An evaluation of diet, energy expenditure, exercise training, menstruation, and bone among female adolescent endurance runners
The following information is from the Dissertation by Michelle T Barrack, Ph.D., University of California, Davis, 2009

Report of dieting behaviors, endurance athlete’s relatively low nutrient intake
According to the nationwide 2007 CDC Youth Risk Surveillance, among the 14,041 students sampled approximately 60% of female high school students reported a desire to lose weight (1). Additionally within the previous 30 days, 53% reported eating less food, fewer calories, or low fat foods, 16% of girls avoided eating for 24 hours, 8% reported use of diet pills, powders, etc., and 6% reported vomiting or use of laxatives to lose weight or keep from gaining weight (1). This survey depicts female US teens’ preoccupation with weight and their widespread use of unhealthy weight loss behaviors (1).

Several studies have evaluated the diet of female endurance runners. These studies identify runners’ trend of low energy intake relative to energy expenditure. Using 3-day diet records, Deuster et al. assesses the dietary intake of 51 highly trained women runners. Runners consumed, on average, 2397.0 ± 1.0 kcal per day. Additionally, 11% reported consuming energy intake levels of <1500 kcal per day (2). The runners in the study ran an average of 10 miles per day and it was estimated that they would need at least 2600 kcal per day to match the energy demands of their running.

Edwards et al measured the 7-day energy expenditure by DLW and energy intake using 7-day food diaries in a group of 9 women endurance runners. While runners’ mean daily energy expenditure was 2990 ± 415 kcal, mean daily energy intake was estimated at 2037 ± 298 kcal, therefore exhibiting a mean energy deficit of 32% (3). Further, Onywera et al. evaluated the diet and energy expenditure of 10 elite Kenyan distance runners. Using a 7-d weighed food record and physical activity ratios (PAR) the researchers determined that energy expenditure was significantly higher than energy intake on 4 of the 7 days of the study (4). These findings indicate that due to the energy-demanding nature of endurance running, runners, on average, do not meet their energy needs. Previous dietary assessments of women runners have also indicated that athletes with disordered eating are more likely to exhibit energy and micronutrient deficiencies.

Cobb et al. assessed 91 female collegiate and post-collegiate elite competitive runners’ diet and eating attitudes and behaviors using a 97-item National Cancer Institute Health Habits and History food frequency questionnaire (FFQ) and the Eating Disordered Inventory (EDI), respectively (5). The diet among runners with elevated vs. normal EDI values was significantly lower in calories and percent fat. Beals and Manore evaluated the diet and energy expenditure among 24 control endurance athletes and 24 endurance athletes with subclinical eating disorders (6). An in-depth interview determined the eating disorder status of the women athletes, while 7-d weighed and measured food records estimated athletes diet (6). The women endurance athletes with subclinical eating disorders had lower energy intakes (1,989 ± 314 kcal/day vs. 2,293 ± 393 kcal/d, P< 0.005) and a more negative energy balance (-516 ± 336 kcal/d vs. -98 ± 361 kcal/d, P< 0.005) (6). Furthermore, the women athletes with subclinical eating disorders had lower food (vs. supplement) derived intakes of magnesium and a higher prevalence of consuming less than the RDA for calcium, iron, magnesium, folate, thiamin, riboflavin, niacin, vitamin B-6, and vitamin B-12 (6). These finding suggest that endurance runners with disordered eating may be at higher risk of developing energy and micronutrient deficiencies

Female athlete nutrition recommendations
Consuming adequate nutrition can optimize sport performance and overall health by reducing injury risk and enhancing energy levels, recovery time, and immune function, among other effects. Given athletes’ high activity levels, their requirements for some nutrients are higher than that of the general population. It is important that female athletes are aware of their unique requirements and pay attention to maintaining a diet that satisfies their specific needs.

**Energy**
Consuming adequate energy is necessary to support high intensity and/or endurance-type exercise. Low energy intakes can reduce muscle mass, disturb menstrual function and bone metabolism, increase risk of injury and illness, reduce time to recovery, lower immune function, etc. The Institute of Medicine (IOM) Dietary Reference Intake (DRI) report provides energy intake recommendations for all ages and activity levels (7). Individuals’ specific needs depends on their age, developmental stage, level of activity, and proportion of lean tissue mass.

**Macronutrients**
Carbohydrates are important components of an athlete’s diet, particularly among endurance athletes. Besides acting as one of three primary macronutrients, carbohydrates are used to replenish muscle glycogen stores from which athletes use, in part, to fuel their workout. It is recommended that athletes’ consume a high carbohydrate snack or beverage within 30-60 minutes of a strenuous glycogen depleting exercise bout (8), as this improves glycogen repletion and recovery. Depending on athletes’ training volume, carbohydrate requirements range from 6-10 g/kg body weight per day (8, 9).

According to the most current research, protein needs of athletes not participating in a power or endurance sport are similar to those of the general population. Therefore, most athletes’ should consume at least 0.8 g/kg of body weight per day (8). In addition, protein should make up ~10-35% of total calories consumed (8, 9). However, endurance and power athletes may require higher intakes ranging from 1.2 to up to 1.7 g/kg of body weight per day to maintain nitrogen balance (8). It is recommended that athletes consume high quality proteins, i.e. whey, casein, egg, or other animal protein to best aid in the post-exercise repair, synthesis, and maintenance of skeletal muscle. Consuming dietary fat promotes the absorption of important fat-soluble vitamins (A, D, E, K) and essential fatty acids. Dietary fat should make up 20-35% of the total diet, and intakes <20% do not benefit performance (8).

**Micronutrients**
Due to their relatively high metabolic and nutrient needs, athletes should consume diets that provide at least the age- and gender-specific RDA for all micronutrients (8). B vitamins facilitate energy metabolism (thiamin, riboflavin, niacin, pyridoxine, pantothenic acid, and biotin) (10) and promote muscle repair (folate, vitamin B12) and some reports suggest that competitive athletes’ B vitamin requirements are slightly higher than non-athletes (8). If so, these higher needs likely are easily met with increased energy intakes (11, 8). Several B vitamins are often observed to be low in female athlete’s diets, these include riboflavin, pyridoxine, folate, and vitamin B12 (8). This can deter performance since severe deficiencies in vitamin B12 and/or folate lead to anemia, a condition causing severe fatigue.

Antioxidant vitamins and minerals, such as vitamin C, E, β-carotene, and selenium act to protect cell membranes from oxidative damage. These compounds become highly important during periods of increased exercise, particularly endurance-type exercise since oxygen consumption increases by 10-15 times with prolonged moderate-to-high-intensity aerobic activity (8, 9). Therefore, it is important that athletes consume sufficient levels of dietary antioxidants (8, 9, 12, 13). Some reports suggest that endurance athletes’ vitamin E (antioxidant) requirements may be higher than the general population, as vitamin E supplementation has been documented to reduce inflammation, muscle soreness, deter exercise-induced DNA damage and speed up recovery time (8). Populations at risk of low vitamin C, E, β-carotene, and selenium intake are those with diets low in fat, total energy, vegetables, and whole grains.
Calcium serves many important functions and facilitates in the processes of nerve conduction, muscle contraction, maintenance of blood calcium levels, and mineralization of bone. Calcium thus promotes normal growth as well as the development and maintenance of strong bones. Vitamin D facilitates the absorption of calcium from the gut and is therefore important for optimizing calcium’s important roles. Female athletes with the highest risk of calcium deficiencies are those with low energy intakes (8, 9). In addition, calcium absorption may be hindered by low estrogen levels in girls and young women with disordered eating and/or amenorrhea (11, 5, 14, 15). Therefore, the calcium and vitamin D requirements for athletes exhibiting these conditions increase from 1300 to 1500mg of calcium and from 200 to 400-800 IU of vitamin D per day (8, 9).

Iron is an important mineral for optimal athletic performance, due to its oxygen carrying capacity and role in energy production (10). Iron deficiency is one of the most common deficiencies among female athletes and leads to impaired muscle function and reduced work capacity (16, 11). Endurance athletes’ iron needs are particularly high and have been reported to be up to ~70% higher than requirements among non-athletes (8, 9). Endurance athletes that consume a plant based diet and therefore primarily non-heme iron, which is absorbed much less efficiently than heme iron, may have even higher requirements (8, 9). Female athletes at risk of consuming low iron levels are endurance runners, vegetarians, adolescents, and athletes that frequently donate blood (8, 9).

In athletes, zinc is important for normal growth, immune function, muscle repair, and energy production. Zinc has also been reported to influence BMR, protein utilization, and thyroid hormone function, while low zinc levels have been associated with reduced muscle strength, aerobic function, and endurance (8, 9). Female athletes with low protein and high fiber intakes are at increased risk of developing a zinc deficiency. Adequate magnesium levels aid performance due to its role in facilitating cellular metabolism, cardiovascular, immune, and hormone function (8, 9). If deficient in magnesium, the oxygen required for submaximal endurance activities increases, which therefore hinders performance. Athletes with diets low in energy have been documented to consume low magnesium levels (8, 9, 11).