



Published in final edited form as:

Semin Pediatr Surg. 2009 August ; 18(3): 152–158. doi:10.1053/j.sempedsurg.2009.04.005.

Diet, Exercise, Behavior: The Promise and Limits of Lifestyle Change

Brian Bennett, MPH [Research Associate] and

School of Public Health, Louisiana State University Health Sciences Center, New Orleans, LA 70112

Melinda S. Sothern, PhD, CEP [Professor and Director]

Section of Health Promotion, School of Public Health, Louisiana State University Health Sciences Center, New Orleans, LA 70112

Abstract

The prevalent surge in childhood and adolescent obesity within the past 3 decades poses a significant challenge for many pediatric clinicians who are charged with treating this condition. The need for comprehensive, research-based pediatric obesity treatment programs are essential in addressing this problem and preventing the transition of obesity and its many co-morbidities into adulthood. This paper will identify dietary, physical activity, and behavioral approaches to lifestyle change and describe how they are incorporated as part of multidisciplinary treatment interventions in youth. Specific tailoring of treatment programs to address age and varying degrees of overweight and obesity will also be presented along with recommendations for future research.

Keywords

Children; Obesity; Treatment; exercise; behavior; lifestyle change

Obesity is one of the foremost public health concerns and is quickly becoming an epidemic as evidenced by rapidly increasing prevalence rates (1,2). Although rates of obesity are increasing across all age groups, the rise in childhood and adolescent obesity is particularly alarming. Within the past 30 years the prevalence of obesity in youth ($\geq 95^{\text{th}}$ body mass index [BMI] percentile for age and sex specific growth charts) has more than doubled among children (5–12.4% in children 2–5 years and 6.5–17% in children 6–11 years) (3,4). Furthermore, obesity prevalence in adolescents (ages 12–19 years) has more than tripled within the same time period from 5% in 1980 to 17.6% in 2006. Despite recent research that suggests a leveling off of overweight and obesity trends among children and adolescents (4), the proportion of the pediatric and adolescent populations currently classified as obese is still very large. In addition, the prevalence of severe obesity ($> 99^{\text{th}}$ BMI percentile) in youth continues to rise and at even faster rates than obesity (5). Consequently, this places many children and adolescents at risk for developing numerous adverse health conditions that will likely carry over into adulthood. Cardiovascular, gastrointestinal, pulmonary, and orthopedic complications, as well as, insulin resistance are all associated with increased adiposity especially if the condition is severe (2,

© 2009 Elsevier Inc. All rights reserved.

Correspondence: Brian Bennett, 1615 Poydras Street, Suite 1400, New Orleans, LA 70112, Phone: (504) 568-6005, Fax: (504) 568-5701, Email: bbenn1@lsuhsc.edu.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

6). In addition to the numerous physiological disorders, research indicates obese youth are also at increased risk for developing psychological complications such as depression and low self-esteem (7,8). These have the potential to adversely affect a child's adherence or motivation to adopt healthier behaviors. Thus, impairments to the psychological well-being of the participant may ultimately affect his or her ability to successfully participate and complete weight management programs (6).

This review will examine treatment interventions targeting dietary counseling, physical activity patterns, and behavior modification strategies in order to highlight both the promises and limitations of lifestyle change in the management of pediatric obesity.

Measuring and Evaluating Pediatric Obesity

Body mass index is the most commonly used clinical method of assessing obesity in youth and monitoring weight status throughout maturation. Age- and sex-specific BMI growth charts are suggested for diagnosing and tracking obesity in the clinician's office and should be utilized during all well-child visits (2). Weight status classifications and definitions based on BMI percentiles are presented in table 1. When using BMI as a method of evaluation, measures are usually expressed as BMI values (kg/m^2), centiles, or Z scores (9). Recent changes are proposed in classifying normal weight, overweight, and obese patients, which address the diverse levels and magnitude to which obesity exists among children and adolescents. In 2007 an expert committee offered the following two recommendations for assessing weight status in youth: substitute "overweight" in place of "at risk for overweight" for those falling in the 85th – 94th percentiles and the addition of a fourth classification - severely obese - encompassing patients with recorded BMI values greater than the 99th percentile for age and sex (10). Weight, BMI, and fat mass are all key outcome measures that most pediatric obesity treatment interventions aim to positively affect. However, many other measures are often targeted for improvement. These include secondary outcomes measures (e.g. cholesterol, blood pressure, psychological well-being) that reflect the many co-morbidities of obesity (11). Measures examining the maintenance of behaviors following an intervention are also occasionally evaluated to determine short- and long-term adherence and the likelihood of the subject maintaining any positive outcomes associated with the intervention (12). Once the child is diagnosed with obesity, the next step is to locate and enroll the patient into an appropriate treatment program. A family-centered design incorporating dietary, physical activity, and behavioral components used in conjunction with medical monitoring by the child's pediatrician represents an evidence-based solution for addressing the growing problem of pediatric obesity. (6,12–14)

Dietary Counseling and Nutrition Education Interventions

A position paper recently published by the American Dietetic Association (15) cites three sources used in developing dietary recommendations and guidelines for children: (a) The Institute of Medicine's Food and Nutrition Board publication of dietary reference intakes (DRI's); (b) The U.S. Department of Health and Human Services Dietary Guidelines for Americans 2005; (c) The U.S. Department of Agriculture's My Pyramid for Kids. Also, other areas from the 2005 Guidelines were highlighted in this report: encouraging consumption of certain food groups and limiting fat and sodium intake in children (15). Whole-grain products, fruits, and vegetables should be consumed often along with 2–3 cups of fat-free or low-fat milk per day. Fat intake for children 4–18 years should be limited to 25–35% of total caloric intake and consumption of unsaturated fats (e.g. fish, poultry, and nuts) should be encouraged. Daily sodium intake should be limited to 1.2 g/day for children 4–8 years and 1.5 g/day for older children. Parents largely determine the availability of healthy and unhealthy foods in the home and the frequency of meals consumed from fast food restaurants (15). Therefore, parental

influence and the family environment both play important roles in shaping children's eating habits (15,16). For this reason, the cooperation and presence of a parent(s) is critical when attempting to manipulate a child's diet and/or eating patterns.

The increased consumption of sugar-sweetened beverages over the past 20 years parallels the rapid increases in observed rates of child and adolescent obesity (17). The consumption of calories in liquid form, particularly soft drinks, should be limited and discouraged especially when attempting weight reduction (18). In a study by Ludwig and colleagues (2001), consumption of sugar-sweetened beverages was compared with measures of obesity in school-aged children (19). Results indicated that for every additional serving consumed both BMI and the frequency of obesity increased among subjects.

Adequate amounts of fiber in the diet should be encouraged when counseling children and families that are attempting to reduce weight. Estimated daily intake of fiber in children can be determined using the "age + 5" rule where 5 is added to the child's age to obtain an estimate in grams for recommended daily allowance (6,20). Aside from the many benefits that fiber has on the digestive system, glucose levels, and LDL cholesterol, its ability to promote satiety makes it a useful tool in limiting food intake and preventing overeating (6). Promoting increased fruit and vegetable consumption will automatically increase fiber intake (6). However, it is recommended that other sources of fiber, such as whole grains (e.g. whole-wheat breads, cereals, brown rice), are also incorporated into the child's diet.

Children falling in the healthy weight category should abide by a well-balanced diet and adhere to age- and sex-appropriate dietary reference intakes (15). Overweight and obese children are advised to adopt dietary strategies to assist with weight reduction (6). These are largely regulated by parents in the home environment and include limiting portion sizes, frequency and type of snacking, restrict eating in front of the television or computer, and providing nutrient dense rather than calorically dense foods (18). Children and adolescents diagnosed with severe obesity often times require the addition of a structured diet to regulate the amounts of calories, carbohydrates, or fats consumed (6).

Dietary investigations examining the alteration of macronutrient intakes intend to determine the optimal composition of carbohydrates, fat, and protein for weight loss. A study of obese adolescents looked at satiety responses produced by low and high glycemic index (GI) foods (21). Data revealed that low GI foods resulted in prolonged satiety as well as lower glucose and insulin concentrations following meals. Ebbeling et al. (2003) compared a low-GI diet with an energy-restricted, reduced fat diet in obese adolescents aged 13–21 years (22). Following a 6 month intervention and 6 month follow-up period, subjects in the low-GI group displayed a significant decrease in fat mass (−3.0 vs. 1.8 kg; $p = .01$) and BMI (−1.3 vs. 0.7 kg; $p = .02$) when compared with the reduced-fat diet subjects. An investigation by Sondike and colleagues (2003) examined low-carbohydrate versus low-fat diets under experimental conditions in adolescents (23). Results were similar to a comparable study conducted in adults (24) in that the low-carbohydrate diet resulted in larger weight loss than the low-fat diet; however, only Sondike's investigation indicated significantly lower LDL-cholesterol ($p = 0.006$) in the low-fat group (25). While the use of alternative diets in youth to treat severe obesity are promising, caution should be exercised when prescribing such treatment due to the limited amount of research and the lack of long-term examination of their effects. Prescribing altered macronutrient diets to obese children should only be considered once other therapies are shown to be ineffective or in the case of severe conditions of obesity with significant comorbidities.

Exercise and Physical Activity Interventions

All school-age youth should participate daily in at least 60 cumulative minutes of moderate to vigorous physical activity that is developmentally appropriate, enjoyable, and includes a variety of activities (26). Within each week, at least 3 days should include activities of vigorous-intensity (27). In addition, recent recommendations add bone- and muscle-strengthening activities for inclusion into each day's 60 minutes of activity (27). In determining whether or not activity requirements are satisfied, clinicians must first assess or estimate their patient's physical activity patterns. Measuring the amount and frequency of physical activity patterns in youth is challenging, especially children, as most methods of estimating habitual physical activity involve questionnaires or surveys which are subjective and susceptible to recall bias (28). Additionally, parents are often times relied on to provide estimates of their child's physical activity and sedentary (e.g. television viewing) behaviors. The use of pedometers or accelerometers should be considered for measuring physical activity in youth as they are recognized for both their ease of use and objectivity (28).

Obesity in children is associated with low levels of physical fitness and reduced speed and agility (6). Thus, obese children are often unable to perform certain physical activities as well and to the extent of their normal weight peers. As a result of their excess weight, obese children may have a greater metabolic cost or energy expenditure for executing the same physical activity than does a normal-weight child (6). The higher metabolic costs expended may explain why obese children may not perform as well as normal weight children during aerobic tasks. Research examining maximal oxygen consumption (VO_2 max) in obese and non-obese children indicated a significant difference in exercise tolerance (29). When children's VO_2 max values were compared, healthy weight children (50th– 85th percentile BMI) exhibited values more than twice those of their severely obese counterparts when expressed relative to body weight.

For sedentary youth, especially those that are overweight or obese, completing an hour or more of moderate to vigorous physical activity can be challenging. For that reason an incremental approach is suggested in order to gradually increase time engaged in physical activity until the recommendation of at least 60 minutes can be achieved (26). Using this approach, progression is accomplished by increasing time spent engaged in physical activity by 10% each week.

Aside from using progression to accomplish daily physical activity requirements, recommendations also suggest that activities be fun, varied, and developmentally appropriate. Developmentally appropriate activities are those that are suitable for the physical and cognitive development of the child or adolescent. Examples of each grouping of developmentally appropriate activities are listed below (10):

1. Preschool years: General movement activities (e.g. jumping, throwing, running, climbing)
2. Pre-pubertal (6–9 years): More specialized and complex movements, anaerobic activities (e.g. tag, recreational sports)
3. Puberty (10–14 years): Organized sports, skill development
4. Adolescence (15–18 years): More structured health and fitness activities, refinement of skill

In addition to being developmentally appropriate, activities should also be specific to the physical abilities of children in each weight category to ensure safety and reduce risk of injury. Overweight children (85th – 94th BMI percentile) should engage in weight bearing activities such as brisk walking, field sports, tennis, and martial arts. However, as research indicates that overweight children may have difficulty maintaining extended periods of vigorous activity,

spacing skills should be introduced to ensure that adequate amounts of physical activity can be performed (ref. handbook chapter). Obese children (>95th BMI percentile) are recommended to alternate between participation in weight-bearing activities and non-weight bearing activities such as swimming, cycling, and seated or lying circuit training (6). Children with severe levels of obesity should begin with only non-weight bearing exercise and after 12–15 weeks be re-evaluated to determine exercise ability.

A meta-analysis examined 30 childhood obesity treatment studies that included an exercise intervention (6). Significant improvements in body composition were associated with programs including high-repetition strength training in conjunction with moderate intensity aerobic exercise. Thus, the combination of high-repetition resistance training, moderate aerobic exercise, and behavioral modification may be most efficacious for reducing body fat variables in overweight children. Another review conducted by Strong and colleagues (2005) indicated that programs incorporating 30–60 minutes of moderate exercise 3 to 7 days per week resulted in decreased total body and visceral adiposity among obese children and adolescents (10). However, similar reductions were not reported in normal weight children and adolescents. The authors suggest that in order for similar effects to be seen in normal weight children that exercise of a higher duration and intensity might be necessary to decrease adiposity.

Habitual physical activity has the potential to improve many facets of physical and psychological health (30). Some of the benefits of long-term exercise training previously reported include improvements in lipid profiles, increases in fat free mass and reductions in fat mass, improved oxidative capacity, increased resting metabolism, increased fat oxidation, and improvements in insulin sensitivity (30–33). In addition to the many physiological benefits, routine physical activity is shown in observational studies to positively influence academic and intellectual performance, concentration, and memory (10).

Efforts aimed at increasing physical activity should coincide with attempts to decrease sedentary behavior. The American Academy of Pediatrics recommends a maximum of 2 hours of television viewing daily (34). Limiting television viewing in children is associated with decreases in BMI (35). Recent research has examined the effectiveness of converting traditional sedentary screen time into active screen time through the use of interactive gaming. The use of such devices (i.e. Nintendo Wii, Dance Dance Revolution) over traditional, sedentary screen time produced significantly higher energy expenditure values in children (36).

Behavioral Counseling and Modification Interventions

Behavior modification strategies are utilized in facilitating behavior change (6). Prior to the employment of other strategies, the first interview or meeting typically involves evaluating the participant's motivation or readiness to change problem behaviors using the stages of change model. This model involves gauging the participant's and sometimes parent's readiness to change and categorizes them into one of five distinct categories: precontemplation (no intention to change), contemplation (considering to make the change but not yet committed), preparation (intention to change), action (modifying behavior), and maintenance (maintaining the behavior change). A recent review of behavioral treatment techniques suggests that parents not only need to be involved in their child's treatment program but initiation of the program should not occur until the parent(s) are ready and accepting of proposed lifestyle changes (9).

Goal setting, self-monitoring, cue elimination and stimulus control, modeling, and problem solving and relapse prevention are all commonly used strategies employed in behavior modification interventions. Goal setting involves the selection of modifiable behaviors that are to be targeted by interventions and selecting specific short- and long-term benchmarks by which progress will be evaluated (6). The term mastery experiences entails establishing

realistic, achievable, and short-term goals. These are critical in promoting the participant's self-efficacy and facilitate the accomplishment of long-term goals. The strategy of self-monitoring requires the participant to record routine observations involving eating and activity patterns. By maintaining regular accounts of their behaviors, participants are able to recognize past precursors and emotions associated with lapses in desired behaviors. While self-monitoring enables participants to identify personal barriers to behavior change and increasing self-awareness, stimulus control and cue elimination targets maladaptive environmental influences (e.g. places, stressors) and reduces the participant's exposure to these influences or the degree to which they negatively affect behavior change. Parents play a critical role in behavior modification but are particularly important when implementing the modeling strategy. In this strategy parents serve as role models to their child (i.e. participant) by exhibiting positive behaviors that are targeted in the intervention. For example, if the child is expected to increase fruit and vegetable consumption then the parent would be expected to buy, prepare, and eat these foods along with their child. In other words, this strategy encourages parents to model the behaviors that they wish their child to adopt. Finally, problem solving and relapse prevention center on the idea that barriers to achieving behavior modification goals should be identified and subsequently plans are then formulated to overcome and prevent these barriers from re-occurring in the future.

Motivational interviewing is a technique that aims to increase intrinsic motivation while promoting resolve toward a desired behavior (37). According to VanWormer and Boucher, there are four fundamental principles of motivational interviewing: (a) expressing empathy toward the patient/participant; (b) developing discrepancies by which both the negative and positive aspects of the behavior are highlighted thereby increasing motivation to change; (c) the clinician should "roll with resistance" expressed by the patients in order to prevent the perception of an imposing feeling from the clinician; (d) foster self-efficacy within the participant. Although traditionally used in treating substance abuse, motivational interviewing has begun to be used as a method for treating many other behaviors including those associated with obesity (6,37). Several studies have indicated promising results using motivational interviewing to increase fruit and vegetable consumption and reduce dietary fat intake (38, 39); however, most available data employing this technique involves data from adult samples.

Summary

Obesity treatment recommendations for each weight group are described in table 2. Tertiary prevention of pediatric obesity should include dietary, physical activity, and behavioral components as part of a multidisciplinary intervention. Additionally, parents are also a critical part of treatment interventions involving youth, especially younger children under the age of 12, because of their influence on the home environment (10).

Challenges and future research

There are many challenges to providing weight management interventions to the increasing number of overweight and obese youth, including financial and time limitations. That said, there are also many well-designed studies that document successful weight loss, improvement of chronic disease factors, and long-term weight maintenance in overweight children. Cost-effective, targeted family-based dietary and physical activity interventions are available. Physician-supervised individual and group programs that use quality, clinically proven, and scientifically tested approaches should be encouraged for the treatment of pediatric obesity. Many common barriers to providing such treatment can be addressed through education, careful planning, and the application of sound implementation strategies.

Non-Hispanic black and Hispanic youth generally exhibit higher rates of obesity than their non-Hispanic white counterparts (40,41). Future research should include adequate

investigations that examine the effectiveness of obesity treatment interventions across different racial minority groups. Additionally, investigations should also examine culturally- and ethnically-sensitive approaches to addressing obesity treatment in children and adolescents (42). The conspicuous increases in obesity prevalence rates are appearing in children of younger and younger ages. Future research should examine behavioral, dietary, and physical activity treatment interventions in pre-school age children (≤ 5 years).

One of the more challenging aspects of prescribing evidence-based obesity treatment programs for youth is due to the fact that there are still some areas of research that are lacking data from pediatric populations. There is a need to translate several types of research studies that have for the most part examined adults and apply these in children and adolescents. As mentioned earlier, data documenting the results of motivational interviewing predominately involve adult samples. Research is needed to examine this model in studies aimed at increasing physical activity/reducing sedentariness and improving dietary behavior in youth as both of these behaviors are linked to the obesity epidemic.

A recent comprehensive investigation of alternative diets in adults examined the effectiveness of altering macronutrient composition (24). Shai and colleagues (2008) conducted a randomized controlled trial of moderately obese adults examining the benefits of three diets: low-fat, restricted calorie; Mediterranean, restricted-calorie; and low-carbohydrate, non-restricted calorie(24). Following the two year trial, the subjects' mean weight losses for each of the three diets were 2.9kg (low-fat), 4.4kg (Mediterranean), and 4.7kg (low-carbohydrate). Aside from producing the largest weight losses, the low-carbohydrate diet also significantly ($p=0.01$) reduced the ratio of total cholesterol to HDL-cholesterol when compared to the low-fat group. Diabetic subjects following the Mediterranean and low-fat diets reported more favorable fasting glucose and insulin levels ($p<0.001$) from those following the Mediterranean diet. Although this study was conducted in adults, the results offer potential insight into the relative advantages of each diet. Aspects of this investigation's design and implementation that should be replicated in forthcoming pediatric studies are the relatively high retention rate of subjects (85%) and a longer follow-up period (2 years) than most previous comparable studies.

In order to formulate more definitive, evidence-based statements on the subject of child and adolescent obesity treatment, proposed strategies should first be thoroughly and adequately evaluated under experimental conditions in large, age-appropriate cohorts examined under extensive follow-ups periods.

Acknowledgments

Acknowledgment of grant support when appropriate

NICHD # 1 R01 HD41071-01A2 and 1 R01 HD49046-01

Supported in part by the Tulane University and Louisiana State University Health Sciences Center's Clinical and Translational Research Center as part of the Louisiana Board of Regents RC/EEP Fund

This work was partially supported by a CNRU Center Grant # 1P30 DK072476 entitled "Nutritional Programming: Environmental and Molecular Interactions" sponsored by NIDDK

References

1. Barlow SE, Committee E. Expert Committee Recommendations Regarding the Prevention, Assessment, and Treatment of Child and Adolescent Overweight and Obesity: Summary Report. *Pediatrics* 2007;120:164–192.
2. Mitka M. Experts weigh pros and cons of screening and treatment for childhood obesity. *JAMA* 2008;300:1401–1402. [PubMed: 18812525]

3. Ogden CL, Flegal KM, Carroll MD, Johnson CL. Prevalence and trends in overweight among US children and adolescents, 1999–2000. *JAMA* 2002;288:1728–1732. [PubMed: 12365956]
4. Ogden CL, Carrol M, Flegal KM. High body mass index for age among US children and adolescents, 2003–2006. *JAMA* 2008;299:2401–2405. [PubMed: 18505949]
5. Ogden CL, Yanovski SZ, Carroll MD, Flegal KM. The epidemiology of obesity. *Gastroenterology* 2007;132:2087–2102. [PubMed: 17498505]
6. Sothern, MSGS.; von Almen, TK. *Handbook of Pediatric Obesity: Clinical Management*. Boca Raton: Taylor & Francis; 2006.
7. Fonseca H, Matos MG, Guerra A, Pedro JG. Are overweight and obese adolescents different from their peers? *Int J Pediatr Obes* 2008;1–9.
8. Eremis S, Cetin N, Tamar M, Bukusoglu N, Akdeniz F, Goksen D. Is obesity a risk factor for psychopathology among adolescents? *Pediatr Int* 2004;46:296–301. [PubMed: 15151546]
9. Stewart L, Reilly JJ, Hughes AR. Evidence-Based Behavioral Treatment of Obesity in Children and Adolescents. *Child Adolesc Psychiatric Clin N Am* 2008;18:189–198.
10. Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics* 2007;120:S164–S192. [PubMed: 18055651]
11. Active healthy living: prevention of childhood obesity through increased physical activity. *Pediatrics* 2006;117:1834–1842. [PubMed: 16651347]
12. Ritchie LD. Position of the American Dietetic Association: Individual-, Family-, School-, and Community-Based Interventions for Pediatric Overweight. *Journal of the American Dietetic Association* 2006;106:925–945. [PubMed: 16812927]
13. Savoye M, Shaw M, Dziura J, et al. Effects of a weight management program on body composition and metabolic parameters in overweight children: a randomized controlled trial. *JAMA* 2007;297:2697–2704. [PubMed: 17595270]
14. Sothern, Udall JN Jr, Suskind RM, Vargas A, Blecker U. Weight loss and growth velocity in obese children after very low calorie diet, exercise, and behavior modification. *Acta Paediatr* 2000;89:1036–1043. [PubMed: 11071081]
15. Nicklas T, Hayes D. Position of the American Deitetic Association: Nutrition Guidance for Health Children Ages 2 to 11 Years. *Journal of the American Dietetic Association* 2008;108:1038–1047. [PubMed: 18564454]
16. Tanofsky-Kraff M, Haynos AF, Kotler LA, Yanovski SZ, Yanovski JA. Laboratory-Based Studies of Eating among Children and Adolescents. *Current nutrition and food science* 2007;3:55–74. [PubMed: 19030122]
17. Sherry B. Food behaviors and other strategies to prevent and treat pediatric overweight. *International journal of obesity (2005)* 2005;29:S116–S126. [PubMed: 16385763]
18. Sothern, M.; Von Almen, TK.; Schumacher, H. *Trim Kids: The Proven Plan that has Helped Thousands of Children Achieve a Healthier Weight*. New York, NY: Harper Collins Publishers; 2001.
19. Ludwig DS, Peterson KE, Gortmaker SL. Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet* 2001;357:505–508. [PubMed: 11229668]
20. Spear BA, Barlow SE, Ervin C, et al. Recommendations for treatment of child and adolescent overweight and obesity. *Pediatrics* 2007;120:S254–S288. [PubMed: 18055654]
21. Ball SD, Keller KR, Moyer-Mileur LJ, Ding YW, Donaldson D, Jackson WD. Prolongation of satiety after low versus moderately high glycemic index meals in obese adolescents. *Pediatrics* 2003;111:488–494. [PubMed: 12612226]
22. Ebbeling CB, Leidig MM, Sinclair KB, Hangen JP, Ludwig DS. A reduced-glycemic load diet in the treatment of adolescent obesity. *Arch Pediatr Adolesc Med* 2003;157:773–779. [PubMed: 12912783]
23. Sondike SB, Copperman N, Jacobson MS. Effects of a low-carbohydrate diet on weight loss and cardiovascular risk factor in overweight adolescents. *J Pediatr* 2003;142:253–258. [PubMed: 12640371]
24. Shai I, Schwarzfuchs D, Henkin Y, et al. Weight loss with a low-carbohydrate, Mediterranean, or low-fat diet. *N Engl J Med* 2008;359:229–241. [PubMed: 18635428]

25. Stewart L, Houghton J, Hughes AR, Pearson D, Reilly JJ. Dietetic management of pediatric overweight: development and description of a practical and evidence-based behavioral approach. *Journal of the American Dietetic Association* 2005;105:1810–1815. [PubMed: 16256768]
26. Strong WB, Malina RM, Blimkie CJ, et al. Evidence based physical activity for school-age youth. *J Pediatr* 2005;146:732–737. [PubMed: 15973308]
27. U.S. Department of Health and Human Services. Physical Activity Guidelines for Americans. 2008. <http://www.health.gov/paguidelines/>
28. Council on Sports Medicine and Fitness and Council on School Health. Active Healthy Living; Prevention of Childhood Obesity Through Increased Physical Activity. *Pediatrics* 2006;117:1834–1842. [PubMed: 16651347]
29. Sothorn MS. Exercise as a modality in the treatment of childhood obesity. *Pediatric clinics of North America* 2001;48:995–1015. [PubMed: 11494648]
30. Sothorn MS, Loftin M, Suskind RM, Udall JN, Blecker U. The health benefits of physical activity in children and adolescents: implications for chronic disease prevention. *European journal of pediatrics* 1999;158:271–274. [PubMed: 10206121]
31. Nassis GP, Papantakou K, Skenderi K, et al. Aerobic exercise training improves insulin sensitivity without changes in body weight, body fat, adiponectin, and inflammatory markers in overweight and obese girls. *Metabolism* 2005;54:1472–1479. [PubMed: 16253636]
32. Dao HH, Frelut ML, Oberlin F, Peres G, Bourgeois P, Navarro J. Effects of a multidisciplinary weight loss intervention on body composition in obese adolescents. *Int J Obes Relat Metab Disord* 2004;28:290–299. [PubMed: 14970838]
33. Dao HH, Frelut ML, Peres G, Bourgeois P, Navarro J. Effects of a multidisciplinary weight loss intervention on anaerobic and aerobic aptitudes in severely obese adolescents. *Int J Obes Relat Metab Disord* 2004;28:870–878. [PubMed: 15170464]
34. American Academy of Pediatrics: Children, adolescents, and television. *Pediatrics* 2001;107:423–426. [PubMed: 11158483]
35. Robinson TN. Reducing children's television viewing to prevent obesity: a randomized controlled trial. *JAMA* 1999;282:1561–1567. [PubMed: 10546696]
36. Lanningham-Foster L, Jensen TB, Foster RC, et al. Energy expenditure of sedentary screen time compared with active screen time for children. *Pediatrics* 2006;118:e1831–e1835. [PubMed: 17142504]
37. VanWormer JJ, Boucher JL. Motivational interviewing and diet modification: a review of the evidence. *Diabetes Educ* 2004;30:404–406. [PubMed: 15208841]8–10, 14–6 passim.
38. Resnicow K, Jackson A, Wang T, et al. A motivational interviewing intervention to increase fruit and vegetable intake through Black churches: results of the Eat for Life trial. *Am J Public Health* 2001;91:1686–1693. [PubMed: 11574336]
39. Bowen D, Ehret C, Pedersen M, et al. Results of an adjunct dietary intervention program in the Women's Health Initiative. *Journal of the American Dietetic Association* 2002;102:1631–1637. [PubMed: 12449286]
40. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999–2004. *JAMA* 2006;295:1549–1555. [PubMed: 16595758]
41. Cali AM, Caprio S. Obesity in children and adolescents. *J Clin Endocrinol Metab* 2008;93:S31–S36. [PubMed: 18987268]
42. Crawford PB, Story M, Wang MC, Ritchie LD, Sabry ZI. Ethnic issues in the epidemiology of childhood obesity. *Pediatric clinics of North America* 2001;48:855–878. [PubMed: 11494640]

Table 1
Weight Status Classifications and Definitions for Youth

Weight Status Classification	Definition
Healthy weight	5 th –84 th percentile BMI
Overweight	85 th –94 th percentile BMI
Obese	≥95 th percentile BMI or BMI ≥ 30 kg/m ² ; whichever is lower
Severely obese	> 99 th percentile BMI

Adapted from Barlow, 2007 (10)

Table 2

Lifestyle recommendations by Weight Classification to Treat Obesity in Youth (ages 7–18 years)

Weight Classification	Level of Behavioral Treatment	Diet	Physical Activity*
Healthy weight	Receive support in maintaining or establishing healthy lifestyle (prevention) behaviors	Family nutrition education and parent training emphasizing appropriate food portions, reduced sugar and saturated fat, increased fruits and vegetables, and recommended dairy and fiber intake	limit screen time; recommended physical activity requirements: 60 minutes of daily moderate to vigorous physical activity (3 days/week of vigorous activity) and bone and muscle strengthening activities
Overweight	Some children should receive prevention counseling (if no evidence of health risk), whereas others (evidence of health risk) should receive more-active interventions	Family nutrition education and parent training in combination with portion control methods or balanced calorie meal plans emphasizing appropriate food portions, reduced sugar and saturated fat, increased fruits and vegetables, and recommended dairy and fiber intake	limit screen time; incremental approach to increase physical activity volume; weight bearing aerobic activities (e.g. field sports, tennis, jump rope); pacing skills; parent training; fitness education
Obese	Most children considered obese should be advised to focus on weight control practices	Family nutrition education and parent training in combination with balanced hypocaloric diets emphasizing appropriate food portions, reduced sugar and saturated fat, increased fruits and vegetables, recommended dairy and fiber intake, and Low GI Diet	limit screen time; incremental approach to increase physical activity volume; alternate between weight-bearing and non-weight-bearing activities (e.g. swimming, cycling, seated or lying circuit training); parent training; fitness education
Severely obese	Other emotional and dietary concerns must be addressed	Family nutrition education and parent training in combination with altered macronutrient dietary approaches as follows: Low GI Diet, Atkins Diet, protein modified fast diet followed by balanced hypocaloric diet	limit screen time; incremental approach to increase physical activity volume; non-weight-bearing activities (e.g. swimming, cycling, seated or lying circuit training); parent training; fitness education;

Adapted from Barlow, 2007 (10); Sothorn, 2006 (6)

* Note: Guidelines should be readjusted every 10–15 weeks based on evaluation results