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Title: Physiological and performance effects of carbohydrate gels consumed prior to the extra-time period of prolonged simulated soccer match-play

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Title: Physiological and performance effects of carbohydrate gels consumed prior to the extra-time period of prolonged simulated soccer match-play

Running title: Carbohydrate gel and extra-time

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Abstract

Objectives: The physiological and performance effects of carbohydrate-electrolyte gels consumed before the 30 min extra-time period of prolonged soccer-specific exercise were investigated.

Design: Randomised, double-blind, crossover.

Methods: Eight English Premier League academy soccer players performed 120 min of soccer-specific exercise on two occasions while consuming fluid-electrolyte beverages before exercise, at half-time and 90 min. Carbohydrate-electrolyte (0.7 ± 0.1 $g \cdot kg^{-1}$ BM) or energy-free placebo gels were consumed ~5 min before extra-time. Blood samples were taken before exercise, at half-time and every 15 min during exercise. Physical (15-m and 30-m sprint speed, 30-m sprint maintenance and countermovement jump height) and technical (soccer dribbling) performance was assessed throughout each trial.

Results: Carbohydrate-electrolyte gels improved dribbling precision ($+29 \pm 20\%$) and raised blood glucose concentrations by 0.7 ± 0.8 $mmol \cdot l^{-1}$ during extra-time (both $p < 0.01$). Supplementation did not affect sprint velocities (15-m and 30-m), 30-m sprint maintenance or dribbling speed as reductions compared to 0-15 min values occurred at 105-120 min irrespective of trial (all $p < 0.05$). Plasma osmolality and blood sodium concentrations increased post-exercise versus the opening 15 min ($p < 0.05$) but no effect of supplementation existed. Selected markers of physical performance (jump height, 30-m sprint velocity and 30-m repeated sprint maintenance) also reduced by >3% during half-time (all $p < 0.05$).

Conclusions: Carbohydrate-electrolyte gel ingestion raised blood glucose concentrations and improved dribbling performance during the extra-time period of simulated soccer match-play. Supplementation did not attenuate reductions in physical performance and hydration status that occurred during extra-time.

Keywords: fatigue, football, skill, glucose, intermittent, hydration

Introduction

When scores are tied at the end of specific soccer tournament matches, a 30 min extra-time (ET) period is played. According to official match data (www.FIFA.com), 22% and 35% of knockout phase matches played between 2002 and 2014 at U17 and senior FIFA World Cup competitions required ET, respectively. Given the importance of ET in soccer tournaments, the dearth of literature profiling, 1) the demands of this additional period of play, and 2) the effects of ergogenic interventions throughout 120 min of soccer-specific exercise, is surprising.

Reductions in performance capacity have been observed following intense periods of competition, [1] after a passive half-time period, [2] and during simulated and actual soccer match-play. [3, 4] Although a topic of debate, [5, 6, 7] the mechanisms of reduced performance have primarily been attributed to physiological responses that are either central (i.e., central nervous system) [5] or peripheral (i.e., disturbances in acid-base balance, blood glucose concentrations, muscle ion homeostasis, hydration status, muscle temperature and/or fibre-specific glycogen content) in origin. [6, 7, 8] Notably, the physiological effects of 120 min of soccer-specific exercise have not been reported despite indices of physical and skill performance reducing during ET. [9, 10]

Ergogenic effects have been observed following provision of carbohydrates on physical and skilled actions performed throughout simulated soccer match-play. [4, 11, 12] Increased exogenous energy provision, [14] maintenance of blood glucose concentrations, and improved intermittent exercise capacity have been reported following carbohydrate gel ingestion. [11, 13] Although the ingestion of carbohydrate gels prior to ET is common in professional soccer, the physiological and performance responses to this nutritional strategy are unknown.

Therefore, the aim of this study was to evaluate the physiological and performance responses to carbohydrate-electrolyte gels consumed before the ET period of a simulated soccer match. We hypothesised that carbohydrate provision would influence physiological and performance responses during ET.

Methods

This study received ethical approval from the Health and Life Sciences Ethics Committee at Northumbria University. Male soccer players recruited from an English Premier League club (n = 8, age: 16 ± 1 years, mass: 68.5 ± 5.3 kg, stature: 1.73 ± 0.05 m, estimated $\dot{V}O_{2\,max}$: 55 ± 9 ml·kg^{-1}·min^{-1}) provided written informed consent (and parental consent where players <18 years). Players trained for ~16 h per week and played for a professional academy for >12 months before the study started. Two main trials (carbohydrate: CHO and placebo: PLA), separated by 9 ± 4 days, were completed using a double-blind, randomised, counterbalanced and cross-over design.

A preliminary visit included estimation of $\dot{V}O_{2\,max}$ [15] and procedural habituation, with main trials performed on two subsequent visits. Players performed a light 45 min training session (involving positional and tactic-specific drills), refrained from caffeine consumption and recorded all food consumed (analysed retrospectively; Nutritics Ltd., UK) in the 24 h preceding each main trial. Following an overnight fast, players arrived at 08:00 h and provided a mid-flow urine sample. A resting fingertip capillary blood sample was taken before players consumed a standardised breakfast (2079 kJ, 77.1 g carbohydrates, 12.3 g fats, and 14.3 g proteins) including 500 ml of a fluid-electrolyte beverage (Mineral Water, Highland Spring, UK). Body mass and stature (Seca GmbH & Co., Germany) were then measured.

A pre-exercise blood sample was taken after players rested for ~90 min following breakfast. A standardised warm-up (including multidirectional and linear speed drills, dynamic stretching and dribbling practice), during which players consumed 200 ml of the fluid-electrolyte beverage, was then performed. Performance testing (PT) preceded exercise, with countermovement jump (CMJ) height [16] and 30-m repeated sprint maintenance (RSM) [17] assessed. Players performed three CMJ's interspersed with 10 s passive recovery and three 30-m sprints with 25 s of active recovery. These assessments were repeated on a further four occasions (i.e., post-first half; P2, pre-second half; P3, post-second half; P4, post-exercise; P5).

Using a modified version of the Soccer Match Simulation (SMS), [18] participants performed 120 min of soccer-specific exercise; consisting of two 45 min halves and two additional 15 min periods (ET). The repeatability of the physiological and performance responses to the original SMS have been determined. [19] Directed by audio signals, the SMS required players to cover ~14.4 km (reflecting actual match-play requiring ET) [10] at various running intensities, with backwards and sideward movements over a 20-m distance, while intermittently performing 15-m timed sprints and 18-m ball dribbles (assessed for precision, percentage success, and average speed). [4] Participants were required to dribble a ball between cones as fast and as accurately as possible with a cone being unsuccessfully negotiated if touched by the ball or not completed in the required direction. Video footage (50 Hz; DCR-HC96E; Sony Ltd, UK) and digitisation (Kinovea version 0.8.15; Kinovea Org., France) techniques yielded speed (time taken to successfully complete the distance) and precision (distance of the ball from each cone) data. Dribbling performance was expressed as an average per 15 min of exercise (epochs; E*N*): 0-15 min (E1), 16-30 min (E2), 31-45 min (E3), 46-60 min (E4), 61-75 min (E5), 76-90 min (E6), 91-105 min (E7) and 106-120 min (E8).

A 15 min half-time (HT) passive recovery period, where players consumed 500 ml of a fluid-electrolyte beverage, separated the two 45 min halves. Five min of rest followed the end of normal time and a two min period separated each half of ET. Body mass assessment and gel consumption (with 300 ml of fluid-electrolyte beverage) preceded the start of ET. Gels were professionally manufactured and were taste and texture matched (IsoGel, High5 Ltd., UK). Sachets providing $0.7 \pm 0.1\ g \cdot kg^{-1}$ BM carbohydrates derived from glucose and maltodextrin (808 kJ; 46 g carbohydrates, 0 g fats, 0 g proteins, 0.14 g salt; CHO) or placebo (0 kJ; 0 g carbohydrates, fats and proteins 0.14 g salt; PLA) were consumed using a double-blind, randomised and counterbalanced design.

Fingertip capillary blood samples (170 µl) were collected at rest, P1, HT and at the end of each epoch (i.e., E1-E8) and analysed for blood glucose, lactate and sodium concentrations (GEM Premier 3000;

Instrumentation Laboratory, UK; CV's: 0.6-2.2%). [20] Urine and plasma osmolality (Advanced Model 3300 Micro-Osmometer; Advanced Instruments Inc., USA), urine-corrected mass changes, ratings of perceived exertion (RPE) [21] and abdominal discomfort (AD; similar to the methods of: [22]) were recorded during each trial. Environmental conditions were measured during exercise (Technoline WS-9032; Technotrade GmbH, Germany) and heart rate (HR) was recorded (Polar RS400; Polar Electro, Finland). A mid-flow urine sample was collected post-exercise and body mass was measured.

Statistical analyses were carried out using SPSS Statistics software (IBM Inc., USA) with significance set at $p \leq 0.05$. Data are reported as mean ± standard deviation (SD). Statistical power was calculated using commercially available software (GPower v3.1, Germany) and a sample size of eight was deemed sufficient for >80% power to detect statistical differences in blood glucose and dribbling precision. For parametric data (confirmed by normality and variance assessments), paired sample t-tests were performed for single time-point data. For parametric data expressed over multiple time-points, two-way repeated measures analysis of variance (within-participant factors: treatment x time) were performed. Where significant interactions were observed, supplementation was deemed to have influenced responses and simple main effects were performed. Partial eta-squared (η^2) values were calculated and LSD corrected *post-hoc* tests (with 95% Confidence Intervals; CI) with Cohen's *d* calculations examined between-trial differences. Non-parametric data were analysed using a Friedman test with *post-hoc* Wilcoxon Signed Ranks tests (ES calculated using the Z distribution value) to identify effects. [23] For effect size data, thresholds of 0.2, 0.5, and 0.8 were considered small, medium and large, respectively. [23]

Results

Ambient temperature (18.5 ± 1.5°C), humidity (74 ± 7%) and barometric pressure (1017 ± 3 mmHg) were similar between trials ($p > 0.05$). Players reported to each trial in a similar hydration state (plasma osmolality: 312 ± 6 mOsmol·kg^{-1}, p = 0.936). Energy intake (8.6 ± 0.7 MJ·d^{-1}) and macronutrient content (carbohydrate, fats, proteins: 3.7 ± 0.4, 2.7 ± 0.8, 2.2 ± 0.3 MJ·d^{-1}, respectively) was similar across trials ($p > 0.05$).

Supplementation influenced mean dribbling precision (p = 0.015, $\eta^2 = 0.287$) with dribbles performed during E8 being 29 ± 20% more accurate in CHO than PLA (p = 0.014, *d* = 1.3, CI: 3.2-21.0 cm; Figure 1A). Dribbles were also more accurate during E5 in CHO than PLA (p = 0.002, *d* = 1.0, CI: 3.8-11.3 cm; Figure 1A). Although dribbling speed (p = 0.671, $\eta^2 = 0.091$) and success (p = 0.677, $\eta^2 = 0.070$) were not affected by supplementation (Figure 1C), dribbling speed was lower ($p < 0.001$, $\eta^2 = 0.500$) during E7 and E8 compared to E1 (-12.3 ± 3.8%, -10.1 ± 6.6%, respectively, both $p < 0.001$) (Figure 1B). Dribbles in E8 were 4.6 ± 5.9% slower than E6 (p = 0.046) and 5.7 ± 4.7% slower during E6 versus E1 (p = 0.012) (Figure 1B).

Supplementation did not influence 15- or 30-m sprint velocities (p = 0.772, $\eta^2 = 0.044$ and p = 0.599, $\eta^2 = 0.091$, respectively). Likewise, 30-m RSM and CMJ height were similar between trials (p = 0.528, $\eta^2 = 0.104$ and p = 0.389, $\eta^2 = 0.133$, respectively). However, exercise influenced these variables ($p < 0.001$, $\eta^2 = 0.640$; $p < 0.001$, $\eta^2 = 0.501$; $p < 0.001$, $\eta^2 = 0.527$ and p = 0.053, $\eta^2 = 0.370$, respectively). Sprint velocities over 15-m reduced during E7 (5.52 ± 0.57 m·s^{-1}) and E8 (5.37 ± 0.56 m·s^{-1}) when compared to E1 (5.92 ± 0.47 m·s^{-1}) (both $p < 0.01$) and during E8 compared to E6 (5.63 ± 0.58 m·s^{-1}) (p = 0.001). Sprint velocities over 30-m (-4 ± 2%, p = 0.003) and RSM scores (-4 ± 3%, p = 0.003) were lower at P5 versus P1 (Table 2). Decrements between E6 and E1 existed for 15-m sprint velocities (-5 ± 4%, p = 0.010) and between P4 and P1 for 30-m sprint velocities (-3 ± 3%, p = 0.036) and 30-m RSM (-3 ± 3%, p = 0.018) (Table 2). Compared to other time-points, CMJ height was not different at P5, however; CMJ height, 30-m sprint velocities and 30-m RSM were dampened at P3 compared to both P1 (-7 ± 4%, -4 ± 2%, -5 ± 3%, respectively, all $p < 0.05$) and P2 (-5 ± 4%, -3 ± 3%, -3 ± 3%, respectively, all $p < 0.05$) (Table 2).

Supplementation did not influence RPE ($p = 0.623$, $\eta^2 = 0.098$), however; timing effects were present ($p < 0.001$, $\eta^2 = 0.858$), with significantly higher RPE values during E7 (15 ± 3) and E8 (17 ± 3) compared to E1 (11 ± 3) and E6 (14 ± 3) (all $p < 0.01$). Similarly, increases were found in RPE during E6 versus E1 ($p < 0.001$). The pattern of response for mean HR (HR_{mean}) was not influenced by supplementation ($p = 0.852$, $\eta^2 = 0.023$) or exercise ($p = 0.086$, $\eta^2 = 0.297$).

Both supplementation ($p = 0.026$, $\eta^2 = 0.354$) and exercise ($p < 0.001$, $\eta^2 = 0.656$) influenced blood glucose concentrations with CHO values being 16 ± 17% greater than PLA during E7 (5.6 ± 0.9 $mmol{\cdot}l^{-1}$ vs. 4.6 ± 0.2 $mmol{\cdot}l^{-1}$, $p = 0.028$, $d = 4.2$, CI: 0.18-1.93 $mmol{\cdot}l^{-1}$) (Table 1). Supplementation did not affect blood lactate or sodium concentrations ($p = 0.188$, $\eta^2 = 0.208$ and $p = 0.282$, $\eta^2 = 0.162$, respectively) but exercise did ($p = 0.006$, $\eta^2 = 0.500$, and $p < 0.001$, $\eta^2 = 0.583$, respectively) (Table 1). During E7, blood lactate concentrations were lower than E1 (-94 ± 57%, $p = 0.004$) and E6 (-25 ± 25%, $p = 0.048$). Blood lactate was also lower during E6 versus E1 (-32 ± 17%, $p = 0.001$) (Table 1). Blood sodium concentrations were 1.6 ± 1.9% higher during E8 compared to E1 ($p = 0.045$) and 1.0 ± 0.7% higher during E7 compared to E1 ($p = 0.005$) (Table 1). Blood sodium concentrations were similar at E6 and E1 ($p > 0.05$) (Table 1).

Urine osmolality was similar between treatments ($p = 0.716$, $\eta^2 = 0.020$) remaining unchanged from pre- to post-exercise in both trials (-10 ± 37%, $p = 0.391$). Supplementation did not affect plasma osmolality ($p = 0.936$, $\eta^2 = 0.001$) or body mass ($p = 0.913$, $\eta^2 = 0.003$); however, post-exercise plasma osmolality was 7 ± 4% greater ($p < 0.001$, $\eta^2 = 0.882$) than pre-exercise (332 ± 8 vs. 312 ± 6 $mOsmol{\cdot}kg^{-1}$, $p < 0.001$). Post-exercise body mass (67.8 ± 4.7 kg) was reduced ($p < 0.001$, $\eta^2 = 0.921$) compared to resting (69.4 ± 5.0 kg; $p < 0.001$) and P4 values (68.2 ± 4.8 kg; $p = 0.001$). Supplementation did not affect AD ($p > 0.05$), but exercise did ($p < 0.001$); with E8 (5 ± 3) and E7 (5 ± 3) values being greater than E1 (2 ± 1) ($p < 0.05$, $r = 0.8$ for both). During E6, AD was higher compared to E1 ($p = 0.024$, $r = 0.8$).

Discussion

This is the first study to examine the physiological and performance effects of carbohydrate-electrolyte gels consumed prior to the ET period in soccer. In agreement with our hypotheses, increased blood glucose concentrations and improved dribbling precision occurred during ET in CHO. Additionally, we observed reductions in physical performance throughout 120 min of soccer-specific exercise with evidence highlighting further performance reductions during ET compared to the end of normal time. Therefore, consumption of carbohydrate-electrolyte gels offers an ergogenic strategy for players preparing to engage in an ET period, however; not all performance decrements were ameliorated by carbohydrate provision.

Improved skill performance (i.e., shot velocity and success) has been observed following carbohydrate ingestion.[4, 12] However, the efficacy of carbohydrate provision is unknown when 120 min of soccer-specific exercise is performed. In eight professional academy soccer players, a 0.7 ± 0.1 $g \cdot kg^{-1}$ BM dose of carbohydrate raised blood glucose concentrations by 16 ± 17% (large effect; d = 4.2; Table 1) and resulted in a 29 ± 20% improvement (large effect; d = 1.3; Figure 1A) in dribbling precision throughout E8. Although we found an unexplainable difference prior to carbohydrate ingestion (Figure 1), improved performance of sports skills following carbohydrate consumption has previously been associated with enhanced cerebral glucose supply and preserved central nervous system integrity,[24, 25] even when participants remain euglycaemic.[4] Additionally, elevated blood glucose concentrations induce muscle glycogen sparing,[14] augmented neuromuscular function,[24] attenuated central fatigue *via* serotonergic neurotransmitter release[12] and modified motor output resulting from stimulation of afferent brain signals *via* oropharyngeal receptor activation.[26] Although the precise mechanisms of skill performance regulation have yet to be delineated and are likely multifaceted in origin, our data expands the findings of previous studies that have observed enhanced skill performance with carbohydrate supplementation[4, 12] by demonstrating ergogenic effects of carbohydrate ingested prior to ET on dribbling precision.

Ostensibly, additional fatigue occurs throughout ET as further diminutions in performance were observed after 90 min (Table 2). This finding is corroborated by observations that further reductions in high-intensity distance covered and accelerations occur throughout ET. [10] Moreover, concomitant increases in RPE, a subjective marker of exercise intensity, occurred after 90 min. Notably, the supplementation strategy used in this study did not attenuate the physical performance decrements observed throughout 120 min of soccer-specific exercise. Future research opportunities therefore exist to optimise the hydro-nutritional strategies of players competing in matches requiring ET. In agreement with previous authors, [27, 28] we observed deleterious effects of a passive HT recovery period on CMJ height, 30-m sprint velocities and RSM (Table 2). Therefore, the efficacy of intervention strategies administered over HT also warrants further investigation. [28]

Temporal match-related fatigue development is a complex phenomenon, with a multitude of putative factors, [7] including depletion of endogenous fuel stores, [8] compromised excitation-contraction coupling, [7] and dehydration. [29] Logistical constraints prevented the assessment of each of these factors in isolation in the current investigation. Nevertheless, the timings of fluid and treatment ingestion were reflective of the hydro-nutritional practices of professional players. [29] In ambient conditions, a 1.6 ± 0.6% BM loss at P4 indicates that provision of a fluid-electrolyte beverage with breakfast, during the warm-up and at HT was sufficient to prevent reductions in mass losses that exceed 2%; a threshold commonly associated with onset of reduced performance. [29] However, ET elicited a further 0.5 ± 0.3 kg mass loss as well as increases in plasma osmolality and blood sodium concentrations (Table 1); possibly indicating compromised hydration status. This may be partly due to slower gastric emptying and/or intestinal absorption, as highlighted by elevated abdominal discomfort scores during ET compared to the first 90 min of exercise. [11] Such changes are likely components of a milieu of factors contributing to match-related fatigue and highlight the need for further research to optimise the hydro-nutritional strategies of players involved in 120 min of soccer-specific exercise.

Conclusions

Providing carbohydrate gel (0.7 ± 0.1 $g \cdot kg^{-1}$ BM) before ET increased blood glucose concentrations and improved dribbling precision thereafter but this intervention did not appear to benefit physical performance indices which reduced throughout 120 min of exercise. Alterations in dribbling performance can influence the outcome a match, [30] highlighting the potential benefits of carbohydrate provision prior to ET. Moreover, ET caused additional perturbations in physical and physiological responses compared to the previous 90 min. Therefore, given the role of ET in determining tournament progression, further work is needed to develop intervention strategies that attempt to preserve physical performances throughout 120 min of soccer-specific exercise.

Practical Implications

- Strategies (e.g., nutritional interventions, training programme design, tactical changes etc.) that enable soccer players to cope with the additional demands of the extra-time period are recommended
- Provision of 0.7 ± 0.1 $g \cdot kg^{-1}$ BM of carbohydrate (in gel form) prior to the soccer extra-time period provides an ergogenic strategy for augmented technical (i.e., dribbling precision), but not physical (i.e., sprinting and jumping ability), performance
- Half-time intervention strategies warrant investigation as a passive half-time recovery period elicited reductions in subsequent jump and sprint performance

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Table 1 Blood metabolite data as a function of timing and trial

Variable	Trial	Timing										
		Rest	**Pre**	**E1**	**E2**	**E3**	**HT**	**E4**	**E5**	**E6**	**E7**	**E8**
Glucose (mmol·l^{-1})	CHO	5.0 ± 0.6	5.7 ± 0.6	5.1 ± 0.5	4.7 ± 0.5	4.8 ± 0.4	4.5 ± 0.6	4.3 ± 0.4	4.3 ± 0.2	4.5 ± 0.5	5.6 ± 0.9[a]	5.0 ± 0.6
	PLA	4.9 ± 0.3	5.7 ± 0.5	4.9 ± 0.3	4.7 ± 0.3	4.7 ± 0.3	4.8 ± 0.4	4.6 ± 0.2	4.6 ± 0.4	4.5 ± 0.4	4.6 ± 0.2	4.7 ± 0.5
Lactate (mmol·l^{-1})	CHO	0.8 ± 0.2	1.4 ± 0.5	5.1 ± 3.1	3.7 ± 3.6	4.8 ± 3.3	3.0 ± 1.1	3.9 ± 3.3	4.0 ± 2.7	3.4 ± 2.7	2.4 ± 1.8	2.9 ± 2.2
	PLA	0.7 ± 0.2	1.6 ± 0.7	3.4 ± 1.6	3.0 ± 1.2	3.1 ± 1.7	2.4 ± 0.5	2.4 ± 0.7	2.3 ± 0.7	2.4 ± 1.0	2.2 ± 0.7	3.3 ± 2.2
Sodium (mmol·l^{-1})	CHO	138 ± 2	139 ± 1	141 ± 0	142 ± 1	143 ± 2	142 ± 2	142 ± 1	143 ± 1	142 ± 4	142 ± 1	143 ± 3
	PLA	139 ± 1	140 ± 1	141 ± 1	143 ± 1	143 ± 2	141 ± 2	140 ± 2	141 ± 1	143 ± 3	142 ± 1	144 ± 3

Pre represents pre-exercise and E1-8 represents 0-15, 16-30, 31-45, 46-60, 61-75, 76-90, 91-105 and 106-120 min respectively. HT represents half-time. CHO = carbohydrate-electrolyte gel trial, PLA = placebo gel trial. a = significant difference between trials ($p < 0.05$). Data presented as mean ± SD.

Table 2 Performance variables as a function of timing and trial

Variable	Trial	Timing				
		P1	**P2**	**P3**	**P4**	**P5**
30-m Sprint Velocities ($m \cdot s^{-1}$)	CHO	6.95 ± 0.25	6.80 ± 0.23	6.61 ± 0.33	6.70 ± 0.31	6.76 ± 0.19
	PLA	6.97 ± 0.31	6.92 ± 0.16	6.72 ± 0.30	6.83 ± 0.34	6.63 ± 0.51
30-m Repeated Sprint Maintenance (%)	CHO	99 ± 1	96 ± 4	93 ± 6	95 ± 4	96 ± 3
	PLA	98 ± 1	98 ± 2	94 ± 5	96 ± 4	93 ± 7
CMJ Height (cm)	CHO	34.5 ± 3.2	33.9 ± 2.8	32.3 ± 3.2	33.5 ± 2.5	33.8 ± 2.5
	PLA	35.5 ± 3.7	35.2 ± 4.4	33.2 ± 3.9	35.6 ± 5.0	33.8 ± 6.2

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P1-5 represents pre-exercise, post-first half, pre-second half, post-second half and post-exercise, respectively. CMJ = countermovement jump. CHO = carbohydrate-electrolyte gel trial, PLA = placebo gel trial. Data presented as mean ± SD.

Figure Legends

Figure 1 Dribbling precision (A), speed (B) and success (C) throughout each trial (mean ± SD). E1-8 represents 0-15, 16-30, 31-45, 46-60, 61-75, 76-90, 91-105 and 106-120 min respectively and HT represents half-time. a = significant difference between CHO and PLA ($p < 0.05$) at corresponding time-point.