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1 **Energy expenditure in professional flat jockeys using doubly-labelled water during the racing**
2 **season: implications for body weight management.**

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46
47 **Key words:** Jockey, Energy Expenditure, Doubly-Labelled Water, Weight-making.

48 **Word count:** 3930

49 **Abstract:**

50 To formulate individualized dietary strategies for jockeys, it is vital that energy requirements are
51 quantified. We measured total energy expenditure (TEE) over two separate weeks in spring and
52 summer using doubly-labelled water in a group of male flat jockeys ($n = 8$, 36.9 ± 5.7 years, 164 ± 8
53 cm, 54.6 ± 2.5 kg). Total energy intake (TEI) was self-recorded, as were all riding and structured
54 exercise activity. Mean daily TEE was $10.83 (\pm 2.3)$ and $10.66 (\pm 1.76)$ MJ, ($P = 0.61$) respectively. Self-
55 reported TEI were $6.03 (\pm 1.7)$ and $5.37 (\pm 1.1)$ MJ ($P = 0.40$), respectively, and were significantly lower
56 than TEE ($P = 0.01$). Mean race rides were $17 (\pm 6)$ and $13 (\pm 3; P = 0.37)$ and horses ridden at morning
57 exercise were $8 (\pm 6)$ and $7 (\pm 4; P = 0.77)$ respectively. Additional structured exercise was $76.25 (\pm$
58 $95.1)$ and $52.5 (\pm 80.9)$ min per week ($P = 0.35$) respectively. At the individual level, TEE was related to
59 body mass and the level of non-racing physical activity, but not riding. Physical activity levels for TEE
60 were $1.76 (\pm 0.37)$ and $1.69 (\pm 0.27; P = 0.59)$, and appear modest when compared with other athletes,
61 and similar to age-matched non-athletes, suggesting that conventional sport-specific nutritional
62 recommendations do not appear applicable. The large discrepancy between TEE and TEI suggests
63 significant under reporting of dietary intake. These data now provide an appropriate framework from
64 which to formulate jockey nutritional guidelines to promote the ability to achieve the daily weight
65 target and improve athlete welfare

66 **Key words:** Jockey, Energy Expenditure, Doubly-Labelled Water, Weight-making. Nutrition, Athlete
67 welfare.

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81 **Introduction**

82 Within professional horse racing, jockeys are required to be below a target body weight on a daily
83 basis (known in the sport as ‘making weight’) and are required to be weighed post-event, both of
84 which are unique aspects compared to other sports that involve specifications for body weight
85 (Wilson, Drust, Morton, & Close, 2014). Furthermore, the addition of all-weather and floodlit
86 racetracks means that many jockeys must make weight all year round (Wilson, Drust, et al., 2014). As
87 a consequence of these demands, jockeys commonly engage in activities to reduce their body weight
88 (known as ‘weight-making’) such as calorie restriction, acute/chronic dehydration and forced
89 sweating. Such practices can negatively affect physical and mental health (Caulfield & Karageorghis,
90 2008; Dolan et al., 2011; Leydon & Wall, 2002; Waldron-Lynch et al., 2010; Warrington et al., 2009;
91 Wilson et al., 2012; Wilson, Fraser, et al., 2013; Wilson, Hill, Sale, Morton, & Close, 2015; Wilson,
92 Pritchard, et al., 2015) as well as being detrimental to simulated race riding performance and strength
93 (Wilson, Hawken, et al., 2014).

94 In contrast to the aforementioned practices, we have recently shown that jockeys can make weight
95 safely (Wilson et al., 2012; Wilson, Pritchard, et al., 2015) through the implementation of a structured
96 dietary and exercise strategy. However, to provide individually tailored nutritional strategies for
97 jockeys, it is essential to accurately calculate the daily total energy expenditure (TEE). To date, only
98 one previous study has attempted to assess energy balance in jockeys using 7 day food diaries and 24
99 hour measurement of heart rate (Wilson, Sparks, Drust, Morton, & Close, 2013) where a relatively low
100 TEE was reported compared with other sports. Assessment of TEE was on a non-race riding day, given
101 that the regulations of horse racing prohibited the wearing of heart rate monitors during race riding.
102 Consequently, a simulated race was used to calculate the energetic cost of race riding which has clear
103 limitations including the inability to account for the psychological stress of race riding as well as the
104 physical exertion of ‘real’ race riding which commonly involves substantial isometric contractions
105 (restraining the horse). Nonetheless, this study did suggest that conventional sport nutrition
106 guidelines for athletes (e.g. high carbohydrate and high energy) (Dolan et al., 2011; Rodriguez, Di
107 Marco, & Langley, 2009) may not be relevant for the jockey population owing to their lower absolute
108 energy demands.

109 The use of the doubly-labelled water (DLW) stable isotope method is deemed the ‘gold standard’ for
110 practically measuring TEE in free living mammals (Schoeller, Ravussin, et al., 1986; Speakman & Krol,
111 2010) and is a method that allows for TEE to be measured over a prolonged period of time (days). The
112 DLW method uses the principles of indirect calorimetry to measure TEE from the turnover rates of
113 two stable isotopes, deuterium (²H) and oxygen 18 (¹⁸O) (Speakman, 1997). Since the method involves
114 only the oral administration of stable isotopes and the collection of urine samples it overcomes the

115 limitations that have previously occurred in the limited previous work in this field (Wilson, Sparks, et
116 al., 2013). The capacity to measure TEE in a working week of professional jockeys can provide an
117 insight into the typical energy output which can then be considered when tailoring appropriate
118 nutritional guidelines for jockeys to make weight. Moreover, it could further aid nutritional strategies
119 to understand any potential differences in TEE that may occur at different periods of the flat racing
120 season. Ultimately, this may assist jockeys in making weight more effectively without resorting to
121 severe dehydration techniques, and thereby resulting in improved athlete welfare.

122 Therefore, the aim of the present study was to simultaneously measure TEE (using the DLW technique)
123 and TEI (using self-reported 7 day food diaries) in a cohort of eight professional male jockeys at two
124 distinct points of the racing calendar (spring and summer).

125

126 **Methods**

127 ***Subjects***

128 Eight professional male flat racing jockeys were recruited for the study (36.9 ± 5.7 years, $164.6 \pm$
129 7.5 cm, 54.6 ± 2.5 kg). The cohort consisted of one former Great Britain (GB) champion jockey and all
130 8 jockeys had recorded >500 career flat race wins and ridden in group races domestically and
131 internationally. The professional jockeys recruited had an average win to ride ratio of $14.3\% = 86 (\pm$
132 $37)$ from $600 (\pm 190)$ rides in 2015. Subjects were required to hold a license with the British Horse
133 Racing Authority and were riding in GB at the time of the study, and therefore actively making weight.
134 Recruitment for the study was initially through contact with the Professional Jockeys Association in
135 GB and word of mouth within the jockey and horse racing community. The study was approved by
136 Liverpool John Moores University local ethics committee and all participants provided written
137 informed consent before the study commenced. Four days into phase 2 of this study, one jockey was
138 injured during race riding and therefore these data are averaged for the period up to the injury.

139

140 ***Overall Study Design***

141 The study was conducted during two separate phases of the flat horse racing season, during the last
142 week of August 2015 and first week of May 2016 respectively. These weeks were chosen to investigate
143 any potential seasonal differences in TEE over the course of the annual flat horse racing calendar.
144 Jockeys provided information on their body weight to calculate DLW dose. Given that jockeys are
145 required to make weight daily, jockeys habitually weigh themselves first thing every day and therefore
146 body weight remains relatively stable during race riding periods (Wilson et al., 2012; Wilson, Drust, et

147 al., 2014; Wilson, Pritchard, et al., 2015). Jockeys were informed about the correct procedures for
148 collecting and storing daily morning urine samples (second void), as well as for completing 7 day food
149 diaries to assess total energy intake (TEI) that coincided with the urine sampling collection period.

150 ***Assessment of Total Energy Expenditure (TEE)***

151 On arrival at a racecourse, jockeys had height and weight assessed using a dual-stadiometer (Seca
152 Germany) and provided a single baseline urine sample into a pre-labelled sealable sample pot (Fisher
153 Scientific, England), which was then placed on ice until they could be frozen (-20°C). Jockeys then self-
154 administered a DLW dose pre-calculated to their body weight and weighed to 4 decimal places. The
155 bolus dose of hydrogen (deuterium 2H) and oxygen (18O) stable isotopes (Cortecnet, Voisins-Le-
156 Bretonneux, France) in the form of water ($^2\text{H}_2^{18}\text{O}$) was consumed and the precise time was recorded.
157 The desired enrichment dose was 10 % 18O and 5 % 2H. The calculated DLW dose solution had an
158 enrichment of 108365PPM ^{18}O and 50450PPM Deuterium, and was administered at a dosage rate of
159 1.2g of DLW per kg of subject weight.

160 The administration container was then washed with 100 mL of tap water after the initial dose was
161 consumed, and this tap water was also consumed ensuring the entire dose was received. This process
162 was observed by the researchers to ensure all water was consumed. Jockeys then received their pre-
163 labelled sample pots (Fisher Scientific, England) for self-collection of urine beginning the following
164 morning for 7 days.

165 The morning after administration of the DLW dose, jockeys were instructed to begin urine sample
166 collection and were instructed to collect the second urine void of the day in the pre-labelled sealable
167 sample pot for 7 days at as close to 24 hour intervals as possible and with the time recorded to the
168 nearest minute. The duration of the study was determined by the jockey's complex race schedule.
169 Samples were frozen and stored until later collection. Samples were collected at the end of each phase
170 by the researchers within two days of completion, defrosted and aliquoted into 1.8ml cryogenic vials
171 (Fisher Scientific, England) and samples then remained frozen until analysis

172 For DLW analysis, urine samples were sealed into capillary tubes, which then underwent vacuum
173 distillation (Nagy, Girard, & Brown, 1999) to collect the water which was then analyzed using an off-
174 axis laser spectroscopy liquid water isotope analyzer (Berman, Melanson, Swibas, Snaith, & Speakman,
175 2015). Samples were run alongside international laboratory standards of known enrichment
176 (Speakman & Hambly, 2016) for standardization. Isotope enrichments were converted to daily CO_2
177 production using the two pool model equation A6 from Schoeller, Leitch, & Brown (1986) as modified
178 in Schoeller (1988) as recommended for humans (Schoeller, 1988; Schoeller, Ravussin, et al., 1986).
179 This was converted to TEE assuming a food quotient of 0.85.

180 **Total Energy intake (TEI)**

181 Jockeys were asked to complete a 7 day food diary on two separate occasions during the periods of
182 sample collection. They were given training in completing these and were asked to record all food and
183 fluid consumed, approximate portion sizes and the time of day consumed. Where possible, jockeys
184 were asked to provide labels and/or pictures of the food. Dietary data was then analyzed using a
185 dietary analysis software package (Nutritics Ltd, Ireland). One jockey did not complete any food intake
186 data during the May collection period due to time restraints and therefore all TEI analysis is reported
187 as N=7.

188

189 **Physical Activity**

190 Jockeys were asked to note down daily activity during the study, including race rides, riding horses in
191 morning exercise, and non-riding structured exercise. With an estimated energy cost of riding
192 ascertained by our group in previous work (Wilson, Sparks, et al., 2013), for non-riding structured
193 exercise type and duration we referred to the corresponding activity codes as listed in Ainsworth and
194 co-workers compendium of physical activities table (Ainsworth et al., 2011) (Table 1). We then derived
195 the physical activity level (PAL) score (Speakman & Westerterp, 2010) for each jockey over both testing
196 periods by dividing TEE and their corresponding estimated resting metabolic rate (Cunningham, 1980)
197 (Table 1).

198

199 **Statistical analysis**

200 Paired sample t-tests were used to compare Phase 1 and 2 data for all measures and 95% confidence
201 intervals (CI) are reported. We used single and multiple regression analysis to explore predictors of
202 TEE. All data are expressed as means (SD) with $P < 0.05$ indicating statistical significance. Statistical tests
203 were performed using SPSS for Windows (version 22, SPSS Inc, Chicago, IL) and R (version 3.3.2: R
204 Foundation for Statistical Computing, Vienna, Austria; 2014).

205

206 **Results**

207 Typical isotope washout curves of both stable isotopes illustrated good linearity ($r^2 > 0.98$) in the stable
208 isotope elimination over the measurement period (not shown). Across all 16 measurements the
209 elimination constant of the oxygen-18 washout (k_o) averaged 0.00553/hour giving a half-life of oxygen
210 elimination of 127 hours, with the deuterium elimination constant (k_d) averaging 0.00441 and hence

211 the half-life of deuterium elimination averaging 159 hours. The 7 day measurement period therefore
212 spanned roughly 1.3 half-lives of the oxygen elimination which slightly outside the optimum time
213 window for DLW measurements of 2-3 half-lives. The dilution space ratio (N_d/N_o) averaged 1.0361
214 which is in line with other estimates. The body water % was calculated using the intercept technique
215 where the isotope enrichment at time point zero (dosing) is calculated by back extrapolation. Body
216 water percentage values averaged 59.9% and ranged from 46.9 to 68.4% (excluding one outlier that
217 gave a physiologically unrealistic value of 86.1%). The lowest value of body water coincided with an
218 individual who deliberately dehydrated in a racecourse sauna prior to the measurement period.

219 Comparisons of data for the two periods were made using paired t-tests. Mean TEE during August was
220 $10.83, \pm 2.30$ and in May was $10.66, \pm 1.73$ MJ/day. There was no significant difference in TEE between
221 the two weeks ($P=0.61$). We included individual ID as a random factor in regression analyses of the
222 impact of body weight and activity to account for repeated measurements across individuals. One
223 individual had only a marginally significant effect ($0.05 > P > 0.01$) and was removed from the analysis.
224 Pooling all 16 measurements, there was a significant effect of body weight on the TEE (Figure 1a). The
225 least squares fit regression $TEE \text{ (MJ/day)} = 0.2754 * \text{body wt(kg)} - 4.16$ explained 10.7% of the variation
226 in the TEE. There was no significant difference in either the number of race rides ($17.25, \pm 6.16$ and
227 $13.0, \pm 3.42$ respectively; $P = 0.37$) or number of training rides ($8.12, \pm 6.35$ and $7.37, \pm 4.40$
228 respectively; $P = 0.61$,) during the two collection periods. Individual comparisons of TEE during the
229 two data collection periods are presented in Table 1. Physical activity level (PAL) for the jockeys is also
230 shown in Table 1 and the estimates for the two weeks were $1.76, \pm 0.39$ and $1.69, \pm 0.27$ respectively,
231 ($P= 0.59$). The exercise outside of race riding and training rides are qualitatively described for each
232 individual jockey in Table 1. The extra physical activity ranged from some jockeys performing no
233 additional exercise to approximately 5 hours of running/walking per week ($76.25, \pm 95.1$ and $52.5, \pm$
234 80.9 minutes; $P= 0.35$, respectively). The summed exercise time outside of race riding (independent
235 of the type of exercise) was strongly related to the residual energy expenditure from the relationship
236 between TEE and body weight, and explained 51.3% of the residual variation in TEE (Figure 1b). In
237 contrast the total number of rides during the week (training and race rides) had no significant
238 relationship to the residual energy expenditure (Fig 1c). Treating race rides and training rides
239 separately also yielded no significant effects on residual energy expenditure (not shown). Combining
240 the body mass and time spent in physical activity, the multiple least squares linear regression equation
241 $TEE \text{ (MJ/day)} = 0.56 + 0.17 * \text{Body mass (kg)} + 0.0164 * \text{Exercise activity (mins)}$ explained 58.3% of the
242 variation in TEE ($F_{1,13} = 9.09$, $p = 0.003$). The 95% confidence interval of the residuals to this model was
243 ± 2.33 MJ.

244 Self-reported TEI and macronutrient intake is presented in Table 2. There was no significant difference
245 in estimated TEI between the two collection periods ($6.03, \pm 1.68$ and $5.37, \pm 1.11$ kcal respectively;
246 $P=0.39$). Total TEI was significantly lower than TEE during both collection phases ($P<0.01$ for August
247 and May respectively). There were no significant differences in the macronutrient breakdown
248 between the two phases (Table 2).

249

250 **Discussion**

251 The aim of the present study was to quantify TEE and TEI in professional flat jockeys during a working
252 week at two different stages of the flat racing calendar. Using the DLW technique, we report average
253 TEE during a working week of a group of professional jockeys was 10.8 and 10.7 MJ, in August 2015
254 and May 2016, respectively. We observed no differences in TEE between the two periods suggesting
255 that daily energy expenditure is consistent during the racing season. These data are of practical
256 interest as they provide a benchmark TEE to formulate energy requirements to inform nutritional
257 guidelines. Using a multiple regression approach, we found that body weight and the amount of
258 exercise together explained 58.3% of the variation in TEE. The resultant predictive equation: TEE
259 $(MJ/day) = 0.56 + 0.17 * \text{body mass (kg)} + 0.0164 * \text{exercise activity (mins)}$ can be used as a starting point
260 to design individually tailored nutritional advice for jockeys to manage their weight. Analysis of the
261 residuals suggested 50% of measurements were within 0.76 MJ of the predictions from this equation,
262 and 95% within 2.33 MJ. These data suggest that future studies of jockey TEE could use a longer time
263 window of 10-14 days, particularly when a daily sampling procedure, as utilized here, is employed.

264

265 The absolute energy expenditure was significantly less than that quantified in other elite athletes,
266 however and importantly, the estimated PAL was only higher when compared to that of age matched
267 non-athletes for those jockeys who regularly engaged in additional structured exercise, and typically
268 lower for those jockeys who did little or no additional structured exercise. This finding suggests two
269 things: firstly, to notably increase TEE and in-turn assist weight-control, jockeys need to perform
270 regular additional structured exercise to that expended during riding, and secondly, that conventional
271 sport nutrition guidelines, typically advising high CHO and energy intake, are probably not applicable
272 to this population.

273 Total energy expenditure was similar over the two phases of the flat racing season, likely reflecting
274 the similar number of race rides and additional structured exercise completed by each jockey.
275 Interestingly, the absolute energy expenditure quantified here is similar to that indirectly estimated
276 previously by our group (~ 11.3 MJ), where data was collected during a typical non-racing working day

277 through the use of commercially available heart rate monitors (Wilson, Sparks, et al., 2013). Whereas
278 TEE in the previous study were reported on jump jockeys (races where horse and rider negotiate
279 jumping over hurdles or fences) who are typically 5-7 kg heavier than flat jockeys (Wilson, Fraser, et
280 al., 2013), even when considering the additional mass, the TEE does not still substantially increase to
281 levels of other athletes. Taken together our data suggest, that contrary to previous assertions (Dolan
282 et al., 2011) the TEE of professional jockeys is not high in absolute terms when compared with other
283 athletes of a similar mass (Fudge et al., 2006) (~11 versus 14.6 MJ), or team sport athletes (Anderson
284 et al., 2017) (~11 versus 14.9 MJ). Notably, as highlighted, the data reported here suggest a lower PAL
285 for those jockeys who did not perform additional structured exercise (or did very little) than has been
286 cited on age-matched non-athletes (Speakman & Westerterp, 2010) (Table 1 - 1.28 to 1.73 versus
287 1.79) providing further support for the rationale that high CHO diets are not likely required for
288 professional male jockeys (Wilson, Pritchard, et al., 2015).

289 Given that there was a large difference in TEE and the self-reported TEI, alongside the fact that jockeys
290 were weight-stable throughout the test period, it is likely that there was significant under reporting
291 of TEI. Under reporting of TEI is commonly observed in athletes (Lundy, 2006) and also non-athletic
292 populations, which indeed has recently called this method of data collection into question
293 (Dhurandhar et al., 2015). Our data would suggest that the use of food diaries in jockeys is not the
294 best way to assess TEI and likely to result in inaccurate advice being given. Previous studies on TEI in
295 jockeys have reported similar values to the present study (6.1-7.0 MJ) (Dolan et al., 2011; Leydon &
296 Wall, 2002; Wilson, Fraser, et al., 2013) although in these previous studies TEE was not recorded. Given
297 the reported discrepancy in TEE and TEI observed here, previous data on TEI in professional jockeys
298 should be treated with caution. It is interesting to note that a study on Irish apprentice jockeys
299 reported much higher values (11 MJ) when using a food diary in conjunction with a wearable camera
300 (O'Loughlin et al., 2013). This value is much closer to the TEE reported in the present study and
301 provides support for the suggestion that jockeys may deliberately or unconsciously under report their
302 TEI, and also indicate the use of the camera technology may significantly improve intake estimates.
303 We have recently reported excellent agreement between TEE and TEI in professional football players
304 (using a combination of both food diaries and remote photographic method) where TEE was also
305 measured using DLW (Anderson et al., 2017). When taken together, these data suggest that future
306 studies examining energy intake in jockeys should incorporate a variety of dietary analysis methods to
307 provide more accurate measures.

308 There was a large variability in the TEE between the jockeys with a ~6.9 MJ difference between the
309 highest and lowest recorded expenditures (Table 1). Previous research from our group has suggested
310 that the energetic cost of a typical 2 mile simulated race is only ~0.18 MJ (Wilson, Sparks, et al., 2013).

311 Although we observed no differences in the total number of race rides between the jockeys, it is clear
312 that this major difference in TEE was primarily attributable to the additional structured exercise
313 performed outside of “jockey related activities” (Fig 1b) and not to individual differences in how much
314 riding they performed (Fig 1c). There is a common misconception among professional jockeys that
315 additional exercise could contribute to increased muscle mass and absolute body mass and hence,
316 there is a reluctance to engage in such practices. Given that we have previously demonstrated that
317 additional exercise assists jockeys in making weight safely without increasing muscle mass (Wilson,
318 Pritchard, et al., 2015) combined with the demonstration here that additional exercise is correlated
319 with greater energy expenditure, jockeys should consider including additional daily exercise into their
320 routines, which may also help to aid weight management whilst providing an osteogenic stimulus
321 (Russo, 2009) to help prevent poor bone health, which has been reported previously in jockeys
322 (Greene, Naughton, Jander, & Cullen, 2013; Waldron-Lynch et al., 2010; Wilson, Hill, et al., 2015;
323 Wilson, Pritchard, et al., 2015)

324 In addition to the anomalies previously mentioned regarding EI and EE, similarly this applies in regard
325 to the amount of structured non-riding exercise and the EE calculated for these activities and the
326 corresponding PAL scores listed. Given we have cited race riding as a relatively low energy cost activity,
327 in consideration of these relatively high PAL values we can only speculate that those jockeys were also
328 engaging in substantial activities classified as NEAT (non-exercise activity thermogenesis). Typically,
329 jockeys will also be required to ‘muck out’ (cleaning horses stables prior to saddling up to riding horses
330 to exercise), and brush horses (cleaning sweat marks post-exercise) on a daily basis before going to
331 race ride, and therefore may be expending notable energy in such activities.

332 In order to account for the very low PAL values for other jockeys, apart from not performing any
333 additional exercise as shown in Table 1, it may well be that jockeys can typically spend considerable
334 parts of the day being sedentary as a result of travelling to and from race meetings (Martin, Wilson,
335 Morton, Close, & Murphy, 2017), and again given riding does not appear a high energy sport (Wilson,
336 Sparks, et al., 2013), this may go some way to explain the low values reported.

337 Another consideration may possibly be that In light of previous findings of severe dieting practices in
338 jockeys (Dolan et al., 2011; Wilson et al., 2012; Wilson, Sparks, et al., 2013) as well as numerous studies
339 that have shown that resting metabolic rate (RMR) is suppressed in chronically energy deficient
340 populations (Emery, 2005), it is possible that the approach to derive RMR to calculate PAL data may
341 explain some of these issues.

342

343 Whilst we can only offer up potential explanations to account for the anomalies discussed, we do
344 acknowledge that these are clear limitations to this study. Future studies are therefore recommended
345 to record all activity and non-activity including the time jockeys spend travelling. Whilst there is always
346 the potential that this may prove impractical given time constraints for elite athletes (Bradley et al.,
347 2015), it may help to account for the discrepancies that are evident here.

348 In summary, we report direct measurements of daily energy expenditure in a cohort of professional
349 male jockeys during two working weeks in spring and summer. We observed no differences in TEE
350 between data collection periods (~11 MJ per day) suggesting that daily energy expenditure is
351 consistent throughout the racing calendar. We also observed that TEI was substantially lower than
352 TEE, potentially attributable to under reporting and/or limitations associated with traditional food
353 diary approaches. Nonetheless, the relatively modest TEE in consideration to that observed to
354 endurance and team sport athletes suggest that conventional sport-specific recommendations (i.e.
355 high CHO and high energy intake) may not be applicable to professional jockeys. A multiple regression
356 equation combining the effects of body mass and exercise to predict TEE provides a first step towards
357 creating individual advice for jockeys attempting to manage their energy balance. As such, our data
358 now provide an appropriate framework for which to formulate sport-specific nutritional guidelines to
359 promote the ability to make weight safely and above all, improve athlete welfare.

360

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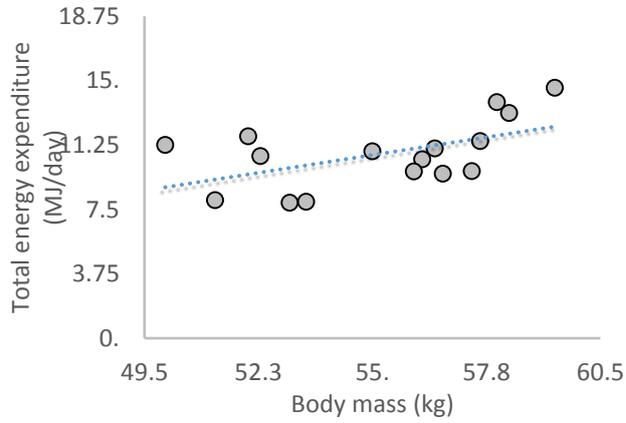
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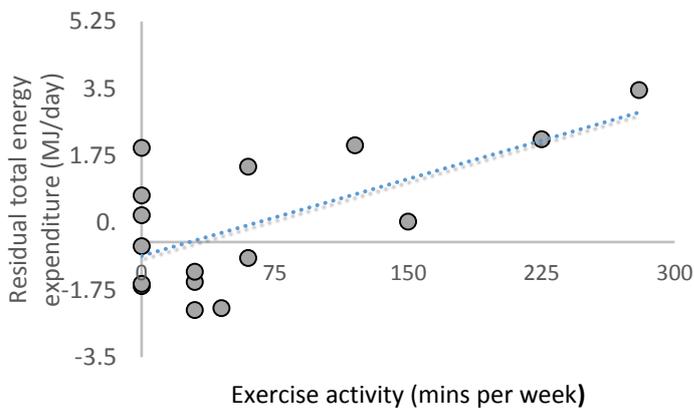
476 **Figure 1**

477 A



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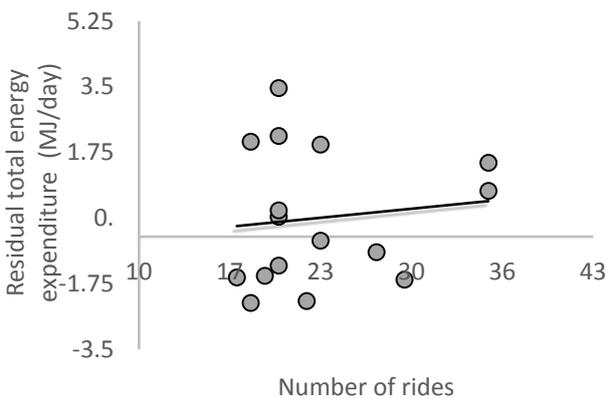
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485 **Figure 1. (A) Total energy expenditure (MJ/day) measured over 7-day periods by doubly labelled water in relation to**
486 **body mass in jockeys. (B and C) Residual variation in total energy expenditure once the effects of body mass were taken**
487 **into account in relation to (B) accumulated minutes spent in non-riding related exercise activity of all types over the**
488 **measurement week and (C) total rides during the week including race rides and training rides.**

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Table1: Self-reported non-riding structured physical activity for two separate weeks during the turf flat horse racing season in GB for 8 professional jockeys

Jockey	August					May				
	Weight (kg)	Mean TEE MJ (SD)	Total Weekly Additional Structured Exercise	MJ	Physical Activity Level (PAL)	Weight (kg)	Mean TEE MJ (SD)	Total Weekly Additional Structured Exercise	MJ	Physical Activity Level (PAL)
1	51.8	8.04 (0.87)	30 min (jog)	0.8	1.31	50.4	11.26 (0.61)	80 min (jog) 20 min (swim)	2.44	1.84
2	53.4	7.95 (1.16)	30 min (bike)	0.65	1.28	53.2	7.89 (1.1)	45 min (bike)	0.99	1.27
3	56.2	9.74 (0.76)	Nil	-	1.53	56.2	10.43 (0.84)	Nil	-	1.64
4	58.5	14.59 (1.23)	210 min (power walk) 70 min (jog)	4.1	2.26	58.0	13.74 (1.19)	225 min (power walk)	5.14	2.13
5	54.9	12.06 (0.66)	60 min (power walk)	1.37	1.91	55.1	10.89 (0.75)	Nil	-	1.73
6	51.4	10.62 (0.97)	Nil	-	1.73	52.1	11.77 (1.21)	Nil	-	1.91
7	55.5	12.12 (1.31)	60 min (jog)	1.69	1.91	56.7	9.59 (0.93)	Nil	-	1.5
8	55.3	13.73 (0.71)	120 min (jog) 30 min (skip)	4.28	2.17	56.0	9.71 (1.1)	30 (jog)	0.86	1.48

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Table 2: Macronutrient values from 7-day self-reported food diaries for two separate weeks during the turf flat horse racing season in GB for 8 professional jockeys

Measure	August	May	T test	CI
Energy Intake (MJ)	5.4 ± 1.1	6.0 ± 1.7	P= 0.398	-246 to 537
CHO (g·d ⁻¹)	146.2 ± 40.1	140 ± 33.8	P= 0.699	-43.3 to 30.1
CHO (g.kg.BM)	2.66 ± 0.73	2.53 ± 0.61	P= 0.656	-0.81 to 0.55
Protein (g·d ⁻¹)	61.9 ± 18.2	60.9 ± 16.4	P= 0.863	-14.3 to 12.4
Protein (g.kg.BM)	1.12 ± 0.33	1.11 ± 0.30	P= 0.810	-0.27 to 0.22
Fat (g·d ⁻¹)	46.74 ± 13.38	54.32 ± 16.14	P= 0.166	-4.17 to 19.33
Fat (g.kg.BM)	0.85 ± 0.24	0.99 ± 0.29	P= 0.181	-0.87 to 0.37

495 MJ – megajoule; CHO – carbohydrate; BM – body mass

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