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# SPRINTING. . . Dietary Approaches to Optimize Training Adaptation and Performance

**Gary J. Slater**
University of the Sunshine Coast

**Jennifer Sygo**
Athletics Canada

**Majke Jorgensen**
Team Danmark

Although sprint athletes are assumed to primarily be interested in promoting muscle hypertrophy, it is the ability to generate explosive muscle power, optimization of power-to-weight ratio, and enhancement of anaerobic energy generation that are key outcomes of sprint training. This reflects the physique of track sprinters, being characterized as ecto-mesomorphs. Although there is little contemporary data on sprinters dietary habits, given their moderate energy requirements relative to body mass, a carbohydrate intake within the range of 3–6 $g{\cdot}kg^{-1}{\cdot}day^{-1}$ appears reasonable, while ensuring carbohydrate availability is optimized around training. Similarly, although protein needs may be twice general population recommendations, sprint athletes should consume meals containing ~0.4 g/kg high biological value protein (i.e., easily digested, rich in essential amino acids) every 3–5 hr. Despite the short duration of competitions and relative long-recovery periods between races, nutrition still plays an important role in sprint performance. As energy expenditure moderates during competition, so too should intake of energy and macronutrients to prevent unwanted weight gain. Further adjustments in macronutrient intake may be warranted among athletes contemplating optimization of power-to-weight ratio through reductions in body fat prior to the competitive season. Other novel acute methods of weight loss have also been proposed to enhance power-to-weight ratio, but their implementation should only be considered under professional guidance. Given the metabolic demands of sprinting, a few supplements may be of benefit to athletes in training and/or competition. Their use in competition should be preceded with trialing in training to confirm tolerance and perceived ergogenic potential.

***Keywords**:* athletics, nutrition, power-to-weight, anaerobic metabolism

Sprint performance, or the ability to generate maximal velocities, is important to competitive success across a range of sports including athletics events and team sports. The latter are characterized by repeated high-intensity sprints. By contrast, the track sprinter is concerned only with generating maximum velocity and with limiting the loss of this as the sprint progresses. The sprints contested at the summer Olympic Games and International Amateur Athletics Federation sanctioned events include the 100-, 200-, and 400-m sprints, 4 × 100-, 4 × 400-m relay (male, female, and mixed gender), and the 100 (female)-/110 (male)- and 400-m hurdles.

This article is intended to serve as an update from the previous International Amateur Athletics Federation consensus on the role of nutrition in elite sprint performance (Tipton et al., 2007). When possible, emphasis is placed on research published since the previous consensus, and reference is made to other articles published in this series to reduce redundancy.

Slater is with the School of Health and Sport Sciences, University of the Sunshine Coast, Sippy Downs, Queensland, Australia. Sygo is with Athletics Canada, Ottawa, Ontario, Canada. Jorgensen is with Danish Elite Sport Institution, Team Danmark, Copenhagen, Denmark. Slater (gslater@usc.edu.au) is corresponding author.

## Determinants of Sprint Performance

Sprint performance is determined primarily by reaction time, acceleration, maximum running velocity, and the ability to sustain this in the presence of increasing fatigue (Ross et al., 2001). A sprint event can be broken down into five interlinked components, including the reaction–response, block clearance, running acceleration, maximum velocity, and decreasing velocity, with the acceleration component contributing approximately two thirds of a race (Watts et al., 2012). During the longer 400-m sprint, running acceleration peaks during the first 100–150 m, followed by a significantly longer decreasing velocity that is accentuated toward the finish of the race (Saraslanidis et al., 2011).

Having an appreciation of training and competition demands offers insight into optimum nutrition support for sprinters. Elite sprinters typically train for 1.5–4 hr/day, 5–6 days/week, with one or two of these days focused on low-intensity regenerative work. Training is typically periodized to develop maximum power of the major muscle groups using a range of modalities including sprinting but also plyometric exercises, resisted running drills, proprioceptive training, plus core stability, power, and Olympic lifts. This reflects the fact that maximal running speed is limited not by the capacity to move limbs quickly but rather by the capacity to produce the greatest ground force with the shortest ground contact time (Weyand et al., 2010). Sprint-specific training typically involves brief maximum intensity repetitions of varying length (both below and above competition distance), with either long- or short-recovery periods. This style of training enhances traits important to athletic development and is common among explosive athletics disciplines.

The structure of the training day may include sprint/track training followed by resistance training, plus ancillary activities such as massage or soft-tissue treatment, travel time to and from the training facility, as well as academic, professional, or personal commitments. This schedule can have an important impact on meal timing and access to food to support pretraining fuelling and recovery and should be considered when developing a sprinter's nutrition plan.

Sprint-training adaptations can be separated into several distinct outcomes, including neural and metabolic (Dawson et al., 1998), as well as physique changes (Watts et al., 2012). Although adaptations are dependent on the specific training intervention applied, sprint training appears to induce favorable enzymatic adaptations across all three energy systems, resulting in faster rates of phosphocreatine breakdown and greater glycolytic and mitochondrial enzyme activity (Ross & Leveritt, 2001).

Intense sprint exercise results in rapid increases in energy turnover from both aerobic and anaerobic metabolism. Having an appreciation of energy system contribution influences training prescription and directing nutrition guidelines for both training and competition. The relative energy system contribution varies between events, with the anaerobic energy system dominant across all distances. Anaerobic glycolysis is a dominant energy system, as is reflected in the high-lactate production, especially during the 400 m (Duffield et al., 2005). This ability to rapidly supply adenosine triphosphate through anaerobic sources correlates with performance in the sprint events. The relative aerobic contribution becomes more important as the distance increases (Table 1), with approximately 40% of energy derived from the aerobic metabolism in the 400 m in national caliber males and slightly higher in female athletes in season, although aerobic metabolism dominates after approximately 30 s (Spencer & Gastin, 2001).

The ability to generate explosive muscle power and strength is critical to success in sprint events (Cunningham et al., 2013). Given the desire to enhance power-generating capacity, it is often assumed sprint athletes are primarily interested in promoting muscle hypertrophy. Although athletes may periodically attempt to promote skeletal muscle hypertrophy, key nutritional issues are broader than those pertinent to hypertrophy alone. These include the strategic timing of nutrient intake to maximize fuelling and recovery objectives, plus the enhancement of power-to-weight ratio, achieved through skeletal muscle hypertrophy and/or maintaining low body fat levels (Huovinen et al., 2015).

The source of fatigue during sprint training is likely multifactorial (Green, 1997), including neuromuscular and peripheral metabolic factors such as a decline in intramuscular pH. The latter is somewhat dependent on the intensity and volume of training undertaken and the time point within a training session. Metabolic fatigue during the earlier part of a workout may be due in part to reductions in phosphagen energy system stores and mild acidosis, while subsequent fatigue may result more from acidosis and impaired energy production from glycogenolysis (Green, 1997). Interestingly, although multiple repeat sprints can have a significant impact on glycogen stores, data from cyclists suggests that low glycogen does not seem to impair single sprint performance (Hargreaves et al., 1997). Taken together, this provides potential opportunities for nutritional interventions that could impact on training and performance, including buffering against acidosis for longer sprints (i.e., 400 m) and optimization of the phosphagen energy systems for shorter sprints (i.e., 100-, 200-m races).

## Physique and Body Composition Periodization

Despite a long history of sprinting in the Olympic Games, relatively few studies describe the physique of elite sprinters. What is known is that successful sprinters have unique physical traits that predispose them to excellence. Some of these are responsive to training stimuli and/or nutritional interventions, including skeletal muscle fiber type and area (Dowson et al., 1998), fascicle area and length (Abe et al., 2001) plus adiposity (Dowson et al., 1998). However, other architectural features such as stature, toe, foot, and lower leg length are not responsive in the same way (Lee & Piazza, 2009). The available literature clearly reflects an emphasis on the importance for sprinters to maximize skeletal muscle mass to enhance power. However, this may not be appropriate for all sprinters with skeletal muscle hypertrophy possibly resulting in adverse adaptations, including a transition away from fast-twitch glycolytic fibers and slower contraction velocity characteristics (Alway et al., 1988) if inappropriately prescribed. Thus, unless the increase in power proportionally exceeds any associated weight gain, sprint performance is unlikely to be enhanced by an increase in skeletal muscle mass.

Sprinters do tend to be heavier and more muscular than other runners. Early data from athletes participating in the 1960, 1968, and 1976 Olympic Games reported elite sprinters had a somatotype of 1.5–5–3 for males and 2.5–4–3 for females, with both genders characterized as ecto-mesomorphs (Carter, 1984). These ratings are consistent with more contemporary data (Abe et al., 2001) demonstrating that sprinters have higher muscularity and low relative adiposity. Sprinters are not on average the tallest or most ectomorphic of the running disciplines and are reported (Uth, 2005) to have a reasonably wide range for stature (men: 1.68–1.91 m; women: 1.52–1.82 m). However, in the past decade, the stature of successful male sprinters has been biased toward the upper limit or even exceeding this range, with speed records suggested to continue to be dominated by heavier and taller athletes (Charles & Bejan, 2009).

A comprehensive description of the evolution of successful world-class 100-m sprinter mass and stature characteristics is

**Table 1 Relative Contribution of Aerobic and Anaerobic Metabolism to Sprint Performance (Duffield et al., 2005)**

| Event, m | %Aerobic (male) | %Anaerobic (male) | %Aerobic (female) | %Anaerobic (female) |
|---|---|---|---|---|
| 100 | 20.4 ± 7.9 | 79.6 ± 7.9 | 25.0 ± 7.4 | 75.0 ± 7.4 |
| 200 | 28.4 ± 7.9 | 71.6 ± 7.9 | 33.2 ± 8.0 | 66.8 ± 8.0 |
| 400 | 41.3 ± 10.9 | 58.7 ± 10.9 | 44.5 ± 7.6 | 55.5 ± 7.6 |

*Note*. Data are presented as $M \pm SD$.

**Table 2 Body Size and Shape Characteristics of Female World-Class Sprinters Per Decade**

| Decade | *n* | Age (years) | Body mass (kg) | Stature (m) | BMI (kg/m$^2$) | RPI (cm/kg$^{0.333}$) |
|---|---|---|---|---|---|---|
| 1940–1949 | 3 | 28.8 ± 5.0 | 65.3 ± 9.9 | 1.73 ± 0.1 | 21.7 ± 1.4 | 43.2 ± 0.9 |
| 1950–1959 | 2 | 28.5 ± 6.4 | 65.4 ± 2.1 | 1.74 ± 0.02 | 21.4 ± 1.2 | 43.3 ± 1.0 |
| 1960–1969 | 2 | 25.8 ± 4.6 | 58.5 ± 2.1 | 1.75 ± 0.08 | 19.4 ± 1.2 | 45.1 ± 1.6 |
| 1970–1979 | 2 | 23.4 ± 4.1 | 62.0 ± 1.4 | 1.73 ± 0.04 | 20.7 ± 0.5 | 43.8 ± 0.7 |
| 1980–1989 | 71 | 25.0 ± 3.1 | 57.7 ± 3.9 | 1.68 ± 0.05 | 20.4 ± 1.1 | 43.6 ± 1.1 |
| 1990–1999 | 74 | 26.4 ± 4.0 | 59.1 ± 5.2 | 1.69 ± 0.07 | 20.8 ± 1.5 | 43.4 ± 1.3 |
| 2000–2009 | 74 | 26.2 ± 3.9 | 58.7 ± 6.6 | 1.66 ± 0.07 | 21.1 ± 1.4 | 42.9 ± 1.0 |

*Note*. Data are reported as *M* ± *SD*. BMI = body mass index; RPI = reciprocal ponderal index. Adapted from "The Changing Shape Characteristics Associated With Success in World-Class Sprinters," by A. S. Watts, I. Coleman, and A. Nevill, 2012, *Journal of Sports Sciences, 30*(11), pp. 1085–1095.

**Table 3 Body Size and Shape Characteristics of Male World-Class Sprinters Per Decade**

| Decade | *n* | Age (years) | Body mass (kg) | Stature (m) | BMI (kg/m$^2$) | RPI (cm/kg$^{0.333}$) |
|---|---|---|---|---|---|---|
| 1910–19 | 9 | 23.3 ± 3.0 | 69.2 ± 3.6 | 1.77 ± 0.04 | 22.1 ± 1.4 | 43.3 ± 1.1 |
| 1920–29 | 23 | 23.6 ± 2.9 | 69.5 ± 4.7 | 1.73 ± 0.04 | 23.3 ± 1.3 | 42.1 ± 0.9 |
| 1930–39 | 25 | 23.7 ± 2.8 | 74.6 ± 6.7 | 1.78 ± 0.03 | 23.4 ± 1.8 | 42.4 ± 1.1 |
| 1940–49 | 22 | 23.4 ± 3.3 | 72.4 ± 4.6 | 1.80 ± 0.03 | 22.5 ± 1.8 | 43.2 ± 1.3 |
| 1950–59 | 30 | 24.1 ± 3.2 | 71.9 ± 6.3 | 1.76 ± 0.09 | 23.3 ± 2.3 | 42.3 ± 2.0 |
| 1960–69 | 23 | 23.6 ± 3.0 | 75.9 ± 7.3 | 1.79 ± 0.07 | 23.7 ± 1.3 | 42.4 ± 1.1 |
| 1970–79 | 21 | 23.2 ± 2.9 | 76.9 ± 5.4 | 1.84 ± 0.07 | 22.8 ± 1.9 | 43.3 ± 1.5 |
| 1980–89 | 34 | 23.8 ± 2.7 | 73.7 ± 6.0 | 1.83 ± 0.05 | 21.9 ± 1.2 | 43.9 ± 0.8 |
| 1990–99 | 54 | 26.1 ± 3.5 | 75.2 ± 5.3 | 1.80 ± 0.05 | 23.1± 1.6 | 42.8 ± 1.2 |
| 2000–09 | 99 | 25.6 ± 3.4 | 77.9 ± 5.6 | 1.81 ± 0.06 | 23.8 ± 1.8 | 42.5 ± 1.4 |

*Note*. Data are reported as *M* ± *SD*. BMI = body mass index; RPI = reciprocal ponderal index. Adapted from "The Changing Shape Characteristics Associated With Success in World-Class Sprinters," by A. S. Watts, I. Coleman, and A. Nevill, 2012, *Journal of Sports Sciences, 30*(11), pp. 1085–1095.

presented in Tables 2 and 3 (Watts et al., 2012). The available data span 10 decades (1910–2009) for men and eight (1940–2009) for women, although earlier female data are derived from case reports and, thus, include very small samples. Records typically included top 10, 100-m sprinters for both sexes during these periods. Athlete speed (m/s), body mass index (BMI, kg/m), and reciprocal ponderal index (RPI, cm/kg$^{0.333}$) were calculated. The BMI provided a proxy for muscularity, and the RPI provided a measure of linearity, with higher BMI and RPI representing greater muscularity and tallness/linearity, respectively. As expected, speed increased over the decades in both genders. Among male world-class sprinters, a high BMI was positively associated with success until the most recent decade where the trend was reversed. Most interesting was the finding that recently successful sprinters tended to have higher RPI. This was consistently observed over the decades for women with RPI positively associated with success and BMI exhibiting a weaker, negative association for speed. Taken together, it appears the influence of muscle mass on sprint performance is less important, with taller, more linear sprinters achieving greater success. This might be explained by the influence of stride length on sprint speed (Watts et al., 2012).

Interestingly, the current 100-m world record for women of 10.49 s attained in 1988 was for a runner (stature: 1.70 m; mass: 59 kg) with a more extreme RPI (43.73 cm/kg$^{0.333}$). The next closest time (10.65 s) to this long-standing world record was for another "linear" sprinter with an identical RPI (stature: 1.80 m; mass: 70 kg). In the men, the current world-record time (set in 2009) for 100-m sprint (9.58 s) was for an athlete with a stature of 1.93 m. It is recognized, however, that the use of prohibited performance-enhancing pharmaceuticals by some athletes may confound this type of analysis.

As elite sprinters are concerned with optimizing power-to-weight ratio, there may be occasions when sprint athletes choose to restrict energy intake in the hope of reducing total body mass or fat mass, especially in advance of key races. When this is undertaken strategically to ensure retention of lean body mass and hormonal status, weight loss of as little as 2–3 kg can have a favorable impact on explosive power and speed (Huovinen et al., 2015). Despite the potential benefits of reducing body mass, sprint athletes may present with indicators of low energy availability, suggesting that attempts to restrict energy intake should be conducted with appropriate caution to ensure athlete health and performance are not compromised (Sygo et al., 2018).

Novel approaches to facilitate acute weight loss in an attempt to optimize power-to-weight ratio have anecdotally been implemented by some sprint athletes in recent times. Although there is no research supporting this practice in a sporting context, low-residue diets have been shown to facilitate weight loss within the range of 300–700 g (Rankin & Gibson, 2015) and, thus, may be insufficient to significantly affect power-to-weight ratio in isolation. Intentional dehydration is an alternative approach to acutely promote sufficient weight loss to potentially favorably influence power-to-weight ratio. Indeed, there is some evidence to show an enhancement in vertical jump performance following dehydration equivalent to ~3% of body mass (Viitasalo et al., 1987). Conversely, sprint performance over distances of 50–400 m remain stable despite an acute reduction in body mass equivalent to 2.0–2.5% facilitated through diuretic-induced dehydration (Watson et al., 2005). Athletes wishing to trial these acute weight loss strategies before competition should seek the advice of a university-qualified nutrition professional in advance so that health and performance implications can be more closely assessed.

Rather than absolute power output, acceleration in sprinting is also a function of power-to-weight ratio. Greater muscle strength and power are usually accompanied by an increase in muscle cross-sectional area but the ability to generate force also requires improved neuromuscular recruitment. In a study comparing heavier, more muscular adults to adolescent sprinters, higher muscularity and mass were reported to explain slower sprint start dynamics in the adults (Aerenhouts et al., 2012). Although optimizing muscle mass is important for the development of explosive power, especially at the sprint start, training should advance technical skills to facilitate effective transfer of strength benefits. Although most studies report a "normalized' muscle strength of participants by adjusting for total or lean body mass, this unfortunately fails to adequately account for regional mass differences (e.g., differences in upper to lower body mass), which are likely to be important to performance. Locating mass closer to the joint center helps optimize biomechanical efficiency, a concept supported by research showing that sprinters with greater deposition of muscle in the upper portion of the quadriceps are faster (Handsfield et al., 2017).

Muscularity for sprinters needs to be optimized rather than maximized, and currently, there are insufficient comprehensive morphological data to provide detailed guidance. Small differences in adiposity on the limbs of sprinters have also been demonstrated to predict performance with relatively small reductions in medial calf skinfold associated with faster run times, at least in less elite runners (Legaz & Eston, 2005). This suggests that subtle differences in the distribution of mass influences performance, possibly the result of increased muscular effort and energy expenditure associated with heavier lower limbs when running. This raises the concept of optimizing nutritional support of some training sessions to facilitate adaptation but not others. For example, support training sessions where hypertrophy may be beneficial, but do not optimize nutritional support of other sessions, where you want neural adaptations but not a hypertrophy response. Such an approach would demand strategic prescription of nutrition support in accordance with the training program, with significant dialog between athlete, coaching personnel, and university-qualified nutrition professional.

## Dietary Practices and Recommendations

The dietary intakes of sprint athletes are poorly represented in the literature (Table 4) (Tipton et al., 2007) and may not accurately represent current practice, given the validity of methods used (Capling et al., 2017). When contrasted against other track-and-field athletes, relative energy and macronutrient intake are lower among sprinters than in the intake of middle-distance and long-distance runners (Sugiura et al., 1999). Despite this, micronutrient intakes are similar between runners. Less is known about the distribution of dietary intake throughout the day, including intake before, during, and after exercise, a time where nutrient intake can have a significant impact on not only substrate availability but also on adaptation to the training stimulus. Nutrition strategies to amplify training-induced adaptive signals outside of protein metabolism among sprint athletes remain to be explored.

## Carbohydrate

The ergogenic potential of carbohydrate availability for sprint athletes is poorly understood. There is evidence that maintenance of an extremely low-carbohydrate diet can impair performance in events as brief as one 30-s sprint, presumably because of low muscle glycogen stores and decreased rates of glycolysis (Langfort et al., 1997). Indeed, muscle glycogen stores can be reduced by almost half following just three 30-s maximal sprints. However, this alone does not appear to affect sprint exercise performance. Rather, fatigue may be caused by reduced creatine phosphate availability, increased hydrogen ion concentration, impairment in sarcoplasmic reticulum function, or some other fatigue-inducing agent (Hargreaves et al., 1998).

Within the training context, where multiple daily sessions are undertaken including repeat sprints and other modalities such as resistance training and plyometrics, carbohydrate availability may play a more important role, with muscle glycogen stores reduced by

**Table 4 Reported Daily Dietary Intake of Energy and Macronutrients Among Sprint Athletes During Training (Unless Otherwise Stated) Since 1980**

| Gender | Population | Body mass (kg) | Energy | | Carbohydrate | | Protein | | Fat | | Survey method | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MJ | kJ/kg | g | g/kg | g | g/kg | g | %E | | |
| Male | 22.4 ± 2.6 years National level ($n$ = 10) | 67 | 11.1 ± 1.5 | 167 ± 33 | 340 ± 57 | 5.1 ± 1.0 | 102 ± 20 | 1.5 ± 0.4 | 90 ± 16 | 30 ± 3 | 3-Day diary | Sugiura et al. (1999) |
| | 12–18 years Adolescent ($n$ = 30) | 61 | 11.1 ± 1.5 | 182 | 362 ± 54 | 6.0 ± 0.9 | 92 ± 17 | 1.5 ± 0.3 | 91 ± 21 | 30 ± 5 | 7-Day diary | Aerenhouts et al. (2008) |
| | National level ($n$ = 7) | 74 | 8.5 | 154 ± 33 | 311 | 4.2 ± 1.5 | 155 | 2.1 ± 0.5 | 96 | 42 | 4-Day diary | Huovinen et al. (2015) |
| | 20–35 years National level ($n$ = 8) | 80 | 11.9 | 149 ± 23 | 368 | 4.6 ± 0.6 | 168 | 2.1 ± 0.7 | 72 | 22 | 4-Day diary | Huovinen et al, (2015) |
| Female | 20.5 ± 3.2 years National level ($n$ = 11) | 54 | 10.0 ± 2.2 | 191 ± 46 | 305 ± 79 | 5.8 ± 1.6 | 89 ± 25 | 1.7 ± 0.5 | 86 ± 17 | 33 ± 4 | 3-Day diary | Sugiura et al. (1999) |
| | 12–18 years Adolescent ($n$ = 26) | 55 | 8.4 ± 1.6 | 153 | 273 ± 54 | 5.1 ± 1.1 | 78 ± 15 | 1.5 ± 0.3 | 69 ± 17 | 30 ± 5 | 7-Day diary | Aerenhouts et al. (2008) |

70–80% following repeated 60-s sprints (MacDougall et al., 1977). These reductions in substrate availability are probably sufficient to impair both repeat sprint performance (Rockwell et al., 2003) and other forms of training undertaken by sprinters. Furthermore, a single resistance–training session can reduce muscle glycogen stores by as much as 24–40% (Koopman et al., 2006). Reductions in muscle glycogen stores have been associated with performance impairment in both isokinetic torque and isoinertial resistance–training capacity. Thus, it is plausible that impaired training performance could occur in any session that relies on rapid and repeated glycogen breakdown. If the low-carbohydrate status is achieved through a low-carbohydrate, high-protein diet, acid–base status may also be impaired if sustained, further adversely affecting performance (Maughan et al., 1997).

Athletes are encouraged to pay particular attention to dietary intake in the hours before exercise, under the assumption that pre-exercise nutritional strategies can influence exercise performance. Evidence is present for a beneficial role of acute carbohydrate ingestion before and/or during strength training (Lambert et al., 1991). However, not all investigations show a benefit of acute carbohydrate ingestion (Kulik et al., 2008). It is proposed that the ergogenic potential for carbohydrate ingestion is most likely to be observed when elite sprint athletes are undertaking longer duration, high-volume training. Currently, specific recommendations for an optimum rate or timing of carbohydrate ingestion for sprint athletes before and during any given training session cannot be made. Furthermore, any nonmetabolic response from mouth rinsing a carbohydrate solution does not appear to influence sprint performance (Painelli et al., 2011), although the impact on training capacity warrants further investigation, especially among athletes who experience gastrointestinal tract distress.

Dietary survey literature relating to sprint athletes suggests that they typically report daily carbohydrate intakes of 4–6 g/kg body mass, independent of gender (Table 4). Although this may appear low relative to the intakes of endurance athletes and may be amplified by underreporting common among dietary assessment methodology (Capling et al., 2017), there is no conclusive evidence of benefit from maintaining a high habitual carbohydrate intake among sprint athletes. Given the lower relative energy expenditure of larger athletes, their requirements for other nutrients, plus the effect of adjusting carbohydrate on total energy intake, recommendations for carbohydrate intake at strategic times, including before, during, and after exercise, may be more applicable for the sprint athlete. This would ensure carbohydrate availability is optimized at critical time points. Thus, a range of daily carbohydrate intakes between 3 and 6 g/kg body mass strategically allocated across the day would be considered reasonable for sprint athletes depending on their phase of training (Bartlett et al., 2015).

## Protein

Strength–power athletes such as sprinters have advocated high-protein diets for many years. Although debate continues on the need for additional protein among sprint-trained athletes, general guidelines now recommend that athletes undertaking strength–power training ingest approximately twice the current recommendations for protein of their sedentary counterparts or as much as 1.6–2.2 $g \cdot kg^{-1} \cdot day^{-1}$ (Stokes et al., 2018). Given the relatively wide distribution of protein in the meal plan and increased energy intake of athletes, it is not surprising to learn that the majority of sprint athletes achieve these increased protein intake targets (Table 4). Exceeding the upper range of protein intake guidelines likely offers no further benefit and simply promotes increased amino acid catabolism and protein oxidation (Witard et al., 2014). Furthermore, there is evidence that an intense period of resistance training reduces protein turnover and improves net protein retention (Phillips et al., 1999), thus reducing relative dietary protein requirements of experienced resistance-trained athletes.

Simply contrasting an athlete's current daily protein intake against generic guidelines does not address whether protein intake has been optimized to promote gains in muscle mass or repair damaged tissues. Rather, consideration should be given to other dietary factors, including total energy intake and the daily distribution and biological value of ingested protein. Although there is little information available on the eating patterns of sprint athletes, available literature on athletic populations suggests that the majority of daily protein intake is skewed toward the evening, with little consideration for breakfast or between-meal intake (Gillen et al., 2017). Thus, rather than focusing on total daily intake, sprint athletes are encouraged to consume meals containing ~0.4 g/kg high biological value protein every 3–5 hr (Witard et al., 2018). Further investigation of contemporary dietary practices of sprint athletes using valid tools is clearly warranted.

## Hydration

As with all athletes, sprint athletes are encouraged to initiate training in a euhydrated state. However, the duration of sprint events ensures that no hydration intervention is warranted during the event itself. Furthermore, the reduction in body mass associated with hypohydration may reduce the work required to accelerate the body, compensating for any reduction in muscular strength/power (Maughan & Shirreffs, 2010). Despite this, longer duration activities undertaken by sprint athletes such as resistance training are impaired by hypohydration (Kraft et al., 2010). On the weight of this evidence, track-sprinting performance does not appear to be influenced by a state of hypohydration within the range of 2–3%, especially among trained individuals (Savoie et al., 2015). However, sprint training characterized by repeat high-intensity efforts may be impaired by hypohydration. Sprint athletes are advised to start training in a state of euhydration, drink to their thirst and gastrointestinal tolerance, and limit body mass loss to no more than 2–3% during any one training session, complementing this with aggressive postexercise recovery strategies, inclusive of adequate fluid and electrolytes. See also Casa et al. (2018).

## Recovery

Given that sprint athletes typically undertake multiple daily training sessions, posttraining nutritional recovery strategies are advocated. The acute ingestion of carbohydrate and protein combined after sprint training results in more favorable recovery outcomes, including restoration of muscle glycogen stores and muscle protein metabolism, than the ingestion of either nutrient alone. Postexercise protein ingestion also lowers carbohydrate intake requirements in the acute recovery period, with an energy-matched intake of 0.8 $g \cdot kg^{-1} \cdot hr^{-1}$ carbohydrate plus 0.4 $g \cdot kg^{-1} \cdot hr^{-1}$ protein resulting in similar muscle glycogen resynthesis over 5 hr compared with 1.2 $g \cdot kg^{-1} \cdot hr^{-1}$ carbohydrate alone following intermittent exercise (van Loon et al., 2000), with a similar response evident following resistance exercise. Preliminary evidence also suggests the post-exercise coingestion of carbohydrate and protein may reduce the muscle damage often seen in strength-trained athletes (Cockburn et al., 2010); whether such a response has a functional benefit is unclear.

Another potential strategy to attenuate the exercise-induced muscle damage common among sprint athletes involves the ingestion of phytonutrient-rich foods such as blueberries, pomegranate, and tart cherry (Levers et al., 2015). The integration of these whole foods or their concentrates into the meal plan of sprint athletes holds interesting promise and warrants further investigation, at least when the focus is on recovery, rather than adaptation (Vitale et al., 2017).

## Supplementation

Supplement use among runners varies based on the event, with sprinters reported to have both higher (Tscholl et al., 2010) and lower (Maughan et al., 2007) rates of supplement use relative to distance runners, with polysupplementation common. Although multivitamin and mineral supplements remain popular, protein powders and specific amino acid supplements, caffeine, and creatine monohydrate are also frequently used by sprinters (Tscholl et al., 2010). Similar to other track-and-field athletes, sprinters are motivated to take supplements to enhance recovery, health, and performance (Peeling et al., 2019).

The majority of the energy required during a single bout of brief, maximal exercise is provided through anaerobic pathways, specifically glycogenolysis resulting in phosphocreatine degradation and lactate formation (Duffield et al., 2005). Interventions able to influence energy availability through these pathways may favorably affect sprint exercise performance. After reviewing the metabolic demands of sprinting, several supplements might benefit the sprint athlete, whether in training or competition, and these are summarized in Table 5 and discussed in detail elsewhere (Peeling et al., 2019).

Creatine monohydrate supplementation has the potential to favorably impact on sprint performance, given the ability to aid in the rapid rephosphorylation of high-energy phosphates and

**Table 5 Ergogenic Aids of Potential Benefit for Sprinters and Sprint Hurdlers**

| Supplement name | Details[a] | Event(s) | Training | Competition | References |
|---|---|---|---|---|---|
| Creatine monohydrate | Aids in rapid rephosphorylation of high-energy phosphates and shortens muscle relaxation time<br>May improve both individual and repeat sprint performances<br>Increases work capacity, potentially augmenting training adaptations for both sprint and ancillary training (weight room, plyometrics) | All sprints but potentially greatest benefit for shorter sprints (100 m, 200 m) | Yes; can provide benefit for both maximal and repeat sprint efforts and weight room activities | Possibly; sprinters must weigh potential performance benefits vs. energetic costs associated with extra body mass and fluid retention that may occur with creatine monohydrate supplementation | Bemben and Lamont (2005), Haff et al. (2000), and Skare et al. (2001) |
| Sodium bicarbonate | Acts as a buffer against acid–base disturbances, providing performance enhancement during sprints of ~60-s duration | 400 m, 400-m hurdles; impact on shorter sprints unknown but is likely smaller than observed in longer sprints | Yes; may provide additional buffering capacity for repeat sprints | Possibly; consideration must be given to potentially undesirable gastrointestinal side effects and acute body mass gains through fluid retention | Carr et al. (2011), Edge et al. (2006), and Zabala et al. (2011) |
| β-Alanine | Acts as a physiochemical buffer by increasing muscle carnosine<br>Muscle carnosine concentration is correlated with increased power output during 30-s sprints, especially in latter half of the sprint | 400 m, 400-m hurdles | Yes; greatest benefit in events ~1–10 min long, suggesting greatest benefits may be observed in training vs. competition in sprint athletes | Yes, although benefits in highly trained sprinters are likely to be lower | Blancquaert et al. (2015), Hobson et al. (2013), Saunders et al. (2017), and Suzuki et al. (2002) |
| Dietary nitrate | Improved muscle oxygenation<br>Improved muscle metabolic efficiency<br>Improved contractile function | 400 m, 400-m hurdles; possibly 100 m and 200 m and shorter hurdles | Possibly; maximal and intermittent sprint performance enhanced in sprint-interval-trained athletes | Possibly; performance benefit may be greatest in longer sprints (400 m, 400-m hurdles) | Jones (2014) and Thompson et al. (2016) |
| Caffeine | Adenosine antagonist, reducing fatigue and increasing alertness and motivation | All | Possibly; impact on sprint performance is not well described and can be contradictory; consideration must be given to tolerance, excessive alertness, and heart palpitations | Possibly; some evidence suggest that 5 mg/kg body mass can enhance both single and multiple sprint performance | Astorino and Roberson (2010) and Glaister et al. (2008) |

[a]For supplement dosing protocols, including acute pretraining and competition dosing, and loading/chronic usage protocols, see Peeling et al. (2019).

enhance buffering capacity (Bemben & Lamont, 2005). Given the dependence on anaerobic glycogenolysis and associated acid–base disturbances, sprint performance may be enhanced if buffering capacity can be increased through the ingestion of acute buffering agents such as sodium bicarbonate. This may be especially relevant for the longer duration (400 m) sprints characterized by substantial acid–base disturbances. More recently, there has been significant interest in the histidine-containing dipeptide carnosine, which contributes significantly to the physiochemical buffering in skeletal muscles. The manipulation of both blood (sodium bicarbonate or sodium citrate supplementation) and muscle-buffering capacity (β-alanine supplementation) in combination (Hobson et al., 2013) or through dietary manipulation also has potential (Limmer et al., 2018).

Recent evidence suggests that dietary nitrate supplementation may have the potential to enhance sprint performance, possibly because of improved muscle oxygenation, muscle metabolic efficiency, and/or contractile function (Jones, 2014). Finally, caffeine ingestion can enhance both single- and multiple-sprint performance (Glaister et al., 2008), and its use should be considered in sprint-trained athletes, although the potential negative implications on subsequent sleep warrant consideration (Dunican et al., 2018).

### Competition Nutrition Strategies

In major competitions, a sprint athlete must advance through qualifying rounds: a semifinal and final, each typically separated by several hours, and in the case of the longer sprints, typically a 24-hr period. Given the brief nature of sprint events, the relative importance of competition nutrition strategies might be assumed to be negligible. However, there is evidence to suggest that precompetition nutrition, including the use of some ergogenic aids, influences performance outcomes in these events.

Competition demands of sprinters are typically characterized by high-intensity efforts lasting approximately 10–60 s, with significant recovery between races. Due to the scheduling of major competitions, it is rare for elite sprinters to participate in more than two individual events, although athletes competing in multiple events, including relays, may have several races on a single day. With significant periods for recovery between races, muscle energy reserves are unlikely to be depleted, even in challenging environmental conditions of competitions such as the summer Olympic Games. Consequently, prerace nutrition priorities remain together with more general goals, for example, optimizing gastrointestinal tract comfort and preventing weight gain during the competition taper.

Major international track-and-field competitions generally see the initial heats of an event being held early in the day, while finals are often run in the evening. Prerace nutrition from qualifying rounds to finals may, therefore, involve different meals. A key consideration for the prerace meal, regardless of the time of day, is to consume a comfortable, familiar meal. The shorter duration of sprint events means that gastrointestinal disturbances are not as commonly reported but inappropriate food selection may affect an athlete's energy availability and gut comfort. A state of low-carbohydrate availability has been shown to impair anaerobic work capacity (Langfort et al., 1997) and peak power output (Wroble et al., 2018). However, this effect is evident only following severe dietary carbohydrate restriction, sufficient to promote a state of ketosis. Such a state is unlikely among competitive athletes tapering prior to competition who follow a meal plan with even a moderate carbohydrate content. In light of this, sprint athletes are advised to choose a familiar meal ideally containing 1–2 g/kg body mass of carbohydrate approximately 1–4 hr prior to competition.

The use of prerace ergogenic aids, such as buffering agents or caffeine, requires careful consideration of the competition schedule. athletes who are using these products should determine the optimum dosage and timing for enhanced performance across single and repeat performances, as repeat dosing may be considered when races are close together, such as the 100-m semifinal and final. Administering a standard dose prior to each race may result in adverse outcomes depending on the specific product and its half-life. Given this, it is essential that athletes should trial supplement strategies in training or smaller competitions to determine optimal dosage and timing of administration. In the case of bicarbonate, this may result in an athlete choosing to complete a chronic supplementation strategy over a period of days, rather than an acute loading protocol immediately prior to competition (McNaughton & Thompson, 2001).

Postrace recovery strategies should emphasize muscle repair, replenishment of carbohydrate stores, and adequate rehydration, while considering the multiple activities that can compete for a sprinter's time and attention after competition (e.g., cooldown, massage or treatment, doping control, media, time with friends and family, and travel from the competition venue). As such, sprinters competing in multiple events would be well-advised to bring recovery foods to the competition venue, emphasizing rapidly digested protein and carbohydrates, as well as antioxidant-rich foods and fluids such as tart cherry or pomegranate juice.

## Conclusions

Nutrition plays a number of important roles for elite sprint athletes. Sprint athletes will benefit from a greater focus on training nutrition, given the metabolic demands of training far exceed those of competition. An emphasis should be placed on the strategic timing of nutrient intake before, during, and after exercise to assist sprinters in optimizing resistance-training work capacity, recovery, and body composition. Although it is often assumed that sprint athletes are primarily interested in promoting muscle hypertrophy, optimization of body composition demands consideration of the effect of any changes in physical traits on power-to-weight ratio and biomechanical efficiency. Nutritional supplements remain very popular among sprinters, and there is some evidence to support the use of a small number of products to assist elite sprinters, albeit marginally, in the training and/or competition environment. However, advice should first be sought from university-qualified, performance nutrition-focused professionals. Any proposed dietary interventions should be trialled in training to assess tolerance and likely individual performance response.

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