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MANUSCRIPT TITLE: The effects of an increased calorie breakfast consumed prior to simulated match-play in Academy soccer players

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ABSTRACT

Dietary analysis of Academy soccer players' highlights that total energy and carbohydrate intakes are less than optimal; especially, on match-days. As UK Academy matches predominantly kick-off at ~11:00 h, breakfast is likely the last pre-exercise meal and thus may provide an intervention opportunity on match-day. Accordingly, the physiological and performance effects of an increased calorie breakfast consumed ~135-min before soccer-specific exercise were investigated. English Premier League Academy soccer players (*n*=7) repeated a 90-min soccer-match-simulation on two occasions after consumption of habitual (B_{hab}; ~1100 kJ) or increased (B_{inc}; ~2100 kJ) energy breakfasts standardised for macronutrient contributions (~60% carbohydrates, ~15% proteins and ~25% fats). Countermovement jump height, sprint velocities (15-m and 30-m), 30-m repeated sprint maintenance, gut fullness, abdominal discomfort and soccer dribbling performances were measured. Blood samples were taken at rest, pre-exercise, half-time and every 15-min during exercise. Although dribbling precision (P=0.522; 29.9±5.5 cm) and success (P=0.505; 94±8%) were unchanged throughout all time-points, mean dribbling speed was faster (4.3±5.7%) in B_{inc} relative to B_{hab} (P=0.023; 2.84 vs 2.75 $m \cdot s^{-1}$). Greater feelings of gut fullness (67±17%, P=0.001) were observed in B_{inc} without changes in abdominal discomfort (P=0.595). All other physical performance measures and blood lactate and glucose concentrations were comparable between trials (all P>0.05). Findings demonstrate that Academy soccer players were able to increase pre-match energy intake without experiencing abdominal discomfort; thus, likely contributing to the amelioration of energy deficits on match-days. Furthermore, whilst B_{inc} produced limited benefits to physical performance, increased dribbling speed was identified, which may be of benefit to match-play.

KEYWORDS: football; nutrition; skill; intermittent; energy

Introduction

The demands of Academy soccer include a requirement to cover distances of ~7-9 km (Goto, Morris, & Nevill, 2015), perform explosive bouts of skill-based work (Stolen, Chamari, Castagna, & Wisloff, 2005) and run at high intensities (>3.0 $m \cdot s^{-2}$) for up to 375 ± 120 m per half (Russell, Sparkes, Northeast, & Kilduff, 2015a). However, given the importance of optimised nutritional intake on the day of competition for team sports players (Williams & Serratosa, 2006), it is surprising that the dietary practices of Academy soccer players (specifically ~U15-U16 and ~U18) rarely meet recommended values (Briggs et al., 2015; Naughton et al., 2016; Russell & Pennock, 2011). With regards to total energy intake, consistent observations highlight less than optimal practices when food is consumed *ad libitum* in free-living conditions (Briggs et al., 2015; Naughton et al., 2016; Russell & Pennock, 2011). Notably, energy deficits of 2278 ± 2307 $kJ \cdot d^{-1}$ have been reported on match days (Briggs et al., 2015), when objective methods of energy expenditure have been utilised, whilst also accounting for any self-reporting bias during the energy intake assessment period. Furthermore, mean habitual breakfast intakes of 1165 ± 129 kJ (Briggs, unpublished observations) have also been identified on match-days, highlighting pre-exercise intake as a particular concern in this population of Academy players.

Whilst a periodised approach to nutrition is advised to compensate for multiple matches played within close proximity and fluctuating daily training volumes (Anderson et al., 2016), a pre-exercise meal containing ~1200-4700 kJ of primarily carbohydrates (1-4 $g \cdot kg^{-1}$; 70-280 g for a 70 kg athlete) is recommended to be consumed >60 min before activity commences (AND, DC & ACSM, 2016). However, in the case of the UK-based Academy soccer player, competitive matches generally kick-off earlier in the day when compared to their senior counterparts (e.g., 11:00 h vs. 15:00 h); thus, limited time separates waking and the onset of exercise. A multitude of reasons may explain sub-optimal pre-match energy intakes in Academy soccer players (e.g., focus on sleep, home vs. away logistical issues etc.); however, the failure to modify habitual food and beverage intake practices in the context of proximity to kick-off is likely a contributing factor. Notably, habitual breakfast intake fails to meet pre-exercise recommendations in terms of energy (i.e., 1165 ± 129 kJ; Briggs unpublished observations) and carbohydrate (i.e., 40-65 g; Naughton et al., 2016) intake; albeit in comparison to recommendations for adult populations (~1200-4700 kJ; AND, DC & ACSM, 2016) in the absence of population-specific data.

While it is evident that the days preceding competition provide an opportunity to positively impact upon performance with respect to macronutrient intake (e.g., 8 $g \cdot kg^{-1}$ BM of carbohydrate for 3.5 days; Souglis et al., 2013), match-day itself also allows practitioners to optimise pre-competition practices (Russell, West, Harper, Cook, & Kilduff, 2015b). As liver and muscle glycogen depletion is attributed as one of the main mechanisms of fatigue in soccer (Krustrup et al., 2006), modified breakfast intake may provide an intervention opportunity on match-day. In the context of morning events, a small pre-exercise meal (~1700-2100 kJ) primarily consisting of carbohydrate has also been recommended 2-3 h before exercise commences (ACSM, 2015). The rationale for modified breakfast intake is further substantiated by data linking the omission of breakfast to impaired exercise performance thereafter (Clayton, Barutcu, Machin, Stensel, & James, 2015) and studies examining the modulation of pre-exercise nutritional status (Anderson et al., 2016) and overnight fasting (Burke, 2007) on endogenous energy storage. Accordingly, the primary aim of the study was to examine the effects of a prescribed (recommended meal composition; ACSM, 2015) versus habitual breakfast intake on performance measures and physiological responses of Academy players during a 90 min soccer match simulation. A secondary aim of the study was to assess whether players could tolerate the increased pre-match energy intake without experiencing detrimental effects on abdominal discomfort.

Methods

Study Design

Using a randomised, counterbalanced and cross over design, professional Academy soccer players completed a simulated soccer match with physiological and performance measurements taken at regular intervals. The dependent variables included in this study were indices of exercise intensity (i.e., heart rate, rating of perceived exertion, blood lactate and glucose concentrations), performance (i.e., 15-m and 30-m sprint speeds, 30-m repeated sprint maintenance, countermovement jump height, soccer dribbling performance), subjective measures assessing the effect of pre-exercise nutritional intake (i.e., abdominal discomfort and gut fullness), and hydration status (i.e., plasma and urine osmolality, plasma volume and body mass changes).

Participants

Seven male soccer players (age: 16 ± 1 y; stature: 1.75 ± 0.04 m; body mass: 69.4 ± 5.2 kg; Body Mass Index: 22.6 ± 1.5 $kg{\cdot}m^{-2}$; estimated $\dot{V}O_{2max}$: 56 ± 3 $ml{\cdot}kg^{-1}{\cdot}min^{-1}$) playing for an English Premier League Academy participated in the study. The maturity offset was 3.9 ± 0.8 y beyond Peak Height Velocity (PHV) indicating that all of the participants had reached their predicted PHV (positive maturity offset) and thus were of a similar maturation status (Mirwald et al., 2002). All players were actively engaged in full Academy training and competition for ~20 h per week. Once institutional ethical approval was granted, written informed consent was obtained from both players and their respective parents or guardians prior to study involvement.

Procedures

Following an initial protocol familiarisation (to reduce trial-order effects) and estimation of $\dot{V}O_{2max}$ (Yo-Yo Intermittent Recovery Test; Bangsbo, Iaia, Krustrup, 2008), players were required to attend two trials. Trials were separated by 9 ± 4 days; ensuring that training days (45 min tactical-specific training session) conducted 24 h prior to testing were of comparable intensities. Players were asked to replicate free-living dietary intake, whilst also refraining from consumption of caffeine and supplements in the 24 h preceding each trial. Players were required to consume the same energy intake prior to both trials; a statement supported by comparable (all P>0.05) pre-trial energy intakes (B_{inc} 8.5 ± 0.7; B_{hab} 8.9 ± 0.3 $MJ \cdot d^{-1}$) and macronutrient contributions (carbohydrates, proteins, fats: 3.03 ± 0.14, 1.83 ± 0.17, 1.13 ± 0.27 and 3.53 ± 0.31, 1.99 ± 0.31, 0.96 ± 0.34 $g \cdot kg^{-1}$, B_{inc} and B_{hab} respectively) for the 24 h prior to testing. Players were required to attend the training ground at 08:00 h (i.e., ~180 min before commencing exercise) following an overnight fast. Body mass and stature (Seca GmbH & Co., Germany) were then measured prior to a resting fingertip capillary blood sample and mid-flow urine sample being obtained.

At ~08:45 h, players consumed an increased calorie breakfast (B_{inc}: 2079 kJ, 77 g carbohydrate, 14 g protein and 12 g fat) that adhered to recommendations specific to morning exercise (ACSM, 2015), or a habitual breakfast (B_{hab}: 1122 kJ, 39 g carbohydrate, 10 g protein and 8 g fat). Pilot testing of the free-living dietary habits of Academy soccer players supported the habitual pre-exercise energy intakes used in this study in B_{hab} (Briggs, unpublished observations) and replicated previously published data with respect to pre-exercise carbohydrate intake (Naughton et al., 2016). Whilst the total energy intake increased approximately two-fold between trials, this was primarily achieved via manipulation of absolute carbohydrate content as relative macronutrient contributions to the total energy yield remained similar for carbohydrates (i.e., 61% vs. 59%), proteins (14% vs. 15%), and fats (25% vs. 26%) for B_{inc} and B_{hab} respectively. After having been pre-weighed by the research team, breakfasts consisted of cereal (Kellogg's Rice Krispies and semi-skimmed milk) and/or buttered toast (Asda, medium sliced white bread and Flora Pro-Active butter) and were provided with 500 mL of a fluid-electrolyte beverage (Mineral Water, Highland Spring, UK). After consuming the entire amount of food, players remained in a rested state for ~90 min; upon which a pre-exercise blood sample was taken. A standardised warm-up (consisting of soccer-specific dynamic movements, stretches and skills; ~10 min) was performed, during which players were required to consume an additional 200 ml of fluid-electrolytes. Measures of physical performance including countermovement jump height (CMJ) and 30-m repeated sprint maintenance (RSM) were tested prior to a modified version of the Soccer Match Simulation (SMS) commencing (Russell, Rees, Benton, & Kingsley, 2011a). A timeline schematic of trial day procedures is outlined in Figure 1.

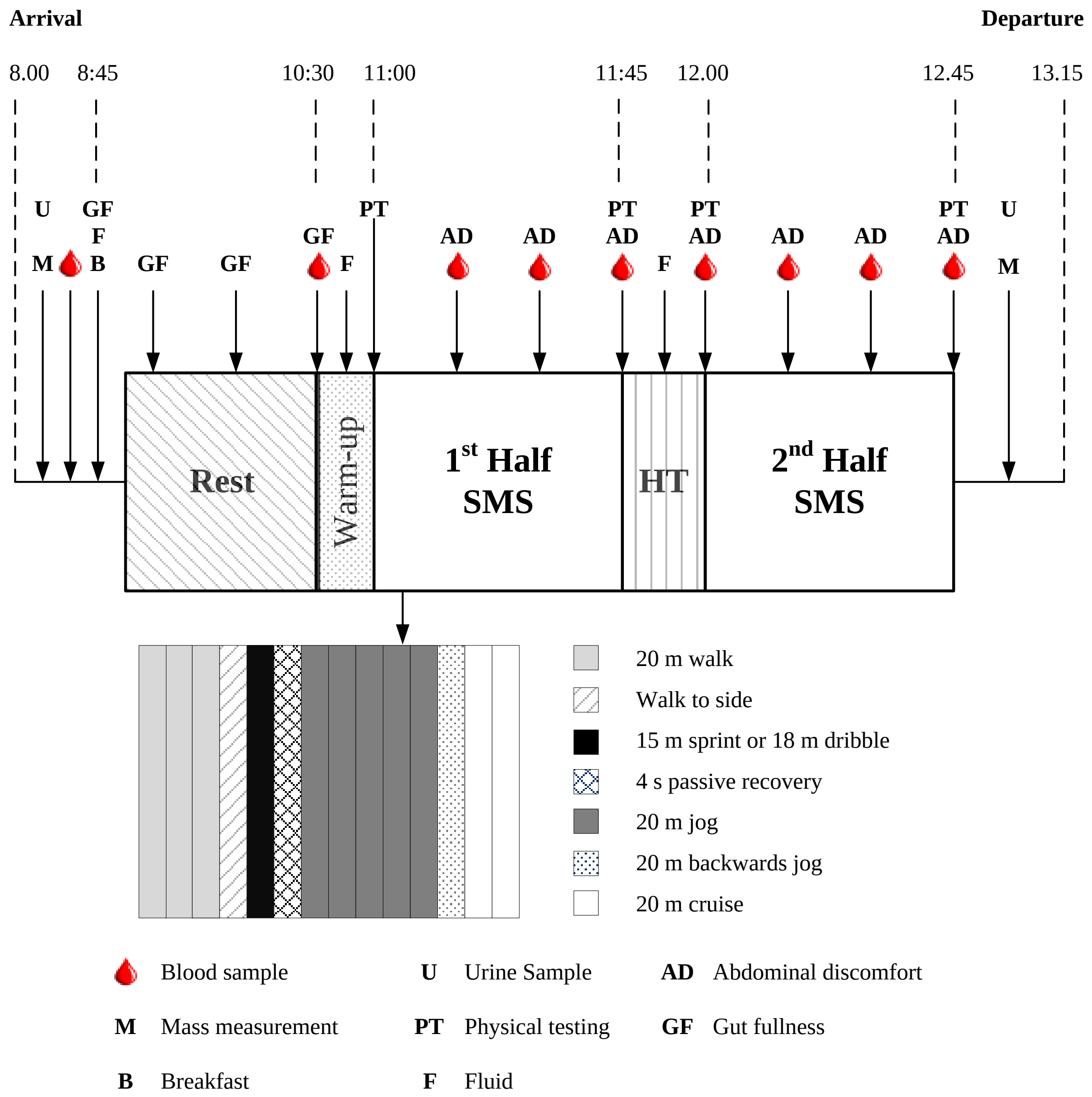

Figure 1. Schematic of trial day procedures.

The SMS is comprised of two 45 min bouts of soccer-specific exercise, with 15 min of passive recovery replicating half-time (HT). During HT players consumed 500 mL of fluid-electrolytes in line with typical behaviours of youth soccer players. Assessments of soccer dribbling (Russell, Benton, & Kingsley, 2010) and 15-m sprinting were performed alternatively during each cycle of the protocol. Full details of the SMS protocol are outlined by Russell et al. (2011a). Briefly, exercise was made up of 4.5 min blocks that consisted of three repeated cycles of three 20 m walks, one walk to the side (~1 m), an alternating 15 m sprint or an 18 m dribble test, a 4 s passive recovery period, five 20 m jogs at a speed corresponding to 40% $\dot{V}O_{2max}$, one 20 m backwards jog at 40% $\dot{V}O_{2max}$ and two 20 m strides at 85% $\dot{V}O_{2max}$. A 2 min recovery period followed all blocks of exercise. Fourteen blocks of intermittent exercise (consisting of 2 halves of 7 blocks) and skill testing were completed during each main trial and participants covered a total distance of approximately 10.1 km while performing ~33 maximal sprints and ~21 dribbles. The repeatability of the original 90 min SMS and responses to this exercise protocol have previously been determined (Harper et al., 2016; Russell, Benton, & Kingsley, 2011b).

Participant CMJ height and 30-m RSM were tested at four time points (pre-exercise; post-first half; pre-second half; post-second half), each requiring three CMJ's separated with 10 s of passive recovery and three 30-m sprints with 25 s of active recovery (light jogging). In both performance tests the mean value of the three attempts was used for analysis. CMJ height was determined using an optical measuring system (OptoJump Next, Microgate Corp, Italy). Players began each repetition from a standing position and performed a preparatory crouching action (at a consistent, self-determined level) before explosively jumping out of the dip for maximal height. Hands were isolated at the hips for the entire movement to eliminate any influence of arm swing. For RSM testing, players commenced each repetition from a standing start at a distance of 0.3-m behind the first timing gate (Brower Timing, Utah) and verbal encouragement was provided throughout each attempt.

Integrated 15-m sprints and 18-m dribbles (assessed for precision, percentage success and average speed) were recorded throughout the SMS. Players were required to dribble the ball as fast and as accurately as possible between cones spaced every 3-m as per Russell et al. (2011a). All dribbles were video recorded (50 Hz; 103 DCR-HC96E; Sony Ltd, UK) and digitisation processes (Kinovea version 0.8.15; Kinovea Org., France) derived speed (time taken to successfully complete the distance) and precision (distance of the ball from each cone) data. The test-retest reliability for all components of the SMS have been determined, including physiological (CV: 2.6%), metabolic (CV: 16.1%) and performance (CV: 2.1%) responses (Russell et al., 2011b).

Fingertip capillary blood samples (170 μl) were taken at rest, pre-exercise, HT and at the end of each 15 min period of the protocol. Blood samples were analysed for variables associated with exercise intensity and fatigue (i.e., blood glucose and lactate concentrations via GEM Premier 3000; Instrumentation Laboratory, UK; CV's: 0.6-2.2%) (Beneteau-Burnat, Bocque, Lorin, & Martin, 2004). Urine and plasma osmolality (Advanced Model 121 3300 Micro-Osmometer; Advanced Instruments Inc., USA; CV: 1.5%) and urine corrected mass changes were determined and the rate of perceived exertion (RPE; Borg, 1973) was recorded every 15 min. Environmental conditions were measured during exercise (Technoline WS-9032; Technotrade GmbH, Germany). Heart rate (HR) was continuously recorded (Polar S610; Polar, Finland), with gut fullness (paper-based 100 mm Visual Analogue Scale (VAS), ranging from 'not full at all' to 'very full') recorded immediately after breakfast, 30 min post, 60 min post and 90 min post/immediately prior to exercise. Abdominal discomfort (based on a self-perceived subjective rating 0-10; 'no discomfort' to 'worst possible discomfort') was determined at the end of each 15 min block of the protocol. Post exercise body mass was also recorded in addition to a mid-flow urine sample.

Statistical Analysis

For parametric data expressed over multiple time-points, two-way repeated measures analysis of variance (within-participant factors: treatment x time) were performed (once confirmed by normality and variance assessments), which included dribbling (precision, speed and success), sprint velocities (15 and 30-m), CMJ height, 30-m RSM, RPE, heart rate (HR), gut fullness, abdominal discomfort and blood glucose and lactate concentrations. Mauchly's test was consulted and Greenhouse-Geisser correction was applied if the assumption of sphericity was violated. Significant main trial effects were further investigated using multiple pairwise comparisons with LSD confidence interval adjustment (95% Confidence Intervals; CI). Partial eta-squared (η^2) values were calculated and Cohen's *d* effect size examined between-trial differences. Where no trial effects were identified, the main effect of time was stated where appropriate (referred to as exercise effect). A paired samples *t*-test was used to analyse differences in mean body mass pre and post-exercise. For η^2 and effect size data, thresholds of 0.2, 0.5, and 0.8 were considered small, medium and large, respectively (Fritz, Morris, & Richler, 2012). All data are presented as mean ± SD, with level of significance set at $P \leq 0.05$ using SPSS (Version 22; SPSS Inc., USA) for all analyses.

Results

Pre-exercise plasma osmolality was similar amongst players between each trial (B_{hab} 310 ± 5; B_{inc} 315 ± 6 mOsmol·kg^{-1}, P=0.936). Ambient temperature (18.5 ± 1.5°C), humidity (74 ± 7%) and barometric pressure (1017 ± 3 mmHg) were also consistent between trials (P>0.05).

Compared to B_{hab}, gut fullness was greater ($F_{(1,7)}$ = 7.262, p = 0.027, η^2 = 0.548) immediately (60 ± 15 vs. 19 ± 15, P=0.002, *d* = 2.8, CI: 22-60), 30 min (58 ± 13 vs. 18 ± 13, P=0.001, *d* = 3, CI: 23-58), 60 min (46 ± 11 vs. 15 ± 13, P=0.003, *d* = 2.5, CI: 15-47) and 90 min after ingestion and immediately pre-exercise (40 ± 11 vs. 13 ± 10, P=0.001, *d* = 2.6, CI: 15-38) during B_{inc}. Abdominal discomfort was similar between trials ($F_{(5,30)}$ = 0.746, P=0.595, η^2 = 0.111).

Mean dribbling precision ($F_{(2,10)}$ = 0.856, P=0.433, η^2 = 0.125) and success ($F_{(2,10)}$ = 0.666, P=0.505, η^2 = 0.100) was comparable between trials whereas mean dribbling speed was faster (-4.3 ± 5.7%) in B_{inc} ($F_{(5,30)}$ = 3.072, P=0.023, η^2 = 0.339) (Figure 2). Post hoc comparisons were unable to isolate these specific differences but dribbling speed was 13.3 ± 10.1% and 7.1 ± 10.2% greater at 61-75 min and 76-90 min respectively during B_{inc}.

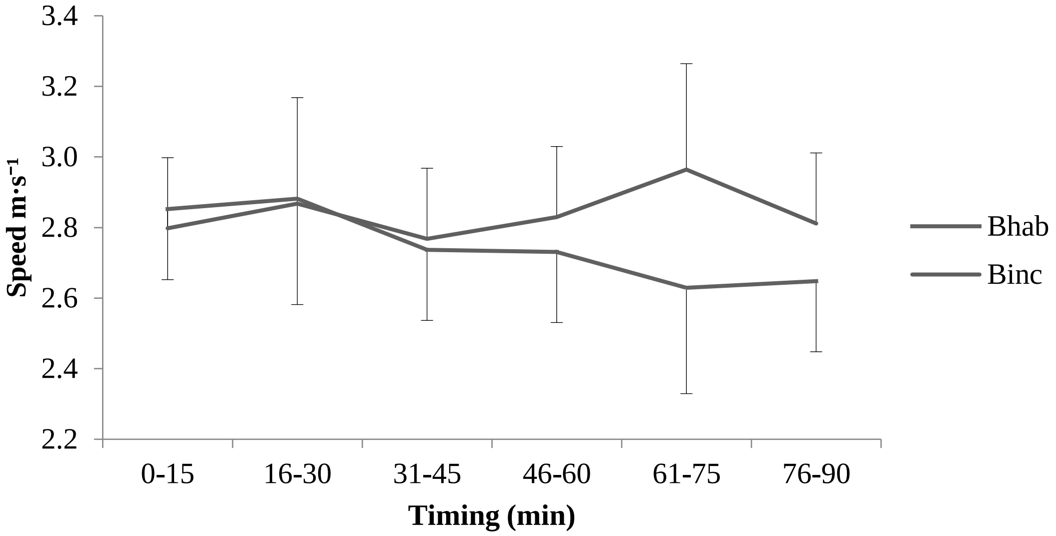

Figure 2. Dribbling speed throughout each trial (mean ± SD). B_{inc} = Intervention Trial, B_{hab} = Habitual intake trial. Treatment effect between B_{inc} and B_{hab} ($F_{(5,30)}$ = 3.072, P=0.023, η^2 = 0.339)

Breakfast did not influence 15-m ($F_{(2,12)}$ = 0.668, P=0.534, η^2 = 0.100) or 30-m sprint velocities ($F_{(3,18)}$ = 0.136, P=0.938, η^2 = 0.022). Similarly, 30-m RSM ($F_{(3,18)}$ = 0.072, P=0.974, η^2 = 0.012) and CMJ ($F_{(3,18)}$ = 0.946, P=0.439, η^2 = 0.136) performance was similar between trials. However, an exercise effect was observed in all these variables (all $P<0.05$; medium effect size). Sprint velocities over 15-m were significantly reduced in the periods 31-45 min (5.72 ± 0.43 $m \cdot s^{-1}$), 46-60 (5.64 ± 0.47 $m \cdot s^{-1}$) and 76-90 min (5.59 ± 0.63 $m \cdot s^{-1}$) when compared to 0-15 min (5.94 ± 0.53 $m \cdot s^{-1}$; all $P<0.05$). Sprint velocity over 30-m and 30-m RSM both demonstrated decrements in performance at post 1st half, pre 2nd half and post 2nd half when compared to pre-exercise (all $P<0.01$; Table 1). Likewise, CMJ height was reduced ($P<0.05$) pre 2nd half (32.5 ± 3.5 cm) when compared to pre-exercise (35.3 ± 2.9 cm; Table 1).

		Timing			
Variable	**Trial**	**Pre-exercise**	**Post-1st Half**	**Pre-2nd Half**	**Post-2nd Half**
30 m Sprint Velocities (m·s-1)	B_{inc}	6.95 ± 0.25	6.80 ± 0.23	6.61 ± 0.33	6.70 ± 0.31
	B_{hab}	7.09 ± 0.16	6.88 ± 0.20	6.61 ± 0.23	6.76 ± 0.30
30 m RSM (%)	B_{inc}	99 ± 1	96 ± 4	93 ± 7	94 ± 4
	B_{hab}	98 ± 2	97 ± 3	94 ± 7	95 ± 3
CMJ Height (cm)	B_{inc}	35.0 ± 2.9	34.3 ± 2.7	32.8 ± 3.1	33.7 ± 2.7
	B_{hab}	35.7 ± 2.8	34.5 ± 5.2	32.0 ± 4.1	34.7 ± 4.3

RSM = Repeated Sprint Maintenance, CMJ = Countermovement Jump, B_{inc} = Intervention Trial, B_{hab} = Habitual intake trial. Data presented as mean ± SD.

Heart rate was similar between trials ($F_{(5,30)}$ = 2.353, P=0.065, η^2 = 0.282) ($F_{(1,9)}$ = 1.294, P=0.307, η^2 = 0.177). Likewise, RPE was not influenced by trial ($F_{(5,30)}$ = 0.691, P=0.634, η^2 = 0.103), despite increases at 46-60 min (13 ± 3), 61-75 min (14 ± 3) and 76-90 min (15 ± 3), when compared to 0-15 min (11 ± 3) values (all P<0.01). Mean differences in body mass pre and post-exercise were not influenced by trial ($t_{(6)}$ = -0.337, P=0.747). Mean body mass changes (pre: 69.6 kg, post: 68.9 kg) equated to a mean difference of 0.75 kg in B_{hab}, similar to B_{inc} (pre: 70.5 kg, post: 69.8 kg, mean difference: 0.70 kg).

Blood lactate ($F_{(2,11)}$ = 0.728, P=0.495, η^2 = 0.108) and blood glucose ($F_{(3,19)}$ = 2.983, P=0.055, η^2 = 0.332) concentrations were not statistically different between trials. Exercise effects were observed in both of these variables ($F_{(2,10)}$ = 9.618, P=0.007, η^2 = 0.616; $F_{(3,19)}$ = 10.563, P=0.0001, η^2 = 0.638, respectively). Blood lactate was significantly higher at15 min (P=0.009), 45 min (P=0.006), HT (P=0.0001), 60 min (P=0.018), 75 min (P=0.008), and 90 min (P=0.045) in comparison to pre-exercise concentrations (Table 2). Blood glucose was significantly reduced (all P<0.05) at45 min (-6.9 ± 7.3%), HT (-10.9 ± 6.4%), 60 min (-11.6 ± 7.9%), 75 min (-12.6 ± 7.5%), and 90 min (-11.2 ± 9.6%) in comparison to 15 min (Table 2).

Table 2. Blood metabolite data as a function of timing and trial

Variable	**Trial**	**Timing (min unless stated)**								
		Rest	**Pre-exercise**	**15**	**30**	**45**	**HT**	**60**	**75**	**90**
Lactate ($mmol \cdot l^{-1}$)	B_{inc}	0.7 ± 0.1	1.4 ± 0.5	5.1 ± 3.4	3.7 ± 3.8	4.9 ± 3.6	3.1 ± 1.1	3.9 ± 3.6	4.1 ± 2.9	3.4 ± 2.9
	B_{hab}	0.9 ± 0.3	1.2 ± 0.4	3.4 ± 1.1	2.8 ± 0.7	3.3 ± 0.5	2.6 ± 0.6	3.3 ± 1.2	2.9 ± 0.5	2.2 ± 0.3
Glucose ($mmol \cdot l^{-1}$)	B_{inc}	5.0 ± 0.7	5.7 ± 0.7	5.1 ± 0.5	4.7 ± 0.6	4.8 ± 0.5	4.5 ± 0.6	4.3 ± 0.4	4.2 ± 0.2	4.5 ± 0.5
	B_{hab}	4.9 ± 0.3	5.0 ± 0.5	5.1 ± 0.3	4.8 ± 0.3	4.7 ± 0.2	4.6 ± 0.3	4.7 ± 0.3	4.7 ± 0.7	4.5 ± 0.6

B_{inc} = Intervention Trial, B_{hab} = Habitual intake trial. HT = half-time. Data presented as mean ± SD

Discussion

The primary aim of the study was to examine the effects of increasing acute pre-exercise energy intake (via manipulation of absolute carbohydrate content) on performance measures and physiological responses of Academy players during a 90 min soccer match simulation. Furthermore, a secondary aim was to assess whether players could tolerate increases in pre-match energy intake without compromising abdominal discomfort. Although dribbling precision and success were unchanged, dribbling speed was improved in B_{inc} relative to B_{hab}. Unsurprisingly, greater feelings of gut fullness were observed in B_{inc} but not to detriment to abdominal discomfort. Compared to B_{hab}, B_{inc} provided an additional ~1 MJ of energy intake; equating to ~50% of the match day energy deficit identified previously in youth soccer players (Briggs et al., 2015). Although limited physical benefits and no physiological benefits were observed, modified breakfast intake may offer an intervention opportunity on match day that likely contributes to attenuating the daily energy deficits previously identified in this population (Briggs et al., 2015),.

When compared to B_{hab}, mean dribbling speed was 4.3 ± 5.7% faster than B_{inc}. Although post-hoc comparisons were unable to detect differences between particular time-points, dribbling speeds were 13.3 ± 10% and 7.1 ± 10% greater at 61-75 min and 76-90 min respectively during B_{inc}. Explanations for the increased dribbling speed may link to the increased carbohydrate content of the B_{inc} breakfast, however whilst higher pre-exercise blood glucose levels were identified in the B_{inc} trial, caution is warranted as blood glucose was not significantly different between trials (P=0.055). Interestingly, more successful Academy players are associated with conducting movement patterns at higher speeds (Goto et al., 2015), therefore an increased dribbling speed may have positive implications for match-play, especially during phases of the game related to higher fatigue (Krustrup et al., 2006). Although not isolated to breakfast intake, match-day carbohydrate ingestion has previously been demonstrated to improve soccer-skills in adolescents (Russell, Benton, & Kingsley, 2012); namely, soccer shooting performance. Current findings are in agreement that the nutritional intervention was beneficial to aspects of soccer skill performance.

The B_{inc} breakfast (2079 kJ, 77 g carbohydrate, 14 g protein and 12 g fat) contained a carbohydrate intake equivalent to 1.11 $g{\cdot}kg^{-1}$ BM which is higher than prescribed in studies with similar populations (0.78 $g{\cdot}kg^{-1}$ BM; Phillips et al., 2010; Phillips et al., 2012). Despite methodological variation regarding the timing of pre-match energy intake, current findings support the notion of limited effects of pre-exercise carbohydrate consumption on maximal sprint performance (Phillips et al., 2010; Phillips et al., 2012). The SMS required ~33 maximal sprints interspersed with both high and low-intensity running to mimic movement patterns associated with soccer match-play. However, whilst sprint performance appears maintained when multiple 15-m sprints are separated by 30 s passive recovery (Balsom, Seger, Sjodin, & Ekblom, 1992), such activity patterns are not congruent with the SMS protocol and indeed match-play itself.

The lack of improvement in CMJ height during B_{inc} is not uncommon as previous research involving adolescent athletes has highlighted a reduction in peak power output when participants do not engage in passive recovery between multiple bouts (Thevenet, Tardieu-Berger, Berthoin, & Prioux, 2007). Despite the higher calorie intake and increased carbohydrate content during B_{inc}, blood glucose concentrations were not significantly enhanced ($P=0.055$); although a trend towards significance and a small effect ($\eta^2 = 0.332$) was found

(Table 2). In addition, blood lactate concentrations, HR and RPE were also similar (all P>0.05) between trials (Table 2). Therefore, the standardisation of the physiological demands between trials and the limited glycaemic response of B_{inc} versus B_{hab} may explain the similar between-trial findings for specific physical variables.

Academy soccer players have been found to display poor nutritional practices with reports of mean daily energy deficits of 1302 ± 1662 $kJ{\cdot}d^{-1}$ (Briggs et al., 2015) and 3299 ± 329 $kJ{\cdot}d^{-1}$ (Russell & Pennock, 2011). Furthermore, match day energy balance within this population is less than optimal; demonstrating mean deficits of 2278 ± 2307 $kJ{\cdot}d^{-1}$ (Briggs et al., 2015). Despite limited evidence of performance benefits with increased energy intake during B_{inc}, the additional calorie content may be worthwhile to simultaneously reducing the energy deficits observed on match-day. Additionally, the increased calorie intake in B_{inc} did not induce any abdominal discomfort versus B_{hab} (P=0.595). Conversely, feelings of gut fullness were increased immediately after consumption until the onset of exercise (all P<0.01). Whilst heightened feelings of gut fullness may induce gastrointestinal discomfort and have subsequent implications for performance (de Oliveira, Burini & Jeukendrup, 2014), abdominal discomfort was not adversely effected in this study. Enhanced gut fullness may therefore have provided an additional subjective preparatory benefit.

The nature of applied research presents concerns of control and as such needs to be interpreted in relation to potential limitations. The issue of access to this population impacted on the intervention strategy. Whilst a clear rationale emerged to devise a strategy to increase habitual pre-match energy intake, it is acknowledged that the days leading up to match day are also important (Souglis et al.. 2013). However, to prescribe a diet with adequate control during this period was not possible in this study due to player availability issues. Additionally, players were expected to engage in pre-exercise testing prior to the completion of the SMS requiring maximal exertion. However, the subsequent impact on the SMS is likely minimal as such movement patterns and the time-frames examined are not dissimilar to that experienced during a standard soccer warm-up.

Conclusion

The study findings demonstrate that Academy soccer players were able to increase pre-match energy intake without experiencing detrimental effects on abdominal discomfort. Such an approach may help to address previously identified concerns of energy deficits on competition days. This finding may be of interest to applied practitioners working with Academy soccer players who typically demonstrate less than optimal pre-match nutritional habits. Furthermore, whilst B_{inc} produced limited benefits to physical performance, increased dribbling speed was identified compared to B_{hab}, a finding which may be of benefit to match-play. However, further investigations in to match-day strategies are warranted to help further reduce energy deficit and elicit subsequent performance improvements.

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