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Title: Racing Weight and Resistance Training: Perceptions and Practices in Trained Male Cyclists

Authors: Matthew W. HOON[a]; Eric C. HAAKONSSEN[b]; Paolo MENASPÀ[c]; Louise M. BURKE[d,e]

Institutions: [a] School of School of Behavioural and Health Sciences; Australian Catholic University, Australia. [b] Physiology; Australian Institute of Sport, Australia; [c] School of Medical and Health Sciences; Edith Cowan University, Australia. [d] Sports Nutrition; Australian Institute of Sport, Australia. [e] Mary MacKillop Institute for Health Research; Australian Catholic University, Australia

Corresponding Author:

Dr. Matthew Hoon

School of Behavioural and Health Sciences; Australian Catholic University

223 Antill St Watson; ACT 2602 Australia

Email: matthew.hoon@acu.edu.au

Phone: +61 2 6209 1118

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Dr. Matthew Hoon

School of Behavioural and Health Sciences; Australian Catholic University

223 Antill St Watson; ACT 2602 Australia

Email: matthew.hoon@acu.edu.au

Phone: +61 2 6209 1118

Abstract

Objectives: This study sought to investigate the perceptions and practices of achieving 'race weight' in a population of trained male cyclists. A secondary focus was to investigate the use of gym-based strength training, a possible attenuator of the side effects associated with weight reduction. **Methods:** A total of n=97 well-trained cyclists ranging from local club level to international standard completed an online survey capturing data on the aforementioned topics. **Results:** 49% of respondents indicated they were unsatisfied with their current bodyweight, with a similar percentage across club, national and international level riders. Riders who identified as climbers had lower reported bodyweight, however all categories of riders expressed a desire to reduce bodyweight by a similar percentage (1.9%, ± 3.4%; 90% CL). 77% of respondents indicated that they had recently tried or were currently trying to reduce bodyweight, most commonly by reducing food intake and avoiding sugary foods. 9% indicated they were using either supplements or medications to lower bodyweight, and 27% reported having sought advice from a health professional. A higher proportion of international riders engaged in strength training (85%), compared to national (50%) and club (55%) riders ($p<0.05$). The most cited reasons for not strength training were time constraints and believing it was not beneficial to their cycling performance. **Conclusion:** These data suggest that trained male cyclists are a highly weight-conscious population who engage in a variety of practices to reduce weight. Practitioners should be aware of these tendencies, as they may carry significant health implications if poorly implemented.

Key words: body image, dieting, energy availability, bone density

Introduction

We recently reported that trained female cyclists considered themselves to be a weight-conscious population, dissatisfied with their body mass coming into competition and generally seeking to reach or maintain low levels of bodyweight (BW) [1]. This is likely attributable to the athlete's desire to improve their ratio of power output relative to their BW (W/Kg), an important measure of cycling performance [2]. Cyclists reported undertaking a wide range of practices in an effort to reduce BW, with common techniques including a reduction of daily food intake and increasing training hours [1]. Excessive reductions in energy availability in the pursuit of low BW may be counterproductive and may result in relative energy deficit syndrome (RED-S). A number of physiological systems are compromised as a result of RED-S, including menstrual function, bone health, immune function, protein synthesis and cardiovascular health [3]. Currently, there are few data on the attitudes of male cyclists towards BW. In a small subsample of university cyclists, 46% reported the pressure to lose weight, and in general had lower satisfaction with their bodyweight and appearance compared to controls subjects [4]. These psychological traits correlated with significantly higher Bulimia and Dieting scores determined from an Eating Attitudes Test, indicating they were at much greater risk of eating disorders [4]. Across all sports, data suggest that male athletes have a higher prevalence of disordered eating and associated symptoms compared to non-athletes [5]. Bingeing, purging, extreme calorie and fluid restriction, as well as laxative and diuretic abuse are the most commonly observed disordered eating practices seen among male athletes, and often accompany other hazardous activities such as excessive training and forced fluid loss [6]. It is apparent that those participating in sports emphasizing a low BW (such as cycling) are the most susceptible to these disordered eating and energy restrictive practices due to the pressure to stay thin and lean [5,6]. It is therefore hypothesized that male cyclists are likely to display levels of weight consciousness and BW manipulation practices similar to female cyclists.

As discussed, the restriction of energy availability may have significant health implications, with a chief issue being compromised bone health [7]. While the link between low energy availability, menstrual function and bone health for women has been previously highlighted under the *Female*

Athlete Triad framework [8], several estrogen-independent mechanisms by which low energy availability affects bone mineral density (BMD) have been more recently identified [7]. These findings have led to the recognition that male endurance athletes are also at risk of osteoporosis from persistent energy deficit [3]. Poor bone health is of concern for this community not only for the impact of osteoporosis on quality of life [9], but also due to the sizeable risk of a high-impact collision that is inherent with cycling. The combination of fast travelling speeds and close proximity to other competitors makes crashes commonplace within the sport [10]. It is perhaps unsurprising then, that bone fractures commonly result from a crash [11]. It may be reasoned that improving bone health in this population would see the incidence of fracture injuries reduce and may also have implications for bone health in later life.

The undertaking of resistance based training is known to have a positive effect on bone strength. There is robust evidence that resistance training can ameliorate the bone mineral loss associated with aging [12], and in some cases elicit a significant osteogenic effect in young individuals [13]. However, cyclists have traditionally shunned elements of strength training from their programs; this may be underpinned by the belief that strength training is concomitantly accompanied by muscle (and therefore weight) gain, conflicting with a desired low BW thought to be optimal for cycling performance [14]. Additionally, the metabolic signaling induced by strength-based exercise may interfere with those stemming from endurance training, potentially resulting in suboptimal adaptations in both domains when undertaken simultaneously [15]. Thus, despite the beneficial effect of resistance training on bone health, it may not be commonly practiced by cyclists. The impact on BW and possibly the additional training load may impact on male cyclists' attitudes toward this training modality. These attitudes have not been previously investigated in this population.

In light of the above, the aims of the current study were to assess the self-reported perceptions and practices related to i) achieving race weight; and ii) resistance-based training in competitive male cyclists.

Materials and methods

Participants

Male cyclists, aged 18 years and over were invited to take part in the study via advertisements on social media pages of cycling clubs or emailed to known coaches. Participants were required to be currently competing at the highest local club level (A/B grade) or higher. Participants were categorised as Local, National (i.e. top domestic competition) or International level in their given cycling discipline (road, velodrome, mountain bike). Data were collected over a 6 month period from December 2016 to May 2017. The study protocols and materials were approved by the Australian Catholic University human research ethics committee (Project 2016-194E).

Survey items

The survey was conducted online and contained questions designed to gather information across 4 categories: i) General demographic and training data; ii) Perceptions and practices of achieving race weight; iii) Perceptions and practices of strength-based training; iv) Injuries from participation in either cycling or strength training. The questions pertaining to race weight perceptions and practices were adopted from a questionnaire previously used by our group [1]. This tool was used to assess firstly the self-reported weight consciousness of participants; and secondly, the self-reported methods used to manipulate their body weight. Questions concerning strength training practices were adapted from a previous study [16], with input from cycling coaches and cycling physiologists to make them more cycling specific.

Data analysis

Missing or incomplete responses resulted in the removal of that participants submitted data and subsequent analysis. A Pearson chi-squared test (or maximum likelihood ratio chi-square test when expected counts were <5) was used to assess differences in nominal responses to BW and strength training questions across: i) cyclist classification (climber, sprinter, all-rounder etc.) and ii) competition level (international, domestic, local). Numerical answers, such as current BW and the difference between ideal and current BW were analyzed across cyclist classifications using a one way ANOVA with Tukey's honestly significant difference post hoc test applied. Statistical analyses were performed using SPSS version 22 (SPSS Inc, Chicago, USA), with significance set at $p < 0.05$. Data is presented as mean ± 90% CL unless otherwise specified.

Results

In total, n=117 individuals submitted questionnaires. Of these, n=16 datasets were removed due to incomplete or missing responses, while n=4 were removed for not meeting the required level of competition. This left n=97 eligible participants (Age: 32.0 ± 1.7 yrs; Height: 180.4 ± 1.0 cm; Weight: 73.1 ± 1.4 kg; Racing experience: 8.3 ± 1.2 yrs; Weekly training hours: 13.9 ± 0.8 h). 26 responders indicated they rode at an International Level, n=27 at the National level and n=44 at the Club level. The cyclists were self-classified as: climbers (n=19); sprinters (n=15); all-rounders (n=33); time-trialists (n=7); track riders (n=15) or endurance mountain bikers (n=8). The current BW reported for climbers was significantly lower than all-rounders, sprinters and track riders (p<0.05, Table 1), with no significant differences between all other classifications.

BW satisfaction and management

A total of 48 cyclists (49%) reported that they were unsatisfied with their current BW in relation to their performance. There were no significant differences in BW satisfaction levels across the various cyclist classifications (p>0.05, Table 1). When competition level was used as a covariate, there were no significant differences in BW satisfaction between International, Domestic and Local level riders (p>0.05). When asked '*Do you think male cyclists are a weight conscious population?'* 86% of respondents either agreed or strongly agreed, and 69% indicated that they believed being at their lowest ever bodyweight was beneficial for their cycling performance.

Seventy-seven (79%) respondents indicated that they had deliberately tried to modify their BW over the preceding 12 months, with a majority of these (95%) aiming to lower their weight. In trying to achieve this goal, a variety of different weight-loss strategies were reportedly employed (Figure 1), with the most common being a deliberate reduction in food intake (n=69) and an avoidance of sugary foods (n=55). Ten respondents indicated they used either a weight loss supplement or medication to reduce BW.

When asked where they obtained their information regarding weight management, the most common responses were: own experience (n=84), internet/books (n=52), and coach / director / other riders (n=39). Only a small minority reported consulting professional help from either a dietitian (n=24) or medical doctor (n=3).

Resistance training

A total of 60 (62%) participants said they regularly participated in strength based exercise, with a significantly higher proportion of International level cyclists (85%) engaging in strength training compared to National (50%) and Local (55%) riders (p=0.018). The most common forms undertaken were: lifting weights (53%), bodyweight-based exercises (51%), and plyometrics/dynamic exercises (31%). Of the cohort that reportedly undertook strength training, a majority focused on lower body and core strength (87% and 88%, respectively), while only a small percentage incorporated upper body work (32%). The main reasons cited for performing strength training are listed in Figure 2a. The main reasons for not undertaking strength training are presented in Figure 2b. Overall, most respondents believed performing strength concurrently with endurance training was beneficial for cycling performance, with 63% reporting that it was 'somewhat beneficial' and 6% reporting that it was 'highly beneficial'.

Injuries

Sixty one respondents (63%) reported they had sustained an acute injury from being involved in a cycling crash, with 40 of those experiencing a broken or fractured bone and 14 reporting a joint dislocation. When cross-tabulated, strength training offered no significant protective benefit to bone during a crash (p>0.05), with 22/37 breaking or fracturing a bone during a crash, compared to 18/24 for individuals not participating in strength training. Forty-one (42%) participants also reported experiencing an overuse injury caused by cycling. There were no significant differences in the incidence of injuries between International, National and Local level riders ($p>0.05$). Seven respondents (representing 12% of individuals currently strength training) reported an acute injury as a result of strength training, which included: joint pain/inflammation (n=3), torn ligament (n=1), and back strain/pain (n=3). Ten participants indicated they had sustained an overuse injury from strength training (17% of the strength training cohort).

A large majority of participants (77%) reported that they had never had an assessment of BMD. Of the 22 (23%) individuals who had undertaken such an assessment, 17 reported a BMD within healthy ranges, while 5 were found to have suboptimal BMD. The likelihood of having BMD professionally assessed was linked to the individual's competition status, with international riders having a significantly higher frequency of assessment compared to national and local riders ($p=0.025$). A logistical regression analysis indicated that age was not related to the likelihood of an athlete having had their BMD assessed ($p > 0.05$).

Discussion

The present study sought to examine BW consciousness in a cohort of well-to-highly trained male cyclists, and their practice of achieving 'race weight'. The primary finding from this investigation was that a large percentage of male cyclists are unsatisfied with their BW (49%), with many seeking to change their weight (79%) in the hopes of improving their cycling performance. Further, a large majority of respondents (86%) agree that *male cyclists are a weight conscious population*, suggesting that weight manipulation is a somewhat known and accepted part of the cycling culture. BW dissatisfaction rates were similar across international, national and local level competitors, which is in conflict to the notion that elite performers are subject to a greater pressure to obtain an 'ideal' bodyweight [19]. When assessed according to riding specialty, climbers had a significantly lower BW than other categories, as might be expected. However, the *desire* to reduce BW was similar across all types, with all groups expressing a similar percentage of desired weight loss to achieve their ideal

BW. Collectively, these data suggest a culture of weight consciousness that is present across multiple levels of cycling ability and competition.

Many respondents indicated they had recently or were currently trying to lower their BW. A range of strategies to reduce weight were reported, with the most common being a reduction in daily food intake, avoidance of sugary foods and an increase in training time. These responses were similar to the findings from a similar group of male cyclists [4], as well as a group of elite female riders [1]. Of concern is the reported use of supplements / medications to reduce BW (10%), and the source of information used to inform weight management practices. Few (28%) riders reported consultations with a health professional, with most relying on their own experience, or advice from other riders, the internet and other reading materials. This may also increase the risk of inadvertent doping violations due to contaminated or misused substances.

Overall, our findings suggest that the prevalence of BW dissatisfaction and the practice of reducing BW in trained male cyclists is high, and comparable to those reported in female riders [1]. This is perhaps a little surprising, with previous investigations typically reporting greater body shape concerns among female athletes compared to male athletes [5], along with a higher incidence of associated issues such as eating disorders [18]. Nevertheless, it is apparent that athletes who participate in sports where a low BW may be beneficial are subject to an enormous pressure to be lean. Endurance cyclists in particular appear to place great value on the pursuit of leanness, with much of the lay media perpetuating the idea it is necessary for optimal performance [19]. This fixation on BW may lead individuals to adopt improper eating practices which may carry significant consequences to health and performance, and possibly develop into more serious disordered eating behaviors [23]. This issue is further compounded by the failure to seek professional advice on training and nutrition, and a reliance on their self-judgement or advice from other riders. We suggest coaches and officials working with trained cyclists be aware of this bias, and provide appropriate counsel where possible (for recommendations, see Sundgot-Borgen and Garthe, 2011 [20]). In particular, referring onto sports dietitians or other appropriate medical professionals should be part of their duty of care to the athlete. Often, '*it is not necessarily dieting per se that triggers disordered eating or an* *eating disorder, but whether dieting is guided or not*' [20]. This highlights the impact a dietitian could have on not only the management of disordered eating, but possibly a preventative influence as well if consults are performed early and regularly.

The present study revealed that a majority of well-trained cyclists (62%) appear to incorporate some element of strength exercise into training, although very few complete any upperbody work (31%). Strength training did not appear to influence the incidence of bone or joint injuries sustained as a result of crashes. However, there are a host of variables which are unaccounted for in this observational study, including the location of the injury on the body vs. the body areas trained, the extensiveness of the individual's strength training, and the speed/impact of the crash. Previous work has highlighted the value of resistance training in reducing the incidence and severity of sports injuries by strengthening tendons, ligaments, joint cartilage and connective tissues [21]. In addition to this preventative effect, resistance training is also known to elicit an osteogenic effect [22]. This is of particular significance for endurance cyclists who demonstrate a heightened risk of osteopenia [23]. Indeed, there exists some evidence to suggest that supplemental weight training offers some osteoprotective benefit in this cohort [24], however studies in this area are limited. These benefits to injury prevention and bone health should warrant consideration by cyclists to incorporate resistance-based exercises as part of the training program, yet a moderate proportion of riders surveyed did not conduct any form of resistance training. These individuals cited that time constraints and the belief that their time would be better spent riding were the primary reasons for not completing any resistance exercise. However, studies have shown that replacing some cycling with resistance-focused sessions may offer greater performance benefits than cycling alone [25]. An optimized program consisting of both cycling and resistance-based training may not only be the most time-efficient approach, but also more effective than a program consisting solely of riding [26]. In light of these benefits to injury prevention and performance, we suggest resistance exercise should be more heavily advocated to cyclists; however best-practice models should be observed (for recommendations, see Mujika et al. 2016 [14]).

Although the questionnaire employed in the present study enabled us to capture a wealth of data from a wider network of participants, we acknowledge that it has not been validated and is a limitation of the study. The self-reporting nature of the survey carries a risk of inaccurate data being submitted, and having predetermined options for participants to select in certain questions may have imprinted some answers and influenced responses. We believed this to be necessary to avoid ambiguous, open-ended responses. However, we justify the use of the current survey items as we have previously demonstrated their content legitimacy and athlete comprehension in previous studies [1, 16]. It was the intention of the current study to collect data on dietary and training practices in competitive athletes, and we believe tools derived for the general population (such as the Eating Disorder Inventory and EAT-26) may not capture the unique experiences of athletes. In this regard, there is a lack of a validated tool to capture data in this population and believe the items we used were currently the best options. Nevertheless, we acknowledge that complementing our survey with a validated tool may have provided more robust data and build upon the observational data captured, as has been the approach in similar investigations [4].

Conclusion

The results from the present investigation suggest that well-trained, male cyclists are a highly weight-conscious population, with approximately half being unsatisfied with their current BW. The level and type of rider did not seem to influence this level of dissatisfaction, suggesting a preoccupation with BW may be systemic within the cycling subculture. Many riders deliberately reduce food intake, increase training volume or a combination of both. This is primarily done without guidance from trained professionals such as sports dietitians, which raises concerns and heightens the risk of a pathophysiological energy deficit. The undertaking of resistance training could serve to offset some complications associated with energy deficiency, whilst potentially increasing performance on the bike as well. Despite this, a portion of cyclists do not engage in any form of resistance training, citing time constraints and a belief that this training modality is not as conducive to performance improvements when compared to riding. Perceptions regarding both ideal BW and resistance training in this population are likely influenced by traditional opinions and practices, which may not necessarily reflect what is advocated by the current scientific literature. It is therefore recommended that riders, coaches, directors, trainers and sport scientists be aware of evidenced best practices and instill them where possible.

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Declaration of interest

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TITLES OF FIGURES

Figure 1. Frequency of self-reported weight-loss strategies utilized by riders aiming to reduce bodyweight

Figure 2. Reported reasons for either a) participating in strength training; or b) not participating in strength training.

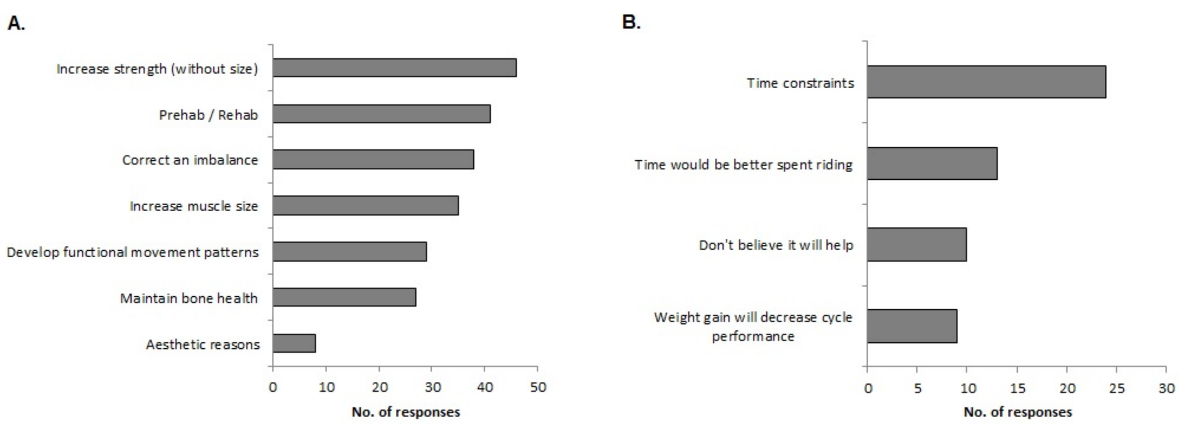

Table 1. Self-reported Current and "Ideal" BW for Different Types of Cyclists

Cyclist Type (n)	Unsatisfied with BW (%)	Career lowest BW ± 90% CL (kg)	Ideal BW ± 90% CL (kg)	Current BW ± 90% CL (kg)	Δ Ideal vs current weight (%)
Allrounder (33)	52	70.4 ± 2.4	70.2 ± 2.2	73.5 ± 2.4*	-3.3
Climber (19)	42	63.7 ± 2.3	64.2 ± 1.2	66.1 ± 2.2	-2.0
Sprinter (15)	53	72.9 ± 3.1	72.5 ± 3.0	76.0 ± 3.3*	-3.5
Track (15)	47	75.5 ± 3.6	75.9 ± 3.4	78.6 ± 3.3*	-2.7
Mountain Bike (8)	50	68.7 ± 3.6	68.5 ± 5.7	72.8 ± 5.3	-4.0
Time trialist (7)	57	69.4 ± 4.1	69.3 ± 4.2	72.4 ± 4.3	-3.1

* Significantly different to Climbers (p<0.05)

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