



GYMNASTICS TO COMPETITIVE CHEERLEADING: THE EVOLUTION OF AN ACROBATIC SPORT

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KEY POINTS

- Decades of research demonstrate that competitive gymnasts are at a high risk for low energy availability, highly correlated to inadequate carbohydrate intake. In addition, a variety of nutritional deficiencies have been shown to be prevalent in the female gymnast population throughout the history of the sport including vitamins B6, B12, D, E and K, folic acid, calcium, iron, zinc, magnesium, potassium and choline.
- Intensive training combined with inadequate nutritional patterns continues to put gymnasts at risk for symptoms of Female Athlete Triad Syndrome, Relative Energy Deficiency in sport (REDs), and disordered eating.
- The physical demands of elite cheerleading most closely resemble those of competitive gymnastics due to their intermittent high intensity performance requirements. This results in similar nutrition-related concerns including low energy availability, nutritional deficiencies, and the risk for symptoms of Female Athlete Triad Syndrome, REDs, and disordered eating.
- A unique difference between gymnastics and competitive cheerleading is that gymnasts often have more immediate and comprehensive access to medical care as a traditional sport, providing them with better support proactively and reactively.
- The primary focus area for nutrition intervention with these athletes should be centered around ensuring adequate energy availability distributed appropriately among macronutrients, as well as fueling tactics, recovery techniques, and hydration protocols aimed at reducing the potential for overuse injuries.
- Efforts should be made to proactively educate athletes, coaches, and parents about the amplified risk for low energy availability, nutritional deficiencies, Female Athlete Triad Syndrome, REDs, and disordered eating.

THE EVOLUTION OF COMPARATIVE RISKS AND RECOMMENDATIONS

Understanding the performance needs associated with gymnastics and competitive cheerleading based on similarities and unique differences is essential in providing appropriate nutrition guidance. Although these sports are very similar, competitive cheerleading is unique in that it requires more intensive athletic skills than traditional cheerleading including choreographed tumbling, stunting, pyramids, dance, and other technical skills, with a primary objective of training for a competitive execution of skills. The purpose of this Sports Science Exchange article is to provide insight into the evolution of competitive cheerleading from gymnastics alongside the physiological demands and nutritional considerations for both sports.

Sport Demands

There are a variety of similarities between gymnastics and competitive cheerleading that have been investigated as the sport has grown and evolved over time. Beyond the integration of acrobatic skills and tumbling, the sport of competitive cheerleading also has similarities in physical demands, nutritional risks, and high-risk control-focused personalities (Sansone et al., 2010). Similarities in the intermittent high intensity performance requirements of gymnastics and competitive cheerleading were demonstrated in a study where heart rates ranged from 50-69% of maximal during portions of training but peaked over 80% during more intense components, with blood lactate

concentration significantly elevated post-workout (Riddell et al., 2025). These high intensity intervals seen in both competitive gymnastics and cheerleading are expected to utilize both aerobic and anaerobic energy systems in a comparable way.

Growth-Related Concerns

The potential for the sport of gymnastics to stunt an athlete's growth has been a topic of debate for years. Research highlights the potential risk of growth compromise during puberty (Weimann et al., 2000) and studies consistently show that a gymnast's body mass is likely to fall below general standards, even when height falls at or above that to be expected with age (Silva & Pavia, 2015). Understanding that these growth-related concerns may be secondary to poor nutrition patterns puts athletes in a position to proactively focus on their performance nutrition regimens. A study reported that training volumes for female gymnasts may attenuate growth, but that a catch-up period of growth may follow once participation in the sport ends alongside optimal nutrition patterns (Caine et al., 2001).

Nutrient Deficiencies

As far back as 1984, high school gymnasts were documented to have diets low in vitamin B6, folic acid, calcium, iron, zinc, and magnesium in 30-60% of those studied (Moffatt, 1984). Over a decade later in 1998, a close look at the eating patterns of the United States National Women's Artistic Gymnastics team illustrated that this group

also had low calcium, zinc and magnesium intake, correlated to an intensified reduction in overall intake (Jonnalagadda et al., 1998). This study showed that gymnasts' daily caloric intake was 20% below recommendations, leading to lower than recommended intakes of calcium, zinc, and magnesium (Jonnalagadda et al., 1998). Chronic micronutrient deficiencies were also demonstrated in a study of Division I collegiate gymnastics with lower than recommended intake of calcium (< 500 mg/d), folate (< 400 mcg/d), and choline (<175 - 212 g/d) (Green et al., 2019a). In a study of 66 gymnasts, with 60% being female, only 2/66 athletes met calcium recommendations and less than 8% of females met iron recommendations (Vincente et al., 2023).

Alongside the growing nutritional concerns with this sport population has been the age of onset. A study with female gymnasts averaging 14 yrs of age highlighted deficiencies in calcium, zinc, and vitamins D and E, showing that these deficiencies begin much younger than college age gymnasts (Aguilo et al., 2021). Interestingly, this study also demonstrated the way in which deficiencies can be missed with carbohydrate percentage of total calories appearing normal while total grams of carbohydrate were still deficient compared to recommendations for training volume.

Female Athlete Triad

Examining the prevalence of the Female Athlete Triad, defined by low energy availability, menstrual cycle dysfunction, and low bone mineral density, had outcomes for competitive cheerleaders that correlated closely to that seen with gymnasts for years (Smith, 2021). All competitive cheerleaders who participated in one study presented with low energy availability, with 56% also presenting eating disorder risk and 52.6% having two triad components (Smith et al., 2022a). Another study with 268 cheerleaders, composed of both all-star and college athletes, examined the Female Athlete Triad components and found a 34.4% overall risk for an eating disorder with 47.7% of athletes having one triad component (Smith, 2022b). And all cheerleaders that were studied presented with low energy availability.

An additional contributing factor to the Female Athlete Triad may be that chronically poor pre-competition nutrition for competitive cheerleaders consistently led to poor recovery (Gavanda et al., 2023). A study published in 2023 with all-star cheerleaders reported that most associated markers indicated that athletes do not reach a state of full recovery before competing (Gavanda et al., 2023).

Like female gymnasts, competitive cheerleaders often experience intensive training and high-pressure competitions long before the college stage, making early intervention and education essential. Interestingly, despite the commonalities between these gymnasts and competitive cheerleaders, access to medical care is distinctly different (Smith, 2021). Over one fourth of all-star and one third of college cheerleaders present with eating disorder risk but have limited access to medical care in comparison to gymnasts. This inconsistency is related to gymnastics being a traditional sport, while cheerleading is a non-traditional sport not recognized by the National Collegiate Athletic Association (NCAA).

Relative Energy Deficiency in Sport (RED-S)

Relative Energy Deficiency in Sport (RED-S) is a condition seen in athletes in which low energy availability affects growth and development, health and wellbeing, and performance. This condition expands the view of the Female Athlete Triad Syndrome to look at both male and female athletes, as well as the impact of low energy availability more holistically. This expansion helps to identify the potential effects of low energy availability across all body systems, not just categories of menstrual function and bone health.

The evaluation of energy availability involves determining the amount of energy available for the body to function after accounting for exercise requirements, which is calculated by subtracting energy expenditure (kcal) from energy intake (kcal) divided by fat free mass (FFM, kg). Optimal energy availability recommendations are 45 kcal/kg FFM, with low energy availability flagged at less than 30 kcal/kg FFM (Cabre, 2025; Grabia et al., 2024; Holtzman & Ackerman, 2021; Nattiv et al., 2007). Several studies found that the nature of both competitive cheerleading and gymnastics presented a high risk for low energy availability concerns (Hecht et al., 2024; Holtzman & Ackerman, 2021; Smith, 2021).

A study published as far back as 1998 showed that gymnasts' daily intake was 20% below recommendations, with an average energy availability of only 34.4 kcal/kg FFM (Jonnalagadda et al., 1998). In a study exploring the daily intake patterns of Division I collegiate gymnasts two decades later, the magnitude of low energy availability became much more alarming with an average value of 27.7 kcal/kg FFM (Green et al., 2019). Carbohydrate intake was also low with less than 4 g/kg body mass (BM) daily when measured at three different time points throughout the year, compared to typical recommendations of 6-10 g CHO/kg BM/d. Interestingly, protein intake consistently fell at the lower end of a general recommendation of 1.2 - 2.0 g/kg BM/d.

Comparison to the General Female Athlete Population

It is important to understand how athletes who participate in gymnastics and competitive cheerleading compare to the general population of female athletes. Beginning with micronutrient concerns, iron deficiency has been generally shown to be an area of concern for female athletes for a variety of reasons including inadequate dietary intake with or without disordered eating present. A broad study examining 669 females across sixteen sports with ages ranging from 13-47 yrs demonstrated that 60% of female athletes experienced iron deficiency, though again not necessarily associated with disordered eating risk (Pengelly et al., 2025). The risk for iron deficiency can be unrelated to disordered eating and correlated to plant-based diets, repetitive ground strikes, endurance training, and heavy menstrual bleeding (Holtzman & Ackerman, 2021). In addition, as high as 80% of youth athletes with an indoor sport have been found to be vitamin D deficient as compared to only 48% of their outdoor sport counterparts (Hecht et al., 2024), a concept that has been reported for decades with youth gymnasts (Lovell, 2008).

Recommendations for focusing on increased intakes of iron, calcium, magnesium, zinc, vitamin B12, and Vitamin D due to risk for deficiency in high-level athletes across a variety of sports have been long-standing for more than three decades (Economos et al., 1993).

For competitive cheerleaders and gymnasts, special attention needs to be paid to amplified risk for Female Athlete Triad, RED-S, and eating disorders. Though 23.4% of the general female collegiate athlete population were found to have low energy availability, these findings weren't necessarily associated with eating disorder risk (Stover, 2024). Another study reported that 28.9% of female athletes across all sports presented eating disorder risk, which included the high-risk category of gymnasts (Torres-McGehee et al., 2023). This prevalence falls below that seen in gymnastics and in competitive cheerleading.

PERFORMANCE NUTRITION RECOMMENDATIONS

Energy Availability

Education and early intervention for gymnasts and competitive cheerleaders is essential to promote optimal performance nutrition and a reduced risk for disordered eating and nutrient deficiencies. Research has shown that education efforts for gymnasts who openly admit low energy and carbohydrate intake are not immediately successful (Aguilo et al., 2021). These limitations appear highly correlated to cultural and structural factors, which seems to demonstrate the need for broadly-focused interventions over a longer time period. In addition, a study found that alongside intensive training, 45% of high school competitive cheerleaders get their nutrition information from the internet (Green et al., 2019b). This demonstrated the necessity of ensuring that education approaches match the learning style of the athletes, embedded into platforms that athletes are most likely to access and utilize. For athletes who have struggled with disordered eating, it is important that return to play standards be followed as guidelines (Williams et al., 2026).

The foundation for performance recommendations for gymnasts and competitive cheerleaders is ensuring adequate energy availability, with an optimal value of 45 kcal/kg FFM (Holtzman & Ackerman, 2021; Smith et al., 2022a). For example, a 132-lb (60-kg) female athlete with 108 lbs (49 kg) of fat-free mass who expends 500 kcal/d with exercise would need to consume 2700 kcal/d to maintain an energy availability of 45 kcal/kg FFM. The definition of low energy availability begins once values fall below 30 kcal/kg FFM. For this same female athlete, a daily intake of 1900 kcal or less would result in low energy availability. For more detailed information on energy availability and interactive applications, please visit the Gatorade Sports Science Institute (GSSI) Female Athlete Toolkit focused on [Energy Availability](#).

Carbohydrates

Though energy availability serves as a foundation for adequate fueling and recovery, sufficient macronutrient diet composition is necessary to promote optimal performance and recovery. Carbohydrates (CHO) serve as the primary source of energy for all female athletes, including gymnasts and competitive cheerleaders, with increased CHO utilization as exercise intensity increases (Burke et al., 2011; Larrosa et al., 2025). Carbohydrate deficiency, even alongside adequate energy intake, can

still lead to qualitative concerns with energy availability (Mountjoy et al., 2023). Recommendations for carbohydrate intake are based on the type and duration of training regardless of sport (Burke et al., 2011; Thomas et al., 2016). Gymnastics and competitive cheerleading practice intensities and durations will vary based on training level and in-season versus off-season demands. Daily carbohydrate recommendations may change with training duration variations as illustrated in Table 1. Typically, each training session will range from 2-4 hr in duration, creating a daily carbohydrate need of anywhere from 6 - 10 g CHO/kg BM.

Carbohydrate intake should be spread throughout the day with pre-training fueling recommendations being 1-4 g CHO/kg BM 1-4 hr prior to exercise (Burke et al., 2011). Pre-exercise meals and snacks should be low in fiber and moderate in protein and fat to reduce the potential for gastrointestinal distress. Combining multiple CHO types helps to promote fast digestion and utilization. Slow digesting CHO like fructose, if consumed alone, may lead to stomach upset prior to and during exercise. During training, athletes are expected to tolerate 30-60 g CHO/hr of a 6-7% CHO solution (Baker et al., 2015). If an athlete engages in multiple workouts in a 24 hr time frame, it is recommended that they consume 1.0-1.2 g CHO/kg BM for the first 4-6 hr following the first training session (Thomas et al., 2016). If an athlete has more than 24 hr to recover from training, it is recommended that they return to meal and snack intake built from their daily carbohydrate recommendations. For more detailed information on carbohydrate recommendations and interactive applications, please visit the GSSI Female Athlete Toolkit focused on [Dietary Carbohydrate](#).

Type of Activity	Carbohydrate Targets
Low-intensity or skill-based activities	3-5 g CHO/kg athlete's BM/day
Moderate exercise program (1 hr/day)	5-7 g CHO/kg athlete's BM/day
Endurance program (1-3 hr/day of moderate to high intensity exercise)	6-10 g CHO/kg athlete's BM/day
Extreme commitment (>4-5 hr/day of moderate to high intensity exercise)	8-12 g CHO/kg athlete's BM/day

Table 1. Daily Carbohydrate (CHO) Recommendations Based on Athlete Training. Reproduced from Burke et al., 2011. BM, body mass.

Protein

Though protein is not a primary source of fuel for athletes, it plays an essential role in recovery related to muscle repair and recovery, including new muscle protein synthesis. Daily protein recommendations for all female athletes, including gymnasts and competitive cheerleaders, range anywhere from 1.2-2.0 g/kg BM/d, depending on the specific nature of their training (Cabre, 2025; Grabia et al., 2024; Hecht et al., 2024; Holtzman & Ackerman, 2021; Larrosa et al., 2025; Phillips & Van Loon, 2011).

Equally as important as the total protein consumed per day is the

dosage strategy utilized for protein intake. To maximize muscle protein synthesis for muscle repair and building, it is recommended that athletes consume protein in dosages equal to 0.25-0.30 g/kg BM with each meal and snack, which when combined, will reach their total protein recommendation for the full day (Larosa et al., 2025; Moore, 2019). Beyond protein dosage and total daily protein recommendations is protein type and quality. It is important that protein sources, unless prohibited by food intolerance or religious exclusion, be a complete protein source with all essential amino acids, rapidly digestible, and rich in the amino acid leucine (Phillips & Van Loon, 2011). Examples of leucine-rich complete protein sources include dairy-based yogurt, milk, and cottage cheese, as well as eggs, poultry, lean beef, pork loin, salmon, and tuna. For individuals who follow a plant-based diet, optimal leucine-rich sources include soybeans, tofu, lentils, peanuts, chickpeas, and quinoa. When these foods are eaten in combination, plant-based proteins can create a complete protein profile similar to those seen primarily in animal-based foods. For example, combining brown rice with lentils or peanut butter with whole wheat bread creates more robust and complete amino acid profiles. For more detailed information on protein recommendations and interactive applications, please visit the GSSI Female Athlete Toolkit focused on [Dietary Protein](#).

Fat

Fat intake is essential for all female athletes related to its role in providing energy for low to moderate intensity, steady-state exercise as well its function in hormone production, cellular structure, and fat-soluble vitamin absorption including vitamins A, D, E, and K. Research suggests that omega-3 fatty acids are especially beneficial to gymnasts and competitive cheerleaders as related to their role in supporting recovery and reducing delayed onset muscle soreness (Ahmadi et al., 2024; Hooks et al., 2023; Snipe et al., 2024). In addition, evidence shows that omega-3 intake, whether food-based or with supplementation, can result in reduced menstrual pain, leading to increased training consistency and overall athlete wellbeing (Snipe et al., 2024). Despite the evidence-based potential benefits of omega-3 implementation in the diet, one study reported that omega-3 intake is limited in these athletes, with barriers being sensory aversions, lack of cooking skills, and nutrition knowledge deficits (Hooks et al., 2023).

Recommendations for dietary fat intake for competitive cheerleaders and gymnasts are comparable to the general female athlete population and should be no less than 20% of total caloric intake, ideally falling in the range of 20-35% of total calories (Grabia et al., 2024; Hecht et al., 2024; Holtzman & Ackerman, 2021; Snipe et al., 2024). Unsaturated dietary fat sources should be prioritized, which include foods such as fatty fish, avocados, nuts and seeds, plant oils, and eggs. Consistently achieving optimal dietary fat requirements will promote proper absorption and utilization of fat-soluble vitamins. In addition, to promote optimal menstrual function, especially with athletes at risk for Female Athlete Triad Syndrome, it is essential that dietary fat be adequate for normal hormone function (Melin et al., 2016). For more detailed information on fat recommendations and interactive applications, please visit the GSSI Female Athlete Toolkit focused on [Dietary Fat](#).

Hydration

The goal for all athletes is to achieve and maintain euhydration, or normal body water content. Research shows that 20-44% of athletes are underhydrated before they even begin training, which sets them up for dehydration and associated risks for compromised performance and health concerns (Hecht et al., 2024). Interestingly, a research study conducted with elite rhythmic gymnasts illustrated that the senior category of gymnasts were more likely to engage in extreme weight loss strategies and fluid restriction related to aesthetics as compared to the junior category, resulting in a greater prevalence of hypohydration in the senior category of gymnasts (Kutlay & Ergun, 2012). In looking more closely at daily hydration patterns, it was determined that 70% of these gymnasts consumed inadequate amounts of water. It is important to note that youth athletes, in comparison to adults, are expected to have a lower sweat rate while producing more heat per body mass. In addition, youth athletes can expect to experience a faster rise in body core temperature than adults, and in combination with a predisposition for voluntary dehydration and a slow acclimatization to hot weather, it is important that youth athletes be monitored for the risk of dehydration (Kutlay & Ergun, 2012).

If an athlete experiences greater than an ~2% loss in body mass due to sweating, they can expect to see impaired cognitive function and aerobic performance (Thomas et al., 2016). As demonstrated in the general female athlete population, 3-5% loss of body mass due to dehydration will result in additional performance detriments including decreased anaerobic and high-intensity performance, reductions in sport-specific skill completion, and even cool weather aerobic performance declines. For gymnasts and competitive cheerleaders, the risk for overuse injuries is already high, which is further amplified at the end of a training session when an athlete is at-risk to be the most dehydrated (Kutlay & Ergun, 2012). Though gymnastics and competitive cheerleading are considered intermittent high-intensity sports, the long duration of training sessions create an increased risk for dehydration as the practice duration progresses. To promote a state of euhydration, these athletes should focus on hydrating not only after the training ends, but before and during training sessions.

Due to limited hydration intervention research with competitive cheerleaders and gymnasts, the focus is on general female athlete hydration recommendations. Ideally, athletes undergo "sweat testing" to identify their sweat rate and sweat sodium content to develop a highly individualized hydration plan. However, because this assessment may not be available, especially with competitive cheerleading not recognized by the NCAA, it is important that standard hydration recommendations be followed. Four hours prior to exercise, it is recommended that athletes consume 5-7 mL of fluid/kg BM, with another 3-5 mL/kg BM if urine is dark 2 hr prior to training (Shirreffs & Sawka, 2011; Thomas et al., 2016).

During exercise, it is recommended that athletes consume a 6% carbohydrate sports drink with electrolytes to promote a reduced potential for excessive fluid loss. Fluid consumption recommendations during exercise will be based on typical sweat loss patterns. Post

exercise fluid recommendations are ~600-700 mL for every ~0.45 kg lost during training. Research completed with female collegiate gymnasts showed a significant improvement in pre-workout hydration status measured via urine specific gravity following educational intervention and notification that assessments would be completed, which highlights the potential for proactive educational measures and accountability efforts to make a positive impact on hydration patterns and status (Schmidt et al., 2013). Though competitive cheerleaders and gymnasts may not present the same ultimate state of dehydration post-workout as other female athletes, it is important that hydration be emphasized during training in an effort to reduce the potential for a detrimental state of hypohydration and an increased risk for overuse injuries.

For more detailed information on hydration recommendations and interactive applications, please visit the GSSI Female Athlete Toolkit focused on [Hydration](#).

Micronutrients

As discussed throughout, gymnasts and competitive cheerleaders are at risk for a variety of micronutrient deficiencies. It is important that these athletes, coaches, and parents become familiar with foods that can proactively reduce the risk for deficiencies. See Table 2 for guidance on consumption of nutrients expected to be at risk of deficiency for these athletes. For more detailed information on hydration recommendations and interactive applications, please visit the GSSI Female Athlete Toolkit focused on [Micronutrients](#).

NUTRIENT	FOOD SOURCE EXAMPLES
Vitamin B6	Fish, meat, poultry, chickpeas, lentils, starchy vegetables, fruits, fortified cereals
Folic Acid	Leafy greens, enriched grains, chickpeas, black beans, oranges, eggs, fortified cereals
Vitamin B12	Shellfish, fish, meat, poultry, dairy, eggs, plant-based milks
Calcium	Milk, yogurt, cheese, tofu, fortified orange juice, collard greens, fortified plant milks
Iron	Meat, seafood, poultry, legumes, nuts and seeds, dark leafy vegetables
Zinc	Shellfish, poultry, red meat, dairy, eggs, nuts, legumes
Magnesium	Seeds, nuts, leafy greens, legumes, dark chocolate
Potassium	Potatoes, sweet potatoes, legumes, dark leafy greens, fish, dairy, fruits
Vitamin K	Dark leafy greens, broccoli, Brussel's sprouts, cabbage, meat, dairy
Choline	Beef liver, eggs, meat, poultry, fish, dairy, soybeans, mushrooms, legumes
Vitamin E	Sunflower seeds, almonds, peanut butter, avocado
Vitamin D	Fatty fish, egg yolk, beef liver, mushrooms, fortified milk, fortified orange juice

Table 2. Food Sources to Address Common Nutrient Deficiencies.

SUMMARY

Gymnastics and competitive cheerleading are similar intermittent high-intensity sports that rely on carbohydrates as the primary fuel source. Low energy availability is common with athletes in these sports, which is a contributing factor to a variety of micronutrient deficiencies

and the risk for the Female Athlete Triad Syndrome, Relative Energy Deficiency in sport (REDs), and disordered eating. The primary focus area for nutrition intervention with these athletes should be centered around ensuring adequate energy availability distributed appropriately among macronutrients, as well as fueling tactics, recovery techniques, and hydration protocols aimed at reducing the potential for overuse injuries secondary to dehydration. Efforts should be made to proactively educate athletes, coaches, and parents about the amplified risk for low energy availability, nutritional deficiencies, Female Athlete Triad Syndrome, REDs, disordered eating, and overuse injuries.

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