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2	Energy intake and expenditure of professional soccer
3	players of the English Premier League: evidence of
4	carbohydrate periodization
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83 Abstract

84	In an attempt to better identify and inform the energy
85	requirements of elite soccer players, we quantified the energy
86	expenditure (EE) of players from the English Premier League
87	(n=6) via the doubly labeled water method (DLW) over a 7-day
88	in-season period. Energy intake (EI) was also assessed using
89	food diaries, supported by the remote food photographic
90	method and 24 h recalls. The 7-day period consisted of 5
91	training days (TD) and 2 match days (MD). Although mean
92	daily EI (3186 \pm 367 kcals) was not different from (P>0.05)
93	daily EE (3566 \pm 585 kcals), EI was greater (P<0.05) on MD
94	(3789 \pm 532 kcal; 61.1 \pm 11.4 kcal.kg ⁻¹ LBM) compared with
95	TD (2956 \pm 374 kcal; 45.2 \pm 9.3 kcal.kg ⁻¹ LBM, respectively).
96	Differences in EI were reflective of greater (P<0.05) daily
97	CHO intake on MD (6.4 \pm 2.2 g.kg ⁻¹) compared with TD (4.2 \pm
98	1.4 g.kg ⁻¹). Exogenous CHO intake was also different (P<0.01)
99	during training sessions (3.1 \pm 4.4 g.h^-1) versus matches (32.3 \pm
100	21.9 g.h ⁻¹). In contrast, daily protein (205 \pm 30 g, P=0.29) and
101	fat intake (101 \pm 20 g, P=0.16) did not display any evidence of
102	daily periodization. Although players readily achieve current
103	guidelines for daily protein and fat intake, data suggest that
104	CHO intake on the day prior to and in recovery from match
105	play was not in accordance with guidelines to promote muscle
106	glycogen storage.

Keywords: glycogen, training load, soccer, GPS

108 Introduction

109	Despite four decades of research examining the physical
110	demands of soccer match play (Reilly & Thomas, 1976; Bush
111	et al., 2015; Russell et al., 2016), the quantification of the
112	customary training loads completed by elite professional soccer
113	players have only recently been examined (Anderson et al.,
114	2015; Anderson et al., 2016; Malone et al., 2015; Akenhead et
115	al., 2016). Such data suggest that absolute training loads are not
116	as high as those experienced in match play. This is the case for
117	parameters such as total distance (e.g. <7 km v ~10-13 km)
118	(Bangsbo et al., 2006), high speed running distance (e.g. <300
119	m v >900 m) (Bradley et al., 2009), sprint distance (e.g. <150
120	m v >200 m) (Di Salvo et al., 2010) and average speed (e.g.
121	<80 m/min v ~100-120 m/min) (Anderson et al. 2015). Daily
122	training load during the weekly micro-cycle also displays
123	evidence of periodization, the pattern of which appears
124	dependent on proximity to the game itself (Anderson et al.,
125	2015) as well as the number of games scheduled (Morgans et
126	al., 2014).

Given the apparent daily fluctuations in training load, it follows that energy expenditure (EE) may vary accordingly and hence, energy intake (EI) could also be adjusted to account for the goals of that particular day. Indeed, the concept of "fuelling for the work required" has recently been suggested as a practical framework for which to apply nutritional 133 periodization strategies to endurance athletes (Impey et al., 134 2016). Such strategies are intended to concomitantly promote 135 components of training adaptation (e.g. activation of regulatory 136 cell signaling pathways) but yet, also ensure adequate 137 carbohydrate (CHO) (and energy) availability to promote 138 competitive performance, reduce injury risk and aid recovery 139 (Burke et al., 2011; Chamari et al., 2012; Burke et al., 2006). 140 Despite such theoretical rationale, however, it is currently 141 difficult to prescribe accurate nutritional guidelines for 142 professional soccer players owing to a lack of study that has 143 provided direct assessments of energy expenditure in the 144 modern professional adult player (Ebine et al., 2002).

145

146 Therefore, the aim of the present study was to 147 simultaneously quantify EI, EE, training load and match load in 148 professional soccer players. To this end, we studied a cohort of 149 professional players from the English Premier League (EPL) 150 during a 7-day in season period in which two match days (MD) 151 and five training days (TD) were completed. Self reported EI 152 and direct measurement of EE was assessed using food diaries 153 (supported by remote food photographic method and 24 h diet 154 recalls) and the doubly labeled water (DLW) method, 155 respectively.

156

158 Methods

159 **Participants**

160 Six male professional soccer players (who have all 161 played international standard) from an EPL first team squad 162 (mean \pm SD; age 27 \pm 3 years, body mass 80.5 \pm 8.7 kg, height 163 180 ± 7 cm, body fat 11.9 ± 1.2 %, fat mass 9.2 ± 1.6 kg, lean 164 mass 65.0 ± 6.7 kg) volunteered to take part in the study. All 165 players remained injury free for the duration of the study. The 166 study was conducted according to the Declaration of Helsinki 167 and was approved by the University Ethics Committee of 168 Liverpool John Moores University.

169

170 Study Design

171 Data collection was conducted during the 2015-2016 172 EPL in-season across the months of November and December. 173 Players continued with their normal in-season training that was 174 prescribed by the club's coaching staff and were available to 175 perform in two competitive games on days 2 and 5 during data 176 collection. The last competitive game where players were able 177 to take part in was 3 days prior to the commencement of data 178 collection. During data collection, game 1 kicked off at 20:05 179 hours and game 2 kicked off at 16:15 hours, both being home 180 fixtures in European and domestic league competitions, 181 respectively. The next competitive game players were due to 182 take part in was the day after the study concluded (i.e. Day 8).

One day before the study commenced all players underwent a
whole body fan beam Duel-energy X-ray absorptiometry
(DXA) measurement scan (Hologic QDR Series, Discovery A,
Bedford, MA, USA) in order to obtain body composition, in
accordance with the procedures described by Milsom et al.
(2015).

189

190 Quantification of Training and Match Load

191 Pitch based training sessions were monitored using 192 portable global positioning systems (GPS) units (Viper pod 2, 193 STATSports, Belfast, UK) using methods described previously 194 (Anderson et al., 2015; Anderson et al., 2016). Players' match 195 data were examined using a computerized semi-automatic 196 video match-analysis image recognition system (Prozone 197 Sports Ltd®, Leeds, UK) and were collected using the same 198 methods as Bradley et al. (2009). This system has previously 199 been independently validated to verify the capture process and 200 subsequent accuracy of the data (Di Salvo et al., 2006; Di Salvo 201 et al., 2009).

Variables from the training and match data that were selected for analysis included duration of activity, total distance covered, the average speed and distance covered inside 3 different speed categories that were divided into the following thresholds: running (14.4-19.7 km \cdot h⁻¹), high-speed running (19.8-25.1 km \cdot h⁻¹), and sprinting (>25.1 km \cdot hr⁻¹).

209 Measurement of Energy Expenditure Using Doubly210 Labelled Water

211 Energy expenditure was determined by using the DLW 212 method. On the day prior to start of data collection of the study, 213 between the hours of 1400 to 1600, players were weighed to 214 the nearest 0.1kg (SECA, Birmingham, UK). Baseline urine 215 samples were then provided and collected into a 35ml tube. 216 Following collection of baseline samples, players were 217 administered orally with a single bolus dose of hydrogen (deuterium ²H) and oxygen (¹⁸O) stable isotopes in the form of 218 219 water $({}^{2}H_{2}{}^{18}O)$ before they left the training ground. Isotopes 220 were purchased from Cortecnet (Voisins-Le-Bretonneux-France). The desired dose was 10% ¹⁸O and 5% Deuterium and 221 222 was calculated according to each participants body mass 223 measured to the nearest decimal place at the start of the study, 224 using the calculation:

225

226
$${}^{18}\text{O} \text{ dose} = [0.65 \text{ (body mass, g) x DIE}]/\text{IE},$$

227

where DIE is the desired initial enrichment (DIE = 618.923 xbody mass (kg)^{-0.305}) and IE is the initial enrichment (10%) 100,000 parts per million.

To ensure the whole dose was administered, the glassvials were refilled with additional water which players were

233 asked to consume. The following morning (between 09:00-234 10:00) baseline weight samples were taken (SECA, 235 Birmingham, UK). Approximately every 24-hour, when players 236 entered the training ground (or hotel on the morning of game 2) 237 they were weighed and provided a urine sample in a 35 ml 238 tube. This urine sample could not be the first sample of the day 239 after waking as this was acting as a void pass throughout the 240 study. Urine samples were stored and frozen at -80°C in 241 airtight 1.8 ml cryotube vials for later analysis.

242 For the DLW analysis, urine was encapsulated into 243 capillaries, which were then vacuum distilled (Nagy, 1983), 244 and water from the resulting distillate was used. This water was 245 analysed using a liquid water analyser (Los Gatos Research; 246 Berman et al., 2012). Samples were run alongside three 247 laboratory standards for each isotope and three International standards (Standard Light Artic Precipitate, Standard Mean 248 249 Ocean Water and Greenland Ice Sheet Precipitation; Craig, 250 1961, Speakman, 1997) to correct delta values to parts per 251 million. Isotope enrichments were converted to EE using a two-252 pool model equation (Schoeller et al., 1986) as modified by 253 Schoeller (1988) and assuming a food quotient of 0.85. The 254 results from the energy expenditure data are expressed as a 255 daily average from the 7-day data collection period.

256

258 Total Energy Intake

259 Self reported EI was assessed from 7-day food diaries 260 for all players and reported in kilocalories (kcal) and kilocalories per kilogram of lean body mass (kcal·kg⁻¹ LBM). 261 262 Macronutrient intakes were also analysed and reported in grams (g) and grams per kilogram of body mass $(g \cdot kg^{-1})$. The 263 264 period of 7 days is considered to provide reasonably accurate 265 estimations of habitual energy and nutrient consumptions 266 whilst reducing variability in coding error (Braakhuis et al., 267 2003). On the day prior to data collection, food diaries were 268 explained to players by the lead researcher and an initial dietary 269 habits questionnaire (24 h food recall) was also performed. 270 These questionnaires were used to establish habitual eating 271 patterns and subsequently allow follow up analysis of food 272 diaries. Additionally, they helped to retrieve any potential 273 information that players' may have missed on their food diary 274 input. In addition, EI was also cross referenced from the 275 remote food photographic method (RFPM) in order to have a 276 better understanding of portion size and/ or retrieve any 277 information that players' may have missed on their food diary 278 input. This type of method has been shown to accurately 279 measure the EI of free-living individuals (Martin et al., 2009). 280 To further enhance reliability, and ensure that players missed 281 no food or drink consumption, food diaries and RFPM were 282 reviewed and cross-checked using a 24-hour recall by the lead researcher after one day of entries (Thompson & Subar, 2008).
To obtain energy and macronutrient composition, professional
dietary analysis software (Nutritics Ltd, Ireland) was used.

286 Throughout the duration of this study, meals were 287 consumed at the club's training ground or home ground, a 288 nearby hotel (where the players often reside on match day) or 289 alternatively, the players' own homes or restaurants / cafes. For 290 meals provided at the training ground, home ground or hotel, 291 menus are provided on a buffet style basis where the options 292 provided are dictated by the club nutritionist and catering staff. 293 Throughout the duration of the study, all meals were consumed 294 ad libitum and it was not compulsory to eat the meals provided 295 at the training / home ground or hotel. Whenever the team 296 stayed in a hotel, the club's chef would travel and oversee the 297 food preparation in order to ensure consistency of service 298 provision.

299 On days 3 and 6, players were provided with breakfast 300 and lunch at the training ground whilst on days 1 and 4 players 301 were provided with lunch and dinner at the training ground. On 302 day 2, players were provided with breakfast at the training 303 round and lunch and pre-match meal at a nearby hotel, which 304 the club uses for each home game. On day 5, players were 305 provided with breakfast and pre-match meal at the hotel. On 306 day 7, players were provided with a lunch and post training 307 snack at the training ground and an evening meal at an away308 game hotel.

309 Breakfast options available daily included: eggs, beans, 310 toast, porridge, muesli, fruits and yoghurts. Lunch and dinner 311 had different options that included 1 x red meat option, 1 x 312 poultry option, 1 x fish option, 3-4 carbohydrate options (e.g. 313 pasta, rice, potatoes, quinoa), 2 x vegetable options alongside a 314 salad bar and snacks such as yoghurts, nuts, cereal bars and 315 condiments. During training sessions, players were provided 316 with low calorie isotonic sports drinks (Gatorade G2), water 317 and upon request, isotonic energy gels (Science in Sport GO 318 Istonic Gels). During games, players were provided with sports 319 drinks (Gatorade Sports Fuel), water and isotonic energy gels 320 (Science in Sport GO Istonic Gels). All carbohydrate provided 321 during training and matches were consumed ad libitum.

322

323 Statistical Analysis

324 All data are presented as the mean \pm standard deviation 325 (SD). Training load data are shown for descriptive purposes 326 only. Daily energy and macronutrient intake were analysed 327 using one-way repeated measures ANOVAs. When there was a 328 significant (P < 0.05) effect of "day", Tukey post-hoc pairwise 329 comparisons were performed to identify which day differed. 330 The normal distribution of differences between data pairs was 331 verified with Shapiro-Wilk tests (P>0.05 for all variables).

332	Paired Student's t tests (with statistical significance set at
333	P < 0.05) were then used to assess the differences between the
334	average daily EI and EE, the difference between CHO intake
335	during training and matches, the difference between EI and
336	CHO intake on match days vs. training days, and changes in
337	body mass from before to after the study period. In all the
338	analyses, the mean difference standardized by the between-
339	subject standard deviation was used as the effect size (ES). The
340	magnitude of the ES was evaluated as trivial (>0.2), small
341	(>0.2 to 0.6), moderate (>0.6 to 1.2), large (>1.2 to 2.0), very
342	large (>2.0 to 4.0), and extremely large (>4.0) (Hopkins et al.,
343	2009). The statistical analysis was carried out with R, version
344	3.3.1.

346 **Results**

347 Quantification of Daily and Accumulative Weekly Load

An overview of the individual daily training and match
load and the accumulative weekly load is presented in Tables 1
and 2, respectively.

351

352 **Quantification of Energy and Macronutrient Intake**

353

A comparison of daily energy and macronutrient intake is presented in Figure 1. Daily absolute and relative EI and CHO intake was significantly different across the 7-day period

357	(all P<0.05). Specifically, players reported greater absolute and
358	relative EI on day 2 (i.e. match day 1) compared with days 1
359	(both P<0.05 and both ES = 1.0, moderate) and 3 (both P<0.05
360	and both $ES = 1.1$, moderate). On day 5 (i.e. match day 2),
361	players reported higher absolute and relative EI compared with
362	days 1, 3, 4 and 6 (all P<0.05; ES for absolute EI equal to 1.9
363	(large), 1.9 (large), 1.8 (large), and 2.1 (very large); ES for
364	relative EI equal to 1.4, 1.5, 1.6, 1.6 (all large)). Additionally,
365	players reported higher absolute and relative EI on day 7
366	compared with day 4 (both P<0.05; $ES = 0.9$ (moderate) for
367	absolute EI and 0.6 (small) for relative EI) as well as higher
368	absolute EI on day 5 compared to day 2 (P= 0.03 ; ES = 0.9 ,
369	moderate).

371 In relation to CHO intake, both absolute (all P<0.01) 372 and relative intake (all P<0.01) was greater on day 2 compared 373 to days 1 (ES = 1.1 and 0.9 (both moderate), respectively for 374 absolute and relative intake), 3 (ES = 1.5 and 1.3 (both large))375 respectively for absolute and relative intake), 4 (ES = 1.4376 (large) and 1.2 (moderate), respectively for relative and 377 absolute intake), and 6 (ES = 1.6 and 1.4 (both large), 378 respectively for absolute and relative intake). On day 5, both 379 absolute and relative CHO intakes were higher than days 1 380 (both P<0.02; ES = 1.5 and 1.3 respectively for absolute and 381 relative intake, both large) and 6 (both P<0.02; ES = 1.1 and 382 1.1 respectively for absolute and relative intake, both 383 moderate). Absolute CHO intake was also higher on day 5 384 compared to day 4 (P=0.05; ES = 2.0, large), but did not 385 achieve significance when expressed relatively (P=0.06).

386

In contrast to energy and CHO intake, there was no significant difference between days in the reported absolute protein (P=0.29), relative protein (P=0.31), absolute (P=0.16) and relative fat (P=0.16) intake.

391

392 Energy and Macronutrient Intake on Training vs. Match393 Days

394 EI and EI relative to LBM were also greater (both P<0.05; ES 395 = 2.2 (very large) and 1.7 (large), respectively for absolute and 396 relative EI) on match days (3789 \pm 532 kcal; 61.1 \pm 11.4 397 kcal·kg⁻¹ LBM) compared with training days (2956 \pm 374 kcal; 45.2 ± 9.3 kcal·kg⁻¹ LBM, respectively). Additionally, CHO 398 399 intake and CHO intake relative to body mass were also greater 400 (both P<0.05; ES = 1.8 (large) and 4.2 (very large), 401 respectively for absolute and relative CHO, respectively, both 402 large) on match days $(330 \pm 98 \text{ g}; 6.4 \pm 2.2 \text{ g} \cdot \text{kg}^{-1})$ compared with training days $(508 \pm 152 \text{ g}; 4.2 \pm 1.4 \text{ g} \cdot \text{kg}^{-1})$. 403

404

405 Carbohydrate intake during training and games

406 The mean quantity of CHO consumed during the two 407 competitive matches $(32.3 \pm 21.9 \text{ g.h}^{-1}; \text{Player 1-6 data: } 25.1,$ 408 24.8, 70.9, 29.9, 38.3 and 4.9 g.h⁻¹, respectively) was 409 significantly higher (P<0.05) than that consumed during training sessions $(3.1 \pm 4.4 \text{ g.h}^{-1}; \text{Player 1-6 data: } 0, 0.3, 11, 0,$ 410 411 5.7 and 1.6 g.h⁻¹, respectively), with an ES of 6.6 (extremely large). During training, 80 and 20% of the CHO consumed was 412 413 provided from gels and fluid, respectively. During match play, 414 63 and 37% of the CHO consumed was provided from gels and 415 fluids, respectively.

416

417 Energy Expenditure vs. Energy Intake

There were no significant differences (P=0.16; see Table 3) between average daily EE (3566 ± 585 kcal) and EI (3186 ± 367 kcal), although one player did exhibit markedly lower self-reported EI compared with EE (see player 6). Accordingly, players' body mass did not significantly change (P=0.84) from before (80.4 ± 7.9 kg) to after the 7-day study period (80.3 ± 7.9 kg).

- 425
- 426

427 Discussion

The aim of the present study was to simultaneously quantify EI, EE, training and match load across a 7-day inseason period. In order to study a weekly playing schedule 431 representative of elite professional players, we studied players 432 competing in the EPL during a weekly micro-cycle consisting 433 of two match days and five training days. To our knowledge, 434 we are also the first to report direct assessments of EE (using 435 the DLW method) in an elite soccer team competing in the EPL 436 and European competitions over a 7-day period. In relation to 437 the specific players studied herein, our data suggest that elite 438 players' daily energy expenditure can range from 3047 to 4400 439 kcal per day. Additionally, players also practice elements of 440 CHO periodization such that absolute daily CHO intake and 441 exogenous CHO feeding is greater on match days compared 442 with training days.

443

444 Key parameters of the physical loading reported here is 445 similar to that previously observed by our group during a two 446 game per week micro-cycle (Anderson et al., 2015), albeit 447 where five days was present between games as opposed to the 448 two-day period studied here. Indeed, similar accumulative 449 weekly high-speed running (1322 v 1466 m, respectively) and 450 sprint (430 v 519 m, respectively) distance were observed. This 451 result was expected given that such high-intensity loading 452 patterns are largely reflective of game time as opposed to 453 training time (Anderson et al., 2016). Interestingly, the weekly 454 accumulative total distance reported here was less than that 455 observed previously (26.4 v 32.5 km), a finding likely

456 attributable to the greater frequency of training sessions
457 completed by each player during the five-day interim period
458 (Anderson et al., 2015). Such data reiterate how subtle
459 alterations to the match and training schedule affects weekly
460 loading patterns.

461

462 The mean daily EI and EE data reported here suggest 463 that elite players are capable of matching overall weekly energy 464 requirements. It is noteworthy, however, that despite no player 465 experiencing body mass loss or gain during the study period, 466 two players appeared to be under-reporting EI as evidenced by 467 a mismatch between EI versus EE data. The mean daily EE 468 $(3566 \pm 585 \text{ kcals})$ and EI $(3186 \pm 367 \text{ kcals})$ observed here 469 agrees well that previously observed in professional Japanese 470 players (3532 ± 432 and 3113 ± 581 kcal, respectively) where 471 both DLW and 7-day food diaries were also used as 472 measurement tools (Ebine et al., 2002). Although these authors 473 did not provide any data related to physical loading, the 474 similarity between studies is likely related to these researchers 475 also studying a two-game per week playing schedule where 476 consecutive games were also separated by two days. 477 Interestingly, our EE data are much lower than that reported by 478 our group for professional rugby players (5378 \pm 645 kcal), 479 thereby providing further evidence that nutritional guidelines

480 for team sports should be specific to the sport and athlete in481 question (Morehen et al., 2016)

482

483 A limitation of the DLW technique is the inability to 484 provide day-to-day EE assessments hence data are expressed as 485 mean daily EE for the 7-day data collection period. 486 Nonetheless, the players studied here appear to adopt elements 487 of CHO periodization in accordance with the upcoming 488 physical load and likely differences in day-to-day EE. For 489 example, both absolute and relative daily energy and CHO 490 intake was greater on match days (3789 \pm 532 kcal and 6.4 \pm 491 2.2 g·kg⁻¹, respectively) compared with training days (2948 \pm 492 347 kcal and 4.2 ± 1.4 g·kg⁻¹, respectively). Such differences in 493 daily EI also agrees with recent observations from adult 494 professional players of the Dutch league (Bettonviel et al., 495 2016) where subtle differences were observed between match 496 days, training days and rest days $(3343 \pm 909, 3216 \pm 834 \text{ and}$ 497 2662 ± 680 kcal, respectively). It is also noteworthy that we 498 observed greater energy intake on day 7 (prior to another match 499 undertaken on day 8) versus day 4 (prior to match day 2). Such 500 differences may reflect additional energy intake that is 501 consumed prior to and during travelling (i.e. snacks provided 502 on the bus) to the away game on day 8. We also observed CHO 503 ingestion was significantly lower during training sessions (3.1 \pm 4.4 g.min⁻¹) compared with matches (32.3 \pm 21.9 g.min⁻¹). It 504

is, of course, difficult to ascertain whether such alterations to
CHO fuelling patterns were a deliberate choice of the player
and/or a coach (sport scientist) led practice or moreover, an
unconscious choice.

509

510 In the context of a two game week, it is likely that 511 players did not consume adequate CHO to optimize muscle 512 glycogen storage in the day prior to and in recovery from the 513 games (Bassau et al., 2002; Krustrup et al., 2006). This point is 514 especially relevant considering the inability to fully replenish 515 muscle glycogen content in type II fibres 48 h after match play, even when CHO intake is > 8 $g \cdot kg^{-1}$ body mass per day 516 517 (Gunnarsson et al., 2013). In relation to match day itself, it is 518 noteworthy that four players did not meet current CHO 519 guidelines (30-60 g.h⁻¹) for which to optimize aspects of 520 physical (Burke et al., 2011), technical (Ali & Williams, 2009; 521 Russell et al., 2012) and cognitive (Welsh et al., 2002) 522 performance. Interestingly, CHO intake during match play was 523 highest in players 3 and 5 who also tended to be the players 524 (midfielders) with the greatest physical load on match days. 525 Positional differences may therefore contribute to habitual 526 fuelling strategies. When taken together, data suggest that 527 players may benefit from consuming greater amounts of CHO 528 in the day prior to and in recovery from match play (so as to 529 optimize muscle glycogen storage) as well as consumer greater amounts of CHO during exercise to maximize theaforementioned components of soccer performance.

532

533 Although we observed evidence of CHO periodization 534 during the week, players reported consistent daily protein and 535 fat intakes. Interestingly, absolute and relative daily protein 536 intakes were higher $(205 \pm 30 \text{ g})$ than that reported two decades 537 ago in British professional players (108 \pm 26 g), whereas both 538 CHO and fat intake were relatively similar (Maughan, 1997). 539 Our observed daily protein intakes also agree well with those 540 reported recently (150-200 g) in adult professional players from 541 the Dutch league (Bettonviel et al., 2016). Such differences 542 between eras are potentially driven by the increased scientific 543 research and resulting athlete (and coach) awareness of the role 544 of protein in facilitating training adaptations and recovery from 545 both aerobic and strength training (Moore et al., 2014; 546 McNaughton et al., 2016).

547

548 In summary, we simultaneously quantified for the first 549 time the daily physical loading, EI and EE during a weekly 550 micro-cycle of elite level soccer players from the English 551 Premier League. Although players appear capable of matching 552 daily energy requirements to EI, we also observed elements of 553 CHO periodization in that players consumed higher amounts of 554 CHO on match days versus training days. Whilst daily protein 555 intake was consistent throughout the week, absolute daily 556 protein intake was greater than previously reported in the 557 literature. Moreover, CHO intakes were below that which is 558 currently recommended for when players are completing 2 559 competitive games in close proximity to one another.

560

561

562 Acknowledgements

563

The authors would like to thank all of the participating players for the cooperation and commitments during all data collection procedures. We would also like to thank the team's coaches for cooperation during data collection.

568

569 Author Contributions

570 Each author contributed as follows: LA, GLC, RM, BD and 571 JPM conceived and designed the experiments. LA, PO, JM, 572 DR, AOB, JL performed sample collection. LA, PO, RJN, JM, 573 RDM, CH, JRS performed analytical measures and related data 574 analysis. LA and JPM wrote the manuscript and all authors 575 revised and critically evaluated the manuscript for important 576 intellectual content. All authors approved the final version of 577 the manuscript prior to submission and are accountable for data 578 accuracy and integrity.

References

- 589 Akenhead, R., Harley, J. A., & Tweddle, S.P. (2016).
 590 Examining the external training load of an English premier
 591 league football team with special reference to acceleration. J
 592 Strength Cond Red, 30, 2424-2432.
- Ali, A., & Williams, C. (2009). Carbohydrate ingestion and
 soccer skill performance during prolonged intermittent
 exercise. *J Sports Sci*, 27, 1499-1508.

598 Anderson, L., Orme, P., Di Michele, R., Close, G.L., Morgans,

R., Drust, B., & Morton, J.P. (2015). Quantification of training
load during one-, two- and three-game week schedules in
professional soccer players from the English Premier League:
implications for carbohydrate periodization. *J Sports Sci, 4,* 110.

605	Anderson, L., Orme, P., Di Michele, R., Close, G.L., Milsom,
606	J., Morgans, R., Drust, B., & Morton, J.P. (2016).
607	Quantification of Seasonal Long Physical Load in Soccer
608	Players With Different Starting Status From the English
609	Premier League: implications for Maintaining Squad Physical
610	Fitness. Int J Sports Physiol Perform, epub ahead of print.

Areta, J.L., Burke, L.M., Ross, M.L., Camera, D.M., West,
D.W., Broad, E.M., Coffey, V.G. (2013). Timing and
distribution of protein ingestion during prolonged recovery
from resistance exercise alters myofibrillar protein synthesis. J *Physiol, 591, 2319-2331.*

- 617
- Bartlett, J.D., Hawley, J.A., & Morton, J.P. (2015).
 Carbohydrate availability and exercise training adaptation: Too
 much of a good thing? *Eur J Sport Sci, 15,* 3-12.
- 621
- Bussau, V.A., Fairchild, T.J., Rao, A., Steele, P., & Fournier,
 PA. (2002). Carbohydrate loading in human muscle: an
- 624 improved 1 day protocol. *Eur J Appl Physiol*, 87, 290-295.
- 625
- Bettonviel, A.EO., Brinkmans, N.Y.J., Russcher, K.,
 Wardenaar, F.C., & Witard, O.C. (2016). Nutritional status and
 daytime pattern of protein intake on match, post-match, rest

- and training days in senior professional and youth elite soccerplayers. *Int J Sport Nutr Exerc Metab, epub ahead of print.*
- 631
- Berman, E.S., Fortson, S.L., Snaith, S.P., Gupta, M., Baer,
 D.S., Chery, I., Blanc, S., Melanson, E.L., Thompson, P.J., &
 Speakman, J.R. (2012). Direct analysis of delta2H and delta180
 in natural and enriched human urine using laser-based, off-axis
 integrated cavity output spectroscopy. *Anal Chem, 84*, 97689773.
- 638
- Braakhuis, A.J., Meredith, K., Cox, G.R., Hopkins, W.G., &
 Burke, L.M. (2003). Variability in estimation of self-reported
 dietary intake data from elite athletes resulting from coding by
 different sports dietitians. *International Journal of Sport Nutrition, 13*, 152-165.
- 644
- 645 Bradley, P.S., Sheldon, W., Wooster, B., Olsen, P., Boanas, P.,
- 646 & Krustrup, P. (2009). High-intensity running in English FA
- 647 Premier League soccer matches. J Sports Sci, 27, 159-168.
- 648
- 649 Burke, L.M., Hawley, J.A., Wong, S.H., & Jeukendrup, A.E.
 650 (2011). Carbohydrates for training and competition. *J Sports*651 *Sci*, 29, 17-27.
- 652

- Burke, L.M., Loucks, A.B., & Broad, N. (2006). Energy and
 carbohydrate for training and recovery. *J Sports Sci, 24*, 675685.
- 656
- 657 Bush, M., Barnes, C., Archer, D.T., Hogg, B., & Bradley, P.S.
- (2015). Evolution of match performance parameters for various
 playing positions in the English Premier League. *Hum Mov Sci*, *39*, 1-11.
- 661
- 662 Chamari, K., Haddad, M., Wong del, P., Dellal, A., &
 663 Chaouachi, A. (2012). Injury rates in professional soccer
 664 players during Ramadan. *J Sports Sci, 30*, 93-102.
- 665
- 666 Craig, H. (1961). Standard for Reporting Concentrations of
 667 Deuterium and Oxygen-18 in Natural Waters. *Science*, *133*,
 668 1833-1834.
- 669
- 670 Di Salvo, V., Collins, A., McNeil, B., & Cardinale, M. (2006).
- 671 Validation of ProZone[®]: A new video-based performance
 672 analysis system. *Int J Perf Anal Sport, 6*, 108-109.
- 673
- 674 Di Salvo, V., Gregson, W., Atkinson, G., Tordoff, P., & Drust,
- 675 B. (2009). Analysis of high intensity activity in Premier League
- 676 soccer. Int J Sports Med, 30, 205-212.
- 677

Di Salvo, V., Baron, R., González-Haro, Gormasz, C., Pigozzi,
F., & Bachl, N. (2010). Sprinting analysis of elite soccer
players during European Champions League and UEFA Cup
matches. *J Sports Sci, 28,* 1489-1494.

682

Ebine, N., Rafamantanantsoa, H.H., Nayuki, Y., Yamanaka, K.,
Tashima, K., Ono, T., Saitoh, S., & Jones, P.J. (2002).
Measurement of total energy expenditure by the doubly labeled
water method in professional soccer players. *J Sports Sci, 20*,
391-397.

688

689 Gunnarsson, T.P., Bendiksen, M., Bischoff, R., Christensen,

P.M., Lesivig, B., Madsen, K., ... Bangsbo, J. (2013). Effect of
whey protein- and carbohydrate-enriched diet on glycogen
resynthesis during the first 48 h after a soccer game. *Scand J Med Sci Sports*, 23, 508-515.

694

Hawley, J.A., & Morton, J.P. (2014). Ramping up the signal:
promoting enurance training adaptation in skeletal muscle by
nutritional manipulation. *Clin Exp Pharmacol Physiol*, *41*, 608-*613*.

699

700 Impey, S.G., Hammon, K.M., Shepherd, S.O., Sharples, A.P.,

701 Stewart, C., Limb, M., Smith, K., Philp, A., Jeromson, S.,

702 Hamilton, D.L., Close, G.L., & Morton, J.P. (2016). Fuel for

- the work required: a practical approach to amalgamating trainlow paradigms for endurance athletes. *Physiol Rep, 4*, e12803.
- Jeukendrup, A. (2014). A step towards personalized sports
 nutrition: carbohydrate intake during exercise. *Sports Med*, *44*,
 25-33.
- 709
- Krustrup, P., Mohr, M., Steensberg, A., Bencke, J., Kjer, M., &
 Bangsbo, J. (2006). Muscle and blood metabolites during a
 soccer game: Implications for sprint performance. *Med Sci Sports Exerc, 38*, 1165-1174.
- 714
- Malone, J.J., Di Michele, R., Morgans, R., Burgess, D.,
 Morton, J.P., & Drust, B. (2015). Seasonal training-load
 quantification in elite English premier league soccer players. *Int J Sports Physiol Perform, 10*, 489-497.
- 719
- Martin, C.K., Han, H., Coulon, S.M., Allen, H.R., Champagne,
 C.M., & Anton, S.D. (2009). A novel method to remotely
 measure food intake of free-living people in real-time: The
 remote food photography method (RFPM). *B J Nutr, 101,* 446456.
- 725

- 729
- Morehen, C.M., Bradley, W.J., Clarke, J., Twist, C., Hambly,
 C., Speakman, J.R., Morton, J.P., & Close, G.L. (2016). The
 assessment of total energy expenditure during a 14-day 'inseason' period of profressional rugby league players using the
 Doubly Labelled Water method. *Int J Sport Nutr Exerc Metab, epub ahead of print.*
- 736
- 737 Macnaughton, L.S., Wardle, S.L., Witard, O.C., McGlory, C.,
- 738 Hamilton, D.L., Jeromson, S., Lawrence, C.E., Wallis, G.A., &
- Tipton, K.D. (2016). The response of muscle protein synthesis
 following whole-body resistance exercise is greater following
 40 g than 20 g of ingested whey protein. *Physiol Rep, 4*,
 e12893.
- 743

Milsom, J., Naughton, R., O'Boyle, A., Iqbal, Z., Morgans, R.,
Drust, B., & Morton, J.P. (2015). Body composition
assessment of English Premier League soccer players: a
comparative DXA analysis of first team, U21 and U18 squads. *J Sports Sci, 33*, 1799-1806.

Moore, D.R., Churchward-Venne, T.A., Witard, O., Breen, L.,
Burd, N.A., Tipton, K.D., & Phillips, S.M. (2014). Protein
ingestion to stimulate myofibrillar protein synthesis requires
greater relative protein intakes in healthy older versus younger
men. *J Gerontol A Biol Sci Med Sci*, *70*, 57-62.

- 755
- Morgans, R., Orme, P., Anderson, L., Drust, B., & Morton, J.P.
 (2014). An intensitve Winter fixture schedule induces a
 transient fall in salivary IgA in English premier league soccer
- 759 players. Res Sports Med, 22, 346-354.
- 760
- 761 Nagy, K. (1983). The Doubly Labelled Water (3HH180)
 762 Method: a Guide to its Use. Los Angeles, CA: UCLA
- 763 Publication 12-1417.
- 764
- Reilly, T., & Thomas, V. (1979). Estimated daily energy
 expenditures of professional association footballers. *Ergonomics*, 22, 541-548.
- 768
- Russell, M., Benton, D., & Kingsley, M. (2012). Influence ofcarbohydrate supplementation on skill performance during a
- soccer match simulation. J Sci Med Sport, 15, 348-354.
- 772
- 773 Russell, M., Sparkes, W., Northeast, J., Cook, C.J., Love, T.D.,
- 774 Bracken, R.M., & Kilduff, L.P. (2016). Changes in acceleration

- and deceleration capacity throughout professional soccer match
 play. *J Strength Cond Res, 30*, 2839-2844.
- 777
- Schoeller, D.A. (1988). Measurement of energy expenditure in
 free-living humans by using doubly labeled water. *J Nutri*, *118*,
 1278-1289.
- 781
- Schoeller, D. A., Ravussin, E., Schutz, Y., Acheson, K. J.,
 Baertschi, P., & Jequier, E. (1986). Energy expenditure by
 doubly labeled water: validation in humans and proposed
 calculation. *Am J Physiol, 250*, R823-830.
- 786
- 787 Speakman, J.R. (1997). *Doubly Labelled Water; Theory and*788 *Practice*. London: Chapman & Hall.
- 789
- 790 Thompson, F., & Subar, A. (2008). Dietary assessment
- 791 methodology. In A. M. Coulston & C.J. Boushey (Eds.),
- 792 *Nutrition in the prevention and treatment of disease* (pp. 3-39).
- 793 San Diego, CA: Academic Press.
- 794
- Welsh, R.S., Davis, J.M., Burke, J.R., & Williams, H.G.
 (2002). Carbohydrates and physical/mental performance during
 intermittent exercise to fatigue. *Med Sci Sports Exerc, 34*, 723731.
- 799
- 800

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Table 1. Training and match load variables (representative of average daily data in bold and individual data from players 1-6) completed in the 7-day testing period. Running distance = distance covered between 14.4-19.8 km/h, high-speed running distance = distance covered between 19.8-25.2 km/h and sprinting distance = distance covered >25.2 km/h. Each player's position is shown in brackets. CF=Centre Forward, WD=Wide Defender, WM=Wide Midfielder, CDM=Central Defending Midfielder, CAM= Central Attacking Midfielder and CD=Central Defender.

$\begin{array}{ c c c c c c c c c c c c c c c c c c c$				D	ay			
Duration (min) 52 ± 26 97 ± 42 17 ± 29 46 ± 0 76 ± 39 8 ± 20 34 ± 0 1 (CT)63125046710342 (WD)63125046500344 (CDA)63125046500344 (CDA)63125046560345 (CAA)63125046560346 (CD)032046560347 (ADA)63125046560346 (CD)032611610216210302010222 (WD)2675117980216210302010223 (WA)338456219782234973010224 (CAA)32814730023497301131Ar Speed minini459 ±1381007 ± 507201 ± 512472 ± 738953 ± 49714.9 ± 56.6452 ± 5.01 (WD)2.41109.40475100.504244241334045.41 (WD)2.41199.40475105.8102.7045.445.41 (WD)2.41109.40475105.8045.445.41 (WD)4.51109.404.51106.4055.4001 (WD)		1	2	3	4	5	6	7
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$\begin{array}{c c c c c c c c c c c c c c c c c c c $	1 (CF)	63	125	0	46	71	0	24
3 (Nb)63555446960244 (CM)63125046960245 (CA)63125046960246 (CD)0122046960247 (D)2067161125046960247 (D)2561131036 ± 1782187 ± 355887 ± 487715 ± 17511061 ± 1861 (CF)2059117980216210302010223 (WA)35344562197822771293010234 (CDA)36031331302040223497304255 (CD)2022430243979044.27 (VD)52.11007 ± 90720.1 ± 31.2478 ± 7.897.8044.21 (CF)52.11007 ± 907042.397.9044.21 (CF)52.11007 ± 907044.297.9044.21 (CF)52.11007 ± 907044.297.9044.21 (CF)13.11007043.3100.9046.41 (CF)14.945.946.645.445.645.44 (CDM)45.8140.213.3014.216.41 (CF)16132.91010.710.635.6001 (CF)18 </td <td>2 (WD)</td> <td>63</td> <td>125</td> <td>0</td> <td>46</td> <td>96</td> <td>0</td> <td>24</td>	2 (WD)	63	125	0	46	96	0	24
4 (CDM) 5 (CAM)63 63125 1250 046 460 6648 6624 24 24 66 Total Discore (m) 2 (CF) 286 2 (CF) 178 1 (CF) 105 2 (CF) 178 1 (CF) 1076 1 (CF) 1076 1 (CF)1 (CF) 2 (CF) 266 2 (CF) 11631 1 (SF) 1055 1 (SF) 2187 2 (SF) 2187 4 (CF) 1075 0 (DF) 1076 1 (DF)1 (CF) 2 (CF) 2669 1 (SF) 1078 1 (SF) 1078 1 (SF) 1076 1 (SF) 1076	3 (WM)	63	55	34	46	96	0	24
$5 (2AM)$ $6 (C)$ $6 (C)$ $6 (C)$ 21 125 $0 (C)$ 46 96 0 24 Total Disance (m) $2 (ND)$ 2865 ± 164 9746 ± 598 1036 ± 178 2157 ± 35 827 ± 474 715 ± 1751 1061 ± 186 $1 (ND)$ 2679 11798 0 2162 00303 0 1072 $2 (ND)$ 2579 11798 0 2162 01033 0 1022 $2 (ND)$ 3384 4552 1737 0 1263 0 4230 737 $5 (CAM)$ 3063 13513 0 1680 0 4230 737 $5 (CM)$ 3063 1553 0 2243 4240 2234 9730 0 4425 $2 (ND)$ 44.1 1057 0 42.8 97.9 0 44.2 303 $2 (ND)$ 44.1 1057 0 42.8 97.9 0 44.2 $2 (ND)$ 44.1 1057 0 42.8 97.9 0 44.2 $2 (ND)$ 51.5 122.2 0 42.8 97.9 0 44.2 $2 (ND)$ 51.5 122.2 0 45.6 10.6 0 0 44.2 $2 (ND)$ 15.7 123.2 0 46.4 36.4 10.6 0 0 $2 (ND)$ 15.7 123.2 0 36.6 10.2 37.6 0 0 $2 (ND)$ 15.7 173.4 0 12.5 </td <td>4 (CDM)</td> <td>63</td> <td>125</td> <td>0</td> <td>46</td> <td>0</td> <td>48</td> <td>24</td>	4 (CDM)	63	125	0	46	0	48	24
6 (CD)032684696024Total Distance (m)2865 ± 14949746 ± 5098106 ± 175812197 ± 355827 ± 4874715 ± 17511016 ± 1861 (C5)2326115310216710203010233 (WD)233415521073116710203010234 (CDM)4258147300235613133013065 (CAM)4258147300235613133013066 (CD)02411057042249733013061 (C5)241105704289068044233 (WD)241105704289068044234 (CDM)2411057055.895.897.8149.256.44 (CDM)57.5122.2036.6089.538.44 (CDM)57.5122.2036.6089.535.66 (CD)0063.448.8100.9046.41 (C5)1817741232252606001 (C5)18179401072732001 (C5)3173908473003 (WA)1647171232252606001 (C5)3173908473001 (C5)<	5 (CAM)	63	125	0	46	96	0	24
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	6 (CD)	0	32	68	46	96	0	24
I (CD, VD) 2006^{00} 1163^{00} 1163^{00} 100^{00} 100^{00} 1161^{00} 100^{00} 3 (WM)3384 4562 1978 2727 12793 0 1002 3 (WM)3384 4562 1978 2727 12793 0 1002 5 (CAM) 4228 14730 0 2256 13153 0 1306 6 (CD)0 2233 2234 9733 0 1313 Ar. Speed (nvinin) $459 + 22.8$ $1007 + 807$ $20.1 + 31.2$ $47.8 + 7.8$ $95.8 + 49.7$ $14.9 + 38.6$ $45.2 + 50$ 2 (WD) 44.1 $1007 + 807$ 0 47.5 100.8 0 42.5 2 (WD) 54.0 132.6 57.4 45.8 100.5 0 42.5 3 (WM) 54.0 132.2 0 36.6 0 89.5 38.4 4 (CDM) 77.5 122.2 0 36.6 0 89.5 38.4 4 (CDM) 67.5 122.2 0 36.6 0 89.5 38.4 6 (CD)0 0 0 43.4 136.4 0 0 4.6 6 (CD)186 1490 0 43.8 100.9 0 0 0 1 (CP) 18.6 1490 0 43.8 100.5 0 0 3 (WM) 166 717 123.2 225 2206 0 0 0 1 (CP) 31 739 0	Total Distance (m)	2865 ± 1404	0746 ± 5008	1036 ± 1758	2187 ± 255	8827 + 4874	715 ± 1751	1061 ± 186
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		2003 ± 1474	11621	1030 ± 1738	1064	6091	115 ± 1751	1076
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	2 (WD)	3200	11709	0	2162	10202	0	1070
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	2 (WD) 2 (WM)	2079	11/98	1078	2102	10502	0	1022
4 (LDA)360313130168004.2904.2907.375 (CAN)425814730022551133013606 (CD)022434240225497330136Ar. Speed (mini)459 ± 2381007 ± 50.720.1 ± 31.247.8 ± 7.895.8 ± 497149.± 6.6452.5 ± 50.71 (CD)41.1109.4047.595.8 ± 497149.± 6.6452.5 ± 50.71 (CD)44.1109.4047.590.6 ± 8.538.43 (WN)54.0132.657.459.8105.8044.23 (WN)54.6132.6036.6089.538.45 (CAN)68134.2051.4136.4033.66 (CD)063.448.8100.9046.41 (CF)1861490043845002 (WD)115175401081646003 (WM)1667171232252606003 (WM)18425130330004 (CDM)37.5268601072732005 (CAM)37.5268601072732006 (CD)0036.66650001 (CF)31739081081002 (WD)21 <td< td=""><td>5 (WM)</td><td>3584</td><td>4362</td><td>1978</td><td>2/2/</td><td>12795</td><td>0</td><td>1092</td></td<>	5 (WM)	3584	4362	1978	2/2/	12795	0	1092
S (CAN)42.5814/300225013133013006 (CD)022434240223497330131Av. Speel (minin)45.9 ± 23.81007 ± 50.720.1 ± 31.247.8 ± 7.895.8 ± 90.714.9 ± 36.645.2 ± 501 (VD)34.1109.4047.5106.8042.52 (WD)34.1109.4047.5106.8042.53 (WN)54.0132.657.459.8132.7046.44 (CDM)57.5122.2036.6089.538.45 (CAN)68134.2051.4136.4053.66 (CD)0063.448.8100.9046.47 (CF)181528175401081546001 (CF)1814532636033039.913 (WN)145175401081546004 (CDM)34251303720.0006 (CD)06275571067001 (DF)343920841.3001 (CF)3439.20841.3001 (CF)3439.20841.3002 (WD)2190.6036665002 (WD)2190.6<	4 (CDM)	3003	13513	0	1680	0	4290	131
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Av. Speed (mbmin)45.9 ± 2.38100.7 ± 0.720.1 ± 31.247.8 ± 7.895.8 ± 49.714.9 ± 36.645.2 ± 5.01107.4107.4047.5106.8042.52 (WD)54.0132.657.459.8132.7042.54 (CDM)57.5122.2036.6089.538.45 (CD)00063.448.8100.9046.46 (CD)0063.448.8100.9046.47 (MD)115175401081646002 (WD)115175401081646002 (WD)1151754033039913 (WD)16677.7103106106004 (CDM)184251303039915 (CAM)752755710670006 (CD)06275571067007 (WD)21790084730003 (WA)4317129010810006 (CD)012700810810007 (WD)1270017010670006 (CD)0366017700007 (WD)21796 <td>6 (CD)</td> <td>0</td> <td>2243</td> <td>4240</td> <td>2234</td> <td>9733</td> <td>0</td> <td>1131</td>	6 (CD)	0	2243	4240	2234	9733	0	1131
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Av. Speed (m/min)	45.9 ± 23.8	100.7 ± 50.7	20.1 ± 31.2	$\textbf{47.8} \pm \textbf{7.8}$	95.8 ± 49.7	14.9 ± 36.6	45.2 ± 5.0
$2 (WD)$ 44.1 109.4 0 47.5 106.8 0 42.5 $3 (WM)$ 54.0 132.2 0 36.6 0 89.5 38.4 $4 (CDM)$ 67.5 122.2 0 36.6 0 89.5 38.4 $6 (CD)$ 0 0 0 51.4 136.4 0 53.6 $6 (CD)$ 0 0 63.4 48.8 100.9 0 46.4 Running Distance (m) 171 ± 122 152 ± 1033 66 ± 114 91 ± 77 1483 ± 1061 67 ± 163 0 $2 (WD)$ 115 1754 0 108 1646 0 0 0 $2 (WD)$ 115 1754 0 108 1646 0 0 $4 (CDM)$ 184 2513 0 3 0 399 1 $5 (CAM)$ 375 2686 0 107 2732 0 0 $6 (CD)$ 0 6 275 57 1067 0 0 $1 (CF)$ 31 739 0 8 473 0 0 $1 (CF)$ 31 739 0 8 6653 0 0 $3 (WM)$ 4 317 12 90 1081 0 0 $3 (WM)$ 4 317 12 90 1081 0 0 $5 (CAM)$ 70 1270 0 8 1081 0 0 $6 (CD)$ 0 1332 0	1 (CF)	52.1	105.7	0	42.8	97.9	0	44.2
$3 (WM)$ 54.0 132.6 57.4 59.8 132.7 0 46.4 $4 (CDM)$ 57.5 122.2 0 36.6 0 89.5 38.4 $5 (CAM)$ 68 134.2 0 51.4 136.4 0 53.6 $6 (CD)$ 0 0 63.4 48.8 100.9 0 46.4 Ruming Distance (m) 171 ± 122 1528 ± 103.3 66 ± 114 91 ± 77 1483 ± 1061 67 ± 163 0 $1 (CP)$ 186 1490 0 43 845 0 0 0 $2 (WD)$ 115 1754 0 108 1666 0 0 $3 (WM)$ 166 717 123 225 2606 0 0 $4 (CD)$ 375 2686 0 107 2732 0 0 $6 (CD)$ 0 6 275 57 1067 0 0 $1 (CF)$ 31 739 0 8 473 0 0 $1 (CF)$ 31 739 0 8 473 0 0 $1 (CF)$ 31 739 0 8 1081 0 0 $3 (WM)$ 4 317 12 90 1081 0 0 $4 (CDM)$ 34 592 0 0 0 0 0 $5 (CAM)$ 70 1270 0 8 1081 0 0 $5 (CAM)$ 70 1332 0 </td <td>2 (WD)</td> <td>44.1</td> <td>109.4</td> <td>0</td> <td>47.5</td> <td>106.8</td> <td>0</td> <td>42.5</td>	2 (WD)	44.1	109.4	0	47.5	106.8	0	42.5
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	3 (WM)	54.0	132.6	57.4	59.8	132.7	0	46.4
5 (CAM) 6 (CD) 68 134.2 0 51.4 136.4 0 53.6 Running Distance (m) 2 (WD) 171 ± 122 1528 ± 1033 66 ± 114 91 ± 77 1483 ± 1061 67 ± 163 0 Running Distance (m) 171 ± 122 1528 ± 1033 66 ± 114 91 ± 77 1483 ± 1061 67 ± 163 0 2 (WD) 115 1754 0 108 1646 0 0 3 (WM) 166 717 123 225 2606 0 0 4 (CDM) 184 2513 0 3 0 399 1 5 (CAM) 375 2686 0 107 2732 0 0 6 (CD) 0 6377 275 57 1067 0 0 0 (CF) 31 739 0 8 473 0 0 1 (CF) 31 739 0 8 473 0 0 2 (WD) 21 906 0 36 665 0 0 4 (CDM) 34 552 0 0 0 0 0 0 0 5 (CAM) 70 224 196 ± 146 0 5 ± 7 273 ± 167 0 0 0 1 (CF) 0 332 0 0 14 379 0 0 0 1 (CF) 0 332 0 0 14 379 0 0 0 1 (CF)	4 (CDM)	57.5	122.2	0	36.6	0	89.5	38.4
6 (CD)0063.448.8100.9046.4Running Distance (m)171 ± 1221528 ± 103366 ± 11491 ± 771483 ± 106167 ± 16301 (CF)18614900438450002 (WD)115175401081446003 (WM)16671712322520060004 (CDM)184251303039915 (CAM)3752686010727320006 (CD)0675771067001 (CF)3173908473002 (WD)219060366650002 (WD)345920000004 (CDM)345920000005 (CAM)701270081081006 (CD)01703660005 (CAM)702260157273 ± 167001 (CF)0332001570002 (WD)013301443790005 (CAM)01130143750003 (WD)0113014	5 (CAM)	68	134.2	0	51.4	136.4	0	53.6
Running Distance (m)171 ± 1221528 ± 1033 66 ± 114 91 ± 77 1483 ± 1061 67 ± 163 0 1 (CF)1861490043845002 (VD)115175401081646003 (WM)1667171232252606004 (CDM)184251303039915 (CAM)375268601072732006 (CD)0627557106700High-Speed Running Distace (m) 27 ± 25 637 ± 446 5 ± 8 24 ± 35 614 ± 421 15 ± 37 0 1 (CF)31739084730002 (WD)219060366655003 (WM)431712901081004 (CDM)34592081081005 (CAM)701270081081006 (CD)00170386001 (CF)03220144325003 (WM)01130144379004 (CDM)0113014379005 (CAM)103860095006 (CD)00000 <t< td=""><td>6 (CD)</td><td>0</td><td>0</td><td>63.4</td><td>48.8</td><td>100.9</td><td>0</td><td>46.4</td></t<>	6 (CD)	0	0	63.4	48.8	100.9	0	46.4
Name International (inf)14 for 14 for 148160 for 1490161 for 143160 for 144160 for 15 for 1007160 for 15 for 1007170 for 1007170 for 15 for 1007170 for 1007170 for 1007 <t< td=""><td>Running Distance (m)</td><td>171 + 122</td><td>1528 ± 1033</td><td>66 + 114</td><td>91 ± 77</td><td>1483 ± 1061</td><td>67 + 163</td><td>0</td></t<>	Running Distance (m)	171 + 122	1528 ± 1033	66 + 114	91 ± 77	1483 ± 1061	67 + 163	0
1 (CP)10017540100103166003 (WD)1667171232252606004 (CDM)184251303039915 (CAM)375268601072732006 (CD)0627557106700High-Speed Running Distance (m) 27 ± 25 637 ± 446 5 ± 8 24 ± 35 614 ± 421 15 ± 37 01 (CF)3173908473001 (CF)31739036665003 (WM)431712901081004 (CDM)34592081081005 (CAM)701270081081006 (CD)00170386005 (CAM)701270081081006 (CD)0226014325002 (WD)0226014379003 (WM)0113014379005 (CAM)10386000006 (CD)00000006 (CD)00000006 (CD)00<	1 (CE)	186	1/100	0	13	845	0 ± 105	0
$2 (WD)$ 1D1D1D100100100100000 $3 (WM)$ 1667171232252006000 $4 (CDM)$ 18425130303991 $5 (CAM)$ 37526860107273200 $6 (CD)$ 0627557106700High-Speed Running Distance (m) 27 ± 25 637 ± 446 5 ± 8 24 ± 35 614 ± 421 15 ± 37 0 $1 (CF)$ 317390847300 $2 (WD)$ 2190603666500 $3 (WM)$ 43171290108100 $4 (CDM)$ 34527008108100 $5 (CAM)$ 70127008108100 $6 (CD)$ 0017038600 $2 (WD)$ 022601432500 $2 (WD)$ 011301437900 $2 (WD)$ 011300000 $5 (CAM)$ 1038600000 $6 (CD)$ 0000000 $6 (CD)$ 0000000 $6 (CD)$ 0000 <td>2 (WD)</td> <td>115</td> <td>1754</td> <td>0</td> <td>108</td> <td>1646</td> <td>0</td> <td>0</td>	2 (WD)	115	1754	0	108	1646	0	0
J (Wh)1001111232232000004 (CDM)18421303039915 (CAM)375268601072732006 (CD)0627557106700High-Speed Running Distance (m)27 ± 25 637 ± 446 5 ± 8 24 ± 35 614 ± 421 15 ± 37 01 (CF)3173908473002 (WD)21906036665003 (WM)345920009004 (CDM)345920081081006 (CD)00170386000Sprinting Distance (m) 2 ± 4 196 ± 146 0 5 ± 7 273 ± 167 0003320143250002 (WD)0226014325003 (WM)0113014379004 (CDM)0119000005 (CAM)1038600406006 (CD)000000006 (CD)00000000	2 (WD) 2 (WM)	166	717	122	225	2606	0	0
$4 \ (CAM)$ 164 2113 0 3 0 3 0 3 0 1 $5 \ (CAM)$ 375 2686 0 107 2722 0 0 0 High-Speed Running Distance (m) 27 ± 25 637 ± 446 5 ± 8 24 ± 35 614 ± 421 15 ± 37 0 $1 \ (CP)$ 31 739 0 8 473 0 0 $2 \ (WD)$ 21 906 0 366 665 0 0 $3 \ (CDM)$ 4 317 12 90 1081 0 0 $4 \ (CDM)$ 34 592 0 0 0 0 0 $5 \ (CAM)$ 70 1270 0 8 1081 0 0 $6 \ (CD)$ 0 0 1270 0 8 1081 0 0 $5 \ (CAM)$ 70 1270 0 8 1081 0 0 0 $5 \ (CAM)$ 70 1270 0 8 1081 0 0 0 $5 \ (CAM)$ 70 224 196 ± 146 0 5 ± 7 273 ± 167 0 0 $2 \ (WD)$ 0 113 0 14 325 0 0 0 $3 \ (WM)$ 0 119 0 0 0 0 0 0 0 $6 \ (CD)$ 0 0 0 0 0 0 0 0 0 0 0 $0 \$	4 (CDM)	184	2512	125	225	2000	300	0
$3 (CAM)$ 37.3 2080 0 10^{7} 27.52 0 0 6 (CD) 0 6 275 57 1067 0 0 High-Speed Running Distance (m) 27 ± 25 637 ± 446 5 ± 8 24 ± 35 614 ± 421 15 ± 37 0 1 (CF) 31 739 0 8 473 0 0 2 (WD) 21 906 0 36 665 0 0 3 (WM) 4 317 12 90 1081 0 0 4 (CDM) 34 592 0 0 0 0 0 0 5 (CAM) 70 1270 0 8 1081 0 0 6 (CD) 0 0 17 0 386 0 0 2 (VD) 0 226 0 144 325 0 0 1 (CF) 0 332 0 144 325 0 0 2 (WD) 0 113 0 144 379 0 0 4 (CDM) 0 113 0 144 379 0 0 4 (CDM) 0 119 0 0 0 0 0 0 6 (CD) 0 0 0 0 0 0 0 0 0 0 6 (CD) 0 0 0 0 0 0 0 0 0 0 0	4 (CDM)	275	2515	0	107	2722	333	1
$6(L)$ 062/33/1007000High-Speed Running Distance (m)27 ± 25 637 ± 446 5 ± 8 24 ± 35 614 ± 421 15 ± 37 0 1 (CF)3173908473002 (WD)21906036665003 (WM)431712901081004 (CDM)345920081081005 (CAM)701270081081006 (CD)00170386005 printing Distance (m) 2 ± 4 196 ± 146 0 5 ± 7 273 ± 167 001 (CF)033200143250003 (WM)01130143790004 (CDM)01190000006 (CD)00000000	5 (CAM)	373	2080	275	107	2732	0	0
High-Speed Running Distance (m)27 ± 25637 ± 4465 ± 824 ± 35614 ± 42115 ± 3701 (CF)3173908473002 (WD)21906036665003 (WM)431712901081004 (CDM)34592000005 (CAM)701270081081006 (CD)00170386001 (CF)033200157002 (WD)0226014325003 (WM)0113014379004 (CDM)01190000005 (CAM)01190000006 (CD)000000000	8 (CD)	0	0	213	57	1007	0	0
Distance (m) 2 ± 4 196 ± 146 0 8 473 0 0 2 (WD) 21 906 0 36 665 0 0 3 (WM) 4 317 12 90 1081 0 0 4 (CDM) 34 592 0 0 8 1081 0 0 5 (CAM) 70 1270 0 8 1081 0 0 6 (CD) 0 0 17 0 386 0 0 1 (CF) 0 332 0 0 157 0 0 1 (CF) 0 332 0 14 325 0 0 1 (CF) 0 133 0 14 379 0 0 3 (WM) 0 119 0 0 0 0 0 4 (CDM) 0 19 0 0 0 0 0 0	High-Speed Running	27 + 25	637 + 446	5+8	24 + 35	614 + 421	15 + 37	0
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	Distance (m)							
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	1 (CF)	31	739	0	8	473	0	0
3 (WM)4 317 12 90 1081 0 0 4 (CDM) 34 592 0 0 0 0 0 0 5 (CAM) 70 1270 0 8 1081 0 0 6 (CD) 0 0 17 0 386 0 0 Sprinting Distance (m) 2 ± 4 196 ± 146 0 5 ± 7 273 ± 167 0 0 1 (CF) 0 332 0 0 157 0 0 2 (WD) 0 226 0 14 325 0 0 3 (WM) 0 113 0 14 379 0 0 4 (CDM) 0 119 0 0 0 0 0 5 (CAM) 10 386 0 0 406 0 0 6 (CD) 0 0 0 0 0 0 0 0	2 (WD)	21	906	0	36	665	0	0
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	3 (WM)	4	317	12	90	1081	0	0
5 (CAM) 70 1270 0 8 1081 0 0 6 (CD) 0 0 0 17 0 386 0 0 Sprinting Distance (m) 2 ± 4 196 ± 146 0 5 ± 7 273 ± 167 0 0 1 (CF) 0 332 0 0 157 0 0 2 (WD) 0 226 0 14 325 0 0 3 (WM) 0 113 0 14 379 0 0 4 (CDM) 0 119 0 0 0 0 0 0 0 5 (CAM) 10 386 0 0 95 0 0	4 (CDM)	34	592	0	0	0	90	0
6 (CD) 0 0 17 0 386 0 0 Sprinting Distance (m) 2 ± 4 196 ± 146 0 5 ± 7 273 ± 167 0 0 1 (CF) 0 332 0 0 157 0 0 2 (WD) 0 226 0 14 325 0 0 3 (WM) 0 113 0 14 379 0 0 4 (CDM) 0 119 0 0 0 0 0 0 0 5 (CAM) 10 386 0 0 406 0 0 0 6 (CD) 0 0 0 0 0 0 0 0	5 (CAM)	70	1270	0	8	1081	0	0
Sprinting Distance (m) 2 ± 4 196 ± 146 0 5 ± 7 273 ± 167 0 0 1 (CF) 0 332 0 0 157 0 0 2 (WD) 0 226 0 14 325 0 0 3 (WM) 0 113 0 14 379 0 0 4 (CDM) 0 119 0 0 0 0 0 5 (CAM) 10 386 0 0 406 0 0 6 (CD) 0 0 0 0 0 0 0	6 (CD)	0	0	17	0	386	0	0
I (CF) 0 332 0 0 157 0 0 2 (WD) 0 226 0 14 325 0 0 3 (WM) 0 113 0 14 379 0 0 4 (CDM) 0 119 0 0 0 0 0 5 (CAM) 10 386 0 0 406 0 0 6 (CD) 0 0 0 0 95 0 0	Sprinting Distance (m)	2 ± 4	196 ± 146	0	5±7	273 ± 167	0	0
2 (WD) 0 226 0 14 325 0 0 3 (WM) 0 113 0 14 379 0 0 4 (CDM) 0 119 0 0 0 0 0 5 (CAM) 10 386 0 0 406 0 0 6 (CD) 0 0 0 0 95 0 0	1 (CF)	0	332	0	0	157	0	0
3 (WM) 0 113 0 14 379 0 0 4 (CDM) 0 119 0	2 (WD)	0	226	0	14	325	0	0
4 (CDM) 0 119 0	3 (WM)	0	113	0	14	379	0	0
5 (CAM) 10 386 0 0 406 0 0 6 (CD) 0 0 0 0 95 0 0	4 (CDM)	õ	119	õ	0	0	õ	õ
6(CD) 0 0 0 0 95 0 0	5 (CAM)	10	386	0	0	406	0	0
	6 (CD)	0	0	0	0	95	0	0

Table 2. Accumulative training and match load variables (representative of average data in bold and individual data from players 1-6) completed in the 7-day testing period. Running distance = distance covered between 14.4-19.8 km/h, high-speed running distance = distance covered between 19.8-25.2 km/h and sprinting distance = distance covered between 19.8-25.2 km/h and sprinting distance = forward, WD=Wide Defender, WM=Wide Midfielder, CDM=Central Defending Midfielder, CAM= Central Attacking Midfielder and CD=Central Defender.

	Matches	Training	Total
Duration (min)	142 ± 45	178 ± 22	321 ± 33
1 (CF)	166	163	328
2 (WD)	191	163	353
3 (WM)	117	202	319
4 (CDM)	94	211	305
5 (CAM)	191	162	353
6 (CD)	96	169	266
	1//77 . 2014	05/0 - 10/0	26429 - 5409
Total Distance (m)	16677 ± 5914	9760 ± 1852	26438 ± 5408
I (CF)	16937	7981	24918
2 (WD)	20602	7362	27963
3 (WM)	15489	11047	26536
4 (CDM)	11511	12311	23823
5 (CAM)	25792	10012	35804
6 (CD)	9733	9849	19582
Running Distance (m)	2920 + 1403	485 + 202	3405 + 1501
1 (CF)	220 ± 1405	307	2564
2 (WD)	3361	263	3624
2 (WD)	3182	655	3827
4 (CDM)	2400	701	2101
4 (CDM)	2400 5253	701 647	5000
S (CAM)	3233	047	3900
6 (CD)	1067	338	1405
High-Speed Running Distance	1218 ± 682	104 ± 46	1322 ± 717
(m)			
1 (CF)	1151	100	1251
2 (WD)	1519	108	1628
3 (WM)	1383	122	1505
4 (CDM)	592	124	716
5 (CAM)	2276	153	2429
6 (CD)	386	17	403
Sprinting Distance (m)	423 ± 269	7 ± 7	430 ± 274
1 (CF)	489	1	490
2 (WD)	552	14	566
3 (WM)	493	14	507
4 (CDM)	119	0	119
5 (CAM)	793	10	803
6 (CD)	95	0	95

Table 3. Individual differences of average daily energy intake vs. average daily energy expenditure and body mass changes from Day 0 to Day 8. Each player's position is shown in brackets. CF=Centre Forward, WD=Wide Defender, WM=Wide Midfielder, CDM=Central Defending Midfielder, CAM= Central Attacking Midfielder and CD=Central Defender.

Player	Energy Intake (kcals)	Energy Expenditure (kcals)	Body Mass Day 0 (kg)	Body Mass Day 8 (kg)
1 (CF)	2817	3047	90.1	89.2
2 (WD)	2905	3050	73.2	73.7
3 (WM)	3563	4140	71.0	71.1
4 (CDM)	3166	3179	80.1	79.1
5 (CAM)	3701	3580	78.9	78.1
6 (CB)	2961	4400	89.0	88.9
Mean ± SD	3186 ± 367	3566 ± 585	80.4 ± 7.9	80.0 ± 7.6