Restoration of Menses With Nonpharmacologic Therapy in College Athletes With Menstrual Disturbances: A 5-Year Retrospective Study

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Background: Functional hypothalamic amenorrhea is common among female athletes and may be difficult to treat. Restoration of menses (ROM) is crucial to prevent deleterious effects to skeletal and reproductive health. Objectives: To determine the natural history of menstrual disturbances in female college athletes managed with nonpharmacologic therapies including increased dietary intake and/or decreased exercise expenditure and to identify factors associated with ROM. Study Design: A 5-yr retrospective study of college athletes at a major Division I university. Methods: 373 female athletes’ charts were reviewed. For athletes with menstrual disturbances, morphometric variables were noted. Months to ROM were recorded for each athlete. Results: Fifty-one female athletes (19.7%) had menstrual disturbances (14.7% oligomenorrheic, 5.0% amenorrheic). In all, 17.6% of oligo-/amenorrheic athletes experienced ROM with nonpharmacologic therapy. Mean time to ROM among all athletes with menstrual disturbances was 15.6 ± 2.6 mo. Total absolute (5.3 ± 1.1 kg vs. 1.3 ± 1.1 kg, \( p < .05 \)) and percentage (9.3% ± 1.9% vs. 2.3% ± 1.9%, \( p < .05 \)) weight gain and increase in body-mass index (BMI; 1.9 ± 0.4 kg/m\(^2\) vs. 0.5 ± 0.4 kg/m\(^2\), \( p < .05 \)) emerged as the primary differentiating characteristics between athletes with ROM and those without ROM. Percent weight gain was identified as a significant positive predictor of ROM, OR (95% CI) = 1.25 (1.01, 1.56), \( p < .05 \). Conclusions: Nonpharmacologic intervention in college athletes with menstrual disturbances can restore regular menstrual cycles, although ROM may take more than 1 yr. Weight gain or an increase in BMI may be important predictors of ROM.

Keywords: functional hypothalamic amenorrhea, menstrual disturbances in athletes, female athlete triad, increased energy availability, disordered eating

The prevalence of menstrual disturbances, luteal-phase defects, oligomenorrhea, and functional hypothalamic amenorrhea (FHA) is higher in women athletes, particularly those competing in lean-build sports, than in the general female population (Loucks, 1990; Loucks & Horvath, 1985; Nattiv et al., 2007). The underlying mechanism for FHA is postulated to be hypothalamic suppression resulting from a state of low energy availability (Loucks & Horvath, 1985; Loucks & Thuma, 2003; Warren, 1980, 1983; Williams, Helmerich, Parfitt, Caston-Balderrama, & Cameron, 2001). Laboratory studies in women have shown that low energy availability, not the stress of exercise, alters the normal luteinizing-hormone (LH) pulsatility pattern necessary for regular menstrual function (De Souza et al., 1998; Loucks & Thuma, 2003; Loucks, Verduin, & Heath, 1998; Williams, Helmerich, et al., 2001). Observations of nutritional deficits and endocrine abnormalities in amenorrheic athletes and patients with FHA resulting from weight loss (Couzin et al., 1999) or anorexia (Laughlin, Dominguez, & Yen, 1998) additionally implicate low energy availability. Furthermore, De Souza et al. (1998) andDueck, Matt, Manore, and Skinner (1996) reported that amenorrheic athletes, compared with their eumenorrheic counterparts, consistently consume insufficient calories to maintain positive energy balance. It has been reported that low body fat (Bronson & Manning, 1991; Sanborn, Albrecht, & Wagner, 1987) and exercise intensity (Loucks, 1990) alone do not appear to have a causal effect on menstrual disturbances.

FHA by definition excludes organic causes of amenorrhea such as polycystic ovarian syndrome, hyperprolactinemia, and thyroid dysfunction. The spectrum of menstrual function in athletes ranges from eumenorrhea to frank amenorrhea. The components of the “female athlete triad”—low energy availability, menstrual disturbance, and impaired bone mass—are often present together, but all three components do not necessarily coexist simultaneously. The most serious sequelae of functional hypothalamic menstrual disturbances and resultant hypoestrogenism are related to abnormal bone metabolism: lower bone-mineral density (BMD) than expected for age (Cobb et al., 2003; Drinkwater et al., 1984), failure to attain peak bone-mineral mass (Barrack, Rauh, & Nichols, 2010; Lloyd, Myers, Buchanan, & Demers, 1988), and failure for bone to mineralize with stress (Ducher, Eser, Hill, &...
independently associated with resumption of menses. These effects are of serious consequence because bone strength and fracture risk depend on the quality of bone protein, bone density, and internal structure of bone mineral. These changes may be irreversible or only partially reversible despite later resumption of menses and can lead to prolonged low bone mass, osteoporosis, and increased risk of fracture (Drinkwater, Bruemner, & Chesnut, 1990; Keen & Drinkwater, 1997; Lloyd et al., 1988). In young female athletes, it is therefore crucial to restore menses as soon as possible, and to maintain normal menses, to prevent adverse changes in BMD.

There is much interest in whether normal patterns of menstruation can be reestablished with nonpharmacologic treatments. This is partially due to conflicting findings among studies of hormonal therapy as a method of restoring menses and treating low BMD. Some studies show benefit in hormone replacement or oral contraceptives, and others show no effect (Fredericson & Kent, 2005; Liu & Lebrun, 2006; Vescovi, Jamal, & De Souza, 2008; Warren et al., 2003; Warren, Miller, Olson, Grinspoon, & Friedman, 2005; Zanker, Cooke, Truscott, Oldroyd, & Jacobs, 2004). In pre- and peripubertal athletes, hormone therapy may promote premature closure of growth plates, and there is evidence that oral-contraceptive use in skeletally immature female monkeys inhibits normal bone-mineral acquisition (Register, Jayo, & Jerome, 1997).

Consequently, nonpharmacologic therapy that targets the elimination of a chronic energy deficit by increasing energy availability may be a superior alternative to restore menses. However, there are few published reports regarding outcomes of such treatment in athletes with functional menstrual disturbances. Dueck et al. (1996) reported trends toward improved LH pulsatility and decreased cortisol levels in a 19-year-old amenorrheic runner when energy balance was brought from negative to positive in a 15-week study period by increasing caloric intake and decreasing exercise. Kopp-Woodruff, Manore, Dueck, Skinner, and Matt (1999) demonstrated resumption of menses in 3 of 4 amenorrheic athletes during a 20-week program that increased energy intake and lowered exercise expenditure. However, those studies were limited by small samples and the inability to distinguish causal factors.

In this study, we expand on these findings by examining a larger population of female athletes at an NCAA Division I institution over a 5-year period to determine the natural history of amenorrhea and oligomenorrhea in athletes managed with purely nonpharmacologic therapies and to determine factors associated with resumption of menses. We hypothesized that measures designed to increase energy availability in female athletes with FHA and oligomenorrhea could serve as efficacious nonpharmacologic methods to restore normal menstrual function in female athletes. More specifically, we hypothesized that increases in body weight and/or BMI may be surrogates for increased energy availability or may be independently associated with resumption of menses.

Methods

Charts of all University of California, Los Angeles (UCLA), Division I female student athletes seen by team physicians over a 5-year period were reviewed—in total, 373 charts. Fifty-one subjects who participated with a UCLA team for more than 12 months and had menstrual disturbances were identified and reviewed in detail. Exclusionary criteria included eumenorrhea, current oral-contraceptive use or the use of oral contraceptives within the previous 6 months, and pregnancy. The study was approved by the UCLA institutional review board.

To meet criteria for menstrual disturbances, a woman must have had lack of menarche before age 15 (primary amenorrhea), absence of menses for 90 or more consecutive days at the time of initial evaluation (secondary amenorrhea), or menses with cycles of 36 days or more in length at the time of initial evaluation (oligomenorrhea; Nattiv et al., 2007; Practice Committee of American Society for Reproductive Medicine, 2008). Athletes who had primary amenorrhea before presentation at UCLA but who went on to experience menarche with normal cycles or subsequent oligomenorrhea during their athletic careers at UCLA were classified as eumenorrheic or oligomenorrheic, respectively. Return of menses for amenorrheic and oligomenorrheic athletes was defined as return of spontaneous, regular menstrual bleeding with cycles of 36 days or less for 3 months or longer, not associated with infection or trauma (Speroff & Fritz, 2005). There was 1 amenorrheic athlete who did not meet these criteria but improved from an amenorrheic state to a cycle occurring every 42 days, and she was considered to have resumption of menses for the purpose of this study.

Athletes with self-reported menstrual disturbances at the time of the preparticipation physical underwent a laboratory evaluation by the treating physician (at the time of the first follow-up visit) to exclude other causes of amenorrhea and oligomenorrhea. Laboratory assessment included measuring estradiol (pg/ml), LH (mIU/ml), follicle-stimulating hormone (FSH; mIU/ml), thyroid-stimulating hormone (mIU/L), and prolactin (ng/ml); a urine pregnancy test; and, for those with restrictive eating, measurement of free-3,5,3'-triiodothyronine (pg/dl) levels. Those with a history of hirsutism, acne, and other signs and symptoms to suggest hyperandrogenism also were assessed for dehydroepiandrosterone sulfate (μg/dl) and free testosterone (pg/ml). Athletes with possible polycystic ovarian syndrome by history and physical exam had LH:FSH ratios assessed (with a ratio >3:1 suggestive for the diagnosis of polycystic ovarian syndrome) and other studies as necessary.

All athletes with identified menstrual disturbances were advised to undergo nonpharmacologic intervention, which included physician counseling, to increase energy availability by increasing dietary energy intake or decreasing exercise energy expenditure based on individual needs. Most athletes with menstrual disturbances saw one of two physicians, and they typically followed up with the same physician. In addition, athletes were...
Baseline intake of total energy (kcal/day), protein (g/day), fat (g/day), and calcium (mg/day) as recorded by 7-day food diary and evaluated by Nutritionist Pro version 5, a nutrition software program, were obtained. As part of the process of determining athletes’ energy requirements, total daily energy expenditure was estimated by calculating resting energy expenditure using the Harris-Benedict equation for females (655.0955 + 9.5634 [weight, kg] + 1.8495 [height, cm] – 4.6756 [age, years]; Roza & Shizgal, 1984), multiplying resting energy expenditure by an activity factor to estimate nonexercise activity thermogenesis (Food and Agriculture Organization of the United Nations, World Health Organization, & United Nations University, 2001; Livingstone et al., 1991; National Academy of Sciences, 2005), and adding an estimate of average daily exercise energy expenditure calculated using activity-specific metabolic equivalents from the American College of Sports Medicine Compendium of Physical Activity (Ainsworth et al., 2011). An activity factor of 1.4–1.5 is routinely used by dietitians to estimate nonexercise activity thermogenesis in athletes. In the current study the activity factor ranged from 1.2 to 1.7 and was determined by the athletes’ reported daily level of activity outside of structured exercise. The specific factor was determined by the dietitian after an interview with the athlete and was assigned on an individual basis. In addition, energy availability was calculated by subtracting exercise energy expenditure from total daily energy intake and adjusted for fat-free mass, and this calculation was used to determine each athlete’s specific intervention.

Athletes with oligo- or amenorrhea preferred to improve energy availability by increasing caloric intake while maintaining exercise energy expenditure, especially during their competitive sport season. However, sometimes a combination of slight decrease in exercise with increase in caloric intake was recommended. Most commonly, athletes in need of increasing their energy availability did so by increasing caloric intake by 250–350 kcal/day. If weight gain was necessary in an underweight athlete, one half to one pound per week was recommended. However, an individualized plan was developed for each athlete depending on her energy availability.

In athletes with menstrual disturbances, variables of interest included sport type, height (cm), weight (kg), BMI (kg/m²), age at menarche (years), hormone levels as described previously, energy intake (kcal/day), and the presence or absence of disordered eating. Baseline measurements were recorded at the time of the initial preparticipation physical exam, when menstrual disturbances were first reported. The type and duration of menstrual disturbances and the duration to resumption of menses (when applicable) were recorded. Follow-up measure-ments such as repeat weights and laboratory testing (when available) were recorded as close to resumption of menses as possible. The diagnoses of disordered eating and eating disorders were made by physician clinical assessment at the preparticipation examination and follow-up visits, as well as assessment by a registered dietitian and a clinical psychologist specializing in eating disorders. The DSM-IV criteria were used to further classify these athletes (American Psychiatric Association Task Force on DSM-IV, 2000).

All mean values were expressed as $M \pm SEM$. Analyses of variance assessed mean group differences between amenorrheic and oligomenorrheic athletes and between athletes with and without resumption of menses. Repeated-measures ANOVA assessed change in body weight and BMI in athletes with and without resumption of menses during the study period. Chi-square tests evaluated differences in prevalence estimates between groups. Univariate- and multivariate-regression analyses were conducted to determine factors that contributed to the prediction of resumption of menses. Statistical significance was set at $p < .05$. All analyses were performed using the Statistical Package for Social Sciences (SPSS) version 16.0.

Results

A total of 373 female athletes participated in the study. One hundred fourteen subjects were excluded because of oral-contraceptive use. Fifty-one athletes (19.7%) reported menstrual disturbances: 13 with amenorrhea (5.0%) and 38 with oligomenorrhea (14.7%). Menstrual disturbances were identified in almost every sport, but track and field/cross-country athletes and gymnasts constituted the majority of athletes with menstrual disturbances, with 28% and 22% affected, respectively (Table 1). There were no athletes with LH:FSH ratios to suggest polycystic ovarian syndrome.

When baseline characteristics among amenorrheic and oligomenorrheic athletes were compared, initial weight and BMI were significantly lower in amenorrheic athletes (Table 1). Despite lack of statistical significance, there was an association toward older age of menarche, lower number of kilocalories per day consumed, and lower estradiol levels in the amenorrheic than the oligomenorrheic group. Late age at menarche (≥15 years) was reported by 58.3% amenorrheic and 54.1% oligomenorrheic ($p = .80$) athletes, respectively.

Over a 5-year period, 9 athletes with amenorrhea or oligomenorrhea at their initial appointment reported resumption of menses (17.6%). Return of menses was achieved in 3 of 13 amenorrheic athletes (23.1%) and 6 of 38 oligomenorrheic athletes (15.8%). Mean length of time for nonpharmacologic therapy until resumption of menses in the sample as a whole ranged from 8 to 33 months, with $M \pm SEM$ of 15.6 ± 2.6 months. The amenorrheic and oligomenorrheic women reported resumption of menses after 17.7 ± 4.8 and 14.5 ± 3.4 months, respectively ($p = .60$).
Of the remaining amenorrheic athletes, 4 did not experience resumption of menses, 5 either initiated use of oral contraceptives or were lost to follow-up, and 1 had resumption of menses without physician intervention (and was therefore excluded from subsequent analysis). Among oligomenorrheic women, 12 reported continued oligomenorrhea and 20 began use of oral contraceptives or were lost to follow-up. A summary of follow-up menstrual status for the combined oligo-/amenorrheic group is reported in Figure 1.

In the sample, the time between the initial and follow-up weight measurements ranged from 12 to 25 months. There was not a significant difference in the mean number of months between weigh-ins among the group

### Table 1  Sport Type and Baseline Characteristics Among Athletes With Amenorrhea and Oligomenorrhea

<table>
<thead>
<tr>
<th></th>
<th>Amenorrhea, n = 12</th>
<th>Oligomenorrhea, n = 38</th>
<th>Total, n, %</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sport</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>track and field, cross-country</td>
<td>5</td>
<td>9</td>
<td>14, 28%</td>
<td>—</td>
</tr>
<tr>
<td>gymnastics</td>
<td>4</td>
<td>7</td>
<td>11, 22%</td>
<td>—</td>
</tr>
<tr>
<td>swimming/diving</td>
<td>1</td>
<td>8</td>
<td>9, 18%</td>
<td>—</td>
</tr>
<tr>
<td>basketball, volleyball, water polo, tennis</td>
<td>1</td>
<td>7</td>
<td>8, 16%</td>
<td>—</td>
</tr>
<tr>
<td>rowing</td>
<td>1</td>
<td>3</td>
<td>4, 8%</td>
<td>—</td>
</tr>
<tr>
<td>golf</td>
<td>0</td>
<td>4</td>
<td>4, 8%</td>
<td>—</td>
</tr>
<tr>
<td><strong>Anthropometrics</strong></td>
<td></td>
<td></td>
<td></td>
<td>.55</td>
</tr>
<tr>
<td>height (cm)</td>
<td>165.3 ± 2.6</td>
<td>167.1 ± 1.5</td>
<td>—</td>
<td>.55</td>
</tr>
<tr>
<td>weight (kg)</td>
<td>53.9 ± 2.3</td>
<td>60.1 ± 1.3</td>
<td>—</td>
<td>.02</td>
</tr>
<tr>
<td>body-mass index (kg/m²)</td>
<td>19.7 ± 0.5</td>
<td>21.4 ± 0.3</td>
<td>—</td>
<td>.004</td>
</tr>
<tr>
<td>age at menarche (years)</td>
<td>15.4 ± 0.5</td>
<td>14.6 ± 0.3</td>
<td>—</td>
<td>.18</td>
</tr>
<tr>
<td><strong>Intake</strong></td>
<td></td>
<td></td>
<td></td>
<td>.21</td>
</tr>
<tr>
<td>energy (kcal/day)</td>
<td>2,076.0 ± 204.4</td>
<td>2,383.0 ± 125.9</td>
<td>—</td>
<td>.21</td>
</tr>
<tr>
<td>protein (g/day)</td>
<td>89.4 ± 9.5</td>
<td>96.0 ± 5.9</td>
<td>—</td>
<td>.55</td>
</tr>
<tr>
<td>fat (g/day)</td>
<td>52.7 ± 9.6</td>
<td>59.8 ± 5.9</td>
<td>—</td>
<td>.53</td>
</tr>
<tr>
<td>calcium (mg/day)</td>
<td>1,211.5 ± 196.9</td>
<td>1,503.6 ± 132.8</td>
<td>—</td>
<td>.23</td>
</tr>
<tr>
<td><strong>Hormone levels</strong></td>
<td></td>
<td></td>
<td></td>
<td>.20</td>
</tr>
<tr>
<td>estradiol (pg/ml)</td>
<td>22.0 ± 8.5</td>
<td>35.9 ± 6.0</td>
<td>—</td>
<td>.20</td>
</tr>
<tr>
<td>luteinizing hormone (mIU/ml)</td>
<td>3.3 ± 2.3</td>
<td>4.7 ± 1.6</td>
<td>—</td>
<td>.63</td>
</tr>
<tr>
<td>follicle-stimulating hormone (mIU/ml)</td>
<td>6.3 ± 0.7</td>
<td>5.1 ± 0.5</td>
<td>—</td>
<td>.19</td>
</tr>
<tr>
<td>free T3 (pg/dl)</td>
<td>135.8 ± 22.7</td>
<td>92.0 ± 18.6</td>
<td>—</td>
<td>.16</td>
</tr>
</tbody>
</table>

*Note.* Units for values for other than sport type are $M ± SEM$. Mean differences assessed by ANOVA, $α = .05$.  

**Figure 1** — Distribution of oligo-/amenorrheic athletes’ follow-up menstrual status during the 5-year study.
with resumption of menses and the group without (16.1 ± 1.9 vs. 17.4 ± 2.0 months, respectively, \( p = .62 \)). Baseline characteristics of athletes with and without resumption of menses (including height, weight, BMI, age at menarche, and kcal/d) did not show any significant differences. In addition, no significant difference was noted in estradiol or any other hormone levels in subjects with resumption of menses compared with those without (Table 2).

Repeated-measures ANOVA indicated that athletes who resumed menses, but not athletes who did not, exhibited a significant increase in body weight and BMI during the study period. BMI values at baseline and follow-up, respectively, were 20.8 ± 0.5 kg/m² to 22.7 ± 0.6 kg/m², \( p < .005 \) (resumption of menses), and 20.8 ± 0.7 kg/m² to 21.3 ± 0.6 kg/m², \( p = .14 \) (no resumption of menses). Body-weight values at baseline and follow-up, respectively, were 58.0 ± 2.0 kg and 63.3 ± 2.3 kg, \( p < .005 \) (resumption of menses), and 57.7 ± 3.2 kg and 59.0 ± 3.4 kg, \( p = .17 \) (no resumption of menses). In addition, athletes with resumption of menses had a higher absolute and percentage weight gain (mean difference –7.02 ± 2.7, \( p < .05 \), 95% CI –12.7, –1.3) and a greater change in BMI during the study period than those without resumption of menses (Table 2, Figure 2). Athletes’ individual data regarding initial weight, follow-up weight, and weight change are presented in Figure 3. None of the athletes with weight loss were noted to have spontaneous resumption of menses or improved regularity of menses. From the univariate logistic-regression analysis, percent weight gain emerged as a positive predictor of resumption of menses, OR (95% CI) = 1.25 (1.01, 1.56), \( p < .05 \). In the amenorrheic but not oligomenorrheic group, athletes with resumption of menses had higher rates of psychologist referral than those without, 66.7% and 0%, respectively (\( p = .05 \)).

Twelve athletes with menstrual disturbances met criteria for disordered eating (23.5%). The prevalence of disordered eating was not significantly different in

| Table 2 | Baseline, Intervention, and Follow-Up Characteristics Among Athletes With and Without Return of Menses, \( M \pm SEM \) |
|---------|-------------------------------------------------|-------------------------------------------------|-------|
| No return of menses, \( n = 16 \) | Return of menses, \( n = 9 \) | \( p \) |
| Baseline | | | |
| height (cm) | 166.7 ± 2.4 | 166.8 ± 3.2 | .98 |
| weight (kg) | 59.3 ± 2.0 | 58.0 ± 2.7 | .70 |
| body-mass index (kg/m²) | 21.2 ± 0.4 | 20.8 ± 0.6 | .57 |
| age at menarche (years) | 15.3 ± 0.4 | 14.8 ± 0.5 | .47 |
| energy intake (kcal/d) | 2,122.7 ± 125.4 | 2,323.1 ± 171.7 | .36 |
| protein intake (g/d) | 90.5 ± 7.1 | 103.8 ± 9.8 | .29 |
| fat intake (g/d) | 53.2 ± 7.1 | 57.5 ± 9.8 | .73 |
| calcium intake (mg/d) | 1,389.1 ± 178.1 | 1,491.0 ± 251.9 | .75 |
| estradiol (pg/ml) | 37.7 ± 10.4 | 24.8 ± 13.9 | .47 |
| presence of disordered eating | 25.0% | 28.6% | .87 |
| Intervention | | | |
| physician visits\( ^a \) | 4.2 ± 0.9 | 4.6 ± 1.2 | .80 |
| dietitian visits\( ^a \) | 2.4 ± 1.5 | 4.9 ± 2.0 | .34 |
| psychology referral\( ^b \) | 37.5% | 33.3% | .84 |
| food diary\( ^b \) | 100% | 88.9% | .19 |
| energy-balance education\( ^b \) | 81.2% | 88.9% | .62 |
| calcium supplement\( ^b \) | 100% | 100% | 1.00 |
| Change | | | |
| weight change (kg) | 1.3 ± 1.1 | 5.3 ± 1.1 | .02 |
| body-mass-index change (kg/m²) | 0.5 ± 0.4 | 1.9 ± 0.4 | .02 |
| weight change (%) | 2.3 ± 1.9 | 9.3 ± 1.9 | .02 |

Note. Athletes using oral contraceptives or lost to follow-up were excluded. Mean differences assessed by ANOVA, \( \alpha = .05 \).

\( ^a \)Measured in number of visits. \( ^b \)Whether a particular measure was prescribed.
athletes who reported and those who did not report resumption of menses. There was a trend toward fewer oligo-/amenorrheic athletes with disordered eating than those without disordered eating to gain 5 or more pounds (2.27 kg), 25.0% versus 63.2% ($p = .07$). Although not statistically significant, presence of disordered eating was associated with lower caloric intake, lower fat intake, and lower absolute and percentage weight gain.

**Discussion**

Our observations provide evidence for the role of nonpharmacologic interventions including education regarding energy availability by a physician and dietitian with a goal of increased dietary intake or decreased exercise expenditure in the treatment of female athletes with menstrual disturbances. In our sample of Division I female student athletes, all but 1 athlete who experienced resumption of menses had concurrent weight increase. In fact, athletes with a weight gain of 5 lb (2.27 kg) or more were twice as likely to resume menses as those with less weight gain. These findings are consistent with prior studies that demonstrated an association between weight gain and resumption of menses in athletes with FHA (Dueck et al., 1996; Fredericson & Kent, 2005; Warren et al., 2002; Zanker et al., 2004). Prior studies in patients with anorexia nervosa have also reported a significant association between restoration of reproductive function and increases in body weight (Golden et al., 1997; Key, Mason, Allan, & Lask, 2002; Miller et al., 2006; Misra et al., 2008; Sobanski, Hiltmann, Blanz, Klein, & Schmidt, 1997).

We would like to emphasize that resumption of menses in this study was defined as return of regular menses with cycles of 36 or fewer days for 3 months or longer. Had a less rigid definition been chosen, the number of athletes with resumption of menses would have been higher. However, we felt that it was important to use a definition that reflected the resumption of a regular cycle that would more likely represent hypothalamic recovery, and not simply the existence of one menstrual bleed.

The mean duration of time for resumption of menses was more than 1 year when subjects were treated with nonpharmacologic therapy, which is longer than previously reported; this is at least partially related to our conservative definition of resumption of menses. Dueck et al. (1996) and Kopp-Woodroffe et al. (1999) demonstrated resumption of menses in athletes at approximately 6 months and 9–12 weeks, respectively. Competitive athletes should be counseled that the sustained resumption of menses (involving regular menstrual cycles of 36 days or less for 3 months or more) may take longer than 1 year when nonpharmacologic therapy is implemented. However, resumption of menses involving a single spontaneous menstrual bleed may occur in less than a year. Future prospective studies assessing resumption of menses with liberal and conservative definitions may help elucidate length of time for true hypothalamic recovery. Nonpharmacologic management for female athletes with FHA and oligomenorrhea, emphasizing increased energy availability, is consistent with the recommendations of the American College of Sports Medicine position stand on the female athlete triad, and it is the preferred initial treatment in this population (Nattiv et al., 2007).
Figure 3 — Baseline and follow-up body-weight values among individual oligo-/amenorrheic athletes (a) with reported return of menses (ROM; \(n = 9\)) and (b) without ROM \((n = 9)\).
Similar to our findings, Dueck et al.'s (1996) subject showed improved LH pulsatility with a concurrent weight increase of almost 3 kg and a 6% body-fat increase. This was thought to represent the early stage of hypothalamic recovery. However, other cross-sectional studies in humans (Loucks et al., 1992; Sanborn et al., 1987) and monkeys (Williams, Caston-Balderrama, et al., 2001; Williams, Helmreich, et al., 2001) suggest that body-weight changes are not associated with menstrual disturbances in athletes, possibly because of the development of adaptive energy-conserving mechanisms that allow for maintenance of body weight despite poor energy availability (Loucks & Callister, 1993; Loucks & Heath, 1994; Loucks et al., 1992; Myerson et al., 1991). However, the subjects in most of these studies were exercised in controlled conditions, as opposed to free-living athletes exercising in a less strict fashion. In addition, the cross-sectional nature of the studies makes it difficult to compare their findings with our longitudinal results showing an association between weight gain and resumption of menses.

In this study, the higher weight gain and BMI increases in athletes who resumed menses may be a sign of increased energy availability. We speculate that weight gain may be a result of increased energy intake relative to exercise energy expenditure. An increase in weight can also result from metabolic diseases such as hypothyroidism, medications, increases in fluid weight, or other factors. However, in this healthy athletic population, these factors were screened for and did not appear to characterize the sample.

In our population, oligomenorrheic athletes had significantly higher absolute weights and BMI than amenorrheic athletes. Whether a less severe extent of energy deficit alone can account for their oligomenorrhea (rather than frank amenorrhea) is unclear. It is possible that some of our amenorrheic or oligomenorrheic athletes may have had underlying polycystic ovarian syndrome, because subclinical hyperandrogenism was not assessed in all athletes in our study group. Correction of any energy deficit that may be contributing to an athlete’s oligomenorrheic state (regardless of underlying polycystic ovarian syndrome) is likely still important, given this population’s risk for osteoporosis as described by Sum and Warren (2009). Most of the athletes in our study preferred a strategy of dietary modification alone to improve energy availability. Limiting nonpharmacologic management to increasing energy intake rather than decreasing physical activity appears reasonable, and several other studies report that increasing calories alone to restore energy availability can ameliorate menstrual disturbances (Loucks & Callister, 1993; Loucks & Heath, 1994; Loucks et al., 1998; Williams, Helmreich, et al., 2001).

When counseling athletes with FHA and oligomenorrhea, it is important to emphasize that intentional caloric restriction is not necessary to lead to poor energy availability, and hunger is an insensitive measure of how many calories are needed (Loucks et al., 1998). Many athletes with decreased caloric intake and low energy availability in our sample did not have evidence of disordered eating. In our study, there was no significant difference in the percentage of athletes with disordered eating in amenorrheic versus oligomenorrheic groups or in those with resumption of menses versus those without. However, athletes without disordered eating were more likely to have higher absolute weight gains, and athletes with higher absolute weight gain were more likely to resume menses.

Substantial increases in BMD have been shown to accompany increases in body weight in studies of amenorrheic athletes (Drinkwater, Nilson, Ott, & Chesnut, 1986; Fredericson & Kent, 2005; Warren et al., 2003; Zanker et al., 2004) and women with anorexia nervosa (Miller et al., 2006). In addition, improved BMD has been more closely associated with increases in weight than with oral contraceptives or hormone-replacement therapy in women with FHA (Nativ, 2007). Female athletes with menstrual disturbances should therefore receive counseling that, in addition to increasing energy availability, increases in body weight may be necessary to resume regular ovulatory cycles and improve BMD (Nativ, 2007).

The fact that not all female athletes with menstrual disturbances in our study experienced resumption of menses with the same intervention aimed at increasing energy availability suggests that there is individual susceptibility to resumption of menses, and other factors may affect the ultimate success of the treatment. These other factors may include genetics (Caronia et al., 2011), psychosocial stressors (Berga et al., 2003; Williams, Berger, & Cameron, 2007), and neuroendocrine and metabolic factors (De Souza, Leidy, O’Donnell, Lasley, & Williams, 2004; Laughlin et al., 1998; Warren & Goodman, 2003). These and other potential contributing factors to menstrual disturbances should be considered in future studies that assess nonpharmacologic interventions of menstrual disturbances in female athletes.

This study had several limitations. Its retrospective nature limits the availability of certain data and laboratory results. Other variables that may affect menstrual function, such as sleep patterns (Baker & Driver, 2007), stress (Berga et al., 2003; Williams et al., 2007), cortisol levels (Ding, Sheckter, Drinkwater, Soules, & Bremner, 1988; Loucks, 1989), leptin, and other metabolic hormones (De Souza et al., 2004; Laughlin et al., 1998), were not formally assessed or documented in most of the athletes with menstrual disturbances. In addition, the study was designed to assess nonpharmacologic management of more severe menstrual disturbances (amenorrhea and oligomenorrhea), not more subtle menstrual disturbances (luteal-phase dysfunction and anovulation) that also occur at a high prevalence in female athletes (De Souza et al., 2010). The self-report nature of assessing dietary intake may introduce error. Although there was no standardized protocol in place for team physicians to use in implementing nonpharmacologic management of FHA and oligomenorrhea, similar protocols were noted in charts reviewed. In our study, energy recommendations were
made for each athlete based on her calculated energy expenditure; however, these data were kept separately by the dietitian, and the authors did not have access to the specific energy calculations and exercise data.

This study differs from all prior studies in that it represents the first large survey of female college athletes in various disciplines participating in high-volume training, with variables captured longitudinally over a 5-year period during active nonpharmacologic intervention in a university training room setting. Improved menstrual function in our population appears to be associated with weight gain and a higher BMI increase, perhaps as a marker of normalizing the neuroendocrine pathways associated with increasing energy availability. Weight gain, therefore, may be the proximal causal factor in resumption of menses, but rather a manifestation of improved energy availability. Longitudinal monitoring of weight changes, while addressing improved energy availability, may be a helpful clinical marker of increasing energy availability during nonpharmacologic management of athletes with FHA and oligomenorrhea. Further research is needed to explore the roles of increasing energy availability, as well as increases in weight and/or BMI, and resumption of menses in female athletes with menstrual disturbances.

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