DIETARY INTAKE IN YOUNG FEMALE GYMNASTS: A SUMMARY

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ABSTRACT
Artistic gymnastics is a popular sport among young females, but, unfortunately, inadequate nutrient intakes are prevalent in these gymnasts. This article, based on summaries of 12 cross-sectional studies published between 1984 and 1998, examines nutrient inadequacies in diets of young female gymnasts and relates these inadequacies to health and performance issues. Family and consumer sciences professionals are encouraged to become involved with nutrition concerns of young athletes by providing nutrition education to groups of young athletes, parents, coaches, and judges; by monitoring growth of these athletes; and by referring athletes at risk to nutrition and health specialists.

Data indicate that today’s children and adolescents are more sedentary and have higher body fat than young individuals of previous generations (McGinnis, 1992). Seemingly contradictory, however, more youths than ever before are engaging in organized sports of a highly competitive nature (Jennings & Steen, 1995). With this increase in participation in competitive sports, nutrition for young athletes is a new concern.

Artistic gymnastics is one of the most popular sports for young girls today. In any given year, approximately two million girls, aged 2 to 18 years, engage in gymnastics training (DiFiori, Puffer, Mandelbaum, & Mar, 1996). While participation in gymnastics is associated with positive health benefits such as low body fat and high lean mass, there are also negative aspects of the sport. These negative aspects include potential for dietary and nutritional inadequacies (Lindholm, Hagenfeldt, & Hagman, 1995) and stunted growth (Theintz, Howald, Weiss, & Szonienko, 1993).

Female gymnasts are characterized by a high lean, low-fat body mass that results in a significantly lower percentage of body fat than in nongymnasts. For example, average body fat percentage of a group of child gymnasts, aged 7 to 9 years, was 15% compared with 24% for a group of same-aged nongymnasts or controls (Cassell, Benedict, & Specker, 1996). Such a lean body composition is conducive to the performance of artistic gymnastics maneuvers and is viewed as aesthetically appealing, particularly during performances, by some coaches, peers, and judges (Bale & Goodway, 1990; O'Connor, Lewis, & Boyd, 1996). Thus, gymnasts may restrict caloric intakes in an attempt to control or lose weight so that appearances are improved and performances enhanced (Harris & Greco, 1990; Rosen & Hough, 1988).

Consequently, diets of gymnasts may be nutritionally inadequate as micronutrient intake, or intake of vitamins and minerals, depends largely on macronutrient intake, or intake of carbohydrate, protein, and fat.

SUMMARY OF DIETARY INTAKES IN FEMALE GYMNASTS
Although assessment methods of dietary intake varied among studies, several similarities were apparent in 12 cross-sectional studies of dietary intakes in child and adolescent female artistic gymnasts (see Table 1). Compared with nationally recommended nutrient intakes (e.g., Recommended Dietary Allowances), diets of gymnasts were consistently deficient in kilocalories (11 of 12 studies or 92%), calcium (10 of 12 studies or 83%), and iron (7 of 12 studies or 58%). In studies that compared dietary intakes of gymnasts with controls (5 of 6 studies) or other athletes (5 of 6 studies), mean daily kilocalorie intakes were significantly lower in gymnasts compared with controls (Bass et al., 1998), swimmers and controls (Benson, Allemann, Theintz, & Howald, 1990), and speed skaters (Webster & Barr, 1995) in three studies (50% of studies). Mean daily dietary carbohydrate, protein, calcium, vitamin A, and fiber intakes were significantly higher in gymnasts versus controls in a separate study (17% of studies; Lindholm et al., 1995). In remaining studies (2 of 6 studies or 33%), significant differences in nutrient intakes between groups did not exist.

Diets of gymnasts may be nutritionally inadequate as micronutrient intake, or intake of vitamins and minerals, depends largely on macronutrient intake, or intake of carbohydrate, protein, and fat.
### Table 1. Cross-sectional Studies of Dietary Intake in Female Artistic Gymnasts and Comparison Groups

<table>
<thead>
<tr>
<th>Reference</th>
<th>Mean age (years)</th>
<th>N*</th>
<th>Dietary intake method</th>
<th>DS</th>
<th>Nationality of participants</th>
<th>Groups</th>
<th>Differences in nutrient intakes between groups</th>
<th>Nutrients below 100% of RDA* or AI* for gymnasts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davies et al., 1997</td>
<td>7.3</td>
<td>6</td>
<td>4-day weighed record</td>
<td>No</td>
<td>Chinese</td>
<td>Gymnasts</td>
<td>NA</td>
<td>kcal</td>
</tr>
<tr>
<td>Cassell et al., 1996</td>
<td>8.8</td>
<td>13</td>
<td>3-day diet diary</td>
<td>No</td>
<td>American</td>
<td>Gymnasts Swimmers Controls</td>
<td>None</td>
<td>kcal, calcium</td>
</tr>
<tr>
<td>Benardot et al., 1989</td>
<td>9.4</td>
<td>51</td>
<td>2, 24-hour diaries</td>
<td>No</td>
<td>American</td>
<td>Gymnasts</td>
<td>NA</td>
<td>kcal, calcium, phosphorus, iron</td>
</tr>
<tr>
<td>Dyson et al., 1997</td>
<td>9.8</td>
<td>10</td>
<td>3-day diet diary</td>
<td>No</td>
<td>Canadian</td>
<td>Gymnasts Controls</td>
<td>None</td>
<td>kcal, calcium, vitamin D</td>
</tr>
<tr>
<td>Bass et al., 1998</td>
<td>10.4</td>
<td>45</td>
<td>3-day diet record</td>
<td>No</td>
<td>Australian</td>
<td>Gymnasts Controls</td>
<td>kcals, carbohydrate, fat; gymnasts &lt; controls</td>
<td>kcal, calcium</td>
</tr>
<tr>
<td>Ersoy, 1991</td>
<td>11.5</td>
<td>20</td>
<td>3-day diet record</td>
<td>No</td>
<td>Turkish</td>
<td>Gymnasts</td>
<td>NA</td>
<td>kcal, calcium, iron, vitamin A, thiamin, niacin</td>
</tr>
<tr>
<td>Benson et al., 1990</td>
<td>12.5</td>
<td>12</td>
<td>7-day diet record</td>
<td>No</td>
<td>Swedish</td>
<td>Gymnasts Swimmers Controls</td>
<td>kcals; gymnasts &lt; controls = swimmers</td>
<td>kcal, calcium, iron, B, folate</td>
</tr>
<tr>
<td>Reggiani et al., 1989</td>
<td>12.0</td>
<td>26</td>
<td>7-day weighed diary</td>
<td>No</td>
<td>Italian</td>
<td>Gymnasts</td>
<td>NA</td>
<td>kcal, calcium, iron, magnesium, thiamin, riboflavin, niacin, B, folate, vitamin E</td>
</tr>
<tr>
<td>Loosli et al., 1986</td>
<td>13.1</td>
<td>97</td>
<td>3-day diet record</td>
<td>No</td>
<td>American</td>
<td>Gymnasts</td>
<td>NA</td>
<td>kcal, calcium, iron, B, vitamin E, folate, zinc</td>
</tr>
<tr>
<td>Webster &amp; Barr, 1995</td>
<td>14.1</td>
<td>32</td>
<td>FFQ for calcium intake</td>
<td>Yes</td>
<td>Canadian</td>
<td>Gymnasts Speed skaters</td>
<td>calcium; gymnasts &lt; speed skaters</td>
<td>calcium</td>
</tr>
<tr>
<td>Lindholm, Hagenfeldt, &amp; Hagman, 1995</td>
<td>14.8</td>
<td>22</td>
<td>7-day weighed record</td>
<td>No</td>
<td>Swedish</td>
<td>Gymnasts Controls</td>
<td>Protein, carbohydrate, fiber, calcium, vitamin A: gymnasts &gt; controls</td>
<td>kcal, iron</td>
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<tr>
<td>Moffatt, 1984</td>
<td>15.2</td>
<td>13</td>
<td>2, 3-day diet records</td>
<td>Yes</td>
<td>American</td>
<td>Gymnasts</td>
<td>NA</td>
<td>kcal, calcium, iron, zinc, magnesium, thiamin, niacin, B, folate</td>
</tr>
</tbody>
</table>

**Notes.**

* N = number of subjects.

* RDA = Recommended Dietary Allowances, USA; AI = Adequate Intake, USA.

* kcal = kilocalories.

* DS = dietary supplement data included in dietary analyses.

* NA = not applicable.

* FFQ = food frequency questionnaire.
IMPLICATIONS FOR HEALTH AND PERFORMANCE

While the majority of cross-sectional studies presented indicate that dietary intakes of gymnasts are not significantly different than other athletes or nonathletes of same ages, concern for the health and performance ability of gymnasts has been expressed because of the early onset of training (as young as 2 years of age), number of years engaged in training (as great as 20 years), timing of training (prepuberty through post-puberty), and duration of training (20 hours per week for highly competitive gymnasts; Malina, 1996). Average daily kilocalorie intakes were as much as 723 kilocalories lower than estimated needs (Lindholm et al., 1995; see Table 2). A lack of adequate caloric intake has been associated with fatigue, susceptibility to injuries, delayed growth and maturation, and menstrual disruptions in gymnasts (Caine, Howe, Ross, & Bergman, 1997; O'Connor et al., 1996; Theintz et al., 1993). Mean dietary calcium intake as low as 31% of the recommended intake has been reported (Ersoy, 1991). Although higher bone mineral density (an indicator of bone strength) despite lower dietary calcium intakes is a prevalent finding in gymnasts of all ages compared with other athletes and nongymnast controls (Bass et al., 1998; Cassell et al., 1996; Dyson, Blimkie, Davison, Webber, & Adachi, 1997; Kirchner, Lewis, & O'Connor, 1995), high calcium intake should be stressed in young athletes. When gymnastics is discontinued, the pattern of a high-calcium intake is more likely to continue if this pattern develops early. Low dietary iron intakes may adversely affect athletic performance and aerobic capacity as well as growth and maturation (Benardot, Schwarz, & Heller, 1989).

Reports of delayed growth and sexual maturation among competitive gymnasts are common. Repeatedly female gymnasts have been shown to be significantly shorter and lighter than other athletes, nonathlete controls, and reference data (Calderone, Leglise, Giampietro, & Berlutt, 1986; Claessens et al., 1992; Lindholm, Hagenfeldt, & Ringertz, 1993; Peltenburg, Erich, Bernink, Zonderland, & Huisveld, 1984; Theintz, Howald, Allemann, & Sizzenko, 1989; Theintz et al., 1993). While parents of elite female gymnasts have been shown to be significantly shorter than parents of female swimmers, suggesting a genetic predisposition for short girls to excel in gymnastics exercise (Theintz et al., 1989), growth velocity, peak height velocity, linear height, leg length, and predicted height have been

<table>
<thead>
<tr>
<th>Reference</th>
<th>EE method</th>
<th>Mean EI (kcal.d⁻¹)</th>
<th>Mean EE (kcal.d⁻¹) or RDA for energy</th>
<th>Energy deficit or surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davies et al., 1997</td>
<td>DLW</td>
<td>1,500</td>
<td>1,938</td>
<td>-438</td>
</tr>
<tr>
<td>Cassell et al., 1996</td>
<td>None</td>
<td>1,740</td>
<td>2,000</td>
<td>-260</td>
</tr>
<tr>
<td>Benardot et al., 1989</td>
<td>None</td>
<td>1,651*</td>
<td>2,000</td>
<td>-349</td>
</tr>
<tr>
<td>Dyson et al., 1997</td>
<td>None</td>
<td>1,706*</td>
<td>2,200</td>
<td>-494</td>
</tr>
<tr>
<td>Bass et al., 1998</td>
<td>None</td>
<td>1,780</td>
<td>2,000</td>
<td>-220</td>
</tr>
<tr>
<td>Ersoy, 1991</td>
<td>None</td>
<td>1,459</td>
<td>2,000</td>
<td>-541</td>
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<tr>
<td>Benson et al., 1990</td>
<td>None</td>
<td>1,568</td>
<td>2,200</td>
<td>-632</td>
</tr>
<tr>
<td>Reggiani et al., 1989</td>
<td>None</td>
<td>1,544</td>
<td>2,200</td>
<td>-656</td>
</tr>
<tr>
<td>Loosli et al., 1986</td>
<td>None</td>
<td>1,552</td>
<td>2,200</td>
<td>-648</td>
</tr>
<tr>
<td>Webster &amp; Barr, 1995</td>
<td>None</td>
<td>1,838</td>
<td>2,200</td>
<td>-362</td>
</tr>
<tr>
<td>Lindholm, Hagenfeldt, &amp; Hagan, 1995</td>
<td>Activity factor</td>
<td>1,930</td>
<td>2,653</td>
<td>-723</td>
</tr>
<tr>
<td>Moffatt, 1984</td>
<td>None</td>
<td>1,923</td>
<td>2,200</td>
<td>-277</td>
</tr>
</tbody>
</table>

Notes.
* EE = energy expenditure; EI = energy intake.
* RDA = Recommended Dietary Allowances, USA.
* DLW = doubly-labeled water.
* 10-10-year-old gymnasts.
* 11-14-year-old gymnasts.
* NR = not reported; NA = not applicable.
observed to be reduced in female gymnasts during the pubertal growth spurt (Lindholm et al., 1994; Theintz et al. 1993).

Older versus younger gymnasts were shown to have a significantly lower growth percentile ranking, suggesting stunting of growth with advanced gymnastics training (Benardot & Czerwinski, 1991). Menarche is delayed in many young gymnasts (Bale, 1994; Pettenburg et al., 1984). Additionally, menstrual cycles are irregular in some adolescent gymnasts (Lindholm et al., 1995). Participation in gymnastics exercise may stunt growth and delay sexual maturation because of low levels of hormones needed for growth and sexual maturation and an inability of long bones to respond to growth factors as a result of epiphyseal damage secondary to inadequate dietary energy and nutrient intakes (Mansfield & Emans, 1993). Consequences of delayed menarche and irregular menstrual cycles among young female athletes such as gymnasts have not been adequately studied, however.

RECOMMENDATIONS FOR PROFESSIONALS

Although dietary intakes of young gymnasts may not be vastly different from other young athletes or nonathletes, when compared with national dietary recommendations, diets of gymnasts are consistently inadequate in kilocalories, calcium, and iron. FCS professionals, specifically nutritionists, dietitians, extension specialists, and FCS educators, can

- Educate gymnasts, parents, and coaches about normal nutrition using tools such as the Food Guide Pyramid. Foods that are high in calcium and iron should be emphasized in the context of a variety of foods and an adequate intake of healthy foods to meet caloric needs.
- Educate gymnasts, parents, and coaches about appropriate food choices for pre-meal and post-meal meals, as well as when eating away from home and when traveling to practices or meets.
- Screen for dietary inadequacies of gymnasts by using simple food and activity records and food composition tables, handbooks, or other more sophisticated or computerized diet analysis programs.
- Monitor height and weight changes in gymnasts by using growth charts for basic screening of growth.
- Conduct follow-up assessments of gymnasts if dietary and growth pattern screenings identify problems.
- Refer at-risk gymnasts to registered dietitians or other qualified sports nutrition and health professionals.
- Educate gymnasts judges about long-term health implications of a poor dietary intake and compromised nutritional status.

Other creative ideas for FCS professionals include incorporation of information from this summary and other sources into monthly newsletters, quarterly diet and health education seminars, and periodic nutrition, health, and performance fairs targeted to gymnasts, parents, coaches, and judges. Motivational programs rewarding sound nutrition can be developed to emphasize overall health of gymnasts rather than body image and performance. For example, FCS professionals can present an annual “excellence in nutrition award” to exemplary teams, coaches, or judges.

Coaches, because of the extensive amount of time spent with their gymnasts, have a major influence on gymnasts’ nutrition knowledge and behaviors. FCS professionals should contact coaches, establish rapport, and emphasize professional availability and services. Being an easily accessible and accurate source of nutrition information for coaches will indirectly affect young gymnasts.

In summary, young gymnasts typically consume inadequate intakes of kilocalories, calcium, and iron compared with recommended needs for good health. These dietary shortcomings may result in poor growth and delays in sexual maturation that possibly extends into adulthood. The positive benefits of participation in artistic gymnastics should not be voided by negative dietary behaviors. FCS professionals can assist young gymnasts by providing general nutrition education, by screening for dietary and health problems, and by referring at-risk athletes to appropriate health professionals.

References


Caine, D., Howe, W., Ross, W., & Bergman, G. (1997). Does repetitive physical loading inhibit radi-


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