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Article

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

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Abstract:

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

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

Introduction

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

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

The use of the doubly-labelled water (DLW) stable isotope method is deemed the 'gold standard' for practically measuring TEE in free living mammals (Schoeller, Ravussin, et al., 1986; Speakman & Krol, 2010) and is a method that allows for TEE to be measured over a prolonged period of time (days). The DLW method uses the principles of indirect calorimetry to measure TEE from the turnover rates of two stable isotopes, deuterium (^{2}H) and oxygen 18 (^{18}O) (Speakman, 1997). Since the method involves only the oral administration of stable isotopes and the collection of urine samples it overcomes the limitations that have previously occurred in the limited previous work in this field (Wilson, Sparks, et al., 2013). The capacity to measure TEE in a working week of professional jockeys can provide an insight into the typical energy output which can then be considered when tailoring appropriate nutritional guidelines for jockeys to make weight. Moreover, it could further aid nutritional strategies to understand any potential differences in TEE that may occur at different periods of the flat racing season. Ultimately, this may assist jockeys in making weight more effectively without resorting to severe dehydration techniques, and thereby resulting in improved athlete welfare.

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

Methods

Subjects

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

Overall Study Design

The study was conducted during two separate phases of the flat horse racing season, during the last week of August 2015 and first week of May 2016 respectively. These weeks were chosen to investigate any potential seasonal differences in TEE over the course of the annual flat horse racing calendar. Jockeys provided information on their body weight to calculate DLW dose. Given that jockeys are required to make weight daily, jockeys habitually weigh themselves first thing every day and therefore body weight remains relatively stable during race riding periods (Wilson et al., 2012; Wilson, Drust, et al., 2014; Wilson, Pritchard, et al., 2015). Jockeys were informed about the correct procedures for collecting and storing daily morning urine samples (second void), as well as for completing 7 day food diaries to assess total energy intake (TEI) that coincided with the urine sampling collection period.

Assessment of Total Energy Expenditure (TEE)

On arrival at a racecourse, jockeys had height and weight assessed using a dual-stadiometer (Seca Germany) and provided a single baseline urine sample into a pre-labelled sealable sample pot (Fisher Scientific, England), which was then placed on ice until they could be frozen (-20^{o}C). Jockeys then self-administered a DLW dose pre-calculated to their body weight and weighed to 4 decimal places. The bolus dose of hydrogen (deuterium 2H) and oxygen (18O) stable isotopes (Cortecnet, Voisins-Le-Bretonneux, France) in the form of water ($^{2}H_2{}^{18}O$) was consumed and the precise time was recorded. The desired enrichment dose was 10 % 18O and 5 % 2H. The calculated DLW dose solution had an enrichment of 108365PPM ^{18}O and 50450PPM Deuterium, and was administered at a dosage rate of 1.2g of DLW per kg of subject weight.

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

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

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

Total Energy intake (TEI)

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

Physical Activity

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

Statistical analysis

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

Results

Typical isotope washout curves of both stable isotopes illustrated good linearity ($r^2 > 0.98$) in the stable isotope elimination over the measurement period (not shown). Across all 16 measurements the elimination constant of the oxygen-18 washout (ko) averaged 0.00553/hour giving a half-life of oxygen elimination of 127 hours, with the deuterium elimination constant (kd) averaging 0.00441 and hence the half-life of deuterium elimination averaging 159 hours. The 7 day measurement period therefore spanned roughly 1.3 half-lives of the oxygen elimination which slightly outside the optimum time window for DLW measurements of 2-3 half-lives. The dilution space ratio (N_d/N_o) averaged 1.0361 which is in line with other estimates. The body water % was calculated using the intercept technique where the isotope enrichment at time point zero (dosing) is calculated by back extrapolation. Body water percentage values averaged 59.9% and ranged from 46.9 to 68.4% (excluding one outlier that gave a physiologically unrealistic value of 86.1%). The lowest value of body water coincided with an individual who deliberately dehydrated in a racecourse sauna prior to the measurement period.

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

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

Discussion

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

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

Total energy expenditure was similar over the two phases of the flat racing season, likely reflecting the similar number of race rides and additional structured exercise completed by each jockey. Interestingly, the absolute energy expenditure quantified here is similar to that indirectly estimated previously by our group (~11.3 MJ), where data was collected during a typical non-racing working day through the use of commercially available heart rate monitors (Wilson, Sparks, et al., 2013). Whereas TEE in the previous study were reported on jump jockeys (races where horse and rider negotiate jumping over hurdles or fences) who are typically 5-7 kg heavier than flat jockeys (Wilson, Fraser, et al., 2013), even when considering the additional mass, the TEE does not still substantially increase to levels of other athletes. Taken together our data suggest, that contrary to previous assertions (Dolan et al., 2011) the TEE of professional jockeys is not high in absolute terms when compared with other athletes of a similar mass (Fudge et al., 2006) (~11 versus 14.6 MJ), or team sport athletes (Anderson et al., 2017) (~11 versus 14.9 MJ). Notably, as highlighted, the data reported here suggest a lower PAL for those jockeys who did not perform additional structured exercise (or did very little) than has been cited on age-matched non-athletes (Speakman & Westerterp, 2010) (Table 1 - 1.28 to 1.73 versus 1.79) providing further support for the rationale that high CHO diets are not likely required for professional male jockeys (Wilson, Pritchard, et al., 2015).

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

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

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

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

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

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

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

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

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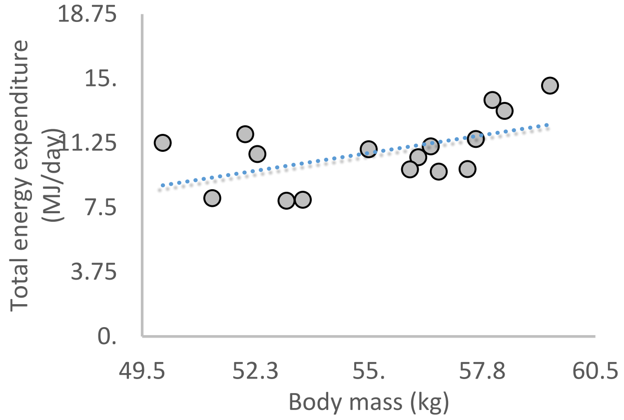
Figure 1

A



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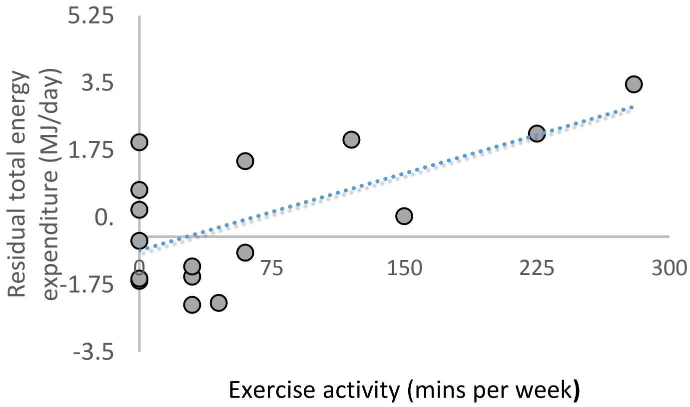

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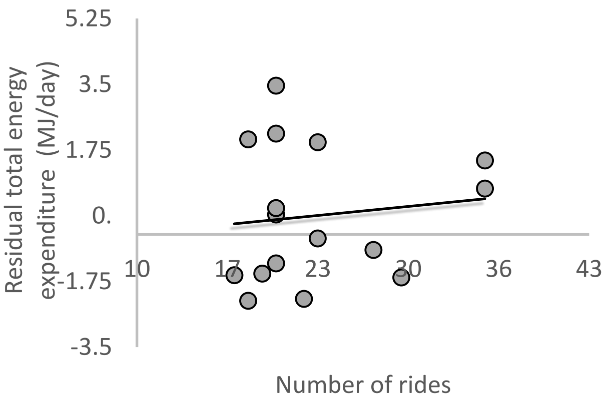

Figure 1. (A) Total energy expenditure (MJ/day) measured over 7-day periods by doubly labelled water in relation to body mass in jockeys. (B and C) Residual variation in total energy expenditure once the effects of body mass were taken into account in relation to (B) accumulated minutes spent in non-riding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

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

	August					May				
Jockey	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

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 ($g \cdot d^{-1}$)	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 ($g \cdot d^{-1}$)	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 ($g \cdot d^{-1}$)	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

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