

Race Weight: Perceptions of Elite Female Road Cyclists

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Purpose: This study investigated the satisfaction of elite female cyclists with their body weight (BW) in the context of race performance, the magnitude of BW manipulation, and the association of these variables with menstrual function. **Methods:** Female competitors in the Australian National Road Cycling Championships ($n = 32$) and the Oceania Championships ($n = 5$) completed a questionnaire to identify current BW, BW fluctuations, perceived ideal BW for performance, frequency of weight consciousness, weight-loss techniques used, and menstrual regularity. **Results:** All but 1 cyclist reported that female cyclists are “a weight-conscious population,” and 54% reported having a desire to change BW at least once weekly; 62% reported that their current BW was not ideal for performance. Their perceived ideal BW was (mean $\pm$ SD) 1.6 ± 1.6 kg ($2.5\% \pm 2.5\%$) less than their current weight ($P < .01$), and 73% reported that their career-lowest BW was either “beneficial” or “extremely beneficial” for performance. 65% reported successfully reducing BW in the previous 12 months with a mean loss of 2.4 ± 1.0 kg ($4.1\% \pm 1.9\%$). The most common weight-loss technique was reduced energy intake (76%). Five cyclists (14%) had been previously diagnosed as having an eating disorder by a physician. Of the 18 athletes not using a hormonal contraceptive, 11 reported menstrual dysfunction (oligomenorrhea or amenorrhea). **Conclusion:** Elite Australian female cyclists are a weight-conscious population who may not be satisfied with their BW leading into a major competition and in some cases are frequently weight conscious.

Keywords: energy intake, cycling, body composition, diet, eating disorder, body weight

A high ratio (W/kg) of power output to body weight (BW) is desirable for performance in road cycling, and higher-performing female Australian cyclists have been shown to be lighter and leaner than their less successful teammates.¹ Indeed, a working group of the International Olympic Committee Medical Commission recently confirmed cycling as a weight-sensitive sport, noting that a high BW “restricts performance because moving the body against gravity is an essential part of the sport.”^{2(p1)} While there are no controlled prospective studies investigating risk factors for disordered eating in athletes, participation in weight-sensitive sports is believed to increase the risk of unhealthy practices used to manipulate body composition. Previous research has shown that endurance athletes, particularly female endurance athletes, perceive a greater pressure to be lean, and this is associated with a greater prevalence of eating disorders.³ While no known studies have investigated these themes specifically in female cyclists, male cyclists have been reported to have a relatively high prevalence of disordered eating behaviors.^{4,5}

Although there is often a need to manipulate diet and training to achieve a competitive body composition in cycling, our experience at the Australian Institute of Sport has made us aware of case histories in which Australian⁶ and international⁷ female cyclists have resorted to “extreme” and potentially unhealthy weight-loss methods to achieve what they believe is an ideal BW for performance. These weight-loss practices increase the risk of creating an energy deficiency, which may result in impaired reproductive function and bone status,⁸ an increased prevalence of illness⁹ and injuries,¹⁰ and a reduction in athletic performance.¹¹ More recently, the concept of relative energy deficiency in sport (RED-S) was introduced, which

emphasizes a more complex interaction between excessive or prolonged energy deficiency, health, and performance in both male and female athletes.¹² In addition to a range of mechanisms impairing performance, the RED-S concept describes a wider range of health consequences broadly categorized as immunological, reproductive, bone health, endocrine, metabolic, hematological, growth, psychological, cardiovascular, and gastrointestinal.¹² It is apparent that athletes exposed to frequent or prolonged periods of energy deficiency are at an increased risk of a broad range of health consequences. It is of interest to better describe the perceptions toward BW of athletes participating in weight-conscious sports such as cycling.

The primary objective of this study was to describe the weight consciousness of elite female road cyclists. The secondary objective was to describe the BW satisfaction of female cyclists in the context of performance at a major competition. Self-reported seasonal fluctuations in BW and the methods used to manipulate BW were also evaluated, as was the association between BW manipulation and menstrual dysfunction.

Methods

Thirty-seven female cyclists who competed in the road race at the 2013 Australian National Road Cycling Championships ($n = 32$) and Oceania Championships ($n = 5$) volunteered to participate in this study after being approached by regional and state coaches who supported this research theme. Both races included multiple laps of an ~10-km circuit with a significant climb totaling ~1500-m ascent. These races were selected as they attract the highest level of Australian cyclists and the course profiles are not dissimilar to those typically used in Union Cycliste Internationale (UCI) World Cup and World Championship road races. The study was approved by the human research ethics committee at the Australian Institute of Sport, and all subjects were informed of testing protocols and risks of the study before providing written informed consent.

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In the week leading up to competition (1–5 d before race day), cyclists were asked to complete the Female Cyclist Weight Management Questionnaire, which consists of 19 questions (see the Appendix) that focus on the following themes: athlete level (professional or amateur); cyclist type (climber, sprinter, time trialist, all-rounder); current actual BW and how much it has fluctuated during her career since she stopped growing; whether she feels that her current BW is ideal for performance in these races and, if not, how much she would like to change it (ideal BW); whether she has attempted to change her BW in the past 12 months and whether she was successful; how effective she perceives racing at her lowest weight to be; how frequently she is conscious of wanting to change her BW (10-point scale); what techniques she has used to manipulate her BW in the past; whether she thinks her coach has ever been dissatisfied with her BW; and the regularity of her menstrual cycle.

Three questions related to BW-reduction techniques (“I avoided foods high in sugar,” “I vomited after eating,” “I used weight-loss supplements or medications”) were adapted from The Eating Attitudes Test,¹³ while those related to menstrual function are adapted from the HUNT-2 Questionnaire.¹⁴ The majority of the questions were designed specifically for this study and have not been used previously. We acknowledge that this questionnaire has not been assessed for validity or reliability.

Statistical Analysis

Self-reported BW was investigated using linear mixed-effects modeling fit by restricted maximum likelihood estimation (REML) with BW context (current BW, career-lowest BW, career-highest BW, and ideal BW) as a main effect and subject as a random effect. The interaction between cyclist type (climber, sprinter, time trialist, all-rounder) and BW context (current BW and ideal BW only) was investigated using a separate model with cyclist type and BW context as main effects and subject as a random effect. Body-mass index (BMI) (BW [kg]/height [m]²) was estimated based on reported current BW (current BMI), ideal BW (ideal BMI), lowest BW (lowest BMI), and highest BW (highest BMI).

The difference between current BW and ideal BW was expressed for all cyclists as a percentage of current BW (weight $\Delta\%$). The weight $\Delta\%$ was investigated using linear mixed-effects modeling fit by REML with cyclist type and professional status (professional and amateur cyclists) as main effects and subject as a random effect.

The Pearson chi-squared test was used to assess differences between professional and amateur cyclists for responses toward perceptions of the effect of career-lowest weight on performance, prevalence of eating disorders, coach dissatisfaction with weight, and whether weight had been manipulated in the previous 12 months. The Fisher exact test was used to identify any differences in the frequency of weight consciousness by professional status and by best National Road Series (NRS) race ranking (top 3, 4–10, 11–20, >20). The magnitude of BW change in the previous 12 months was investigated using a linear mixed-effects model fit by REML, with cyclist type and professional status as main effects and subject as a random effect.

The frequency of weight consciousness was dichotomized to once or more weekly or less than once weekly. A Pearson chi-squared test was used to determine if there were differences in the frequency of weight consciousness depending on menstrual function, normal or dysfunctional (amenorrheic or oligomenorrheic).

A linear mixed-effects model fit by REML was used to determine whether the magnitude of BW change differed in these groups. Tukey honestly significantly different post hoc analysis was used to determine the level of the difference for all mixed models. All statistical analyses were conducted using JMP Pro v10 (SAS Institute Inc, Cary, NC, USA). An alpha level of .05 was used.

Results

Subject Characteristics

Thirty-seven female cyclists completed the survey (range 18–36 y, mean $\pm$ SD 58.4 $\pm$ 5.9 kg, 170 $\pm$ 7 cm). This represents 32 (45%) starters at National Championships and 5 at Oceania Championships who had not already completed the survey at National Championships. Fifteen cyclists classified their status as racing for a professional team internationally in the last 12 months, and the average duration of their racing as a professional was 1.6 $\pm$ 0.8 years. The remaining 22 cyclists reported racing only domestically in the past 12 months (amateur). Of the 22 amateurs, 12 cyclists had achieved a top-3 placing in a NRS race in the previous 12 months, 6 achieved a 4-to-10 placing, and 4 did not achieve a top-10 place. The cyclists classified themselves as climbers, $n = 11$; sprinters, $n = 6$; time trialists, $n = 4$; or all-rounders, $n = 16$.

Perceptions of the Effect of BW on Performance

Twenty-three cyclists (62%) reported that their current BW was not optimal for performance in these races. This did not differ between professional and amateur cyclists ($\chi^2_{1,37} = 0.84$, $P = .36$). The analysis of self-reported BW revealed main effects for BW context ($F_{3,107} = 88.76$, $P < .01$; see Table 1). Current BW was significantly higher than lowest BW (mean [95% confidence interval] 2.3 kg [1.4, 3.2], $P < .01$) and ideal BW (1.6 kg [0.6, 2.5], $P < .01$) but was lower than the highest BW (−3.0 kg [−3.9, −2.1], $P < .01$). The difference between lowest BW and ideal BW was not significant (−0.7 kg [−0.2, 1.7], $P = .16$). Current BMI was estimated to be (mean $\pm$ SD) 20.3 $\pm$ 2.2 kg/m² ($n = 7$ £ 18.5 kg/m²), lowest BMI was 19.5 $\pm$ 2.2 kg/m² ($n = 13$ £ 18.5 kg/m²), ideal BMI was 19.8 $\pm$ 1.9 kg/m² ($n = 10$ £ 18.5 kg/m²), and highest BMI was 20.3 $\pm$ 2.2 kg/m² ($n = 7$ £ 18.5 kg/m²).

As shown in Table 2 there was an interaction between cyclist type and BW context when analyzing only current and ideal BW ($F_{3,33} = 6.15$, $P < .01$). Compared with climbers, current BW was significantly higher for sprinters (9.5 kg [2.2, 16.7], $P < .01$), time trialists (9.4 kg [1.1, 17.7], $P = .02$), and all-rounders (6.2 kg [0.6, 11.8], $P = .02$). There were no significant differences between

Table 1 Comparison of Self-Reported Body-Weight Changes and Perceived Ideal Weight for Performance

Body-weight context	Mean [95% CI]
Current weight	58.3 [56.4, 60.2] ^{L,H,I}
Career-lowest weight	56.0 [54.1, 57.9] ^{C,H}
Career-highest weight	61.3 [59.4, 63.2] ^{C,L,I}
Ideal weight	56.8 [55.2, 58.5] ^{C,H}

^C Significant difference from current weight, $P < .05$. ^L Significant difference from lowest weight, $P < .05$. ^H Significant difference from highest weight, $P < .05$.

^I Significant difference from ideal weight, $P < .05$.

Table 2 Self-Reported Current Body Weight (kg) for Different Types of Cyclists and the Body Weight Perceived to be Ideal for Performance at Major Competition, Mean [95% CI]

Cyclist type	n	Current weight	Ideal weight	Δ weight (%)
Climbers	11	53.1 [50.4, 55.8] ^{S,T,A}	52.8 [50.1, 55.5]	0.5 [−0.7, 1.8] ^{S,T}
Sprinters	6	62.6 [58.9, 66.3] ^C	60.0 [56.3, 63.7]*	4.1 [2.4, 5.9] ^C
Time trialists	4	62.5 [58.0, 67.0] ^C	59.5 [55.0, 64.0]*	4.7 [2.5, 6.8] ^C
All-rounders	15	59.3 [57.0, 61.5] ^C	57.8 [55.4, 59.9]*	2.6 [1.5, 3.7]
All cyclists	37	58.3 [56.4, 60.2]	56.8 [55.2, 58.5]*	2.5 [1.6, 3.3]
Professionals	15	57.6 [54.5, 60.6]	56.2 [53.6, 58.8]*	2.2 [0.9, 3.5]
Amateurs	21	58.8 [56.3, 61.4]	57.3 [55.1, 59.5]*	2.7 [1.5, 3.8]

^A Significantly different from all-rounders, $P < .05$. ^C Significantly different from climbers, $P < .05$. ^S Significantly different from sprinters, $P < .05$. ^T Significantly different from time trialists, $P < .05$.

*Ideal weight significantly different from current weight, $P < .05$.

sprinters, time trialists, and all-rounders ($P > .05$). While there was a trend toward ideal BW being lower for climbers than for sprinters (−7.2 kg [−0.1, 14.4], $P = .05$), there were no statistically significant differences between ideal BW for different types of cyclists. Current BW was greater than ideal BW for sprinters (2.6 kg [0.8, 4.3], $P < .01$), all-rounders (1.6 kg [0.5, 2.8], $P < .01$), and time trialists (3.0 kg [0.8, 5.1], $P < .01$), but not for climbers (0.3 kg [−1.0, 1.6], $P = .99$).

Since, there were no main effects for professional status on weight $\Delta\%$ ($F_{1,28} = 0.43$, $P = .514$) it was dropped from the model. Cyclist type had significant main effects on weight $\Delta\%$ ($F_{3,32} = 5.92$, $P < .01$; see Table 2). Compared with climbers, the weight $\Delta\%$ was significantly greater for sprinters (3.6% [0.7, 6.5], $P < .01$) and time trialists (4.1% [0.8, 4.2], $P = .01$), with a similar trend compared with all-rounders (2.1% [−0.01, 4.4], $P = .007$).

When asked how being at their career-lowest BW affects their performance, 10 (27%) of the 37 cyclists responded saying it was not beneficial. More specifically, 2, 3, and 5 athletes reported that it was extremely harmful, somewhat harmful, or had no effect, respectively. Twenty cyclists (54%) reported that their career-lowest BW was beneficial, and 7 (19%) that it was extremely beneficial. There was no significant difference between amateur and professional cyclists' responses to this question ($\chi^2_{4,37} = 7.77$; $P = .08$). All but 1 athlete reported a belief that female cyclists are a weight-conscious population. Twelve cyclists (32%) reported that their coach or sports director had expressed dissatisfaction with their body weight at some point in past 12 months, and this response was more frequent with the professional cyclists ($n = 8$, $\chi^2_{1,37} = 5.029$, $P = .03$).

BW Changes and Manipulation

Twenty-six (70%) cyclists reported attempting to reduce their BW in the past 12 months. Twenty-four reported reducing BW by an average ($\pm$ SD) of 2.4 ± 1.0 kg (range 1–5 kg). This represented $4.2\% \pm 1.8\%$ of the current BW (range 1.7–9.8%). There was no statistically significant difference between professional and amateur cyclists ($\chi^2_{1,37} = 0.509$, $P = .48$). Five cyclists (14%) reported having been previously diagnosed by a physician as having an eating disorder. This was no more prevalent in professionals than amateurs ($\chi^2_{1,37} = 0.00$, $P = .98$). There were no main effects for cyclist type ($F_{3,18} = 1.75$, $P = .19$) or professional status ($F_{1,18} = 0.021$, $P = .89$)

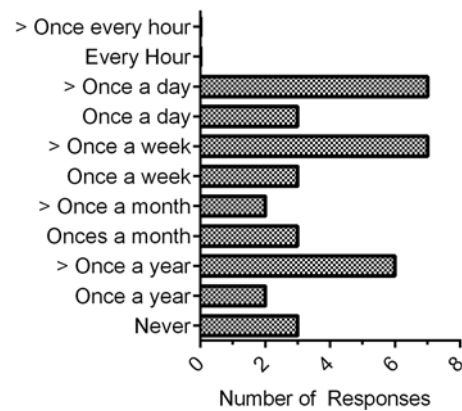


Figure 1 — The frequency with which female cyclists reported they were conscious about wanting to reduce their body mass in the past 12 months.

on the magnitude of BW change in the previous 12 months. These findings persisted when the magnitude of BW change was expressed as a percentage of current BW ($P > .05$).

Responses to the question “In the last 12 months, how often were you conscious about wanting to change your body weight?” are shown in Figure 1. Sixteen (43%) cyclists reported being conscious of this less than once a week, while 20 (54%) reported being conscious of this once a week or more frequently. This included 7 (19%) cyclists who were conscious more than once daily. There was no significant difference in the frequency of weight consciousness between professionals and amateurs ($\chi^2_{1,36} = 0.286$, $P = .60$) or between riders categorized based on best NRS race ranking ($\chi^2_{5,36} = 5.96$, $P = .44$).

BW-reduction techniques reported to have been practiced are reported in Figure 2. The most commonly selected techniques were avoiding foods high in fat ($n = 24$, 65%), avoiding foods high in sugar ($n = 23$, 62%), and reducing total daily energy intake ($n = 28$, 76%). Other more extreme albeit less common practices were also reported: skipping meals ($n = 6$, 16%), training for prolonged periods without eating ($n = 7$, 19%), purging ($n = 2$, 5%), wearing additional clothing or plastic wraps while training ($n = 1$, 3%), and taking weight-loss supplements or medications ($n = 1$, 3%).

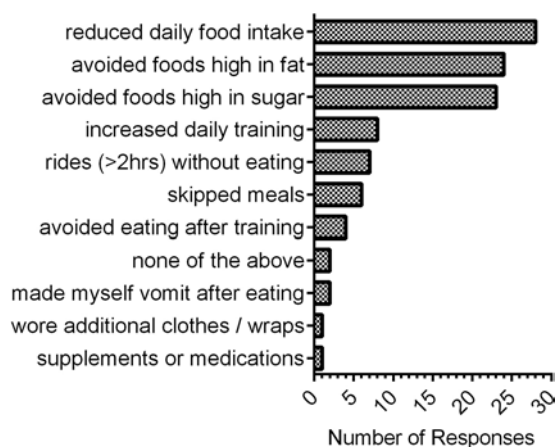


Figure 2 — Self-reported techniques previously used for the specific purpose of reducing body mass.

Association Between Menstrual Function and BW

Of those cyclists who were not using a hormonal contraceptive ($n = 18$), 11 reported having had menstrual dysfunction in the past 12 months. Ten reported that their menstrual cycle had ceased for more than 3 months in the past year (amenorrheic). Of this subsample, those who reported menstrual dysfunction were more likely to be conscious about wanting to change their BW at least once weekly than were those who were not ($\chi^2_{1,17} = 6.80, P = .02$). There were no main effects of menstrual function on the magnitude of BW change in the past 12 months ($F_{1,10} = 0.872, P = .37$) or on current BW ($F_{1,16} = 1.21, P = .29$). When including all the cyclists regardless of use of hormonal contraceptives, those who reported having an irregular menstrual cycle and/or going ≥ 3 months without menstruating in the past 12 months also reported a significantly lower current BW (-4.3 kg [$0.7, 8.0$], $F_{1,35} = 5.78, P = .02$) and current BMI (-1.5 kg/m² [$0.1, 3.0$], $F_{1,34} = 4.69, P = .037$) than those who did not.

Discussion

The current study investigated weight consciousness, BW satisfaction in the context of performance, seasonal and career fluctuations in BW, and BW manipulation in elite female cyclists. The primary finding from this investigation was that elite Australian female cyclists competing in major domestic races are a weight-conscious population. A large proportion of the cyclists (54%) reported being conscious of wanting to change their BW at least once a week, with 19% being conscious of this desire more than once daily. These findings may suggest that a significant number of female cyclists have a longer-term drive for thinness, which may increase their risk of persistent energy deficiency.

It is important to note the subtle difference between these sport-related constructs and the constructs of social physique anxiety,^{15,16} body-image concerns,^{17–19} eating disorders,^{2,3} eating attitudes,^{3,13,15} and sociocultural pressure to be lean,^{3,20} which have been reported on extensively in general and in athletic populations. A unique construct investigated in this study is BW satisfaction, which was framed specifically in the context of performance at a major competition. The majority of female cyclists (62%) reported that their current BW was not ideal for performance at these races. They perceived that their ideal BW was on average ($\pm$ SD) 1.6 ± 1.6 kg ($2.5\% \pm 2.5\%$ body weight) less than the weight at which

they presented at the event. Similarly, 67% of male cyclists in a study by Filaire et al⁴ were dissatisfied with their current BW, and the reported difference between current and preferred BW in other endurance athletes (running, triathlon, orienteering, rowing, swimming) was approximately 2.0 kg.²¹ Previous research on female college athletes has reported that those competing in higher-division schools (Divisions I and II) experience greater body dissatisfaction, weight concern, and preoccupation than those in Division III school athletic programs.¹⁸ In this study, there were no significant differences in the magnitude of weight dissatisfaction related to performance between professional and amateur cyclists, nor was there an effect of best domestic race ranking. While weight satisfaction was investigated in the context of performance at a specific competition, it may be that some of the findings reported persist throughout the season and are not race specific. This study measured weight consciousness and weight satisfaction at only 1 time point—leading into major competition. It is possible that perceptions toward BW and its relation to performance could change throughout the season and possibly even after these races depending on the outcome. Future studies should administer similar questionnaires throughout the year to investigate whether weight satisfaction can be isolated to a specific competition or whether it is a mindset that persists over longer time frames.

Dissatisfaction with BW at the Australian and Oceania Championships is interesting given that these races are preceded by the Australian summer off-season, where there has been sufficient training time and good environmental conditions to achieve desired body-composition changes. It may be that for some athletes, there is a persistent drive for thinness regardless of the preparation made before major competition. It is possible that responses would be similar later in the season, although this warrants further investigation, particularly at larger international races such as World Championships or World Cups.

There was no significant difference between career-lowest BW and the weight perceived to be ideal for these races. This suggests that a majority of these elite female cyclists wanted their current BW to be not only lower but also very close to their career-lowest BW. This supports the finding that 73% of the cyclists agreed that being at their career-lowest weight was beneficial or extremely beneficial to race performance. It is also important to note that 7 (19%) of the cyclists would be classified as underweight (BMI ≤ 18.5 kg/m²)²² based on their estimated current BMI, as well as their highest reported BMI. The lowest BMI categorized 13 (35%) cyclists as underweight while the estimated ideal BMI placed 10 (27%) of the cyclists in the underweight category. The large number of female cyclists who would be considered to have a BW that is unhealthily low relative to their height by World Health Organization standards is concerning.

Unsurprisingly, the difference between current BW and ideal BW was nonsignificant for climbers, whereas other types of cyclists had a significantly lower ideal BW for performance. Given the repetitive climbing on these courses and the fact that the current BW for climbers was lower than the other types of cyclists, this indicates that cyclists of different types may assess their BW against the course profile. With that said, the total vertical ascent of these 2 courses (~ 1500 m) is still less than that experienced in isolated mountain passes frequently experienced in stage races such as the women's Giro d'Italia or even domestic 1-day races such as the Tour of Bright. Furthermore, the winner of the recent National Championships would have been considered an all-rounder. While speculation on the data is interesting, we acknowledge that caution should be taken with interpreting these data given the small sample sizes,

particularly for the time-trialist group ($n = 4$). No validation was made of the BWs the cyclists reported under the various contexts.

The secondary finding from this investigation was that a large proportion (~70%) of elite female cyclists competing at National and Oceania Championships reported attempts to manipulate their BW in the 12 months before these races. The majority of these athletes were successful and reduced BW by an average of 2.4 ± 1.0 kg, which represented $4.1\% \pm 1.9\%$ of their current BW. This is similar to that reported for male cyclists (3.1 ± 0.3 kg), who reported using techniques such as fasting and laxatives (41%) and increased exercise volume (13%).⁴ Other reviews of weight-loss practices of elite male cyclists have noted substantial restriction of energy intake in general or at certain times of the day (eg, evening), undertaking training rides in an overnight fasted state, use of anorexic drugs, and undertaking high-volume stage races without increasing energy intake.²³ In the current female cyclists, reductions in BW were primarily brought about by reducing daily energy intake, avoiding foods high in fat, avoiding foods high in sugar, and increasing training load. Of greater concern was the small number of cyclists who performed what may be described as more extreme weight-loss practices such as skipping meals, training for prolonged periods without eating, purging, wearing additional clothing or plastic wraps while training, and taking weight-loss supplements or medications. It should be emphasized that this represented a small number of the cyclists surveyed (see Figure 2). Nonetheless, there is sufficient evidence to suggest that female cyclists not engaging in extreme weight-loss practices may be attempting to reduce energy intake relative to exercise energy expenditure, thereby placing themselves at risk for a persistent energy deficiency and its associated health and performance risks.

It is noteworthy that in a group of 37 female cyclists, 5 (14%) had been previously diagnosed with an eating disorder by a physician and 12 (32%) reported that their coach or sports director had been dissatisfied with their BW in the past 12 months. While BW and, indeed, body composition have performance implications on cycling performance, consideration must be given to the way this message is delivered. It is acknowledged that the actual prevalence of eating disorders and disordered eating may be higher in this group, and the absence of a validated questionnaire assessing these constructs more thoroughly (eg, Eating Disorder Inventory²⁴ or Eating Disorder Examination²⁵) is a limitation of the study. For instance, Riebl et al⁵ previously reported that from a group of 61 male cyclists, 12 provided responses consistent with disordered eating, whereas only 5 self-reported having an eating disorder. Similar results could be expected from female cyclists. The absence of such a questionnaire makes it difficult to distinguish weight-conscious athletes from those at risk for chronic or excessive energy deficiency and/or behaviors consistent with disordered eating.

Williams et al²⁶ reported that irregular menstrual-cycle length was modestly associated with a higher risk of disordered eating in female athletes. Furthermore, it is well documented that low energy availability negatively affects menstrual function.⁸ Melin et al²⁷ have shown that self-reported menstrual dysfunction has a high specificity and sensitivity for clinically verified menstrual dysfunction. Therefore, the Female Cyclist Weight Management Questionnaire included a series of questions designed to investigate the association between menstrual-cycle regularity, magnitude of BW change, and current BW. This study was limited in sample size, and the questionnaire failed to ask why the cyclists used a hormonal contraceptive; it is not uncommon that women with hypothalamic amenorrhea are prescribed a hormonal contraceptive to improve or maintain bone mineral density. These limitations notwithstanding, there was evidence that female cyclists with menstrual dysfunction

had a lower current BW and were more frequently conscious about wanting to change their BW. Furthermore, of athletes who were not using hormonal contraceptives, 61% reported having menstrual dysfunction. These findings combined suggest that a large number of these cyclists have more persistent suppression of endocrine function, which may be related to energy deficiency.

It is widely accepted that functional hypothalamic menstrual disorders and low bone mineral density stem from energy deficiency.^{8,12,28–31} One of the more serious health implications of energy deficiency is low bone density. While this study did not measure bone density, it did reveal evidence of risk factors for energy deficiency in female cyclists. Female cyclists have been reported to have a high prevalence of poor bone health,³² possibly owing to a combination of persistent energy deficiency and low mechanical bone loading.³³ Future studies should investigate relationships between energy deficiency and bone health in this population, as osteoporosis is one of the more debilitating outcomes associated with prolonged energy deficiency.

Conclusion

These results suggest that Australian female cyclists are a weight-conscious population who are frequently motivated to reduce BW and consciously do so seasonally. It is of concern that the majority of respondents were dissatisfied with their BW leading into a major competition. This, coupled with the relatively high incidence of previous eating-disorder diagnoses, an apparent drive to be underweight (BMI ≤ 18.5 kg/m²), and the prevalence of menstrual dysfunction, supports the opinion that this athletic population is at risk for engaging in practices that may result in deliberate or inadvertent energy deficiency relative to energy intake. This may place them at greater risk of compromising their health and performance. While weight dissatisfaction was affected by the type of cyclist (or perhaps by the course profile) this investigation did not show that professional status or domestic race results influenced this. There was evidence that BW-reducing practices and weight consciousness may be associated with menstrual dysfunction, although this study did not seek to establish causality. Given that road cycling is a weight-sensitive sport, it is perhaps not surprising that athletes participating in the sport manipulate their BW and perceive benefit in a low BW. The high incidence of weight dissatisfaction is, however, noteworthy for support staff engaging with these athletes. These results underscore the importance for coaches, sports directors, and sports scientists to be sensitive and provide appropriate instruction and ongoing support when advising athletes on exercise and diet strategies that may affect energy availability and body composition. In a population that is weight conscious and motivated to have a low BW, strategies aimed at achieving this should place primary emphasis on maintaining good health.

Acknowledgments

The authors would like to acknowledge Cycling Australia and the Australian State Sport Institutes and Academies for providing logistical support for this project and the athletes who gave up their time to be involved.

References

1. Martin DT, McLean B, Trewin C, Lee H, Victor J, Hahn AG. Physiological characteristics of nationally competitive female road cyclists and demands of competition. *Sports Med.* 2001;31(7):469–477. PubMed doi:10.2165/00007256-200131070-00002

2. Sundgot-Borgen J, Meyer NL, Lohman TG, et al. How to minimise the health risks to athletes who compete in weight-sensitive sports review and position statement on behalf of the Ad Hoc Research Working Group on Body Composition, Health and Performance, under the auspices of the IOC Medical Commission. *Br J Sports Med.* 2013;47(16):1012–1022. [PubMed doi:10.1136/bjsports-2013-092966](#)
3. Byrne S, McLean N. Elite athletes: effects of the pressure to be thin. *J Sci Med Sport.* 2002;5(2):80–94. [PubMed doi:10.1016/S1440-2440\(02\)80029-9](#)
4. Filaire E, Rouveix M, Pannafieux C, Ferrand C. Eating attitudes, perfectionism and body-esteem of elite male judoists and cyclists. *J Sports Sci Med.* 2007;6(1):50–57. [PubMed](#)
5. Riebl SK, Subudhi AW, Broker JP, Schenck K, Berning JR. The prevalence of subclinical eating disorders among male cyclists. *J Am Diet Assoc.* 2007;107(7):1214–1217. [PubMed doi:10.1016/j.jada.2007.04.017](#)
6. Lane S. Pedalling the long road back from despair. *Sydney Morning Herald.* January 7, 2012. <http://www.smh.com.au/sport/cycling/pedalling-the-long-road-back-from-despair-20120106-1poc9.html>. Accessed April 5, 2013.
7. Holcombe B. National Day of Listening 2012: Giro champ Mara Abbott forging a comeback. *VeloNews.com.* November 23, 2012. http://velonews.competitor.com/2012/11/analysis/national-day-of-listening-2012-giro-champ-mara-abbott-forging-a-comeback_266066. Accessed April 5, 2013.
8. Loucks AB, Kiens B, Wright HH. Energy availability in athletes. *J Sports Sci.* 2011;29(Suppl 1):S7–S15. [PubMed doi:10.1080/02640414.2011.588958](#)
9. Hagmar M, Hirschberg AL, Berglund L, Berglund B. Special attention to the weight-control strategies employed by Olympic athletes striving for leanness is required. *Clin J Sport Med.* 2008;18(1):5–9. [PubMed doi:10.1097/JSM.0b013e31804c77bd](#)
10. Rauh MJ, Nichols JF, Barrack MT. Relationships among injury and disordered eating, menstrual dysfunction, and low bone mineral density in high school athletes: a prospective study. *J Athl Train.* 2010;45(3):243–252. [PubMed doi:10.4085/1062-6050-45.3.243](#)
11. Vanheest JL, Rodgers CD, Mahoney CE, De Souza MJ. Ovarian suppression impairs sport performance in junior elite female swimmers. *Med Sci Sports Exerc.* 2014;46(1):156–166. [PubMed doi:10.1249/MSS.0b013e3182a32b72](#)
12. Mountjoy M, Sundgot-Borgen J, Burke L, et al. The IOC consensus statement: beyond the female athlete triad—relative energy deficiency in sport (RED-S). *Br J Sports Med.* 2014;48(7):491–497. [PubMed doi:10.1136/bjsports-2014-093502](#)
13. Garner DM, Olmsted MP, Bohr Y, Garfinkel PE. The Eating Attitudes Test: psychometric features and clinical correlates. *Psychol Med.* 1982;12(4):871–878. [PubMed doi:10.1017/S0033291700049163](#)
14. Holmen J, Midtjell K, Krüger Ø, et al. The Nord-Trøndelag Health Study 1995–97 (HUNT 2): objectives, contents, methods and participation. *Nor Epidemiol.* 2003;13(1):19–32.
15. Haase AM, Prapavessis H, Glynn Owens R. Perfectionism, social physique anxiety and disordered eating: a comparison of male and female elite athletes. *Psychol Sport Exerc.* 2002;3(3):209–222. [doi:10.1016/S1469-0292\(01\)00018-8](#)
16. Hart EA, Leary MR, Rejeski WJ. The measurement of social physique anxiety. *J Sport Exerc Psychol.* 1989;11(1):94–104.
17. Hausenblas HA, Downs DS. Comparison of body image between athletes and nonathletes: a meta-analytic review. *J Appl Sport Psychol.* 2001;13(3):323–339. [doi:10.1080/104132001753144437](#)
18. Varnes JR, Stellefson ML, Janelle CM, Dorman SM, Dodd V, Miller MD. A systematic review of studies comparing body image concerns among female college athletes and non-athletes, 1997–2012. *Body Image.* 2013;10(4):421–432. [PubMed doi:10.1016/j.bodyim.2013.06.001](#)
19. Franzoi SL, Shields SA. The Body Esteem Scale: multidimensional structure and sex differences in a college population. *J Pers Assess.* 1984;48(2):173–178. [PubMed doi:10.1207/s15327752jpa4802_12](#)
20. Reel JJ, Petrie TA, SooHoo S, Anderson CM. Weight pressures in sport: examining the factor structure and incremental validity of the weight pressures in sport—females. *Eat Behav.* 2013;14(2):137–144. [PubMed doi:10.1016/j.eatbeh.2013.01.003](#)
21. Fogelholm M, Hiilloskorpi H. Weight and diet concerns in Finnish female and male athletes. *Med Sci Sports Exerc.* 1999;31(2):229–235. [PubMed doi:10.1097/00005768-199902000-00005](#)
22. World Health Organization. *Obesity: Preventing and Managing the Global Epidemic.* World Health Organization; 2000. http://www.who.int/nutrition/publications/obesity/WHO_TRS_894/en/
23. Burke LM. Nutritional practices of male and female endurance cyclists. *Sports Med.* 2001;31(7):521–532. [PubMed doi:10.2165/00007256-200131070-00007](#)
24. Garner DM, Olmstead MP, Polivy J. Development and validation of a multidimensional eating disorder inventory for anorexia nervosa and bulimia. *Int J Eat Disord.* 1983;2(2):15–34. [doi:10.1002/1098-108X\(198321\)2:2<15::AID-EAT2260020203>3.0.CO;2-6](#)
25. Cooper Z, Fairburn C. The eating disorder examination: a semi-structured interview for the assessment of the specific psychopathology of eating disorders. *Int J Eat Disord.* 1987;6(1):1–8. [doi:10.1002/1098-108X\(198701\)6:1<1::AID-EAT2260060102>3.0.CO;2-9](#)
26. Williams NI, Leidy HJ, Flecker KA, Galucci A. Food attitudes in female athletes: association with menstrual cycle length. *J Sports Sci.* 2006;24(9):979–986. [PubMed doi:10.1080/02640410500456986](#)
27. Melin A, Tornberg AB, Skouby S, et al. The LEAF questionnaire: a screening tool for the identification of female athletes at risk for the female athlete triad. *Br J Sports Med.* 2014;48(7):540–545. [PubMed doi:10.1136/bjsports-2013-093240](#)
28. Sangenis P. International Olympic Committee (IOC) Medical Commission position stand on the female athlete triad. http://www.femaleathletetriad.org/~triad/wp-content/uploads/2008/10/ioc_position_stand_on_female_athlete_triad.pdf.
29. Nattiv A, Loucks AB, Manore MM, Sanborn CF, Sundgot-Borgen J, Warren MP. American College of Sports Medicine position stand: the female athlete triad. *Med Sci Sports Exerc.* 2007;39(10):1867–1882. [PubMed doi:10.1249/mss.0b013e318149f111](#)
30. Sherman RT, Thompson RA. Practical use of the International Olympic Committee Medical Commission position stand on the female athlete triad: a case example. *Int J Eat Disord.* 2006;39(3):193–201. [PubMed doi:10.1002/eat.20232](#)
31. De Souza MJ, Nattiv A, Joy E, et al. 2014 Female Athlete Triad Coalition consensus statement on treatment and return to play of the female athlete triad: 1st International Conference held in San Francisco, CA, May 2012, and 2nd International Conference held in Indianapolis, IN, May 2013. *Clin J Sport Med.* 2014;24(2):96–119.
32. Sherk VD, Barry DW, Villalon KL, Hansen KC, Wolfe P, Kohrt WM. Bone loss over 1 year of training and competition in female cyclists. *Clin J Sports Med.* 2014;24(4):331–336. [PubMed doi:10.1097/JSM.0000000000000050](#)
33. Scofield KL, Hecht S. Bone health in endurance athletes: runners, cyclists, and swimmers. *Curr Sports Med Rep.* 2012;11(6):328–334. [PubMed doi:10.1249/JSR.0b013e3182779193](#)

Appendix: Weight-Management Questionnaire

Female Cyclist Weight Management Questionnaire

- Do you race for a professional team competing internationally **Yes / No** (circle one)
If Yes: For how many years? (check one box ☐)
☐ 1 - 2 ☐ 3 - 4 ☐ 5 or more
- What was your best ranking in a National Racing Series (NRS) race between 2012 and today? (check one box ☐)
☐ Top 3 ☐ 4-10 ☐ 11-20 ☐ Never ☐ I have never raced in the NRS because I was racing overseas
- What type of a cyclist would you say you are? (check one box ☐)
☐ Climber ☐ Sprinter ☐ Time Trialist ☐ All rounder (rouler)
- What is your height? _____ cm / ft.in
- What is your CURRENT body weight? _____ kg / lb
- What is the LOWEST body weight you have competed at since you stopped growing? _____ kg / lb
- What is the HIGHEST body weight you have competed at? _____ kg / lb
- Do you think your current body weight is optimal for performance at this race?
Yes / No
If No: What would be your IDEAL body weight? _____ kg / lb
- How do you think being at your LOWEST weight affects your race performance? (check one box ☐)
☐ Extremely Harmful ☐ Somewhat Harmful ☐ No Effect ☐ Beneficial ☐ Extremely Beneficial
- Has a doctor ever diagnosed you with an eating disorder? **Yes / No**
- Do you believe female cyclists are a weight conscious population? **Yes / No**
- Has your coach / director expressed dissatisfaction with your body weight in the past 12 months? **Yes / No**

- Have you tried to change your body weight in the last 12 months? **Yes / No**
If No: continue to Question 13
If Yes: Did you try to increase or decrease your body weight? (circle one)
Were you successful at changing your body weight? **Yes / No**
How much weight did your weight increase or decrease? _____ kg / lb

- In the last 12 months, how often were you conscious about wanting to change your body weight? (circle one number)

Never	Once in the year	Once a month	More than once a month	Once a week	More than once a week	Once a day	More than once a day	Every hour	More than every hour	
0	1	2	3	4	5	6	7	8	9	10

- Have you ever used any of the following techniques for the specific purpose of reducing body weight? (check ☐ as many as apply)

- ☐ I reduced food intake throughout the day ☐ I avoided foods high in fat
- ☐ I increased daily training duration ☐ I avoided foods high in sugar
- ☐ I wore additional clothes or plastic wraps when training ☐ I skipped breakfast, lunch, or dinner
- ☐ I performed long training rides (>2 hrs) without eating ☐ I avoided eating after training
- ☐ I used weight loss supplements or medications ☐ I made myself vomit after eating
- ☐ Describe others: _____ ☐ None of the above

- Do you still menstruate (have your period)? **Yes / No**

- Do you use an oral contraceptive pill, intrauterine device (IUD), or implant which prevents regular menstruation? **Yes / No**

- Have your periods stopped for more than 3 months during the last year without you being pregnant? **Yes / No**

- Have your periods been regular during the last year? **Yes / No / Unsure**
'Regular' means the periods lasted about as long each time with about the same time between them.

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