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Weight control practices of Division I National Collegiate Athletic Association athletes

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Abstract

Objectives: Altering body weight can have substantial effects on an athlete's performance and well-being. Limited information is available describing the weight control practices of Division I National Collegiate Athletic Association (NCAA) athletes.

Methods: Weight control practices data from 188 (138 male and 50 female; 18-23 y) Division I NCAA athletes were analyzed as a part of this cross-sectional, retrospective study. Participants completed questionnaires on weight control practices and weight control nutrition knowledge at the end of their season and were classified into weight-sensitive and less weight-sensitive sports.

Results: A higher proportion of females attempted to lose weight than males among less weight-sensitive sports (61% vs. 22%, chi-square = 15.8, $p < 0.001$). However, the prevalence of weight loss attempts was not different between females and males among weight-sensitive sports (50% vs. 60%, chi-square = 0.5, $p = 0.479$). The prevalence of weight gain attempts differed by gender for less weight-sensitive sports (65% vs. 4% for males and females, chi-square = 33.5, $p < 0.001$) but not weight-sensitive sports (24% vs. 9% for males and females, chi-square = 2.1, $p = 0.146$). Weight control knowledge did not differ between participants attempting versus not attempting to lose weight (Mann-Whitney U

= 3340, z = -1.37, p = 0.17). Common maladaptive behaviors used to lose weight included skipping meals and exercising more than usual.

Conclusion: Weight loss attempts are common among Division I NCAA athletes, and the differences between males and females may be more pronounced among less weight-sensitive sports. Weight gain attempts are more common in select male sports.

Keywords: Anthropometry, diet, disordered eating, nutrition assessment, sport nutrition

Introduction

Losing or gaining body weight are common goals for athletes, and these body weight alterations have important implications for performance and overall well-being.[1] Whether out-maneuvering a defender on the court, sprinting down a track, or pinning an opponent to the mat, all rely, in part, on the athlete moving his/her body efficiently through space. However, the unique force, speed, and endurance demands of each sport — and even position — imply obligatory differences in an athlete's ideal overall body weight, as well as relative percentages of fat versus fat-free tissue. As a consequence, it is common for athletes to strive for an "ideal" body weight that they believe will ultimately enhance their performance. Unfortunately, striving for excessive leanness or substantial weight gain can have deleterious effects on an athlete's well-being.

The consequences of pursuing excessive leanness can be substantial. Female athletes competing in weight-sensitive sports (e.g. gymnastics, distance running) are more susceptible to menstrual dysfunction, reduced bone mass, and musculoskeletal injuries.[2] Similarly, male athletes participating in weight-sensitive sports (e.g. wrestling) are more likely to have low bone mass relative to age- and body weight-matched controls.[2] Beyond chronic effects, acute reductions in body weight can cause substantial side effects, worsen mood, and impair some types of athletic performance that rely heavily on strength and power.[3–5] Despite potentially negative consequences, fat reduction in conjunction with muscle mass preservation can improve an athlete's power-to-weight ratio.[6] As a result, some athletes are instructed by coaches to reduce body weight or feel pressure to drop weight. Unfortunately, many athletes are not equipped to lose body weight appropriately and ultimately experience hazardous effects on their well-being.

While some sports traditionally emphasize leanness, others have experienced a notable increase in body size over the past century.[7,8] Collegiate American footballers, for example, have shown average weight increases of 0.16 to 0.57 kg per year for all position groups from 1959 to 2011.[9] Likewise, professional football lineman and offensive backs have shown average weight increases of –0.05 to 0.57 kg per year from 1942 to 2011.[9] Obviously, a desire to increase body weight will depend heavily on the sport being examined. Regardless, a larger general population, financial incentives, and the widespread use of anabolic substances are factors driving these longitudinal changes among selected sports that have been studied.[7] Emerging research shows that athletes with large body

masses, such as football lineman, are at high risk for having metabolic syndrome.[10]

One group that may be particularly susceptible to the negative effects of weight control practices is collegiate athletes. The combination of societal, institutional, and familial expectations to perform at a high level and in the classroom, along with transitioning to living independently, creates a highly stressful environment for some student-athletes.[11] Division I National Collegiate Athletic Association (NCAA) athletes, in particular, may be vulnerable to detrimental weight control practices because of the pressure associated with performing well. Despite this, scarce data are available to address several important questions in this population: (1) what are the weight loss methods most commonly employed among a variety of Division I NCAA sports?, (2) what are the physical and cognitive symptoms experienced as a result of these weight loss attempts?, and (3) what are the primary methods used to gain weight among sports that encourage a large body mass?

Demographic factors may be important determinants to consider in weight control practices among Division I NCAA athletes. For example, it is well-known that, in general, female athletes are more likely to exhibit disordered eating patterns than male athletes, although the magnitude of difference varies substantially depending on the sport.[2] However, the effect of gender on weight control practices is less extensively studied among Division I NCAA athletes. Furthermore, factors such as year in school may influence an athlete's likelihood of engaging in weight control practices because of differences in physical maturation, psychological development, and personal priorities. As such, additional research is needed to assess if and how these weight control practices change over a collegiate career, which would facilitate tailoring of interventions aimed at reducing the negative sequelae of maladaptive weight control practices (e.g. prolonged fasting, excessive exercise).

Nutrition knowledge is another factor that could modify the likelihood of an athlete engaging in maladaptive weight control practices, as well as the likelihood they experience negative side effects. Higher nutrition knowledge has been associated with positive weight control outcomes among selected groups in the general population.[12–14] In other instances, however, disordered eating patterns can be present among individuals with relatively high levels of nutrition knowledge.[15,16] As a result, population-specific studies need to be conducted to examine how nutrition knowledge relates to weight control practices and their related side effects.

With these issues in mind, the purpose of this investigation was to assess the weight control practices and associated symptoms of Division I NCAA athletes over a competitive season. Additional objectives were to: (1) examine if these practices varied with gender and year in school; and (2) assess nutrition knowledge – specifically weight control knowledge – among athletes attempting and not attempting to alter body weight. We hypothesized there would be a negative association between weight control knowledge and symptoms among athletes attempting to lose

weight, believing that knowledge of weight control principles would help athletes implement weight loss strategies with fewer side effects.

Materials and methods

Design and participants

This was a cross-sectional, retrospective, survey-based study conducted at a Division I NCAA Midwestern university during the spring and summer of 2015. Coaches were contacted around the end of the competitive season and asked whether they would be willing to allow a researcher to attend a meeting or practice to recruit athletes.

Data from 188 athletes (138 male and 50 female) were analyzed as a part of this study; 19.1% were freshmen, 29.3% were redshirt freshmen, 29.3% were sophomores, 14.4% were juniors, and 8.0% were seniors. The racial/ethnic distribution of the sample was 68.6% white, 21.8% African American, 4.8% multi-ethnic, 3.2% Hispanic, 1.1% Asian-Pacific Islander, and 0.5% American Indian. Female athletes from the following sports participated: basketball (n = 4), bowling (n = 3), gymnastics (n = 11), rifle (n = 7), soccer (n = 7), swimming/diving (n = 7), track/field (n = 5), and volleyball (n = 6). Male athletes from football (n = 98), golf (n = 1), gymnastics (n = 14), track/field (n = 4), and wrestling (n = 21) participated.

Athletes were categorized into weight-sensitive and less weight-sensitive groups, in accordance with the work from Martinsen and Sundgot-Borgen.[17] Gymnastics, wrestling, and swimming/diving were considered weight-sensitive sports, along with jumping and middle- and long-distance events in track/field (n = 37 males; n = 22 females). Basketball, bowling, rifle, soccer, volleyball, football, golf, and sprinting and throwing events in track/field were considered less weight-sensitive sports (n = 101 males; n = 28 females).

Weight control and nutrition knowledge were the main topics of interest, and details of the two questionnaires used to assess these factors are provided in subsequent sections. Participants had the option of completing questionnaires online or in-person. Interested athletes completed an informed consent document approved by the local university's Institutional Review Board prior to completing the questionnaires.

Weight control practices questionnaire (WCPQ)

Participants were asked to complete a questionnaire regarding attempts to lose and gain weight over the past season, hereafter referred to as the Weight Control Practices Questionnaire (WCPQ). The WCPQ was developed using several strategies, including through examination of previous research with athletes [18–20] and through consultation with dietitians and a sport psychologist. The WCPQ first asked whether the participant attempted to lose weight over the past season. If the

participant responded yes, they reported on a list how frequently they used 12 methods (e.g. ate less calories, skipped meals, exercised more than usual). Possible responses included *never, rarely (<1 day/week), occasionally (1–3 days/week),* and *frequently (>3 days/week)*. Participants then reported the frequency of experiencing the following symptoms as a result of trying to lose weight: light-headedness, headaches, agitated mood, difficulty concentrating, nausea, nose bleeds, increased fatigue, and difficulty with school work. These symptoms were chosen, in part, through examination of relevant literature.[18–20] Next, participants indicated if they attempted to gain weight over the past season. If the participant responded *yes*, they reported on a list the frequency of using eight different methods (e.g. increased meal frequency, consumed protein powders). It was made clear to participants that their individual answers would not be shared with their coaching staff.

Sport nutrition knowledge questionnaire

After the WCPQ, participants completed an adapted version of a previously validated questionnaire on sport nutrition knowledge.[21] The original questionnaire demonstrates good test–retest reliability, with Pearson's correlations ranging from r = 0.74 to 0.93 and 81.2% of questions being duplicated with multiple administrations.[21] The questionnaire contains sub-scales on general nutrition, fluid, weight control, recovery, and supplements. For the present study, the weight control sub-scale was the focus, which consists of questions on knowledge related to energy content of foods and myths surrounding the role of protein in weight gain and loss. The original questionnaire for the present study was altered to eight weight control questions, which was done to reduce the overall completion time given the athletes' busy schedules. In addition, minor alterations were made to some of the questions and answers to make them more relevant to an American population, such as changing units of measurement (e.g. grams to ounces) and examples of foods (e.g. Edam cheese to American cheese).

The questionnaire is scored based on the number of "correct" answers a participant selects. Correct answers represent a nutrition fact (e.g. fat has more calories per gram than carbohydrate) or scientific consensus around a topic (e.g. negative energy balance is the primary factor driving weight loss). The format of questions varied, with some allowing participants to select between two foods (e.g. identifying the food with the lowest energy content) while others allowed participants to indicate *agree, disagree,* or *unsure* for a particular statement (e.g. protein powder is an essential product to have if you want to increase lean muscle mass). Participants were encouraged to indicate *unsure* for questions they did not genuinely know the correct answer to and were discouraged from guessing as a way to achieve a higher score. *Unsure* responses were scored as incorrect. Possible scores on the weight control subscale ranged from 0 to 8. Questions on the weight control subscale can be viewed as online supplementary material.

Statistics

Because of non-normality (Shapiro–Wilk test), descriptive statistics for continuous and ordinal variables are presented as medians (inter-quartile range [IQR]) and proportions. Participants were categorized into groups depending on whether they reported attempting to lose or gain weight over the previous season.

Gender has been identified as a modifier of weight loss desires in previous research,[22] and it is logical to assume that academic year may influence weight control attempts as athletes continue to develop physically and transition to different team roles throughout their collegiate career. Thus, prevalences of weight loss and gain attempts were compared across gender and academic year using the Pearson chi-square test. Gender-specific prevalences were also calculated separately for weight-sensitive and less weight-sensitive sports and were compared using the Pearson chi-square test. Scores on the weight control sub-scale of the sports nutrition knowledge questionnaire were compared across weight loss attempt groups using the Mann–Whitney U test.

To test our hypothesis of a negative association between weight control knowledge scores and weight loss symptoms, the Spearman's rho co-efficient was used to examine the strength of association between these factors. Numerical values were assigned to four possible answers for weight loss symptoms (*never* = 1; *rarely* = 2; *occasionally* = 3; *frequently* = 4), and a total was generated by adding symptom scores together, with possible values ranging from 4 to 32. All analyses were carried out using SPSS version 22 (IBM, Armonk, NY), and significance was set at $p < 0.05$.

Results

The prevalence of weight loss attempts among males was 32%, which was less than the prevalence of 56% among females (chi-square = 9.03, df = 1, $p = 0.003$). Similarly, a higher proportion of females attempted to lose weight among less weight-sensitive sports (61% vs. 22% for females and males, chi-square = 15.8, df = 1, $p < 0.001$). However, the prevalence of weight loss attempts was not significantly different between males and females among weight-sensitive sports (50% vs. 60% for females and males, respectively, chi-square = 0.5, df = 1, $p = 0.479$).

The prevalence of weight loss attempts did not vary significantly by academic year among male (chi-square = 3.8, df = 4, $p = 0.43$) or female (chi-square = 1.3, df = 3, $p = 0.72$) participants. Among sports with at least 10 participants, the highest prevalence of weight loss attempts was for wresting (95%; Figure 1). The weight loss methods utilized as well as symptoms experienced are summarized for male (Table 1) and female (Table 2) participants.

The prevalences of weight gain attempts differed significantly between male (54%) and female participants (6%; chi-square = 35.3, df = 1, $p <$

0.001). This sex difference was apparent among less weight-sensitive sports (65% vs. 4% for males and females, chi-square = 33.5, df = 1, $p < 0.001$) but not among weight-sensitive sports (24% vs. 9% for males and females, chi-square = 2.1, df = 1, $p = 0.146$).

Prevalences of weight gain attempts for sports with at least 10 participants are shown in Figure 2. Football had the highest prevalence at 67%, and among the remaining male sports, only gymnastics (21%) and wrestling (29%) had any participants report weight gain attempts. The prevalence of weight gain attempts did not vary significantly by academic year among male participants (chi-square = 6.4, df = 4, $p = 0.17$), and due to the low prevalence in female sports, we did not examine if it varied by academic year among women. Data on weight gain methods for males and females were grouped together (Table 3) due to the low prevalence among women.

A total of 179 participants had complete responses on the weight control sub-scale of the sport nutrition knowledge questionnaire, and the median (IQR) number of correct answers was 2 (1–4). The median number of correct answers was not significantly different between participants attempting (3, 2–4) versus not attempting to lose weight (2, 1–4; Mann–Whitney U = 3340, z = –1.37, $p = 0.17$). Furthermore, no difference in correct answers was observed between male and female participants (2, 1–4 vs. 2.5, 1–4; Mann–Whitney U = 3217, z = –0.03, $p = 0.98$). However, athletes from weight-sensitive sports had a higher number of correct answers compared to athletes from less weight-sensitive sports (3, 2–4 vs. 2, 1–3; Mann–Whitney U = 2534, z = –3.14, $p = 0.002$).

As mentioned, we hypothesized there would be a negative association between weight control knowledge scores and symptom scores among participants attempting to lose weight. On the contrary, a modest positive correlation (*rho* = 0.26, $p = 0.03$) was observed between weight loss symptoms and weight control knowledge scores.

Discussion

The primary objective of this investigation was to describe the weight control practices of Division I NCAA athletes. Although this study used convenience sampling and did not include all possible NCAA sports, the data herein suggest that weight loss attempts are common among Division I NCAA athletes. Roughly 56% of females attempted to lose weight over the past season, which was greater than the prevalence among males (32%). However, there was an interaction between gender and sport type (weight-sensitive vs. less weight sensitive), such that there was only a significant difference between males and females among less weight-sensitive sports. The reason for the greater prevalence of weight loss attempts among females from less weight-sensitive sports is likely multi-factorial, but probably includes greater societal pressure to conform to a specific body size. Some female athletes may strive for leanness for aesthetic reasons, partly because of worries about how teammates,

coaches, and spectators perceive their weight.[23] Other athletes associate lower body weight and body fat to improved performance.[24] These gender differences have been observed in the general population, where women have greater desires to lose weight and are more likely to actively pursue weight loss.[22] The reason for the lack of difference between males and females from weight-sensitive sports may be due to male athletes feeling equal pressure to maintain a weight they believe will enhance performance. Overall, these results indicate that nearly half of all Division I NCAA athletes will attempt to lose weight over a season, and importantly, that the risk is high even among female athletes from less weight-sensitive sports.

Attempts at weight loss can contribute to negative health and performance outcomes when maladaptive strategies are used to achieve a negative energy balance. Behaviors of concern most frequently employed by participants in this sample were skipping meals and exercising more than usual. Skipping meals, which leads to within-day energy deficits, can contribute to higher body fat levels [25] and may be particularly problematic for athletes because of their high energy demands during certain periods of the day.[26] Of equal concern, using excessive exercise to increase energy expenditure represents a potentially deleterious strategy to reduce body weight in athletes. Excessive training can induce over-reaching, and in rare instances, overt over-training syndromes.[27] While the prevalence of over-reaching and over-training in specific athletic populations is not well-defined, at least one third of high-level athletes experience one of these disorders at some point during their career.[27] Furthermore, weight loss success with exercise training in the absence of caloric restriction is highly heterogeneous, with some individuals showing little-to-no weight loss or even weight gain.[28] Thus, it appears that some collegiate athletes would benefit from additional education on appropriate weight loss methods that are likely to be successful while minimizing the risk of over-reaching and over-training.

While direct outcomes such as over-reaching were not evaluated for this study, we did solicit information on symptoms experienced by athletes attempting to lose weight. Among eight symptoms evaluated, psychological and cognitive symptoms seemed to be experienced more often than overt physical symptoms (lightheadedness, nausea, headaches, or nose bleeds). Indeed, agitated mood, difficulty concentrating, increased fatigue, and difficulty with school work were most likely to be experienced occasionally or frequently, and these patterns were relatively consistent between males and females. These symptoms are concerning given the importance of collegiate athletes performing well in both the sport and academic environments. The practical importance of this information is that despite studies examining the effects of weight loss strategies on performance and body composition in athletes, some have failed to evaluate subjective measures such as diet acceptance, side effects, quality of life, or academic performance.[5,29,30] These subjective factors are important for student-athletes, and future studies examining weight loss

in collegiate athletes should consider including subjective measures as secondary outcomes.

With respect to weight gain attempts, males more frequently engaged in these behaviors compared to their female counterparts. Again, there was an interaction between gender and sport type with respect to weight gain attempts. Specifically, a difference between males and females emerged for less weight-sensitive but not weight-sensitive sports. The relatively large number of football athletes drove this relationship and is likely due to the sport's emphasis on increasing body mass as a way to modify performance. This finding concurs with previous research showing secular increases in the average size of collegiate football players.[9] Beyond the obvious performance benefits of increasing body mass, some of these attempts to gain weight may have been driven by societal pressures. Specifically, cultural messages regarding ideal body size have evolved over time to emphasize greater muscularity, particularly for men.[31,32]

Participants used a variety of methods to gain weight (Table 3), although more seemed to focus on protein-rich foods than carbohydrate-rich or fatty foods. Eating a high-protein diet helps preserve lean mass during periods of caloric restriction,[33] but the value of focusing on protein-rich foods is less clear when body weight gain is the main objective. The athletes' perception that protein is an important contributor to weight gain is also reflected by 78% using protein powders at least 1 day per week.

Another finding from this investigation was the observed modest positive association (*rho* = 0.26, $p = 0.03$) between weight loss symptoms and weight control knowledge scores. To the contrary, we hypothesized there would be a negative association between these factors, believing that knowledge of weight control principles would help athletes implement weight loss strategies with fewer side effects. The reason for the modest positive association in this sample is unclear, but it suggests that simply educating athletes about energy balance principles may not protect them from the negative effects of weight loss attempts. In fact, other literature shows that disordered eating patterns can be present among those with relatively high levels of nutrition knowledge.[15,16]

Several limitations to this study need to be acknowledged. The most important limitation of this study is that convenience sampling from a single university was utilized. Furthermore, athletes from football and wrestling were disproportionately represented, especially considering our modest sample size for survey-based research. Therefore, the observed prevalences of weight control attempts, methods, and symptoms are somewhat skewed and not completely representative of all Division I NCAA athletes. With that said, male and female athletes from a variety of sports and academic classes participated, and the racial/ethnic distribution of the sample was similar to nationwide Division I NCAA trends.[34]

An additional limitation is that males and females were not completely represented by the same sports, which somewhat limits the sex comparisons. We attempted to address this limitation by grouping athletes into weight-sensitive and less weight-sensitive sports, but we acknowledge there likely remain some cultural differences between the

different sports that could influence the prevalence of weight control practices. We also did not collect anthropometric data in conjunction with self-reported weight control practices. Consequently, no conclusions can be drawn regarding the success or failure of participants' weight change attempts, nor can any conclusions be made about how body weight relates to nutrition knowledge or weight control behaviors and symptoms. Finally, the results are based on retrospective self-report data, which is likely associated with some degree of inaccuracy.

Conclusion

Weight loss attempts are relatively ubiquitous among Division I NCAA athletes, although females engage in these behaviors more frequently. The differences in weight loss attempts between males and females, however, may be more pronounced among less weight-sensitive sports. Weight gain attempts, on the other hand, are common in select male sports while few female athletes attempt to gain weight.

Skipping meals and increasing exercise are two common methods used to lose weight, which is concerning given their effects on body composition and the risk of over-reaching. The most common symptoms experienced by athletes attempting to lose weight are psychological or cognitive in nature, which could impact not only athletic performance but also academic success. Unfortunately, simply educating athletes on principles of weight control may not help them avoid negative side effects experienced when attempting to lose weight. There is an ongoing need for research evaluating the weight control practices of a variety of athletic populations. Future studies should continue to explore the association between weight control knowledge and weight loss symptoms in order to establish whether the modest positive association observed in this sample can be replicated.

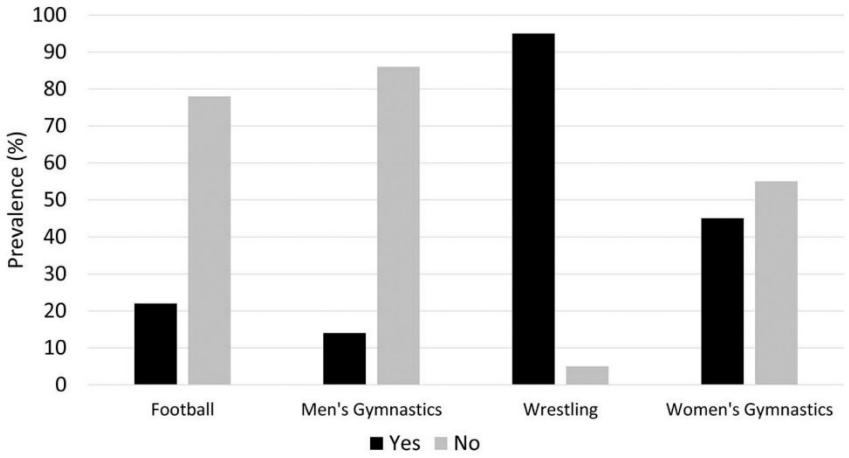

Figure 1. Prevalence of weight loss attempts among sports with at least 10 participants.

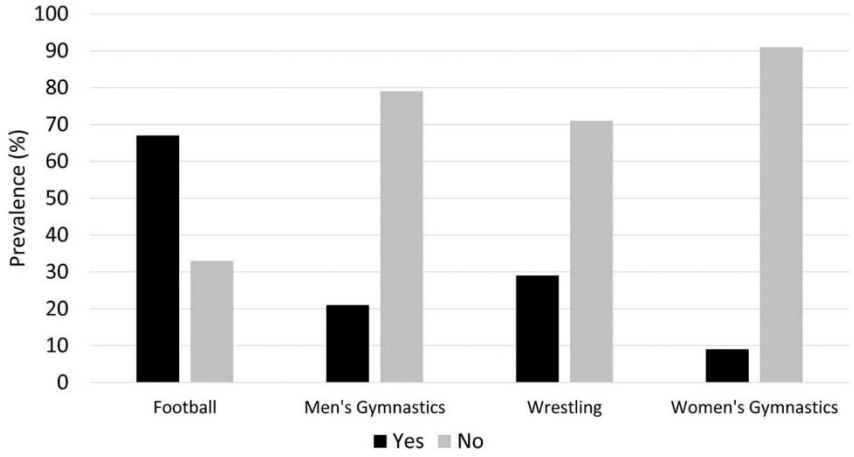

Figure 2. Prevalence of weight gain attempts among sports with at least 10 participants.

Table 1. Frequencies of weight loss methods and associated symptoms among male athletes. Rarely = <1 day/week; Occasionally = 1–3 days/week; Frequently = >3 days/week

	Never	Rarely	Occasionally	Frequently
Behaviors (% indicating *yes*)				
Ate less calories	2.3	7.0	30.2	60.5
Ate fewer fatty foods	7.0	4.7	27.9	60.5
Ate fewer carbohydrate-rich foods	9.3	9.3	44.2	37.2
Ate more protein-rich foods	2.3	11.6	39.5	46.5
Ate meal replacement products	27.9	27.9	30.2	14.0
Skipped meals	20.9	34.9	34.9	9.3
Fasted >24 hours	62.8	25.6	9.3	2.3
Took weight loss or diet pills	86.0	7.0	4.7	2.3
Took laxatives	93.0	4.7	2.3	0.0
Took water pills (diuretics)	93.0	4.7	2.3	0.0
Vomited	93.0	4.7	2.3	0.0
Exercised more than usual	18.6	11.6	55.8	14.0
Symptoms (% indicating *yes*)				
Light-headedness	55.8	34.9	7.0	2.3
Headaches	65.1	20.9	11.6	2.3
Agitated mood	39.5	25.6	30.2	4.7
Difficulty concentrating	41.9	30.2	23.3	4.7
Nausea	86.0	11.6	2.3	0.0
Nose bleeds	86.0	9.3	2.3	2.3
Increased fatigue	51.2	18.6	25.6	4.7
Difficulty with school work	55.8	18.6	23.3	2.3

Results among *n* = 43 participants with complete responses (one male participant responded *yes* to attempting to lose weight but had incomplete responses on the methods and symptoms sections).

Table 2. Frequencies of weight loss methods and associated symptoms among female athletes. Rarely = <1 day/week; Occasionally = 1–3 days/week; Frequently = >3 days/week)

	Never	Rarely	Occasionally	Frequently
Behaviors (% indicating *yes*)				
Ate less calories	3.6	21.4	46.4	28.6
Ate fewer fatty foods	3.6	14.3	46.4	35.7
Ate fewer carbohydrate-rich foods	14.3	14.3	53.6	17.9
Ate more protein-rich foods	14.3	21.4	17.9	46.4
Ate meal replacement products	60.7	17.9	17.9	3.6
Skipped meals	53.6	21.4	17.9	7.1
Fasted >24 hours	89.3	7.1	3.6	0.0
Took weight loss or diet pills	89.3	3.6	7.1	0.0
Took laxatives	100.0	0.0	0.0	0.0
Took water pills (diuretics)	96.4	3.6	0.0	0.0
Vomited	100.0	0.0	0.0	0.0
Exercised more than usual	50.0	17.9	25.0	7.1
Symptoms (% indicating *yes*)				
Light-headedness	64.3	25.0	10.7	0.0
Headaches	60.7	32.1	7.1	0.0
Agitated mood	39.3	25.0	32.1	3.6
Difficulty concentrating	53.6	25.0	17.9	3.6
Nausea	78.6	14.3	7.1	0.0
Nose bleeds	96.4	3.6	0.0	0.0
Increased fatigue	46.4	25.0	21.4	7.1
Difficulty with school work	60.7	25.0	10.7	3.6

Results among *n* = 28 participants with complete responses on the methods and symptoms sections.

Table 3. Frequencies of weight gain methods among athletes. Rarely = <1 day/week; Occasionally = 1–3 days/week; Frequently = >3 days/week)

	Never	Rarely	Occasionally	Frequently
Behaviors (% indicating *yes*)				
Ate more calories	3.8	2.6	33.3	60.3
Increased meal frequency§	3.9	6.6	42.1	47.4
Increased meal size	2.6	2.6	50.0	44.9
Consumed more liquid calories§	5.3	9.2	35.5	50.0
Ate more fatty foods	10.3	29.5	38.5	21.8
Ate more carbohydrate-rich foods‡	3.9	9.1	50.6	36.4
Ate more protein-rich foods	1.3	3.8	29.5	65.4
Consumed protein powders	15.4	6.4	24.4	53.8
Took weight gain supplements‡	49.4	16.9	16.9	16.9

Results among n = 78 participants except for those questions with missing responses as indicated: n = 77‡ and n = 76§.

Conflicts and competing interests — The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

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Supplemental material

Weight gain

15. Do you *agree* or *disagree* with the following statements? (Click on one box per statement.)

a. For body mass gain to occur, it is more important to increase protein than calories in the diet.
☐ Agree ☐ Disagree ☐ Unsure

b. Protein powder is an essential product to have if you want to increase lean muscle mass.
☐ Agree ☐ Disagree ☐ Unsure

c. If exercise is unchanged, it is possible for a rugby player to put on weight if they have six glasses of fruit juice **in addition** to their normal food intake.
☐ Agree ☐ Disagree ☐ Unsure

16. A player is eating the following meal for dinner: 5 oz skinless chicken breast, 1 cup cooked rice and 2 cups vegetables (broccoli, carrots, cauliflower). If he kept the rest of his day's diet the same and only altered his dinner meal, which option would be the preferred one to increase body mass? (Click on one box only).

Eat 6 oz chicken instead of 5 oz. ☐
Eat the chicken with the skin on. ☐
Eat 2 cups rice and 5 oz chicken. ☐
Eat 4 cups vegetables ☐
Eat the same amount, but train harder at the gym. ☐
Unsure ☐

Weight loss

17. Do you *agree* or *disagree* with the following statements? (Click on one box per statement).

If a volleyball player wanted to lose weight, they should:

a. Exchange 1 tsp of butter on sandwiches for 1 tsp of regular margarine.
☐ Agree ☐ Disagree ☐ Unsure

b. Replace American cheese with cheddar cheese.
☐ Agree ☐ Disagree ☐ Unsure

c. Eat less salami and more turkey breast.
☐ Agree ☐ Disagree ☐ Unsure

d. Stop eating pasta and rice after 4pm.
☐ Agree ☐ Disagree ☐ Unsure