

Female artistic gymnasts caloric and nutrient intake



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Proper caloric and macro and micro nutrients intake has a significant influence in athletic performance among female artistic gymnasts (Applegate, 2001). Appropriate nutrition is an important portion of a female artistic gymnast's training program because it provides the energy required by the body for optimizing performance during practice sessions and competitions (Achten et al., 2004). Following an adequate diet during the years gymnasts are engaged in extraneous exercise routines contributes for maintaining a healthy life after their athletic careers, delaying the effects of aging (Beals, 2002). Also, a balanced diet improves the immune system and enhances a person's ability to concentrate (Applegate, 2001).

Although appropriate diet is extremely important for athletes, female artistic gymnasts are a group predominantly predisposed for engaging in unhealthy eating behaviors for weight management purposes (Benson & Gillie, 2001). In addition to the typical social pressure placed on females in general to be thin seen in the Western culture, these athletes are part of an environment that focuses on their bodies' appearance (Nutter, 2000). Factors such as pressure from coaches, comparison with teammates, performance demands, aesthetics concerns, and physique-revealing uniforms are positively related to an increase in weight control practices in the sport context that female artistic gymnasts are inserted in (Yoon, 2002). Also, different researchers support the idea that the sport setting may contribute to heighten anxiety related to maintain a perfect body image and promote pathogenic eating behaviors among female gymnasts (Beals, 2002; Soares & Ribeiro, 2002).

The most common weight control practices observed among female artistic gymnasts are fasting and extremely low calorie intake (Phillips, 2004). Other

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methods include self-induced vomiting and the use of diet pills, diuretics, and laxatives (Hassapidou & Manstrantoni, 2001). Extremely low energy intake is associated with delayed puberty, growth problems, and amenorrhea, which has been shown to affect bone development among women (Beals, 2002).

In spite of the unquestionable importance of a balanced diet in terms of energy requirements and macro and micro nutrients for female artistic gymnasts, various researchers have demonstrated that there is a substantial lack of information about sport nutrition among artistic gymnastic coaches and athletes (Ziegler, Jonnalagadda, & Lawrence, 2001; Yoon, 2002). According to Beals (2002), it is not rare to find gymnasts with erroneous ideas about sport nutrition who engage in extremely low calorie diets in order to lose weight and modify their body composition and appearance (p. 1934).

The interest in analyzing the food intake of female artistic gymnasts is attributed to the fact that even with evidences proving the importance of proper nutrition for athletic performance, many gymnasts neglect following a balanced diet. Many times, inappropriate weight control methods are adopted because of the lack of information about sports nutrition and/or constant concern about reaching a specific body composition (Applegate, 2001). Therefore, an analysis of the eating habits of female artistic gymnasts should be conducted in order to determine if their diet contains the proper amounts of calories and macro and micro nutrients.

1. 1 Statement of the Problem

Appropriate nutrition is a key component on the athletic performance of female artistic gymnasts (Phillips, 2004). However, many athletes tend to adopt inadequate weight control practices that end up compromising their diet as a result of the constant concern with body composition and image (Burke, Gollan, & Read, 2001). Therefore, the goal of this paper is to answer the following question: On average, do females artistic gymnasts have a proper caloric and macro and micro nutrient intake based on their nutritional needs?

CHAPTER II

LITERATURE REVIEW

2. 1 Artistic Gymnastics

According to the International Federation of Gymnastics, artistic gymnastics, also known as Olympic gymnastics is a sport in which athletes perform a set of exercises in different events. The movements of the gymnasts must be elegant and demonstrate strength, agility, flexibility, coordination, balance and control of the body. The events present in women's artistic gymnastics are vault, uneven bars, balance beams, and floor. In 1881 the International Gymnastics Federation was founded and women's artistic gymnastics entered the Olympics as a team event in 1928. After that, the participation of women's teams in international gymnastics competitions gradually increased.

2. 2 Body Composition

Body composition measurements are used to describe fat, bone, and muscle percentages in the human body (Berger & Shenkin, 2006). It is basically measured in terms of body fat percentage, which can influence athletic performance during competitions and training sessions (Applegate, 2001). Athletic performance in gymnastic is, to a large extent, dependent on the athlete's ability to sustain power (both anaerobically and aerobically) and to overcome resistance. Both of these factors are interrelated with the athlete's body composition (Burke et al., 2001).

Gymnasts with a higher body fat percentage than the desirable may be more prone to injury when performing difficult skills than athletes with a more optimal body composition. Also, excessive body fat can reduce speed and increase the metabolic cost of an action (Nieman et al, 2001). A high lean body mass, which is the sum of the nonfat parts of the human body like muscle, organs, blood and water, may aid athletic performance by improving the strength-to-weight ratio. A higher percentage of lean mass facilitate power production (Jonnalagadda, Nelson, Lawrence, & Bacick, 2002). A low body fat content also helps performance by lowering the resistance because the smaller the body profile, the less resistance the body is likely to produce. For example, a gymnast who weighs 110 pounds (50 kilograms) and is 5 feet (152 centimeters) tall with a body fat percentage of 15 percent will have a lower air resistance tumbling through the air than a gymnast with the same weight and height but with a body fat percentage of 20 percent (Burke et al., 2001).

However, many gymnasts when attempting to achieve an optimal body composition use counterproductive methods (Economos, Bortz, & Nelson, 2003). Diets and excessive training often result in such a severe energy deficit that, although total body mass may be reduced, the constituents of weight also change, commonly with a lower muscle and a relatively higher fat percentage (Singh, Evans, Gallagher, & Deuster, 2003). The resulting higher body fat and lower muscle mass is associated with performance reduction that motivates the athlete to follow regimens that produce even greater energy deficits, which can place gymnasts at serious health risk (Nutter, 2000).

2. 3 Macronutrients

There are two types of essential nutrients, macronutrients and micronutrients. Carbohydrates, proteins, and lipids are the three types of macronutrients (Burke et al., 2001). Macronutrients are the substrates required to maintain the different energy systems responsible for energy production in the body. Each macronutrient produces distinct amounts of energy and plays a unique role during extraneous physical activity (Baechle & Earle, 2008). In general, in a balanced diet 55-75% of the total energy comes from carbohydrates, 12-15 % from proteins and 25-30 % from lipids (p. 74). A diet should be adjusted to the specific needs of each gymnast. Many aspects should be considered when prescribing a diet to an athlete, such as weight, height, sex, body fat percentage, age, metabolism and the type, frequency, intensity, and duration of training (Nutter, 2000).

2. 3. 1 Carbohydrates

Carbohydrates are the most important source of energy for athletes because they provide adenosine triphosphate (ATP) for muscle contractions (Baechle & Earle, 2008). Once ingested, carbohydrates are broken down into smaller sugars, such as glucose, that are absorbed by the body and utilized as energy (p. 76). Glucose molecules that are not immediately needed, get stored in the muscles and liver in the form of glycogen. Glycogen forms an energy reserve that can be quickly mobilized to meet a sudden need for glucose (Phillips, 2004). In the liver cells, glycogen can compose up to 8% of the fresh weight (100-120 g in an adult) soon after a meal. Only the glycogen stored in the liver can be made accessible to other organs. In the muscle, glycogen is found in a much lower concentration (1% to 2% of the muscle mass), but the total amount exceeds that in the liver (Baerchle & Earle, 2008).

Since ATP and muscle glycogen are immediately accessible in the muscle, they are the main fuels utilized for short and intense bouts of exercise, such as the ones performed by gymnasts (p. 90). A short duration and high intensity exercise period is classified as an anaerobic, which utilizes primarily anaerobic pathways for energy production (without oxygen). There are two types of anaerobic energy systems: ATP and creatine phosphate (phosphagen) system and anaerobic glycolysis (p. 80). Creatine phosphate molecules, which quickly re-synthesize ATP in the muscle cells, are stored in very limited quantities (Ziegler et al., 2001). So, the phosphagen energy system can only provide fuel for the muscle for approximately thirty seconds. After that, energy will be primarily produced by the anaerobic

glycolysis process (Singh et al., 2003). Anaerobic glycolysis exclusively uses glucose as a fuel in the absence of oxygen or more specifically, when ATP is needed at rates that exceed those provided by aerobic metabolism (energy production with oxygen). The result of rapid glucose breakdown is the formation of lactate (Baerchle & Earle, 2008).

According to Singh et al (2003), glycogen has four main purposes in the body: functioning as a source of energy for muscles, sparing protein consumption, working as metabolic activator, and providing fuel for the brain (p. 329). Muscular glycogen depletion leads to lower levels of blood glucose and liver glycogen (Singh et al., 2003). During prolonged physical activity, insulin secretion from the pancreas decreases, while glucagon and catecholamine concentrations in the blood increase. Catecholamine are hormones (adrenaline, noradrenalide and dopamine) released by the adrenal gland. Together with glucagon they stimulate the breakdown of liver glycogen, a process called glycogenolysis (Achten et al, 2004).

When glycogen storages reach a very low level, energy is originated from gluconeogenesis, an energy production process in which amino acids, lactate, and glycerol are converted into ATP for muscle contraction (Baechle & Earle, 2008). This process becomes an important source of energy during periods of prolonged exercise and low carbohydrate intake. In extreme condition, gluconeogenesis can cause a significant reduction in the lean body mass, which is associated with higher production of nitrogenous wastes (bi-products of protein breakdown) (Jonnalagadda et al., 2002).

One way of classifying carbohydrates is based on the glycemic index (GI), which is a measure of the effect of a carbohydrate rich food on blood glucose levels relative to glucose. Carbohydrates that break down quickly during digestion, releasing glucose rapidly into the bloodstream, have a high GI; carbohydrates that break down more slowly, releasing glucose more gradually into the bloodstream, have a low GI (Singh et al, 2003). A lower glycemic response is associated to a smaller insulin demand. Glucose and white bread are used as reference foods and have a glycemic index of 100. The glycemic index is determined by measuring the postprandial glycemia (glucose levels after a meal) for a time interval of two hours after the ingestion of 50g of a specific food (Berger & Shenkin). A glucose response curve is plotted depicting the relationship between blood glucose elevation and time. The area of the curve above the fasting level is measured and divided by the area of the curve of the standard food (either glucose or white bread) and multiplied by 100 (Jonnalagadda, 2002).

Up to two hours prior exercise, a meal that is rich in carbohydrates of low (milk and vegetables) or moderate GI (fruits) is preferred instead of one with a high GI. Foods with low to moderate GI will maintain the energy level balanced and avoid energy peaks by keeping the blood glucose and insulin levels low (Burke et al., 2001). In addition, these foods tend to be lower in fat and contain more vitamins, minerals and fiber than the ones with a high GI. Also, low to moderate IG foods promote glycogen storages, which will consequently improve performance during competition or practice session (Benson & Gillie, 2001).

Carbohydrate intake after physical activity is extremely important because it will replenish glycogen storages used during exercise (Burke et al, 2001). Also, after physical activity cells become more sensitivity to insulin, increasing glucose uptake by the tissues. After physical activity, muscle and liver glycogen is completely replenished in 24 hours. Therefore, adequate carbohydrate intake is extremely important for athletes (Nutter, 2000). According to Economos et al. (2003), 50 to 55% of the total caloric intake should come from carbohydrates. Other authors believe that the carbohydrate percentage in the diet of artistic gymnasts should vary from 55 to 75% of the total calories (p. 388). The American Dietetic Association (ADA) recommends a daily intake of 150 to 175 grams of carbohydrate for each 1000 calories consumed (Yoon , 2002). Lastly, the American College of Sports Medicine (ACSM) suggests that more than 55% of the total calories should be in the form of carbohydrates (Beals, 2002).

2. 3. 2 Proteins

Proteins are composed of one or more amino acids. A typical protein contains 200-300 amino acids but some are much smaller (the smallest are often called peptides) (Beals, 2002). More than 300 different types of amino acids are found in nature but only 20 exist in the human body. Among these 20 amino acids, eight are essential, which means that they cannot be synthesized by the body. The others are called non-essential amino acids, since they are produced by the organism (Phillips, 2004).

When the body does not have enough carbohydrate, protein is broken down to produce glucose for energy (Baerchle & Earle, 2008). Adequate

carbohydrate intake helps prevent protein from being used as energy.
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Because the primary role of protein is to function as the building blocks for muscles, bone, skin, hair, and other tissues, relying on protein for energy (by failing to take in adequate carbohydrate) can limit the athlete's ability to build and maintain tissues. Additionally, utilizing protein as an energy source stresses the kidneys because they have to work harder to eliminate the byproducts of protein breakdown (Soares & Ribeiro, 2002).

In the body, proteins play other important roles such as functioning as hormones, enzymes and neurotransmitters, participating in the process of energy production, and regulating several metabolic pathways important during physical activity. Amino acids also have a small participation in energy production during extenuating physical activities (Economos et al., 2003). Whereas carbohydrates provide more than 80% of the fuel utilized in the metabolic pathways, amino acids contribute for only 5 to 10% in physical activities of long duration (Jonnalagadda et al., 2002). The recommended protein intake for gymnasts is around 1.1 grams/kg of body weight or 12 to 15% of the total caloric intake (Burke et al., 2001).

2.3.3 Lipids

The main lipids in the human body are triglycerides, phospholipids, steroids, and lipoproteins. Triglycerides, which are composed by one glycerol molecule and three molecules of fatty acids, are the most common lipids in the diet and are stored by the body (Nieman, 2001).

During a prolonged exercise period, such as a long gymnastic practice, stored triglycerides in the adipose tissue are broken down into fatty acids and glycerol by the enzyme lipase (Economos, 2003). Adrenaline and

glucagon secreted in response to low levels of blood glucose stimulate the release of triglycerides from the adipose tissue. High levels of insulin and blood glucose have the opposite effect, since it is associated with the deposit of triglycerides in the adipose tissue (Singh et al, 2003). Glycerol is phosphorylated in the liver into glucose-6-phosphate, resulting in substrate for the formation of glucose (glyconeogenesis) (Baerchle & Earle, 2008). The American Dietetic Association (ADA) recommends that 30% of the total caloric intake should come from lipids. The American College of Sports Medicine (ACSM) suggests a lipid intake of 25-30% of the total caloric intake.

2. 4 Micronutrients

Vitamins and minerals play an important role in regulating energetic pathways, contracting and building muscles, functioning as antioxidants, and participating in the immunologic system (Economos, 2003).

2. 4. 1 Minerals

Minerals represent 4% of total body weight. The two most important minerals in the diet of athletes are iron and calcium because the body concentrations of these are more likely to be affected by intense training periods. Also, they play significant roles in athletic performance (Singh et al., 2003).

Calcium plays an important role in muscle contraction. It is stored in the sarcoplasmic reticulum of muscles and released when muscles fibers are stimulated, forming actine-miosine bridges and causing the muscle to contract (Yoon, 2002). Besides, according to Phillips (2004), there is a correlation between a poor diet in calcium and the occurrence of stress

fractures. Low calcium levels in the diet of female athletes are also related to the incidence of earlier osteoporosis than in the average women after menopause (Nutter, 2000). Athletes should have a daily intake of calcium equal to 1.2 grams (Achten et al., 2004).

Besides calcium, iron is also significant in the diet of athletes. Since iron is found in the hemoglobin and myoglobin, lack of this mineral directly affects oxygen transport in the blood and to muscles (Beals, 2002). Iron deficits in the body can cause anemia, condition in which hemoglobin is reduced in the blood and red blood cells become small and pale (Berger & Shenkin, 2006). Common symptoms associated with iron-deficiency anemia are: slow recovery after physical activity, irritability, tiredness, depression, insomnia, and consequently a decrease in athletic performance (Beals, 2002). For female athletes the recommended dietary intake of iron is 18mg/day (Baerchle & Earle, 2008).

2.4.2 Vitamins

Vitamins A, D, E, and K are denominated liposoluble and vitamins B1 (thiamin), B2 (riboflavin), niacin (B3), pyridoxine (B6), cobalamin (B12), pantothenic acid, and vitamin C are called hydrosoluble (Willmore & Costill, 2001). Vitamins from the B complex function as co-factors and coenzymes in reactions related to the energetic metabolism, such as glycolysis, tricarboxylic acid cycle, and beta oxidation of fatty acids (Singh et al., 2003).

Vitamin C is important for iron absorption and plays an important role in the synthesis of collagen, carnitine, epinephrine, and serotonin (Yoon, 2002).

Vitamin C, E, and beta-carotene (precursor of vitamin A) function as

antioxidant, protecting the organism against infections and preventing any harm that free radicals (toxic substances released during physical activity) may cause to tendons and ligaments (Nutter, 2000). Therefore, a proper intake of beta-carotene and vitamin C and E are important in the diet of athletes, since they will help in the elimination of free radicals. Lack of vitamin C may cause muscular weakness, decrease lipid breakdown, and increase occurrence of injuries (Applegate, 2001). Restrictions in energy and nutrient intake in the diet of gymnasts may cause lack of vitamins in the body (Mullinix, Jonnalagadda, Rosenbloom, Thompson, & Kicklighter, 2003).

2. 5 Caloric Intake

Energetic expenditure is determined by the thermic effects of food (5-10%), basal metabolic rate (60-65%) and intensity, duration, and frequency of physical activity (25-35%). The thermic effect of food is the energy required to process and store nutrients for use. The basal metabolic rate (BMR) is the amount of energy spent by the body at rest to maintain in the vital organs functioning. A low body fat percentage and a high muscle mass increase BMR (Baerchle & Earle, 2008).

Female artistic gymnasts should have a caloric intake adequated to their energy expenditure in order to maximize proper performance, body composition, and health (Phillips, 2004). A low energy intake or an inadequate diet in terms of macro and micro nutrients may result in improper intake of important nutrients for the energetic metabolism and muscle tissue regeneration (Ziegler et al., 2001). Female artistic gymnasts usually practice for long periods (5 to 6 hours a day), which results in high

energy expenditure, so they should have a caloric intake of 40-45 kilocalories/kilogram of body weight (Economos et al., 2003).

Excessive concern with body image and weight control may affect caloric intake among female artistic gymnasts (Ziegler et al., 2001). Inadequate energetic consumption and eating disorders are frequently seen among athletes who participate in sports in which performance is associate to low body weight, such as ice skating and gymnastics (Ziegler et al, 2001; Yoon, 2002). Soares & Ribeiro (2002) reported that 75% of gymnasts who have been told to be overweight from their coaches adopted strong measures in order to loose weight. Therefore, coaches play important roles in avoiding extreme weight control measures and consequently excessive low calorie diets among gymnasts. Also, female artistic gymnasts should consult with sports dietitian in order to minimize this type of problem (Hassapidou & Manstrantoni, 2001).

2. 6 Eating Behavior:

Benson and Gillie (2001) evaluated the eating habits of 32 female artistic gymnasts (20 to 24 years old) from six different gymnastics schools in Canada based on their food intake of three distinct days in which they had normal practice schedules. The average caloric intake (1, 838 calories (kcal)/day) was relatively low compared with the energetic recommendation for female artistic gymnasts. Besides, 40% of the athletes had diets that were low in calcium, folic acid, vitamin E, and pyridoxine and 53% showed a low iron intake. On average, the diet of athletes was constituted of 15% of proteins, 36% of lipids, and 49% of carbohydrates (p. 83).

Mullinix et al. (2003) analyzed the dietary intake of 13 members of two different collegiate women's artistic gymnastic teams (19 to 25 years old) based on the dietary intake of six days collected during 2 weeks. The average caloric intake was equal to 1,845kcal/day and athletes presented a lower caloric intake inferior to the recommendation, like the previous study. Fifty-five percent of athletes consumed less than 50% of the recommended intake for pyridoxine, folic acid, calcium, and iron (p. 590).

Yoon (2002) also studied the eating habits of ten collegiate athletes using the food intake and activity level of three days. It was estimated on average the daily energy expenditure was 2,855kcal/day. However, the caloric intake was, on average, only 1,357kcal/day, representing a deficit of 1,498 calories per day. More than 50% of the gymnasts had a low intake of calcium, iron, and vitamin A (p. 1553)

In a study conducted by Ziegler et al. (2001), twenty American gymnasts (22 years old on average) recorded their food intake during three days in which they had training. After analysis, it was possible to conclude that, on average, there was a lack of vitamins A, D, folic acid, calcium, magnesium, phosphorus, and zinc. One fourth of the athletes were taking vitamin supplements. The average caloric intake was equal to 1,771kcal/day (56g of proteins, 75g of lipids, and 218g of carbohydrates) (p. 106).

In a study conducted by Soares and Ribeiro (2002), the food intake of 20 Brazilian gymnasts was evaluated (18-20 years old). In order to analyze the eating behavior of athletes, the authors recorded their food intake for three days and asked participants to do a 24 hour food recall. The average caloric

intake was equal to 1, 521kcal/day. The carbohydrate content in their diet ranged from 50% to 58% and the protein intake from 15% to 19%. On average, there was a deficit of calcium (45% below the recommendation), magnesium, iron, and zinc (p. 350).

Hassapidou & Manstrantoni (2001) compared changes in the diet of 25 Greek female artistic gymnastics between competitive and non-competitive stages of training. Authors reported that there was no variation in the diet among these two different periods. In both stages, there was a negative energy balance in the diet of 68% of athletes, which was below the recommended caloric intake for gymnasts. Protein intake and micronutrient intakes were, on average, within the recommendation for athletes. Adequate micronutrient intake was attributed to the high consumption of vegetables and fruits, which is a characteristic of the Mediterranean diet (p. 395).

3. CONCLUSION

In order to achieve a good performance, female artistic gymnasts should adopt a balanced and adequate diet. Athletes should have a varied diet that provides them with proper caloric and macro and micronutrients intake. Factors, such as pressure from coaches to keep a perfect body composition lead many gymnasts to adopt inappropriate weight control methods. In the last decade, eating behavior of gymnasts has caught the attention of many researchers in the field of sports nutrition and exercise science. Recent studies have indicated a constant anxiety related to weight control among many gymnasts, which frequently results in inappropriate eating habits and extremely low calorie diets compared to the recommendations.

The studies presented showed that, on average, gymnasts follow low calorie diets, which are below the recommended caloric intake and do not provide athletes with the proper amounts of macronutrients. Besides, also according to the studies there appears to be a low mineral and vitamin intake in the athletes' diet. As a result, performance is very likely to be compromised since appropriate nutrition is essential for optimal functioning of the body and health. The only exception was the study conducted by Hassapidou & Manstrantoni (2001), in which Greek gymnasts had an adequate intake of micronutrients. This can be attributed to the fact that athletes were probably eating according to the Mediterranean diet, which is rich in fruits and vegetables.

In conclusion, the analysis of the studies showed that, on average, the eating behavior of female artistic gymnasts does not follow the nutritional recommendations and adequate intake of calories and macro and micro nutrients. For future studies, in order to improve their eating behavior and mindset about body image, the food intake of athletes should be evaluated after exposure to psychological counseling and nutritional reeducation for a reasonable period of time.