Optimal Nutrition for Youth Athletes: Food Sources and Fuel Timing

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Summary

Proper nutrition for youth athletes is not only important for maintaining health and optimizing sports performance, but also is critical for meeting growth and development requirements. In addition to the consumption of adequate calories and balanced nutrients for growth and performance, fuel timing should be a key consideration for youth athletes. This brief report will discuss proper nutrition for growth and athletic performance and timing of fueling prior to exercise, with practical recommendations for sustained energy and performance.

Introduction

Nutrition for youth athletes must meet the demands of growth and development as well as increased physical activity. Proper sports nutrition helps to sustain energy during exercise, ensures normal blood glucose concentration, prevents hunger, preserves muscle mass and accelerates recovery. Despite higher energy requirements, recommended food sources for youth athletes do not deviate far from general recommendations for optimal health. Parents and coaches should guide youth to obtain adequate calories from fruits and vegetables, whole grain carbohydrates, and lean animal and vegetable protein, such as from beans and legumes.[1] Beyond meeting energy needs, these healthy food choices can provide the vitamins and minerals that are essential for regulating energy, growth, and repair processes.

Caloric (Energy) Needs

Caloric requirements for youth athletes depend on age, gender, and physical activity level. While there is limited evidence for the amount of energy expended in various sports, it is well established that youth expend approximately 10 to 25% more energy per pound of body mass compared to adults.[2,3] Table 1 lists the estimated caloric requirements of children and adolescents according to age, gender and physical activity levels.[4] Exact requirements will vary depending on the sport and duration of play.[1]

Table 1: Daily Estimated Calorie Needs[a] by Age, Gender and Physical Activity Level.

Activity Level[b]	Male			Female		
	Sedentary	Moderately Active	Active	Sedentary	Moderately Active	Active
Age (years)						
4-8	1400	1400-1600	1600-2000	1200	1400-1600	1400-1800
9-13	1800	1800-2200	2000-2600	1600	1600-2000	1800-2200
14-18	2200	2400-2800	2800-3200	1800	2000	2400

[a]Recommended energy intakes are based on Estimated Energy Requirements (EER) from the Institute of Medicine Dietary Reference Intakes macronutrients report, 2002.
[b]Sedentary means a lifestyle that includes only the light physical activity associated with typical day-to-day life. Moderately active means a lifestyle that includes physical activity equivalent to walking about 1.5 to 3 miles per day at 3 to 4 miles per hour, in addition to the light physical activity associated with typical day-to-day life. Active means a lifestyle that includes physical activity equivalent to walking more than 3 miles per day at 3 to 4 miles per hour, in addition to the light physical activity associated with typical day-to-day life.

What to Eat: Macronutrients

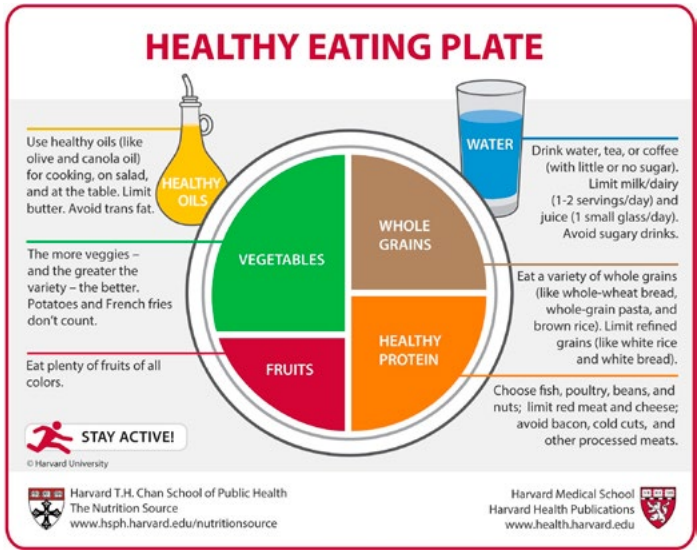
A healthy eating pattern is shown in Figure 1 and can be used as a general guide for food sources in youth.[5] If this pattern is consumed, children and adolescents should be achieving the recommended intake of approximately 45-65% of daily calories from carbohydrate (good sources depicted here as fruits, vegetables and whole grains), 25-35% from healthy fats (depicted here as healthy oils, but may also come from foods such as nuts, seeds and avocado), and 10-30% from protein.[6]

Carbohydrates

Overview

Despite recent trends in low-carbohydrate diets, the safety and efficacy of these dietary patterns in youth athletes have yet to be rigorously evaluated. As such, carbohydrates remain an important dietary component for the youth athlete. Consuming adequate amounts of carbohydrate supports usual training intensity and promotes rapid recovery. Carbohydrates are the most readily available source of food energy for the exercising muscle, the primary fuel source for high intensity exercise, and the exclusive source for the brain and nervous system.

Carbohydrates are stored in the muscle and liver as glycogen. Stored muscle glycogen resulting from carbohydrate consumption pre-exercise may help delay fatigue during exercise. Carbohydrate consumption during exercise that lasts more than 60 minutes helps the body maintain blood glucose availability late in exercise.[7] Post-exercise carbohydrate consumption helps to improve muscle glycogen storage, especially within 30-60 minutes after the activity.[8]



Food Sources

Nutrient dense sources of carbohydrate include fruit, vegetables, legumes and whole grain cereals. At least half of the grains consumed by youth athletes should be whole grains, which are full of nutrients and fiber.[9] In addition, parents and coaches should encourage a wide range of color in the diet, which can be accomplished by increasing consumption of fruits and vegetables, thereby delivering important vitamins and minerals, such as vitamins A and C, phytochemicals and fiber.

In addition to nutrient density, glycemic index or load should be considered. Glycemic index or load of an individual food or meal is a measure of how quickly it causes blood sugar levels to rise and fall. A high glycemic food or meal, characterized by simple and refined sugars (i.e. candy, white bread, white rice), will not provide sustained energy and should be avoided, especially prior to activity/training. Alternatively, low glycemic foods can help to sustain and maintain steady blood sugar levels throughout the day and during exercise, which not only impacts performance, but has also been shown to maintain cognitive performance and reduce excess calorie intake later in the day.[1,10] Oftentimes, low glycemic foods are more nutrient dense, as demonstrated in Tables 2A and 2B.

Table 2A: Best Carbohydrate Choices for Sustained Energy

Whole Wheat	Beans/Peas	Starchy Vegetables
Pasta Rice Bread Pita Tortillas English Muffins Bagels Cereals Oatmeal	Dried beans and peas Black beans Kidney beans Garbanzo beans Lentils	Squash and zucchini Eggplant Corn Carrots Green beans/peas Sweet potatoes
Vegetables		**Fruit**
Broccoli Spinach/collard greens Mushrooms Romaine lettuce Tomatoes Peppers		Apples Bananas Grapes Nectarines/peaches Oranges/grapefruit Peaches Plums

Table 2B: Carbohydrate Choices to Minimize

Breads	Vegetables	Fruits
Muffins Biscuits Cinnamon rolls Coffee cake Croissants Danish pastries Doughnuts Pies	"Corn" chips Onion rings French fries Potato chips Vegetables cooked in butter Vegetables in creamy sauce	Fruit pastries Fruit canned in syrup High sugar "fruit" juices Fruit salad with creamy sauce

Protein

Overview

Protein is an important component of an athlete's diet as it aids in muscle glycogen recovery and muscle tissue synthesis. In addition, protein is critical for building and repairing the body's cells and boosting the immune system. While it is not a primary fuel source, its role in recovery and repair is critical to the youth athlete.

Due to the demands of growth and development, protein needs, on a per kilogram basis, are greater for youth than for adults.[2] For example, the adult recommendation is 0.8 g protein/kg body weight while children ages 7-10 years old require 1.2 g/kg body weight. This recommendation, however, does not account for the increased energy and protein needs of athletes. While explicit recommendations for youth athletes have yet to be determined, athletes may require anywhere from 1.0 to 1.6 grams of protein per kilogram body weight per day.[11-14]

Food Sources

Healthful sources of protein include lean meats and poultry, dairy products, eggs and fish. Dried beans and nuts also provide high quality protein (see Table 3). The Recommended Dietary Allowance for protein is 34 grams/day for children ages 9-13, 46 grams/day for girls ages 14-18 and 52 grams/day for boys ages 14-18.

Table 3A: High Quality Protein Choices

Meat *choose baked, roasted, grilled, broiled, poached*	Dairy and Eggs	Vegetarian
Chicken (white best) Turkey (white best) Lean roast beef >85% lean meats Trimmed pork chops Fish Lean baked ham Canned tuna - in water	Milk Dried milk Greek yogurt Yogurt (regular or low-fat) Cheese Eggs or egg whites	Dried beans and peas Lentils Black beans Kidney beans Chick peas Peanut butter Nuts/seeds Soy products

Table 3B: Protein Choices to Choose Less Frequently

Meat	Dairy
Poultry with skin Hot dogs Bacon Sausage Pepperoni Fried meat/fish Processed or cured meats (bologna, salami)	Whole milk Cream Non-fat yogurt (higher sugar) Higher fat cheeses Butter

Fat

Overview

Fat is the major fuel source for low and moderate intensity exercise. Research demonstrates that children and adolescents, relative to adults, rely more on fat than carbohydrate as an energy source; however, we have plenty of fat stores in our bodies to support these needs.[15,16] Dietary fat is also important for the absorption of fat-soluble vitamins (A, D, E and K) and for optimal immune function, which is important to prevent fatigue and illness.[17]

Food Sources

The major source of dietary fat should be polyunsaturated fatty acids (omega-3 and omega-6), such as those found in healthy oils, nuts and fish (Table 4). Children should aim to consume less than 10% of calories from saturated fatty acids and avoid trans fatty acids.[6] Trans fatty acids are found in many processed foods (as partially hydrogenated vegetable oil), such as packaged cookies, boxed baking mixes, refrigerated dough products, stick margarine, cakes, cookies, crackers, and do not contribute to a healthy and energizing diet. As such, youth athletes will benefit from focusing on foods containing healthy rather than unhealthy fat sources.

Table 4: Examples of Healthy and Unhealthy Fat Sources

Healthy Fat Sources	Unhealthy Fat Sources
Nuts and nut butters Olives Avocados Almonds Walnuts Tuna Salmon Foods cooked with olive or vegetable oils	French fries Chips Doughnuts Commercial/packaged baked goods Foods cooked in coconut or palm oil Cream Butter Fried foods Fatty meats (bacon, sausage, pepperoni, bologna, salami)

When to Eat: Fueling for Exercise

While a healthy, well-balanced diet is a priority for youth athletes, the timing of meals and snacks is equally as important to optimize sports performance and recovery. To meet nutrient requirements, experts suggest frequent meal consumption beyond the typical breakfast, lunch and dinner structure typically reinforced by school schedules.[15] It is suggested that youth athletes consume food approximately every three hours in an effort to minimize within-day energy deficits.[15] In general, the dynamics of energy intake should match the dynamics of energy usage, with consumption of foods at times when the body can benefit most from them.[15]

Pre-Exercise

The purpose of a pre-exercise meal or snack is to increase energy stores (liver and muscle glycogen) before a game or practice, and to ensure that the youth athlete is comfortable and does not feel hungry or too full.

Composition

Typically, a high carbohydrate and low fat meal or snack that is easily digested should be consumed, and high fat and fiber meals should be avoided to prevent delayed stomach emptying and resulting cramps. The pre-exercise meal or snack should contain approximately 10-25% of calories from protein, with an effort to satisfy hunger. Simple and refined sugars (candy, sodas, white bread, etc.) should be avoided as these foods result in a spike and subsequent drop in blood sugar, which can negatively impact energy levels during sports. On game or competition day, athletes should only consume food and drink to which they are accustomed. Experts recommend practicing timing and composition of fuel several weeks prior to the event to prevent gastrointestinal distress on competition day.

Timing

The timing of consumption on competition or game day will depend on whether athletes are engaging in activity in the morning, afternoon or evening. In general, experts suggest consumption of a pre-exercise meal or snack approximately 90 minutes prior to the activity, with a focus on maintaining blood glucose up until the event begins. For morning events, youth should have a high carbohydrate meal the night before and a snack that is low in fat and fiber in the morning, rather than a full breakfast. For late-morning or early-afternoon events, experts recommend eating approximately every 2.5 to 3.5 hours to avoid feeling tired or hungry, and to keep the body energized for activity.[15] Athletes should strategically time breakfast and a snack such that the second eating occasion takes place approximately 1.5 to 2 hours prior to competition. Similarly, athletes competing in the evening may follow a typical eating pattern during the day, paying particular attention to consuming a snack approximately 1.5 to 2 hours prior to the event.

In general, youth athletes should consume a normal meal (~400 kcal) approximately 3-4 hours before exercise or a small snack (~200 kcals) approximately 1-2 hours before exercise. The closer the athlete eats to a workout, the fewer calories they should consume in order to allow appropriate digestion and to avoid stomach upset. It is recommended not to eat within 30 minutes of exercise, as foods will have less time to be digested. Blood will also flow to the stomach, away from the exercising muscles, which can result in stomach upset. Some good examples of pre-exercise snacks are listed in Table 5.

Table 5: Pre-Exercise Snack Ideas

For Morning Events	For Afternoon/Evening Events
Whole grain pretzels Half wheat bagel with jam Fresh fruit Yogurt Cereal	Half cup raisins and peanuts Hummus, carrot sticks and pita Whole wheat crackers Yogurt and granola Fruit/dried fruit

Snacks range from 100-300 calories, depending on portion size

During Exercise

The purpose of fuel consumption during exercise is to sustain energy levels and maximize performance. For events or competitions lasting less than 60 minutes, fuel during exercise is often not needed.

Composition

Sports drinks, which contain both carbohydrates and electrolytes, are designed for athletes engaging in activities lasting longer than 60 minutes. Sports drinks are designed with 6-8% sugar, which is quickly absorbed and used for energy. Soda and 100% fruit juices, however, should be avoided during exercise, as their high sugar and caffeine content may cause stomach upset. Youth athletes may also benefit from consuming hydrating fruit snacks, such as orange slices, melon, and cantaloupe, when possible, during a long game or competition.

Timing

Youth athletes should be encouraged to drink fluids beginning early during a long practice or game, and throughout the duration of activity. Each child should have his or her own personal water bottle and should drink 5-9 ounces every 15-20

minutes during prolonged exercise, even if they do not report thirst.[18]

Post-Exercise/Recovery

The purpose of fuel following exercise is to support the recovery and repair of a youth athlete's growing body and to replace liver and muscle glycogen stores that were lost during exercise.

Composition

Post-exercise snacks and meals should contain both carbohydrate and protein. Consumption of foods high in carbohydrate with moderate protein following exercise helps to restore muscle glycogen. Table 6 lists some ideas for healthy snacks to consume in the hour following exercise. These snacks are high in carbohydrates, but lower in fat and fiber, so that the sugars in them will readily enter the blood stream to replenish and sustain lost stores.

Timing

Youth athletes should consume their post-exercise meal or snack within 30-60 minutes of finishing their exercise bout, which is when the muscles are "primed" for energy uptake. Muscles store more glycogen immediately after exercise than in later hours.[19] Athletes should follow the snack an hour or two later with a high carbohydrate meal that also contains lean protein (limit fast-foods, fried and processed foods).

Table 6: Post-Exercise Snack ideas

For Morning Events	For Afternoon/Evening Events
Bagel with cream cheese/jelly	Pretzels and hummus
Yogurt with granola	Sports bar and sports drink
Fruit smoothie with yogurt	Trail mix
Applesauce and string cheese	Apple and peanut butter
Cereal bar and milk	Banana and yogurt

Snacks range from 100-300 calories, depending on portion size

Conclusion

Food sources and timing are both critical considerations to optimize the health and performance of youth athletes. Energy sources for youth athletes should include consuming a wide variety of healthy fruits and vegetables, whole grains, lean meats and proteins, and low-fat dairy throughout the day. The energy derived from these foods will not only fuel youth athletes during their sport, but will also optimize their performance and provide the necessary nutrition for proper growth and development.

References

1. *Gidding SS, Dennison BA, Birch LL, et al. Dietary recommendations for children and adolescents: a guide for practitioners: consensus statement from the American Heart Association. Circulation 2005;112:2061-75.*
2. *Bar-Or O. Nutrition for child and adolescent athletes. Sports Science Exchange 2000;77.*
3. *Astrand PO. Experimental studies of physical working capacity in relation to sex and age. Munksgaard, Copenhagen; 1952.*
4. *U.S. Department of Agriculture. Energy Levels for Proposed Food Intake Patterns. Washington DC: Center for Nutrition Policy and Promotion; 2002.*
5. *Healthy Eating Plate. Digital Image. Harvard Researchers Launch Healthy Eating Plate. Harvard T.H. Chan School of Public Health. Web <https://www.hsph.harvard.edu/news/press-releases/healthy-eating-plate>*
6. *Food and Nutrition Board. Dietary Reference Intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids. Washington D.C.: The National Academies Press; 2005.*
7. *Romijn JA, Coyle EF, Sidossis LS, et al. Regulation of endogenous fat and carbohydrate metabolism in relation to exercise intensity and duration. The American Journal of Physiology 1993;265:E380-91.*
8. *Rodriguez NR, DiMarco NM, Langley S. Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. Journal of the American Dietetic Association 2009;109:509-27.*
9. *U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015-2020 Dietary Guidelines for Americans. Washington D.C.; 2015.*
10. *Ingwersen J, Defeyter MA, Kennedy DO, Wesnes KA, Scholey AB. A low glycaemic index breakfast cereal preferentially prevents children's cognitive performance from declining throughout the morning. Appetite 2007;49:240-4.*
11. *Boisseau N, LeCreff C, Loyens M, Poortmans JR. Protein intake and nitrogen balance in male non-active adolescents and soccer players. European Journal of Applied Physiology 2002;88:288-93.*
12. *Boisseau N, Vermorel M, Rance M, Duche P, Patureau-Mirand P. Protein requirements in male adolescent soccer players. European Journal of Applied Physiology 2007;100:27-33.*
13. *Howat PM, Korslund MK, Abernathy RP, Ritchey SJ. Sweat nitrogen losses by and nitrogen balance of preadolescent girls consuming three levels of dietary protein. The American Journal of Clinical Nutrition 1975;28:879-82.*
14. *Ziegler PJ, Khoo CS, Kris-Etherton PM, Jonnalagadda SS, Sherr B, Nelson JA. Nutritional status of nationally ranked junior US figure skaters. Journal of the American Dietetic Association 1998;98:809-11.*
15. *Benardot D. Advanced Sports Nutrition. Second Edition ed. Champaign, IL: Human Kinetics; 2012.*
16. *Ratel S, Duche P, Williams CA. Muscle fatigue during high-intensity exercise in children. Sports Medicine 2006;36:1031-65.*
17. *Butte NF. Fat intake of children in relation to energy requirements. The American Journal of Clinical Nutrition 2000;72:1246s-52s.*
18. *Climatic heat stress and the exercising child and adolescent. American Academy of Pediatrics. Committee on Sports Medicine and Fitness. Pediatrics 2000;106:158-9.*
19. *Hawley JA, Tipton KD, Millard-Stafford ML. Promoting training adaptations through nutritional interventions. Journal of Sports Sciences 2006;24:709-21.*