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Youth Sports Nutrition: A Review

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Youth Sports Nutrition: A Review

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Report

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Youth Sports Nutrition: A Review

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Youth athletes in the 21st century have increasingly high demands to be bigger, stronger and faster. Starting as early as age four through high school, developing athletes may be practicing their sport upwards of 20 hours per week. Proper nutrition is paramount to fueling the body for energy during play, repair and recovery. Pediatric athletes have unique nutritional needs that differ from the principles of sports nutrition for adults. Some important differences include energy expenditure, substrate utilization and thermoregulation in youth during exercise. There are ample resources for adult athletes but specific research findings, recommendations and counselors are limited for children and adolescent athletes. This report compiles and dissects information from robust studies on adult athletes, current pediatric athlete recommendations and suggested applications, assessments and programs from real world experience. Youth Sports Nutrition: A Review relays this comprehensive information in a compact, readable format to be used in the practical application of properly nourishing youth athletes.

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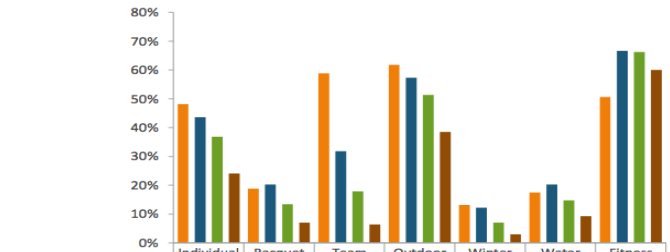
Introduction

In the United States, more than 38 million children participate in sports each year. (Nat Inst of Arth, 2009). According to a survey by the Physical Activity Council (PAC), the Generation Z population (born in 2000 onward) prefers outdoor sports (62%) and team sports (57%) as seen in Figure 1. In 2015, the PAC found that over 80% of



	Individual Sports	Racquet Sports	Team Sports	Outdoor Sports	Winter Sports	Water Sports	Fitness Sports
Gen Z (2000+)	48.2%	18.8%	58.8%	61.8%	13.1%	17.5%	50.6%
Millennials (1980-1999)	43.6%	20.2%	31.8%	57.4%	12.2%	20.3%	66.7%
Gen X (1965-1979)	36.9%	13.4%	17.9%	51.4%	7.0%	14.8%	66.2%
Boomers (1945-1964)	24.1%	7.1%	6.4%	38.6%	2.9%	9.2%	60.0%

Figure 1. Activity Category Segmented by Generations

Source. Participation Report

Gen Z are active with a quarter being active to a healthy level. Generation Z also showed the smallest percentage of sedentary individuals (Participation Report), possibly because physical activity declines with age. Recent trends in youth sports participation include: increased numbers of female participants, increased duration and intensity of training, increased participation in “extreme” sports, earlier specialization and consequently year-round training, and increased difficulty of skills practiced (Participation Report). Despite these growing numbers, the epidemic of pediatric obesity continues, this will be discussed in a later section of the report. The purpose of this paper is to offer an overview of sports nutrition for youth athletes regarding their

nutritional intake, expenditure and the nutritional requirements needed to sustain them throughout training and recovery.

There are positive and negative aspects associated with the increasing popularity of participation in youth sports. The positives include: overall improved physical fitness, reduced body fat levels, decreased risk for cardiovascular and metabolic diseases, and hence bone health, reduction of the symptoms of depression and anxiety (Caine, 2009), and increased self-esteem and emotional well-being. In addition, it has been shown that adolescents that learn about healthy nutrition habits at an early age maintain these habits more so than their non-athletic peers. Data has found that sports-involved adolescents have better eating habits and nutrition habits than their non-sport-involved peers (Croll, 2006).

The negative aspects include: the risk of injury, including overuse injury, a “win at all costs” which can lead to unhealthy behaviors such as drug use and violence, disordered eating, and an increased risk for injury (Calfee, 2006; Caine, 2009; Brenner, 2007). According to the National SAFE KIDS Campaign and the American Academy of Pediatrics, more than 3.5 million children ages 14 and younger get hurt annually playing sports or participating in recreational activities. The most common injuries include sprains, strains, growth plate injuries, repetitive motion injuries, heat-related illnesses, including dehydration and stroke, overuse injuries and overtraining (NIAMS, 2009). More than 775,000 children, ages 14 and younger, are treated in hospital emergency rooms for sports-related injuries each year (Brenner, 2007). The highest rates of injuries for children from 5-14 include: bicycling (200,000), basketball (170,000), baseball and

softball (110,000). Most of the injuries occurred as a result of falls, being struck by an object, collisions, and overexertion during unorganized or informal sports activities. Sports and recreational activities contribute to approximately 21% of all traumatic brain injuries among American children with baseball and softball resulting in 3-4 deaths per

Differences between Youth and Adults

Young athletes are not mini adults. There are many factors that affect the rate of maturation, including genetics and metabolic and hormonal responses to exercise. Substantial differences that exist between adult athletes and young athletes, include the following:

- Immature anaerobic metabolic system, their substrate utilization during activity may vary depending on age and puberty status (Boisseau, 2007).
- Anaerobic glycolysis (ATP rephosphorylation) may be reduced in young individuals during high-intensity exercise (Boisseau, 2007).
- Pre-puberty children may have reduced activity of phosphofructokinase-1 and lactate dehydrogenase enzyme; these may be related to reduced sympathetic response to exhaustive resistance exercise.
- Children may rely more on fat oxidation for energy than adults, although this age-dependent glycolytic activity increases with age. This hypothesis is supported by findings that children have increased free fatty acid mobilization, glycerol release, and growth hormone levels during exercise (Boisseau, 2007).
- Children are less able than adults to achieve ATP phosphorylation by anaerobic metabolic pathways during high-intensity exercise.
- Adolescent development involves anatomic, physiological, and metabolic changes. It is also characterized by a faster rate of growth than any other period of life. This rapid growth results in increased requirements for energy and nutrients (Rogel, 1990).

- Children have lower muscle strength that is related to altered muscle fiber growth and results in lower anaerobic capacity (Boisseau, 2007).
- There is limited data and research on young athletes compared to adults due to ethical concerns and methodological constraints. Much of the research involves very small samples and indirect relatively non-invasive study designs (Boisseau, 2007).

Muscle glycogen levels at rest are less in children, but during adolescence these reach levels observed in adults. Immaturity of anaerobic metabolism in children is a major consideration, and there are several possible reasons for this reduced glycolytic activity. There appear to be higher proportions of slow twitch (type I) fibres in the vastus lateralis part of the quadriceps in children than in untrained adults, and anaerobic glycolytic ATP rephosphorylation may be reduced in young individuals during high intensity exercise. Reduced activity of phosphofructokinase-1 and lactate dehydrogenase enzymes in prepubertal children could also explain the lower glycolytic capacity and the limited production of muscle lactate relative to adults. These observations may be related to reduced sympathetic responses to exhaustive resistance exercise in young people. In contrast, children and adolescents are well adapted to prolonged exercise of moderate intensity.

Growth and maturation induce increases in muscle mass, with proliferation of mitochondria and contractile proteins. However, substrate utilization during exercise differs between children and adults, with metabolic and hormonal adaptations being suggested. Lower respiratory exchange ratio values are often observed in young individuals during prolonged moderate exercise. Data indicate that children rely more on

fat oxidation than do adults, and increased free fatty acid mobilization. Glycerol release and growth hormone increases in preadolescent children support this hypothesis. Plasma glucose responses during prolonged exercise are generally comparable in children and adults. When glucose is ingested at the beginning of moderate exercise, plasma glucose levels are higher in children than in adults, but this may be caused by decreased insulin sensitivity during the peripubertal period (Boisseau).

In sum there are numerous physiological and psychological differences between children and adults. Such characteristics are influenced by the stage of development and training volume. Development, over chronological age, is a necessary consideration for those working directly with youth.

Growth and Development

The growth pattern of each individual child is often neither stable nor predictable. The body mass index (BMI) charts are helpful in assessing risk of underweight, overweight, and obese status. Traditionally, BMI has been the standard for evaluating an individual's health regarding their weight (see Figure 2). Obtaining a BMI measurement is easy, non-invasive and inexpensive, requiring nothing more than a scale and measuring tape. BMI formula: BMI = weight (lb) / height (inches) / height (inches) x 703 and is considered a reasonable and acceptable practice.

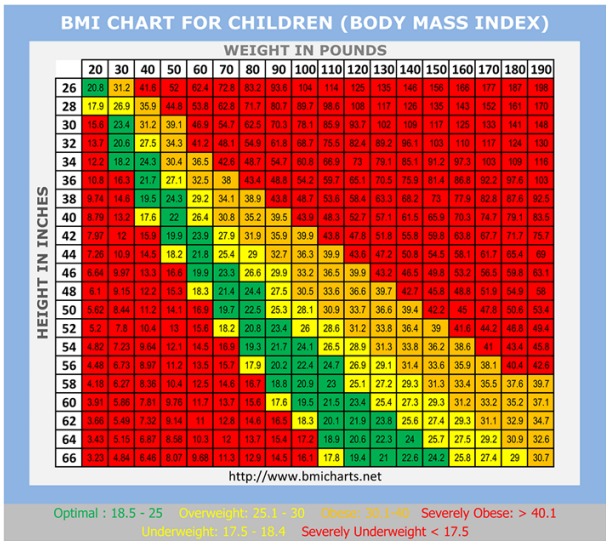


Figure 2. BMI Chart for Children

Source: http://buecherbeutel.com/bmi-kids-chartspeed-trained

However, although growth charts are appropriate for large sample sizes, it should not be relied on alone as there is potential for error when interpreting BMI without taking into account some assessment of body composition (lean body mass and bone density). A less biased and more direct assessment of fatness than BMI can be obtained using surface anthropometry such as skinfolds taken by experienced practitioners. It is critical to understand the accuracy of BMI in special populations,

such as athletes (Ode, 2007). In a 2005 study, Nevill and colleagues found that having controlled for differences in body size (approximate BMI) and age, male strength- and power athletes had significantly lower skinfolds (32% and 23%, respectively) compared with controls. Similarly, female strength athletes had 29% lower skinfold measurements compared to controls (Nevill, 2005). Athletes or individuals with a high lean body mass (i.e. bodybuilders, football players) are often inaccurately assessed as overweight or obese when a BMI chart is used when, in fact, the athlete may be dramatically healthier than a similar individual with matching height and weight but different body compositions.

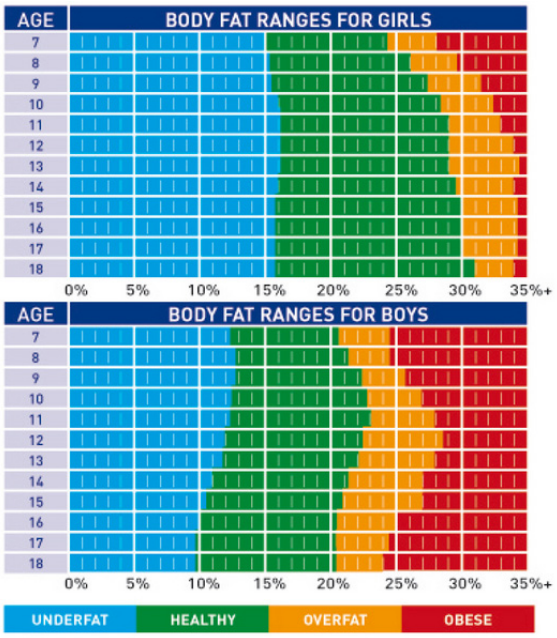


Figure 3. Body Fat Ranges for Girls and Boys, Ages 7-18 years

Source: http://zocenter.com/fitness-nutrition-calculators/bmi-fat-muscle-charts/

Because of these fluctuations in patterns of growth, it may be difficult for a sports dietitian to estimate the energy needs of young athletes. The best determinant of energy intake of an athlete is to monitor body mass trends and other anthropometric variables of the athlete. During periods of rapid growth, adolescents may experience unexpected

periods of lethargy, or coordination and movement efficiency and result in considerable fluctuations in energy needs.

Childhood

During preschool and school years, growth tends to be steady and slow. Growth spurts are often accompanied by changes in appetite and food consumption (Lucas, 2004). Growth during childhood is slower than growth in infancy and adolescence. On average, a weight increase of approximately 2 to 3 kilograms per year is expected until age 9 or 10. At this point the rate of weight gain increases, signaling the approach of puberty and adolescence. Increases in height average between 6 to 8 centimeters per year from age 2 years until puberty begins.

There is limited information on the effect of intense exercise on the growth of youth athletes. Current research does not suggest that high levels of training will decrease growth potential although delays and growth have been documented in athletes and sports such as dance and gymnastics (Boisseau, 2005). These delays in growth are thought to be related to inadequate nutritional practices versus excessive training causing the decrease in growth potential. Studies also found that once training load was decreased, thereby allowing energy available for growth “catch up”, growth was subsequently achieved (Meyer, 2007).

Adolescence

This period of life is accompanied by a multitude of changes including physical, cognitive, emotional and social changes, all of which provide challenges and opportunities both to sports dietitians and the athletes. Rapid yet fluctuating growth accompanied by changes in body composition and patterns of eating , makes youth nutritionally vulnerable (Holt, 2003).

Growth spurts in adolescents typically occur between 10-12 years of age for females and 12 and 14 years for males (Holt, 2003). In females, the growth is accompanied by an increase in the proportion of body fat to muscle mass and in males, growth is accompanied by increases in lean body mass and increased blood volume. Males who participate in sports have normal growth rates compared to their non-athletic peers but may seemingly be advanced in maturation as their increased muscle mass allows them greater power and performance (Malina, 1994). It is estimated that pubescent adolescents accrue 15% of their final adult height and 45% of their maximal skeletal mass during adolescence. On average, girls grow 10 inches and gain 53 pounds and boys grow 11 inches and gain 70 pounds (Mitchell, 2003). Growth pattern and velocity may be related to genetics but can be influenced by many factors including energy balance.

Research in this age group has found that adolescents do not readily adhere to the dietary guidelines and consequently do not consume adequate amounts of fruits, vegetables, calcium-rich foods and many micronutrients. Conversely, this age group

tends to have an excessive intake of total fat, saturated fat, cholesterol, sodium and sugar (Position of the ADA, US Dept Ag).

Energy Balance

Participation in sports generally increases nutrient requirements. Athletes need energy to fuel training and competition while also meeting needs for growth, healthy body mass maintenance and daily physical activities. If these elevated energy requirements are not met, it may result in short stature, delayed puberty, menstrual irregularities, poor bone health and increased risk of injuries. To determine overall total energy requirements some estimates can be extrapolated from adult data however, this approach is flawed because children are less metabolically efficient Meyer, 2007; Bar-Or, 2001). Children's energy requirements per kilogram of body weight can be as much as 30% higher than adults. Young athletes may compensate for the elevated energy expenditure by conserving energy via increased sedentary behavior the remainder of the day (Petrie, 2004). It is difficult to determine a DRI (daily required intake) for energy in young athletes. Researchers Eisenmann and Wickel reviewed research regarding the total daily energy expenditure (TDEE) of young athletes and categorized energy needs based on age groups (Eisenmann, 2007): TDEE ranged from 2457 kcal to as high as 4022 kcal for males and 2184 kcal to 2886 kcal for females. For studies that provided TDEE as a measure of kcal/kg, the TDEE ranged from 44 kcal per kilogram up to 57 kcal per kilogram for males and up to 51 kcal per kilogram for females (Eisenmann, 2007). Comparisons between research studies involving young athletes should be made with caution because it varies by age and body size of the subject’s sport, level of competition, and overall methods of assessing TDEE.

Tools for Evaluating Nutrition Profile

Most research involving young athletes is non-invasive and uses diet records and recalls. These are heavily relied on as a tool to aid sports dietitians in evaluating the adequacy of an athlete's diet and energy needs.

Accurate food records can provide the practitioner with a wealth of information; however young athletes may fail to provide accurate information because of lack of knowledge, forgetfulness or may purposely underreport or over-report to please a parent, coach, athletic trainer or sports dietitian. Parents can be a reliable source for recording and reporting accurate energy intake of younger athletes in order to avoid the inaccuracies presented by young test subjects food records (Soric, 2008). Bandini and colleagues examined the accuracy of reported energy intake as 26 females ages 10, 12, and 15 years old moved from middle school to high school (Bandini, 2003). Using 7-day diet records (energy intake, EI) and doubly labeled water to determine energy expenditure (EE), they found that as the girls aged they tended to report energy intake less accurately, decreasing from 88% accuracy at 10 years old to 68% at 15 years old.

Despite the accuracy of diet records possibly being skewed, many well-designed studies have found that young athletes tend to eat more healthfully than their non-athletic peers. The Project EAT (Eating Among Teens) student survey revealed that among females, breakfast was eaten more often among weight-related sport participants than other team sports. The weight-related sports female athletes also ate more dinner and snacks than the team sports athletes and non-athletic females. Males involved in sports also ate breakfast and lunch more frequently than their less athletic counterparts. Reviewing all data from the survey, researchers concluded there were

substantial differences between athletes participating in team sports versus weight-related sports and also reported a statistical significant difference between youth in sports and youth not involved in sports. Based on these studies, sports dietitians can assume that active youth eat breakfast more often and have greater intake of protein, calcium, iron and zinc.

Daily required intakes (DRIs) aim to ensure adequate energy for growth but do not take into account the increased nutritional needs of the very active child or adolescent athletes. Due to large individual variability, it is difficult to develop a standardized recommendation for energy intake. The practitioner should calculate an athlete's estimated energy requirement using equations that consider the individual's age, height, body weight, and physical activity classification (Petrie, 2004).

Appendix A includes a Comprehensive Client Information Sheet I developed through the research for this Report and through professional development of my nutritional practice as a profession. The Comprehensive Client Information Sheet is to be used as a tool for gathering initial onboarding information about the young athlete, including past injuries, training goals, medical information, 3 day dietary record, learning style assessment and a look into their support system (see Appendix A).

Macronutrients & Fiber

Carbohydrates

Carbohydrates are made up of a collection of carbon, hydrogen, and oxygen molecules; all carbohydrates have a 2:1 ratio of hydrogen to oxygen. Because of their similar chemical structures, sugars, starches, and fibers are all considered carbohydrates. Carbohydrates are divided into three general groups of saccharides: monosaccharides, oligosaccharides, and polysaccharides (see Figure 4).

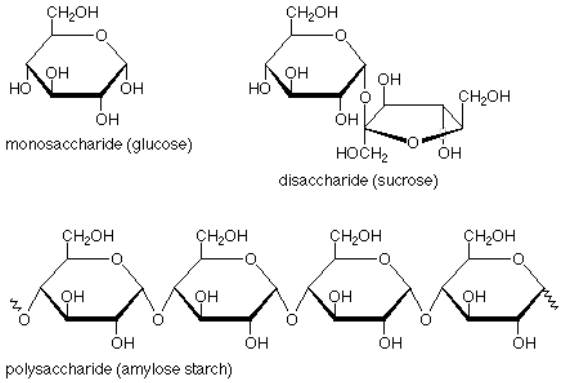


Figure 4. Carbohydrate Structure

Source: http://chemistry2.csudh.edu/rpendarvis/monosacch.html

Monosaccharides contain only one (“mono”) sugar group, oligosaccharides are chains of monosaccharides linked together in the form of disaccharides, trisaccharides, etc. Maltose, sucrose and lactose are the most common disaccharides. Polysaccharides are long, complex chains of monosaccharide units. Starches, glycogen and fiber are the most commonly referenced polysaccharides.

Carbohydrate digestion breaks down the oligo- and polysaccharides into the monosaccharides glucose, fructose, and galactose, for eventual release into the bloodstream as glucose.

Young children lack the full development of glycolytic capacity and may rely more on fat to fuel activity. This seems to be resolved in adolescence. Research by Riddle and colleagues found that during heavy exercise, total carbohydrate utilization in adolescents may be as high as 1.0 to 1.5 grams per kilogram per hour (Riddell, 2000). Carbohydrate is certainly important to optimize athletic performance and recovery in young athletes, although due to lack of research, it is yet to be determined if youth can fully benefit from a high-carbohydrate diet as do adult athletes. Carbohydrate loading is not recommended for young athlete because they benefit the most from a well-balanced diet rich in whole grains, fruit, vegetables, and low-fat dairy because these foods provide energy, nutrients, and fiber. It is recommended that young athletes consume at least 50% of total daily energy intake of carbohydrates (Petrie, 2004). Burke and colleagues suggest that the use of refined carbohydrates (i.e.sports drinks, cells, and energy bars) during training and competition can be helpful. Research suggests young athletes can tolerate a concentration of 6% to 8% carbohydrate solutions but keeping in mind that overuse of these items may increase the risk for childhood obesity (Shi, 2004).

Sources of carbohydrates

Most young athletes consume carbohydrates regularly but they need to be encouraged to reduce consumption of snack foods (i.e. chips, candy, ice cream) and sugar-laden beverages (i.e. sodas, juices). Intake of simple sugars with young athletes is likely to be higher than what is recommended. Sweets and beverages such as sports drinks, energy drinks, and soft drinks rank fourth out of the top 25 sources of energy in the diet of Americans over the age of 2 (US Dept Ag, 2010). There is a preference for sweet foods, which may lead to food patterns that are not conducive to high levels of performance. Many young athletes are not aware of the range of carbohydrate sources available and need to be encouraged to expand their palate. The sports dietitian can help to identify which flavors and textures an athlete might prefer and recommend a healthier, more appropriate option. For example, many children and adolescents do not like the taste of vegetables but with a little creativity these can be added into the diet in a fun and even tasty way. Smoothies are an easy way to include greens, such as spinach or kale, without having to eat a salad and typically the taste of the greens disappears with the other ingredients.

Protein intake

Rapid growth and development during childhood and adolescence increase the requirements for energy and nutrients. Restriction of overall energy intake combined

with a high level of physical activity could lead to altered protein metabolism and impaired growth and maturation. The recommended protein intake is 0.8 - 1.0 grams per kilogram per day in adolescents; however, this recommendation is based on non-active adolescents (Boisseau, 2007). Studies show an upper limit of 1.7 grams per kilogram per day to be appropriate for adults in training; this amount may be applicable for children and adolescents as well (Tipton, 2007). Boisseau examined whether regular intensive exercise training affected protein turnover in young gymnasts. Results suggested that the athletes do not need more protein to meet the needs of growth, maturation, and exercise. In athletes whose energy balance may be compromised due to growth spurts, excess energy expenditure due to a high volume of training, or energy intake restriction for a weight class sport, the requirement for protein relative to energy intake needs more clarification through studies. Many studies do suggest that young athletes require more protein per kilogram than their inactive peers (Cole, 2000).

Protein- Rich Snacks / Sources

The palate of young children tends to be limited. Young children may be hesitant to add more animal products to their diet; observations show that young children may prefer carbohydrate and fat rich foods over proteins. An assessment of protein intake in young athletes has shown that on average and per kilogram of body weight most

adolescent athletes often have an adequate intake of protein but should be encouraged to select lean protein choices. Table 1 shows some appropriate protein-rich and nutrient-dense snack and meal choices.

Table 1. Protein-Rich Snacks and Meals for Young Athletes
Source of nutrient information: Nutritionist Pro Version 4.4.0. Copyright 2010 Axxya Systems.

Meal or snack	*Energy, kcal*	*Carbohydrate, g*	*Protein, g*	*Fat, g*
2 slices whole wheat bread, 2 teaspoon light cream cheese spread, 1 egg, cooked, 1/2 cup fresh baby spinach, 1 navel orange	445	61	18	17
1 English muffin, 1 slice low-fat (2%) American cheese, 1 cup low-fat fruit-on-the-bottom yogurt, 1 serving of fresh fruit	450	78	17	8
Shake made from 2 tablespoons whey protein powder, any flavor, 1 medium banana, 2 tablespoons fat-free chocolate syrup, 8 oz fat-free milk, 1/2 cup crushed ice	420	77	19	4
3 mini Bagels topped with 1 tbsp low-fat cream cheese, 1 cup fresh berries, water to drink	365	73	10.6	5
1 cup grapes, 1 ounce pretzels dipped in 1 tbsp peanut butter	360	44	18	11.5
½ cup fat-free fruit sorbet topped with 2 tablespoons ground nuts, 1 cup fresh blueberries, 1 slice angel food cake	350	65	9	6
8 ounce light yogurt mixed with 1/2 slice kiwi fruit and 1/2 cup low-fat granola	335	55	13	7

Grilled sandwich: 2 slices of whole-grain bread topped with 1 slice low-fat (2%) American cheese and 1 ounce of deli roast beef, chicken, and lean ham	290	27	26	8
1 whole grain bagel topped with 1/3 cup marinara sauce and 1 ounce low-fat mozzarella cheese, broiled	260	37	15.3	6
8 ounce low fat chocolate milk, 1 cup fresh apple or pear	230	45	8.3	3
3 ounce grilled, non-breaded chicken fingers, 2 tablespoon barbecue sauce for dipping	180	9	27	3

Table 1. Cont'd

Fat intake

There is no recommended dietary allowance RDA or adequate intake (AI) set for fat intake for youth, however AIs have been established for the essential fatty acids linoleic acid and linoleic acid. The Acceptable Macronutrient Distribution Range (AMDR) suggests 20% to 35% of daily energy intake should come from fat (Lucas, 2004; Petrie, 2004). If an athlete is desiring weight control, they may reduce overall dietary fat to create an energy deficit, without sacrificing carbohydrate or protein intake. Children use proportionally more fat as a substrate during exercise than adults (Burke, 2007) although there is no research to support the impact of adjusting fat intake on performance. Researchers have found that ingestion of high-fat foods before exercise may reduce the magnitude of growth hormone secretion during exercise. Growth

hormone increase during exercise is important to muscle adaptation and growth (Galasetti, 2006). So it is suggested to eat a diet low in fat prior to exercise, with higher carbohydrates and protein, in order for growth hormone secretion to take place and allow proper muscle adaptation and growth to result from the training (Meyer, 2007).

Fat Sources

Over the past 25 years, the percentage of fat intake from poultry, cheese and snacks has increased. There has been a decrease in the consumption of fat from milk as well as from fats, oils, pork, mixed meats, eggs, and desserts. Due to lack of education many athletes ingest more fat than they realize by consuming items labeled as “crispy”, “pan-fried”, “roasted”, “creamed” and others. Young athletes could benefit from learning appropriate intake and sources of fat. Data from NHANES from 2005 to 2006 showed that on average children from ages 2 to 19 consumed an average of 30% of calories from total fat and approximately 12% of total calories from saturated fat (Position of ADA, 2004; US Dept of Ag, 2008). Young athletes should be encouraged to obtain less than 10% of their total daily energy from saturated fat and to keep trans fat intake to a minimum. Parents and sports dietitians may need to help guide adolescents

with helping to fill the void left by by chips, crackers, cookies, cakes, candy, and fried foods.

Micronutrients

Minerals represent approximately 4% to 5% of the young athlete's body weight (Lucas, 2004). Minerals and vitamins are necessary for normal growth and development, and insufficient intake can result in impaired growth and diseases associated with deficiencies (Lucas, 2004). Micronutrients play the same roles in athletes as a non-athlete; these roles include the synthesis and formation of body tissues, maintenance of fluid balance within specific compartments, and acting as co-factors for facilitating metabolic reactions regulated by enzymes (Petrie, 2004). Young athletes tend to consume vitamin levels at or close to the DRIs and surpassing the intake of the inactive peers. At this time, there is no evidence to support that vitamin needs for athletic youth is any higher than their sedentary counterparts. Two micronutrients are frequently identified as being deficient and can affect overall health and performance - Iron and calcium.

Puberty increases the requirement for iron because of increases in hemoglobin mass, tissue deposition, growth spurts, and onset of menstruation in females (Petrie, 2004). Deficiencies may be seen in endurance athletes, athletes restricting dietary intake, and female athletes. Studies have found that as many as 40 to 50% of female athletes have low ferritin stores (Rowland, 1991). Low iron intake may lead to impaired muscle metabolism and cognitive function and at worst, anemia. Cause of low iron stores may be related to the following (Constantini, 2000; Spodaryk, 2002; Felesky-Hunt, 2001):

- Increase growth and physical demands
- Menstruation and females or bleeding disorders in either sex
- Poor absorption
- Sports-related hemolysis and blood loss
- Poor overall intake (self-imposed restriction or unbalanced diet pattern)
- Heavy sweat loss
- Poor socioeconomic status and food insecurity

Inadequate intake of calcium, along with heavy intense training, can have a detrimental effect on bone health. Amenorrheic female athletes may require more calcium; an intake closer to 1500 mg / d of calcium may be necessary (Burke, 2007). There is a threshold for calcium intake beyond which any additional intake does not result in retention. If calcium intake is low, a higher calcium retention rate partially compensates for the deficit (Abrams, 1997). However, chronic low calcium intake below 400 mg / d is detrimental to bone development and overall health (Lanou, 2005).

It is important for the sports dietitian to discuss optimal intake and food sources of iron and calcium such as the examples seen in Table 2. A candid discussion on the side effects and consequences of an adequate macronutrient intake would be of benefit to the athlete that is at risk for deficiency.

Food, Standard Amount	*Calcium, mg*	*Energy, kcal*
Plain yogurt, non-fat (13g protein/8 oz), 8 oz	452	127
Plain yogurt, low fat (12g protein / 8 oz), 8 oz	415	143
Soy beverage, calcium fortified, 1 cup	368	98
Fruit yogurt, low fat (10g protein / 8 oz), 8 oz	345	232
Sardines, Atlantic, in oil, drained, 3 oz	325	177
Mozzarella cheese, part-skim, 1.5 oz	311	129
Fat-free (skim) milk, 1 cup	306	83
Low-fat (1%) milk, 1 cup	290	102
Low-fat chocolate milk (1%), 1 cup	288	158
Reduced fat (2%) milk, 1 cup	285	122

Fortified ready-to-eat cereals, 1 oz	236-1043	88-106
Spinach, cooked from frozen, 1/2 cup	146	30
Soybeans, green, cooked, 1/2 cup	130	127

Table 2. Good Sources of Calcium for Young Athletes.

Source: Nutrient values from Agricultural Research Service (ARS) Nutrient Database for Standard Reference, Release 17.

Ergogenic Aids & Supplements

Ergogenic aids are substances that are used to enhance athletic performance. Success in sports involves obtaining an “edge” over the competition, and children and adolescents may be uniquely vulnerable to the lure of supplements (Burke, 2006). Sometimes the drive for success can be so engrossing and so compelling that a young person can easily lose sight of what is fair and right. Some individuals may view the use of performance-enhancing substances as a substitute for hard work. The pressure to “win at all costs”, extensive coverage in lay publications and influential advertisements from manufacturers with exciting and emotive claims can all play a role in the use of supplements by young athletes. Additionally, the knowledge that famous athletes and other role models use or promote these supplements often adds to the allure.
There is poor regulation of supplements in many countries comma allowing young athletes to be the target of these marketing campaigns based on exaggerated claims and hype.

The American Academy of Pediatrics strongly condemns the use of performance-enhancing substances and vigorously endorses efforts to eliminate their use among children and adolescents (AAP, 2005). Commonly used supplements by young athletes include: anabolic-androgenic steroids, steroid precursors or prohormones, growth hormone, creatine, and ephedrine (Reeder, 2002; Rickert, 1992; Kayton, 2002). A semi-

structured focus group interviews (*n* = 16) were conducted among 78 adolescents aged 11–18 years from a co-educational government high school. Participants reported consuming sports drinks, vitamin and mineral supplements, energy drinks, herbal supplements, guarana, creatine, high protein milk supplements, and coenzyme Q_{10}. Reasons for supplement use included perceived short-term health benefits, prevention of illness, improved immunity, parental supply of supplements, taste, energy boost, better sports performance and to rectify a poor diet. Results suggest that some adolescents consume nutritional supplements, sports drinks and energy drinks for their perceived physiological benefits, and that they may not be aware of any potential risks (O'Dea). Creatine monohydrate is a very popular supplement not only among youth athletes but in active individuals of all ages. Although creatine monohydrate has been found to be safe and effective, especially in strength and power-dependent athletes (Naughtin, 2000), the ACSM recommends creatine monohydrate not to be used by children younger than 18.

Fluids

It is vital for the young athlete to monitor and maintain adequate fluid balance to prevent dehydration in order to sustain normal cardiovascular and thermoregulatory functions required for exercise performance (Petrie, 2004). Children have a greater ratio of surface area to body mass and absorb environmental heat more readily than adults, creating a greater risk for experiencing heat stress when exercising in hot environments (AAP, 2000). Non-athletic children have a faster metabolic rate and generate greater heat production than adults working at the same volume. In addition, children not only have higher thresholds before beginning to sweat but their sweating capacity is much lower, reducing their ability to dissipate body heat by evaporation. Given this information, it is highly critical to provide information to parents and children on proper peri- and intra-workout hydration. For new athletes, it is important to educate them that children take longer to acclimate to hot humid environments (2 weeks vs 1 week), which increases their risk of heat-related injury (AAPCSMF, 2005). .

There is an increase in sweat rate when adjusting for body surface area as children mature, which concurrently includes an increase in electrolyte loss. Young athletes should be encouraged to replenish electrolytes by using sports drinks to replenish not only electrolytes but also carbohydrates. Research has shown that children more readily replace their fluid losses when offered a flavored drink or a

flavored sports beverage vs. plain water. The presence of sodium in the beverage replaces electrolyte losses but also heightens the desire to drink more, resulting in better recovery and optimal hydration. In adults a loss of 2% of body weight due to dehydration will have detrimental effects on performance. The same is true for children but occurs at a 1% decrease in body weight. It can be assumed that dehydration in children has similar effects as dehydration in adults, which leads to decreased endurance and performance by negatively affecting the cardiovascular system, thermoregulation, and central fatigue or perceived exhaustion. Beyond dehydration of 1% this can lead to disturbances in physiological function and increase the risk for heat illness. To prevent dehydration and promote euhydration in young athletes, the sports dietitian can offer the following advice from the National Athletic Trainers' Association Position Statement: Fluid Replacement for Athletes as well as recommendations from the American Academy of Pediatrics (AAP):

- Establish a hydration protocol for young athletes, including a rehydration strategy that considers the athlete sweat rate, sport dynamics such as rest breaks, timeouts, fluid access, etc, availability of fluids and reminder to bring fluids to all practice sessions and games, environmental factors, level of fitness, exercise duration and intensity, and individual preferences.
- Be aware that hypohydration and dehydration practices are used by athletes who participate in weight sensitive sports in an attempt to lose weight or appear leaner. Voluntary dehydration practices to watch out for and discourage include: food restriction, spitting, use of laxatives and diuretics, rubber suits, steam baths, and saunas.

- Ensure that fluids are easily accessible to all athletes. Young athletes often forget their water bottle and coaches and parents should be encouraged to ensure that there is fluid provided each practice and game.
- Encourage athletes to begin a practice session or competition well hydrated and drink electrolyte-containing fluids throughout the training session. Athletes can be instructed to observe the color of their urine and continue drinking fluids until urine is light yellow to clear in color.
- Emphasize that after exercise young athletes should focus on correcting fluid losses accumulated during the event. Young athletes may become more aware of their personal sweat rate lots of fluids by monitoring hydration status by weighing before and after exercise sessions. Additionally, young athletes should be encouraged to achieve a euhydration status within two hours after activity and via use of carbohydrate and electrolyte containing beverages.

Behavior and lifestyle

Female Youth Athletes

Female youth athletes face unique challenges compared to male athletes. The sociocultural pressures toward being thin may be compounded by similar influences related to their sport, resulting in more prevalent disordered eating behaviors and body-shaping drug use (tobacco, diet pills, diuretics, laxatives, amphetamines, and anabolic steroids) (Elliot, 2004). Research indicates that as girls move into adolescence, their average intake of vitamins and minerals per kcal decreases while their requirements increase, making it increasingly difficult for them to meet their nutrient needs (Beals, 2002). A deficit in caloric and nutritional needs can lead to lowered body weight, loss of muscle mass, decreased energy, eating disorders, amenorrhea and psychological and physiological complications. ATHENA (Athletes Targeting Healthy Exercise and Nutrition Alternatives) examined the nutritional status, eating behaviors and menstrual function in 23 nationally ranked female adolescent volleyball players. ATHENA's overall objective is to reduce the young female athletes disordered eating habits and to deter use of body-shaping substances. Survey results prior to and within 2 weeks of the sports seasons' conclusion indicated that following the intervention, the experimental participants reported less recent (last 3 months) diet pill use. The prevalence of creatine use was low, limiting the ability to demonstrate effects on use, and tobacco use decreased in both experimental and control student athletes during their sport seasons (Elliot, 2004).

One more consideration for coaches, parents and sports dietitians to be on the lookout for are symptoms of the "Female Athlete Triad" including the interrelated

components of disordered eating, amenorrhea, and osteoporosis (Otis, 1997). Adolescents and women participating in sports that stress weight management or aesthetic goals are at greatest risk of developing the Female Athlete Triad. These disorders can lead to decreased physical performance and cause morbidity and mortality.

Social Environment and Support

Social support is defined as having a network of people that support your endeavors, contribute positively to your decision-making processes, and are there for you when you need help. Researchers have suggested that people with this kind of network around them can transcend even the worst environments and accomplish great things. Unfortunately, people who don't have this type of network have a harder time accomplishing even modest goals. Young athletes are particularly susceptible to giving into peer pressure involving activities as simple skipping practice because it's "not cool" or as serious as partaking in recreational drugs. One study found that elite adolescent athletes experience competitive stressors because of the size and importance of competitions, and organizational stressors (e.g., housing, lining up for food, and transportation) exacerbated by the weather conditions (hot, cold, rain) (Kristiansen, 2009). Parental support of the child's athletic goals, practice times, materials needed and even nutritional support is paramount to an athlete's success in their drive, motivation and determination to excel at a sport.

Youth Obesity

Obesity in the United States has officially been labeled as an epidemic. In 2012, more than one third of children and adolescents were overweight or obese, with 18% of children ages 6-11 and 21% of youth ages 12-19 being obese (Ogden, 2014). This is the one race we're winning as a country and shouldn't be proud (see Figure 5).

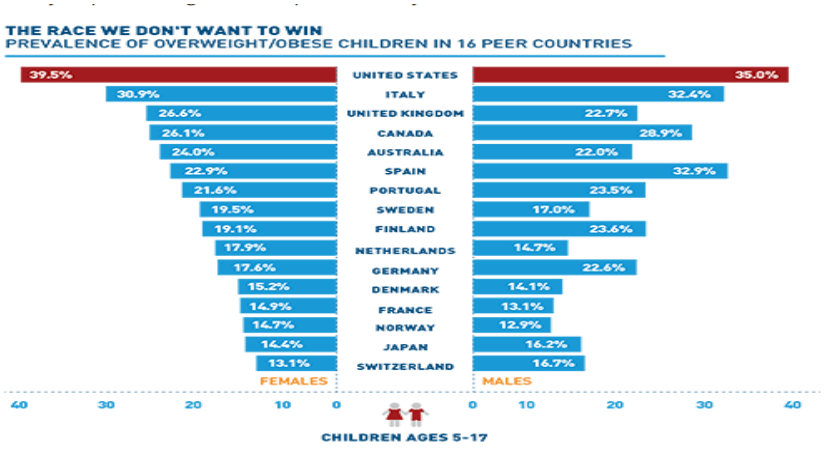


Figure 5. Prevalence of Overweight/Obese Children in 16 Peer Countries.

Source:http://www.aspeninstitute.org/about/blog/7-charts-that-show-the-state-of-youth-sports-in-the-us-and-why-it-matters

This epidemic is most likely due to a hypercaloric diet coupled with a multitude of factors including, but not limited to, reduced physical activity in everyday tasks as well as reduced leisure-time exercise (Leyk, 2006). Obese children and adolescents are at risk for health problems including these early on-set risk factors: cardiovascular disease (such as high blood pressure, high cholesterol), type 2 diabetes, and metabolic syndrome (Freedman, 2007). Obesity as a child or youth oftentimes leads to a higher likelihood of being an obese adult. Excessive weight may have effects on the athlete's performance. These may include:

- Decrease in postural stability and balance control.

- Higher incidence of injuries, possibly due to these athletes' overall reduced physical activity.
- Reduced speed, endurance, agility, work efficiency and poor acclimation to heat.

Not all overweight or obese athletes need to lose weight, some may naturally come to a healthier BMI as their height increases. Athletes who would benefit from weight loss should be counseled on the proper speed of weight loss and appropriate amount of weight to lose for their height and build. The loss should be gradual and monitored for total body weight lost and body composition. The information in Table 3, which is based on the 2007 Expert Committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity, can be helpful in determining whether a young athlete requires weight maintenance or weight loss (Barlow, 2007). The Evidence Analysis Library of the Academy of Nutrition and Dietetics recommends that the weight-management program involve a nutrition prescription translated into a specific eating plan. In order to determine a nutrition prescription plan, the sports dietitian must consider multiple components including: the young athlete's age, growth parameters, body composition, potential need for weight loss, and physical activity. Table 4 provides equations to assist in determining energy needs for overweight youth ages 3 to 18 years. Once the athlete's energy needs are determined, the sports dietitian and athlete can work together to create a manageable eating plan.

Age, y	BMI Status	Recommended Treatment
2-5	BMI = 85th - 94th percentile	Weight maintenance until BMI is < 85th percentile or slowing of weight gain is indicated by a downward deflection in the BMI curve.
	BMI > 95th percentile	Weight maintenance until BMI is < 85th percentile; however, if weight loss occurs with a healthy adequate diet, then it should not exceed 1 lb/mo.[a]
	BMI > 21 or 22	Gradual weight loss, not to exceed 1 lb/mo.[a]
6-11	BMI = 85th - 94th percentile	Weight maintenance until BMI is < 85th percentile or slowing of weight gain is indicated by a downward deflection in the BMI curve.
	BMI = 95th - 98th percentile	Weight maintenance until BMI is < 85th percentile; however, if weight loss occurs with a healthy adequate diet, then it should not exceed 1 lb/mo.[a]
	BMI > 99th percentile	Weight loss not to exceed an average of 2 lb/wk. [a]
12-18	BMI = 85th - 94th percentile	Weight maintenance until BMI is < 85th percentile or slowing of weight gain is indicated by a downward deflection in the BMI curve.
	BMI = 95th - 98th percentile	Weight maintenance until BMI is < 85th percentile; however, if weight loss occurs with a healthy adequate diet, then it should not exceed 2 lb/wk.[a]
	BMI > 99th percentile	Weight loss not to exceed an average of 2 lb/wk.[a]

Table 3. Recommendations From the Expert Committee Regarding the Prevention, Assessment, and Treatment of Child and Adolescent Overweight and Obesity

Source: Barlow, 2007.

According to the *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty acids, Cholesterol, Protein, and Amino Acids (Macronutrients)*, Total Energy Expenditure (TEE) in overweight youth (ages 3 - 18 years) in a weight maintenance situation should be calculated using the following equations:

Overweight Boys Ages 3 - 18 years

TEE = 114 - (50.9 x Age [y] + PA x (19.5 x Weight [kg] + 1161.4 X Height [m])

Where PA is the physical activity coefficient:

- PA = 1.00 if physical activity level (PAL) is estimated to be >1.0 < 1.4 (sedentary)
- PA = 1.12 if PAL is estimated to be >1.4 < 1.6 (low active)
- PA = 1.24 if PAL is estimated to be >1.6 < 1.9 (active)
- PA = 1.45 if PAL is estimated to be >1.9 < 2.5 (very active)

Overweight Girls Ages 3 - 18 years

TEE = 389 - (41.2 x Age [y] + PA x (15.0 x Weight [kg] + 701.6 X Height [m])

Where PA is the physical activity coefficient:

- PA = 1.00 if PAL is estimated to be >1.0 < 1.4 (sedentary)
- PA = 1.12 if PAL is estimated to be >1.4 < 1.6 (low active)
- PA = 1.24 if PAL is estimated to be >1.6 < 1.9 (active)
- PA = 1.45 if PAL is estimated to be >1.9 < 2.5 (very active)

Table 4. Determining Energy Needs in Overweight Children and Adolescents.

Source: American Dietetic Association Evidence Analysis Library. Determining Energy Needs in Overweight Children and Adolescents. http://www.adaevidencelibrary.com/topic.cfm?cat=3060. Accessed June 5, 2010.

Discussion

As children and adolescents become increasingly tasked with long practice hours and demand to perform better and faster, the research and development of youth sports

nutrition is critical to positively affecting their overall health, growth and recovery. Ultimately, we want to achieve the interlocking goals of good health, improved performance and optimal body composition. This can be achieved by, but not limited to, controlling energy balance, improving nutrient density and using honest and outcome-based evaluations.

It is suggested that the future direction of youth sports nutrition incorporate a closer look into the application of science-backed research to the psychology of children and adolescent athletes. This may involve developing a curriculum that includes a broad scope of overall health and nutrition practices, resetting behaviors and setting easy to remember goals.

Appendix A

Comprehensive Client Information Sheet

Name: _____ Date: _____

Instructions:
This is your comprehensive client information sheet, in which we will ask you to provide some relevant personal information. The answers to these questions are essential in order to allow us to design an optimized individual fitness program for you. Please answer all questions in the most accurate manner possible while being as concise as possible. Feel free to consult your parents on any questions that you may not know the answer.

Part 1: Basic Information

Name (First, Last): _____ Parent Name:_____

Gender: _____ *Age*: _____ *Date of Birth* (*month/day/year*): _____

Height (*feet, inches*): _____

Weight: *(the client will be weighed during the onboarding process - boys in lbs, girls in kg)*

Part 2: Goals

Given the following goals, please rank them in order of importance, with 1 being most important and 8 being least important:

Improved health	Improved endurance	Increased strength	Increased muscle mass
Increased power	Sport-specific*	Weight management	

Please provide the sport or athletic event for which you are training:

_____

Do you have a specific timeline for achieving a specific goal? If so, please specify:

_____

On the following chart, fill in your approximate workout duration for each day (in minutes):

Day	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*	*Saturday*	*Sunday*
Duration							

Please fill out the following timetable with your most normal daily schedule listing the times you wake up, go to school, train, have breaks, eat and go to sleep.

Are you in tournament season? If so, please explain how often and how long tournaments are.

_____

_____

Part 3: Medical and Health Information

If you have any diagnosed health problems, list the conditions(s).

If you are on any prescription or over-the-counter medications, please list them.

If you have any injuries, please list them.

If you are using any nutritional supplements, please list them.

This includes: protein powders, powdered vitamins or drink mixes with BCAA's, multivitamins, vitamins, minerals, creatine, anything in pill form that was not prescribed by a doctor.

Do you ever feel pressured to eat less or be skinnier?

Are you experiencing any stresses, mood problems, relationship difficulties, or substance-related problems for which you would like resource or referral information for your and your parent on a confidential basis?

Has anyone offered you something that may help you lose weight quickly?

Do you have any food allergies or intolerances?

_____

Are there any other foods that you are particularly sensitive or prefer not to eat?

_____

Are you vegetarian or vegan? If so, how long?

_____

What are you preferred and/or favorite foods?

_____

Please provide a three-day dietary record. Include all food and drinks, including quantity, size, etc. Be specific as possible.

Day	***Meal 1***	***Meal 2***	***Meal 3***	***Meal 4***
Sunday				
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				

Saturday				

Part 4: Baseline Assessment

Please rate your personal well-being in the following areas (1 being least and 10 being most):

Appetite 1 2 3 4 5 6 7 8 9 10

Sleep Quality 1 2 3 4 5 6 7 8 9 10

Tiredness 1 2 3 4 5 6 7 8 9 10

Willingness to train 1 2 3 4 5 6 7 8 9 10

Resting Heart Rate at Wakeup (bpm): _____

Weight (lb/kg): _____

Measurements:

Boys *(recorded in inches)*:

Neck: _____ Shoulders: _____ Chest: _____ Arm: _____

Abdomen (belly button): _____ Thigh: _____ Calf: _____

Girls *(recorded in inches)*:

Chest: _____ Arm: _____ Waist: _____

Abdomen (belly button): _____ Thigh: _____ Calf: _____

Body Composition (lean muscle mass, fat mass): (measured via BIA (bioelectrical impedence analysis)

Part 5: Learning Style *(Optional)*

Source: http://www.scholastic.com/parents/resources/article/parent-child/quiz-whats-your-childs-learning-style

1. You let your child pick out one toy at the dollar store. Which is he most likely to choose?

a) Paint-by-number set

b) Play microphone

c) Hula hoop or football

2. If your child could only pick one after-school activity, which would he choose?

a) Art lessons

b) Music lessons

c) Sports or drama lessons

3. You're out to dinner and there's a 10-minute wait. How does your child occupy himself?

a) Doodling

b) Talking your ear off

c) Digging in your purse while bouncing in place

4. When your child picks the family activity, which is he most likely to choose?

a) A movie

b) A concert

c) Mini golf

5. When your child reads a book to himself, he:

a) Sits quietly, immersed in its contents

b) Mouths the words aloud or asks you to read it to him

c) Fidgets frequently

6. Which of these iPad activities is your child most drawn to?

a) Looking at photos

b) Listening to music

c) Playing Angry Birds or another video game

Mostly A's: Learns by looking

Your kid responds best when new material is in lists, charts, graphs, and diagrams. A little color goes a long way: He can write spelling words or state capitals in different colors so they're easier to memorize. Abstract math homework goes faster when you give your visual kid objects to help him think through the problem. (If I had 12 M&M's and Mom ate 7, how many are left?)

Mostly B's: Learns by listening

If your child is one of the 10 percent of kids who are auditory learners, she does well with verbal instructions and shines in discussions. She'll learn faster if she has a voice recorder: Saying things aloud can help her retain info, and re-playing the recording boosts comprehension even more. If she turns a book's dialogue into a puppet show, she'll remember the story.

Mostly C's: Learns by doing

Like the majority of children, your kid absorbs info best when she's physically engaged on some level. Many kinesthetic learners have trouble sitting still for long stretches. So turn homework into a sporting event: Let her shoot a foam basketball into a laundry basket every time she answers a question correctly or give her a squishy ball to squeeze and manipulate.

Part 6: Support Questionnaire *(Optional)*

---

1. Do the people with whom you spend each day follow healthy lifestyle habits such as exercising regularly and watching what they eat?
    a) Yes, most of them do.
    b) About half do and half don't.
    c) No, most them don't.

2. Do your parents follow healthy lifestyle habits such as exercising regularly and watching what they eat?
    a) Yes, most of the time.
    b) About half the time they do, half the time they don't.
    c) No, most of the time they do not.

3. When you want to perform some physical activity such as going for a workout or playing a sport, is it easy to find a partner to do it with you?
    a) Yes, it's easy to find a partner.
    b) Yes, but very infrequently.
    c) No, they never do.

4. When you go out to eat with family or friends, do they usually order healthy selections?
    a) Yes, they often do.
    b) Only about half the time.
    c) No, they never do.

5. At home, is it easy to find healthy snacks and meals?
    a) Yes, always.
    b) Sometimes.
    c) No, never.

6. Do you ever feel pressure from family or friends to eat unhealthy food or drinks that you would prefer not to?

a) Yes, they always do.
b) Only about half the time.
c) No, they never do.

7. Do you ever feel pressure from friends and family or yourself to take part in activities that may not be good for your health?

a) Yes, very frequently.
b) Sometimes I feel pressured.
c) No, I never do.

8. Do you ever feel pressure from friends and family or yourself to lose weight or are told not to eat in order to lose weight?

a) Yes, very frequently.
b) Sometimes I feel pressured.
c) No, I never do.

9. Are you a part of any sports teams, clubs or groups that meet at least twice per week and do some physical exercise?

a) Yes, I've been a member for years.
b) Yes, I've just started.
c) No, I don't.

10. If you talk about your nutrition and exercise goals with friends, do they seem interested in getting on board, or do they think you're crazy?

a) They're very interested.
b) They're not interested.
c) They think I'm crazy.

11. If you have a scheduled activity, like sports practice or a game, are you easily able to find transportation?

a) Always
b) Sometimes
c) Never

10. Do those around you bring nutrition and exercise information to your attention so that you can stay informed about these topics?

a) Always
b) Sometimes

c) Never

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