muscle than their male counterparts [9]. However, the optimum body composition for all the various playing positions across both the male and female game is currently unknown.

Study	Subjects	Method of assessment	Findings
Koley., *et al*. 2012	N = 271 Male amateur cricketers	Skinfold Calipers Sum of 7	Mean skinfold (mm) = 115.31 Range 103.52 - 126.15
Koley., *et al*. 2012	N = 56 Female amateur cricketers	Skinfold Calipers Sum of 5	Mean skinfold (mm) = 90.65 Range 80.67 - 100.64
Micklesfield., *et al*. 2011	N = 34 Male elite cricketers	DEXA	Whole Body Fast Mass (%) = 15.7 ± 4.9
Johnstone and Ford 2010	N = 15 Male elite cricketers	Skinfold calipers Sum of 7	Mean skinfold sum of 7 (mm) = 69.7 ± 0.9
Stuelcken M., *et al*. 2007	N = 26 Male elite cricketers	Skinfold calipers Sum of 7	*Males* - mean skinfold sum of 7 (mm) = 62.3 ± 18.2
	N = 26 Female elite cricketers	Skinfold Calipers Sum of 8	*Females* - mean sum of 7 (mm) = 98.1 ± 21.7
Grobbelaar, 2003	N = 27 Male amateur males		Mean skinfold sum of 8 (mm) = 71.5 ± 19.10

Table 3: *Summary of studies investigating the body composition of cricketers.*

Nutrition and the impact on performance

Nutrition is the process in which macro and micronutrients, fluid and electrolytes are metabolized by the body for health, performance, growth and repair. Although the macro and micronutrient of elite cricketers are relatively unexplored, it is commonly accepted that athletes need to consume adequate energy during periods of high-intensity and/or long-duration training to maintain body weight, health and maximize training efficacy. There is a paucity of research exploring the role of macro and micronutrients on cricket performance and recovery. This may leave practitioners, players and coaches alike in a vulnerable position when giving evidence-based information on nutrition.

Macro and micronutrients

One sport that elicits similar performance traits to cricket, such as batting, pitching, run scoring and fielding, is baseball. A recent study explored the intentions of college baseball players to eat a healthy diet [10]. They found that an athletes' daily schedule and their perception of the impact of a healthy diet on their focus and concentration had the biggest impact on intention to eat healthful food.

In relation, a further investigation found that male athletes aged between 14 - 19 years old who participate in skill based team sports consumed carbohydrate and protein intake in closer proximity to current recommendations than that of the females. The most common shortfall was carbohydrate intake during exercise. Only 18% of male and 29% of female athletes metabolised 30 - 60g carbohydrate per hour during practice and/or competition [11]. An intake of 30 - 60g of carbohydrate per hour has been previously recommended to spare glycogen depletion during heavy exercise [12], although this guideline should be adapted to the needs of the individual and their sport. However, given that the ideal diet in cricket is unknown, consideration must be given to the relevancy of these findings along with the current dietary recommendations for athlete's participating skill-based sports such as cricket.

Fluid and electrolytes

Cricket is traditionally played during the summer and players may compete for up to six hours in hot conditions over repeated days [13], wearing uniforms considered less than appropriate for effective sweat evaporation [14]. Research has shown that mean pulse rate and core temperature increases when athletes complete periods of exercise at 30% VO_2 max in hot conditions whilst wearing long sleeve 100% polyester clothing, similar to those worn during test match cricket [14]. These factors may impact on the hydration status of cricketers (Summarized in table 4).

Publication	Participants	Hydration Status Assessment Protocol	Exercise Protocol	Summary of findings
Soo., *et al.* 2007	18 female Elite, cricketers	• Body mass before and after each innings was recorded to estimate sweat rate, sweat loss, and percentage body-mass loss. • Fluid intakes determined by measuring the drink-bottle weight before and after fluid consumption or by determining drink weight minus cup weight. • Morning hydration status assessed via urine specific gravity measurement.	• Data was collected across 4 consecutive match days during an international cricket competition.	• Sweat rates were comparable to other female team sports but less than results from male cricket players. • No significant change in pre and post 2hr body mass • Significant change in body mass between active and less active players were significant ($P < 0.05$). • No significant change in sweat rates between batters, bowlers and fielders ($P > 0.05$). • Significant change in sweat rates between active and less active players ($P < 0.05$). • USG values did not vary across tournament days.

Devlin., *et al.* 2001	7 male (bowlers) Amateur, cricketers	• Fluid loss was determined via body mass measurements pre and post-trial. • Pre-trial hydration status was determined via blood sample, to assess haemoglobin concentration.	• Simulated bowling test (36 deliveries; PREBOWL) in a thermoneutral (16-+2°C) environment. • Followed by ~1 hr of intermittent exercise in a heated environment (28_+2°C). • A further thermoneutral-bowling test (36 deliveries; POSTBOWL). • During one trial fluid intake was restricted (HYPO). • During the other trial, subjects were forced to drink to maintain euhydration (EUH). • Bowlers provided with a fixed target on a cricket pitch and the line, length, and velocity of each delivery was determined.	• Dehydration significantly impaired bowling accuracy for line (16.4%) and length 15.4%) (P < 0.01). • A combination of both line and length indicate that dehydration significantly impaired bowling accuracy compared to euhydration (P<0.05). • Dehydration had no effect on bowling velocity.
Gore., *et al.* 1993	20 male (8 batsmen, 12 bowlers) Elite, cricketers	• Sweat rate, urinary volume, osmolality, electrolyte concentration and pH measured.	• Data collated over 3 days across 3 cricket seasons. • Subjects assessed under cool, warm and hot conditions. • Simulated match conditions were used on the cold and warm days. • The hot day was measured during competition.	• Sweat rates during cool, warm and hot days were significantly different (P < 0.05). • Fluid consumed was significantly different between the cool and warm days (P < 0.05) and hot, warms and cool days (P < 0.05). • Urine osmolality was higher on the warm day vs. cool day (P < 0.001). • Fast bowlers recorded a - 4.3 ± 0.7 % reduction in body mass from initial weight loss.

Table 4: *Summary of studies investigating hydration in cricket.*

The most recent of these studies considered the hydration profile of 18 elite female cricket players (mean age 22.3 ± 6.7 years) during competition. The dual objectives were to advance the understanding of fluid losses in cricket sessions across a tournament, and to assess the hydration knowledge and practices of female cricket players by monitoring status and use of a hydration habits questionnaire [13]. Hydration was determined by calculating mean sweat rate, fluid intake rate and percentage change in body mass. Comparisons were also made between groups and categorized according to level of activity during each inning. The results indicated that the sweat rates between batters, bowlers and fielders were not statistically significant. However, they found a significantly higher sweat rate in players who were more active across each game day innings. No differences were observed in the morning body-mass measurements of participants across tournament days, and only three players showed a bodyweight decrease greater than 2% (1 batter on 2 occasions, 1 wicket keeper on 1 occasion). However, cricketers that completed more physical activity recorded a greater total body mass loss during competition, in comparison to those who were less active (P = 0.05). The findings of this observational study suggest that female cricketers successfully limit their fluid losses within a range that may not compromise physical or cognitive performance.

A further study investigated the effects of dehydration during cricket [15]. The study evaluated sweat rate, urinary volume, urine osmolality, urine electrolyte concentration and urine pH of first class cricketers on cool, warm and hot days (batsman, n = 8, bowlers, n = 12). They found that fast bowlers demonstrated higher sweats rates in comparison to those reported in other sports. This could be due to the impact of cricket specific clothing on sweat rates.

A secondary aim of this study was to determine if the current playing rules of cricket provide sufficient opportunities for players to adequately hydrate to sustain optimum performance. After seven hours of play, a - 0.3 ± 0.2% of initial body mass was lost on the cool day, and - 1.2 ± 0.2% of initial body mass was lost on the warm day. This suggests that there is no requirement for extra drinks breaks when cricket is performed in similar environmental conditions. In contrast, the fast bowlers recorded a mean body mass loss of - 4.3 ± 0.7% on the hot day, suggesting an in sufficient amount of fluid was consumed for euhydration. Sweat losses as high as 4% of body should mass be avoided as this may impair cognitive function result in decreased performance [16].

The evidence related to the performance impact of hydration in cricket is limited. However, a study of considerable interest evaluated the effect of moderate levels of exercise-induced dehydration on cricket bowling accuracy and bowling velocity in sub-elite, medium-fast bowlers (n = 7, mean age 21 ± 1 years, Body Mass 89 ± 13 kg). The study found a significant difference in bowling accuracy for those who performed in a dehydrated state, however there was no correlation between the magnitude of dehydration and bowling speed [17].

The authors concluded that moderate (-2.8% of Body Mass) exercise-induced hypohydration has minimal effect on maximal bowling velocity, but there is a detrimental effect on skilled motor performance in well-trained subjects. Previous literature indicates that dehydration (< 2% body mass) may impair mental/cognitive performance [16]. This could be an important consideration for cricketers who strive to maintain a consistently high level of skill execution, particularly during competition in hot environments where sweat rates may be higher than normally observed in cooler conditions. This was the first study that attempted to establish a performance link between hydration and cricket performance, and further research is required to investigate the impact of hydration status on cricket skill execution.

Measuring the hydration status of cricketers

There are several methods of assessing the hydration status of an individual, including isotope dilution, urine specific gravity (USG), urine color, bio-electrical impedance, thirst, changes in body mass, blood serum and urine osmolality. Of these methods, USG, urine osmolality, urine color and body mass changes are considered to be the most practical field based measures of acute hydration status.

In consideration of this, given the volume of travel that modern day cricket teams must undertake both domestically and internationally, the requirement for easy to use, practical and reliable methods to assess hydration status is important.

Urine osmolality, a measure of total urine solute content, is affected by all dissolved particles in a known sample [18]. It is a practical field based measure of moment in time hydration status. A recent study of elite male cricketers during a training camp in the sub-continent, found that self-assessment of hydration can feasibly be carried out 30 minutes before exercise by using urine osmolality as an assessment method [19]. The decline compared to baseline in pre-exercise urine osmolality by day five, suggests self-directed management of hydration contributed to improved fluid intake over a prolonged period. However, the ease of use and apparent efficacy of the regimen requires further evaluation at competition level. A further study evaluated the day-to-day use of urine osmolality on the hydration status of athletes who trained in a hot environment [20]. They found that hydration status during competition or training in a warm environment can be effectively monitored by measuring urine osmolality [18]. Although these studies endorse the practically of the urine osmolality as method of hydration analysis, the validity and reliability is still to be determined.

Performance in extreme conditions: Cricketers are often required to compete in hot and humid environments [21] such as the severe environmental conditions in Africa, Australia and India. Exercise in the heat poses a challenge to the body's ability to regulate its core temperature, due to the high rates of metabolic heat production, and heat gain by physical transfer from the environment [22]. The optimum temperature for endurance performance, in a laboratory setting, is approximately 11°C [23], with the heat induced reduction in performance being related to the progressive dehydration that results from sweat losses, with negative consequences for cardiovascular capacity and thermoregulatory function [24]. As previously discussed, moderate dehydration can impair fast bowling accuracy [17], thus the potential impact of hydration status and cognitive performance in cricket may be of relevance. It has been established that hypohydration affects subjective feelings in healthy adults participating in a non - exercise protocol. It was found that when dehydrated to 2.7% of body mass, subjects demonstrated exaggerated feelings of thirst, reduced perception of alertness and impaired ability to concentrate [25]. There are a lack of studies that have recorded the physiological response of cricketers when performing in hot conditions. However, one study evaluated the heart rate of fast bowlers and batsmen in varying temperatures including 22°C (cool day), 30°C (warm day) and 38°C (hot day) [15]. Fast bowlers recorded peak hearts rates of 198 ± 3 bpm on both cool and warms days with batsmen recording heart rates of 194 ± 3 bpm and 191 ± 3 bpm on the cool and warm days respectively. nificant levels.

A more recent study assigned six male club cricketers into a heat acclimation chamber and completed four high intensity cycle ergometer (30 - 45 minutes) acclimation sessions on consecutive days at approximately 30°C, vs. a control group at 20°C. They found that the group exercising at 30°C showed a moderate decrease in heart rate, and moderate to large reductions in electrolyte concentrations, with trivial changes in core and skin temperatures and sweat rate. After the intervention, both groups perceived they were more comfortable exercising in warmer conditions [21]. Given that cricket is often played in uncomfortable conditions, this protocol may help the player's preparation in advance of competition in similar environmental conditions. However, it is not clear how the cycling protocol will relate to cricket specific activity over periods greater than 45 minutes.

Playing cricket in hot conditions can accelerate the sweat rate and increase the possibility of dehydration, [15], thus an area of concern is the potential negative effect on a cricketer's skill output. As previously discussed, moderate dehydration can impair fast bowling [17] and there is growing evidence that via an effect on the central nervous system, high ambient temperature and dehydration can alter cognitive performance. Recent evidence suggests that the integrity of the blood brain barrier may be compromised by combined heat stress and dehydration, and this may play a role in limiting performance in the heat [26]. This research has found that acute heat exposure and dehydration increase the permeability of the blood brain barrier, with increased blood serum concentrations of the calcium binding protein, S100beta, recorded in dehydrated subjects excising in hot conditions. *In vivo* studies of 23 male Long-Evans rats suggest that brain temperature per se is an important factor in regulating blood-brain barrier permeability, alterations in brain water homeostasis, and subsequent structural abnormalities of brain cells [27]. Given the high skill competent of cricket, more insight into this will be an important area of research.

Dietary supplements and ergogenic aids

Although the use of dietary supplements and nutritional ergogenic aids are highly prevalent in sport, the fact remains that very few improve performance [2]. However, the use of sports foods, such as protein powders, energy bars and meal replacement products may be a practical option and support a cricketer's diet, particularly during competition in the sub-continent when food quality and variety may be limited. Alongside these, the use of sports drinks that provide carbohydrate for energy and electrolytes to aid hydration may be beneficial during long periods of play, particularly when performing in hot environments.

Creatine

Creatine can aid in the rapid rephosphorylation of adenosine diphosphate (ADP) to adenosine triphosphate (ATP), by the creatine kinase reaction during high-intensity exercise, especially if the bouts of intense activity are repeated with short rest periods between them [28]. No studies to date have involved cricketers in the research, however, the large volume of high intensity sprints exerted during fast bowling, run scoring and fielding in addition to periods of strength and conditioning work, could provide rationale for the use of creatine as an ergogenic aid to promote recovery and adaptation to training.

Caffeine

The effects of caffeine in reducing fatigue and increasing wakefulness and alertness have been recognized for many centuries [29]. These properties have been targeted by shift workers, long-haul truck drivers, members of the military forces, athletes, and other populations who need to fight fatigue or prolong their capacity to undertake their occupational activities [29].

The potential ergogenic effects of caffeine may be more closely related to its role as a central nervous system stimulant and the associated decreased perception of effort [30,31]. Although no cricket specific research is available, the effect of caffeine with other team sports has been investigated. A study using probability statistics found that rugby union players ingesting 6 mg/kg recorded a possible improvement in sprint performance [32]. In addition, a study of tennis players found that caffeine ingestion of 3 mg/kg improved forehand stroke during 90 minutes of simulated tennis activity [33]. Given that cricket is primarily a skill-based sport, further investigation into dietary and ergogenic interventions that may improve cognitive performance, alterness and decision-making may be desirable.

Nutrition and impact on injury and exercise recovery

Injury surveillance has been an integral part of elite adult men's cricket for several seasons [34]. In more recent years, there has been an expansion in the newest form of the game, Twenty20 cricket, with an associated increase in prevalence of injury with the increased burden of play. Thigh and hamstring strains were recorded as the most common injury [35] and spinal injuries constituted approximately 7% of cricket related injury, with fast bowler's being most prone to this particular type of damage [36].

Minimizing the impact injury and injury prevention

The ability to minimize the impact of injury alongside measures to prevent injury from occurring is a key determinant of success for cricket teams and players. In accordance with this, player workloads have been investigated to help reduce injury risk. For fast bowlers, a total bowling match workload of > 50 overs in a first class match is associated with a 1.8 times increased risk of bowling injury over the subsequent 21 days [37].

Therefore implementation of nutritional strategies to reduce the prevalence and severity of these injuries are important. Unpublished data has shown that stress fractures carry the biggest time cost of all the injuries sustained whilst playing cricket. In consideration of this issue, the impact that nutrition may have on bone health is of interest, particularly the vitamin D status of cricketers. Although there is no consensus on optimal serum levels of 25-hydroxyvitamin D3 for the athletic population, vitamin D deficiency is defined as a total 25-hydroxyvitamin D level of less than 20 ng/mL. Vitamin D inadequacy is defined as a level of 20 to 31 ng/mL, and a level of 32 ng/mL or greater is indicative of sufficient levels [38].

A recent study examined vitamin D levels from 89 players on a single National Football League team and found that 30% of the players were deficient while 51% had insufficient levels. The players with muscle injuries were found to have significantly lower vitamin D levels than uninjured players [39].

When serum vitamin D levels fall below 30 ng/mL, parathyroid hormone levels are increased, which triggers an increase in osteoclastic activity in bone [40]. This osteoclastic activity in bone leads to increased bone breakdown, which may have an impact on athletes who are at an increased risk for stress fractures due to activity levels [38]. Research has shown that calcium and vitamin D supplementation can significantly decrease the incidence of stress fractures among female military recruits [41], although how this extrapolates to cricket is yet to be determined.

Bone is a highly metabolically active tissue, which is influenced by both aerobic [42] and resistance type exercise [43], both of which will be performed by cricketers either in training or competition. It appears that markers of bone resorption, such as C-terminal telopeptide region of collagen type 1 (CTX), are affected by exercise to a greater extent than bone formation [42]. Intake of nutrients around training can have an effect on the bone metabolic response to the exercise bout. Exercising in a fasted state leads to a small, but significantly increase in markers of bone resorption (CTX) compared to exercising in a non-fasted state [44]. The impact of bone health on injury prevention will be an important area future research in cricket. Furthermore, annual screening of a cricketer's vitamin D status may help identify those at increased risk of born stress related injury and provide practitioners with a rationale for subsequent interventions.

Exercise recovery

As elite level cricketers are required to perform over a multi-day period, the need for adequate post exercise nutrition is an important consideration. Several studies have investigated exercise performance following post exercise recovery nutrition. Studies have shown that a positive muscle protein balance is needed to facilitate the repair of exercise-induced muscle damage and allow the skeletal muscle's adaptive response to exercise [45]. Furthermore, it has been shown that the ingestion of carbohydrate and protein post exercise can positively affect an athlete's ability to recover optimally [46]. However, it may be less important for athletes who rest one or more days between exercise or competition to optimize macronutrient intake immediately, provided sufficient carbohydrates are consumed during the subsequent 24-h period [47].

There is emerging evidence that ingestion of tart cherries may help prevent symptoms of muscle damage. Consumption of 45/day has been shown to reduce circulating concentrations of inflammatory markers in healthy men and women. After 28 days, concentrations of the inflammatory markers; C-reactive protein (CRP) and Regulated Upon Activation, Normal T-cell Expressed and Secreted (RANTES) decreased by 25% and 18% [48,49]. Considering the natural anti-inflammatory and antioxidant capacity of tart cherries, it is plausible that cherry consumption before and after eccentric exercise may have a protective effect against injury [50].

Conclusion and Future Research

Cricket is a complex sport, and the variety of game formats, prolonged playing schedule and diverse playing conditions present multi-faceted challenges for players, coaches and support staff. The current research investigating the link between nutrition and performance, injury rehabilitation/prevention and recovery is relatively unexplored in the literature. Further research is required across the majority of areas of nutrition for cricket, including:

- What are physical characteristics of elite level cricketers and does body composition or individual somatotype have an impact on cricket performance?
- How does the culture of cricket influence dietary behaviors and what impact does that have on cricket performance and recov ery?
- What nutritional interventions can be administered to help minimize the impact of illness and injury sustained in cricket?
- What dietary interventions can improve skill execution, cognitive performance and decision-making during cricket?

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