Position of the Academy of Nutrition and Dietetics: Interventions for the Prevention and Treatment of Pediatric Overweight and Obesity

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ABSTRACT

It is the position of the Academy of Nutrition and Dietetics that prevention and treatment of pediatric overweight and obesity require systems-level approaches that include the skills of registered dietitians, as well as consistent and integrated messages and environmental support across all sectors of society to achieve sustained dietary and physical-activity behavior change. This position paper provides guidance and recommendations for levels of intervention targeting overweight and obesity prevention and treatment from preschool age through adolescence. Methods included a review of the literature from 2009 to April 2012, including the Academy's 2009 evidence analysis school-based reviews. Multicomponent interventions show the greatest impact for primary prevention; thus, early childhood and school-based interventions should integrate behavioral and environmental approaches that focus on dietary intake and physical activity using a systems-level approach targeting the multilevel structure of the socioecological model as well as interactions and relationships between levels. Secondary prevention and tertiary prevention/treatment should emphasize sustained family-based, developmentally appropriate approaches that include nutrition education, dietary counseling, parenting skills, behavioral strategies, and physical-activity promotion. For obese youth with concomitant serious comorbidities, structured dietary approaches and pharmacologic agents should be considered, and weight-loss surgery can be considered for severely obese adolescents. Policy and environmental interventions are recommended as feasible and sustainable ways to support healthful lifestyles for children and families. The Academy supports commitment of resources for interventions, policies, and research that promote healthful eating and physical-activity behaviors to ensure that all youth have the opportunity to achieve and maintain a weight that is optimal for health.
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POSITION STATEMENT

It is the position of the Academy of Nutrition and Dietetics that prevention and treatment of pediatric overweight and obesity require systems-level approaches that include the skills of registered dietitians, as well as consistent and integrated messages and environmental support across all sectors of society, to achieve sustained dietary and physical-activity behavior change.

PEDIATRIC OVERWEIGHT AND obesity are a significant public health problem in the United States. Between 1976-1980 and 2009-2010, there was over a twofold increase in obesity prevalence for children ages 2 to 5 years (5% to 12.1%) and a threefold increase for children ages 6 to 11 years (6.5% to 18%) and adolescents ages 12 to 19 (5% to 18.4%).[1] There has also been a concomitant rise of health complications associated with excess body fat in youth, including hyperlipidemia, hypertension, abnormal glucose tolerance, and reduced quality of life.[2-4] Psychological distresses, such as weight stigma and bullying, have been reported.[5] Furthermore, childhood obesity is likely to persist into adulthood.[6]

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SCOPE OF PAPER

This position paper expands on the 2006 position paper[7] by including the following:

1. an overview of the problem;
2. a summary of six evidence-based reviews conducted through 2009 on obesity prevention and related behaviors through school-based interventions;
3. an updated review of additional primary, secondary, and tertiary childhood obesity prevention and treatment literature from 2006 through April 2012 not included in the school-based reviews; and
4. recommendations.

Material in this position paper complements information presented in the following related position papers: Comprehensive School Nutrition Services,[8] Local Support for Nutrition Integrity in Schools,[9] Benchmarks for Nutrition in Child Care,[10] Child and Adolescent Nutrition Assistance Programs,[11] Nutrition Guidance for Healthy Children Aged 2 to 11 Years,[12] and Weight Management for Adults.[13]

Additional primary, secondary, and tertiary intervention studies that were reviewed were classified based on the setting (eg, child care, school, clinic), as well as the predominant age of the sampled population: preschool age (2 to

This Academy of Nutrition and Dietetics position paper includes the authors' independent review of the literature in addition to systematic review conducted using the Academy's Evidence Analysis Process and information from the Academy Evidence Analysis Library (EAL). Topics from the EAL are clearly delineated. The use of an evidence-based approach provides important added benefits to earlier review methods. The major advantage of the approach is the more rigorous standardization of review criteria, which minimizes the likelihood of reviewer bias and increases the ease with which disparate articles may be compared. For a detailed description of the methods used in the evidence analysis process, go to www.andevidencelibrary.com/eaprocess.

Conclusion Statements are assigned a grade by an expert work group based on the systematic analysis and evaluation of the supporting research evidence. Grade I = Good; Grade II = Fair; Grade III = Limited; Grade IV = Expert Opinion Only; and Grade V = Not Assignable (because there is no evidence to support or refute the conclusion).

See grade definitions at www.andevidencelibrary.com

5 years old), school age (6 to 11 years old), and adolescents (12 to 18 years old). Studies of infants and toddlers under 2 years of age were not included and are to some extent included in the position paper on breastfeeding.[14]

NEED FOR PEDIATRIC OBESITY PREVENTION AND TREATMENT

Healthy People 2010 goals identified reducing the proportion of overweight and obesity in children and adolescents as a key health indicator, however, this was not achieved.[15] No significant change in obesity prevalence by age group was observed between 1999-2000 and 2009-2010.[1] Although a "leveling off" of obesity in youth is preferable to continual increases, the prevalence rates are still alarmingly high. In addition, certain race and ethnic groups are disproportionately affected. In 2009-2010, Hispanic and non-Hispanic black children and adolescents, ages 2 to 19 years, were significantly more likely to be obese than non-Hispanic white children.[1] The current Healthy People 2020 objectives[15] are to decrease the proportion of children and adolescents considered obese by 10% by 2020, which would reduce obesity rates for children ages 2 to 5 years from 10.7% to 9.6%; ages 6 to 11 years from 17.4% to 15.7%; and ages 12 to 19 years from 17.9% to 16.1%.

Researchers have begun to examine the cost effectiveness of clinical screening and intervention in children and adolescents. Methods and outcomes vary across studies, and results are mixed. Brief clinic-based interventions appear not to be cost effective,[16] while two large multicomponent school-based interventions—Coordinated Approach to Child Health (CATCH) and Planet Health—were cost effective when estimating the levels of adult obesity prevented.[17,18]

Using a systems-level approach, macro-level environmental factors, such as societal and cultural norms, influences of the food and beverage industry, food marketing practices and regulations, and governmental zoning and other policies, as well as the interactions among these factors, all potentially contribute to the prevalence of childhood obesity[19,20]; a discussion of their contributions and roles in prevention is beyond the scope of this position paper. Readers can refer to a recent review of economic policies that contribute to childhood obesity in the United States and the impact of altering them to reverse this trend,[21] as well as to relevant position papers and other publications from the Academy of Nutrition and Dietetics.[8-13]

Measures of Adiposity in Children

Body Mass Index. Body mass index (BMI) is a relatively easy, low-cost, and noninvasive measure to obtain in community, school, and clinical settings, and is increasingly used in studies to evaluate the effectiveness of interventions and for surveillance. For US children, weight status is determined using BMI age and sex norm-referenced values derived from previous national surveys. Using the Centers for Disease Control and Prevention growth charts, obesity is defined as a BMI $\geq$95th percentile and overweight is BMI $\geq$85th and $<$95th percentile.[22] This weight classification conveys the association between excess adiposity and serious health risks, such as type 2 diabetes, obstructive sleep apnea, asthma, nonalcoholic fatty liver disease, hypertension, and lipid abnormalities,[3,4] while providing continuity with adult BMI criteria.[22] For children and adolescents with more severe obesity, an additional category (BMI $>$99th percentile) was established[22] to highlight further elevated risks of developing cardiovascular and metabolic diseases[23] and the urgency for intervening. However, the current Centers for Disease Control and Prevention growth charts only extend to the 97th percentile,[24] which limits the utility of this tool to accurately classify and track clinical changes in weight status for severely obese youth ($>$99th percentile).[22] In response, a new electronic growth chart was developed that graphically represents a child's BMI as a "percentage of the 95th percentile."[25] Currently, this new tool is undergoing further evaluation of its clinical application.

BMI *z* score, an alternative to BMI percentile, is now widely used in research and clinical studies in youth. BMI *z* score is defined as the BMI of the child or adolescent transformed into the number of standard deviations (SDs) above or below the population mean BMI for age and sex.[26] BMI *z* scores, like BMI percentiles, allow comparison of weight change across different ages and sex, but are more sensitive to quantifying changes in weight status.[27] As a frame of reference, weight status criteria using BMI *z* scores are overweight $\geq$1.04 SD, obesity $\geq$1.64 SD, and severe obesity: $\geq$2.33 SD. A decrease in BMI *z* score of at least 0.6 SD (over 6 to 12 months) or 0.5 SD decrease (over 0 to 6 months) can be associated with a clinically relevant reduction in percent body fat.[27]

Recommendations from the Institute of Medicine (IOM) have called for BMI screening or surveillance in school settings.[28] Surveillance studies in which the distribution of weight status is measured are helpful in determining population-based trends in child overweight and obesity.[1] However, BMI screening has recently been regarded less favorably,[29] probably because schools and communities have limited resources for families with children who are obese or severely obese, and current insurance or Medicaid reimbursement for child obesity is difficult without the presence of comorbidities.

Waist Circumference. There is evidence that obtaining waist circumference as an indicator of abdominal adiposity offers additional information about metabolic and cardiovascular disease risk. A waist circumference $>$90th percentile for age and sex using

the 1988-1994 National Health and Nutrition Examination Survey[30] has been associated with increased risk of diabetes and other cardiovascular disease.[31] However, the most recent waist circumference percentiles for youth based on the 1999-2008 National Health and Nutrition Examination Survey[32] reflect the secular trend of pediatric obesity, with the 90th percentiles having larger waist circumferences over time. In addition, during the collection of these National Health and Nutrition Examination Surveys data, the protocol for the waist circumference measurement was revised; therefore, additional research is needed before a clinically useful cutoff for cardiometabolic disease risk can be established for waist circumference percentiles among youth.

Overview of Current Significant Child-Obesity Initiatives and Programs

Child obesity has garnered the attention of numerous national organizations, initiatives, and funders. For example, since 2007, the Robert Wood Johnson Foundation (www.rwjf.org), the largest foundation in the United States to focus on health promotion, has committed $500 million to reverse child obesity by the year 2015. In 2010 alone, the Robert Wood Johnson Foundation funded over 700 grants to improve access by children and their families—with an emphasis on underserved populations—to affordable healthy foods and to increase opportunities for physical activity.

Since 2010, First Lady Michelle Obama has devoted considerable attention to ending child obesity in the United States within a generation. The multicomponent Let's Move campaign (www.letsmove.gov) advocates for improvements in children's nutrition and physical activity across multiple sectors. The campaign promotes adoption of existing programs, such as the US Department of Agriculture's Healthier US School Challenge, which provides incentive awards to schools that create healthier environments and the US Department of Agriculture's MyPlate based on the 2010 Dietary Guidelines for Americans. It also includes new initiatives, such as President Obama's Task Force on Childhood Obesity, to develop and implement a coordinated interagency action plan, and the Partnership for a Healthier America, to mobilize leadership across multiple sectors, including industry.

Provisions for addressing pediatric overweight and obesity can be found in the Affordable Care Act of 2010.[33] For example, one provision requires labeling of menus for calorie content information at point of purchase in restaurants and other food retail establishments, as well as vending machines.

The IOM has produced a report series focusing on childhood obesity prevention and treatment, beginning with Preventing Childhood Obesity: Health in the Balance.[28] Recently, the IOM released an updated report addressing the problem of obesity in the United States, Accelerating Progress in Obesity Prevention.[19] Recommendations from this report include:

1. make physical activity an integral and routine part of life;
2. create food and beverage environments that ensure healthy food and beverage options are the routine, easy choice;
3. market healthy messages about physical activity and nutrition;
4. expand the role of health care providers, insurers, and employers in obesity prevention; and
5. make schools a national focal point for obesity prevention.[19]

In 2009, the Academy's House of Delegates proposed the formation of a Childhood Obesity Prevention Coalition to determine an action plan for child obesity prevention for the organization. This coalition created four emphasis areas: policy, resources, publicity, and collaborations. The Academy of Nutrition and Dietetics Foundation has created resources and positive messages through its Kids Eat Right initiative, which are available to Academy members and the public via a public site and are consistent with the proposed Coalition Action Plan. In addition, the Academy provides guidelines for practice through the Evidence Analysis Library, which includes the Pediatric Weight Management Evidence-Based Nutrition Practice Guidelines.[34]

REVIEW OF EVIDENCE

The focus of this position paper is to provide guidance and recommendations for interventions targeting overweight or obesity prevention or treatment based on the available evidence. The core of this review is the 2009 evidence-based analysis conducted by the Academy on review articles examining the effectiveness of school-based interventions for nutrition education, for physical activity, and multilevel interventions, including both nutrition and physical activity on both adiposity and behavioral outcomes (Figure 1). Primary, secondary, and tertiary prevention studies in other age groups and other settings that measured adiposity as an outcome and were published since these reviews were also examined and incorporated into this paper.

As in the previous position paper,[7] prevention and treatment for pediatric obesity and overweight were operationalized using a combined public health and treatment approach.[35] This paradigm can be seen as a continuum that ranges from low-intensity, population-level prevention approaches to high-intensity medical treatment (Figure 2).

Primary prevention includes interventions that emphasize healthful diet, physical activity, and other health-related behaviors. These interventions are offered to the entire population in community, school, or health care settings, and do not focus on specific body size or weight.

Secondary prevention refers to more structured interventions and strategies designed to help overweight and obese youth achieve a healthier weight.

Tertiary prevention interventions provide the most intensive and comprehensive treatments for overweight and obese youth. These programs are conducted under medical supervision and focus on resolving or decreasing the severity of weight-related comorbidities.

Studies that did not include an assessment of adiposity (by BMI or another method) as an outcome measure were not included in the updated review. Although a randomized controlled intervention is the most rigorous design for inferring causation, quasi-experimental studies (eg, using pre- and post-intervention comparisons without a control group and/or without random group assignment) were included. Observational or epidemiological

1. **In school-based programs, what is the effectiveness of nutrition education as a part of an intervention to treat childhood overweight?** Conclusion statement: There is insufficient evidence to draw conclusions about the effectiveness of school-based nutrition-education interventions alone to address adiposity in children. Grade III[a]
2. **In school-based programs, what is the effectiveness of altering physical-activity patterns as a part of an intervention to treat childhood overweight?** Conclusion statement: The use of school-based physical-activity interventions alone is unlikely to bring about improvement in measures of adiposity in school-aged children. Grade I
3. **In school-based programs, what is the effectiveness of combined nutrition-education and physical-activity interventions to address childhood overweight?** Conclusion statement: School-based interventions that combined both a physical-activity and a nutrition-education component were diverse, combining different types of interventions for different lengths of time. Multicomponent school-based interventions that include at least physical-activity and nutrition-education interventions may be effective in improving adiposity measures, although results appear to be heavily dependent on a wide range of intervention design factors, population, and context. Grade II
4. **Among systematic reviews that reported on anthropometric outcomes and also reported on behavioral outcomes of school-based interventions, what is the effectiveness of school-based nutrition-education programs for bringing about improvements in behaviors related to childhood overweight and obesity?** Conclusion statement: There is insufficient evidence to draw conclusions about the effectiveness of school-based nutrition-education interventions alone to address behaviors related to overweight and obesity in children. Grade III
5. **Among systematic reviews that reported on anthropometric outcomes and also reported on behavioral outcomes of school-based interventions, what is the effectiveness of school-based physical activity programs for bringing about improvements in behaviors related to childhood overweight and obesity?** Conclusion statement: Among systematic reviews that reported on anthropometric outcomes and also reported on behavioral outcomes, school-based physical-activity programs alone may be successful in increasing time spent in physical activity and reducing screen time. Grade I
6. **Among systematic reviews that reported on anthropometric outcomes and also reported on behavioral outcomes of school-based interventions, what is the effectiveness of school-based programs that include physical-activity and nutrition-education components for bringing about improvements in behaviors related to childhood overweight and obesity?** Conclusion statement: Few systematic reviews that reported on anthropometric outcomes also reported on behavioral outcomes of school-based interventions that combined nutrition education and physical activity. However, among those that did, studies demonstrated improvement on at least one behavior associated with childhood overweight, such as increased physical activity, increased fruit and vegetable intake, decrease in sedentary behaviors, and so on. Grade II
[a]The Academy classifies evidence as Grades, with Grades I, II, III, IV, and V indicating strong, fair, weak, expert opinion, and no evidence, respectively.

Figure 1. Summary of results from the Academy of Nutrition and Dietetics' 2009 evidence-based review of the evidence for school-based primary prevention interventions for the prevention of child overweight and obesity.

studies that involved an adiposity measure but not a specified intervention were not included. Intervention studies focusing on populations with specific clinical conditions (eg, Prader-Willi syndrome, Down syndrome, use of certain medications) that can increase obesity risk in children were also excluded.

	Population	Strategies	Correspondence to staged approach for treatment of pediatric obesity[22]	Example
Primary prevention	Population-wide interventions that include youth of all body sizes or weight	Eating and physical-activity messages or programs intended to prevent incidence of overweight/obesity and/or provide a supportive environment for weight maintenance	NA[a]	School-based health promotion programs for healthy eating and physical activity
Secondary prevention	Overweight or obese youth with no weight-related comorbidities	More structured and involved eating and physical-activity programs intended to help overweight and obese youth obtain a healthy weight; may require medical approval or limited supervision	Stage 1: Prevention Plus Stage 2: Structured Weight Management Stage 3: Comprehensive Multidisciplinary Intervention	Brief motivational interviewing on selected behaviors (eg, decreased consumption of sugar-sweetened beverages), with progression to other stages if warranted
Tertiary prevention	Overweight or obese youth with comorbidities Severely obese youth	Intensive and comprehensive treatments for overweight and obese youth conducted under medical supervision with a focus on resolving weight-related comorbidities or at least decreasing their severity	Stage 1: Prevention Plus Stage 2: Structured Weight Management Stage 3: Comprehensive Multidisciplinary Intervention Stage 4: Tertiary Care Intervention	Multidisciplinary program offered at a pediatric weight-management center, which may include pharmacologic treatment or bariatric surgery

[a]NA=not applicable.

Figure 2. Definitions of primary, secondary, and tertiary pediatric obesity prevention as compared with the staged approach for treatment of pediatric obesity.

Primary Prevention

Preschool-Aged Child-Care and Community-Based Interventions. Preschool age has been identified as a critical period for obesity prevention efforts as young children may be more amenable to changing behaviors than older children.[36] However, preschool-aged children and child-care settings have received comparatively little attention.[37] Most primary prevention interventions targeting preschool-aged children have been home-based or delivered in child-care settings (eg, child-care center or preschool),[37] and have focused on improving nutrition and/or physical-activity behaviors. Hesketh and Campbell[38,39] conducted two comprehensive reviews of studies on obesity prevention in infants to 5-year-olds. Of the six studies in these reviews, only two achieved a significant impact on a measure of adiposity, and both were conducted in preschools.[38,39] In a more recent 2-year large-scale group, randomized controlled trial in France, preschools were assigned to one of two interventions: (1) a program in which parents were provided information on overweight and health, periodic monitoring of weight and height was conducted, and follow-up by a physician was conducted when indicated; or (2) a program in which information was enhanced with a preschool education curriculum to promote healthy eating, physical activity, and reduction of screen time.[40] In multivariate analyses, both interventions were effective in reducing BMI *z* score relative to the control group, but only in preschools in low-income communities. Given that some studies have found risk of overweight to be higher among low-income populations, prevention interventions in young children might offer more benefit to those at highest risk of overweight.

In the studies reviewed by Hesketh and Campbell,[38,39] education on improving diet, increasing physical activity, and/or reducing sedentary behaviors were provided to children. Two thirds of the studies examined were successful in modifying some aspect of diet or activity behavior. However, none included changes to the child-care environment, although expert consensus is mounting that environmental and policy change is critical to obesity prevention.[20] A more recent quasi-experimental study

1. **Integrate education with supportive environmental change.** In school and child-care settings, the most successful interventions at achieving behavior change coupled educational messages with institutional change, so that children are taught about healthy eating and physical activity while provided healthy foods and more opportunities for physical activity.
2. **Include both nutrition education and physical education.** The most successful interventions were those that included both nutrition and physical activity as integral parts of the intervention. Targeting obesity prevention through physical activity alone does not seem to be as effective without incorporating nutrition education. Younger children appear to learn best when exposed to behaviorally based or hands-on (rather than didactic) activities including ample opportunities for tasting, touching, and working with food. Providers, caregivers, and parents should be reminded that repeated exposure is typically required to promote acceptance of new foods by children.
3. **Build in parent engagement for younger children.** Interventions that aimed to involve parents were generally more successful than those that did not, especially among preschool and elementary school-age children. Efforts to include parents are most effective when the parent not only receives information that reflects what the child is learning, but is also given guidance and at-home activities to aid in the progression of healthier lifestyle changes for the child at home.
4. **Promote community engagement in schools and child care.** School− and child-care−based interventions show better results when coupled with community efforts that reinforce healthy eating and activity, as well as consistent messaging, both in and out of school and child care.
5. **Policies that limit food availability show promise.** Policies that limit food availability, especially in schools, seem to be associated with lower body mass index.
6. **Dose and continuity is important.** Children are inundated with messages promoting consumption of high-energy foods, so it is important to intensify and sustain the dose of nutrition education. More intensive interventions show better results. Although including health education in curricula is important, more innovative and "out of the box" messaging and other strategies should be explored, such as role model stories or novels, social media, and incorporation of health outcomes and consequences into all facets of society.

Figure 3. Summary of recommendations from the review of child obesity primary prevention literature.

(pre−post comparison without a control group) in Chile focused on reducing the energy content (by 10%) of breakfast, lunch, and afternoon snacks served to low-income children in 538 nursery schools (n=67,841 children) during a staggered 3-year period.[41] The prevalence of obesity decreased significantly in children at preschools that adopted the dietary changes for the longest period of time (3 years), while no change was observed when the intervention was implemented for less time (1 to 2 years). This finding suggests that relatively lengthy time periods can be required to observe changes in obesity prevention in young children and that environmental approaches can be a critical intervention component (Figure 3).

The most comprehensive intervention in the early childhood education setting was the Romp & Chomp quasi-experimental study conducted in Australia involving approximately 12,000 children.[42] This community-wide, 4-year effort included training and education coupled with environmental changes at child-care centers and preschools targeting staff, parents, and children, as well as community capacity building and media campaigns. Nutrition objectives included decreasing sugar-sweetened beverages, promoting water and milk, decreasing energy-dense snacks, and promoting fruits and vegetables. Activity objectives included increasing active play in child care and home and decreasing television viewing at home. Post-intervention findings included a significantly lower prevalence of overweight and obesity by 2.5 and 3.4 percentage points in the 2- and 3.5-year-old subsamples, respectively.

Differences in intervention objectives, setting, population, and study design and methods complicate interpretation of findings. It should be noted, however, that most studies to date have lacked a parent component, likely essential for young children. Although more interventions have targeted obesity of young children within child-care settings than at home, changes implemented in child care might not carry over into the home. Also, studies with obesity outcomes were relatively short in duration, ranging from 14 weeks to 12 months. Given that rates of overweight are generally lower in younger compared with older children, a longer intervention period might be required to observe a significant impact on weight status in younger children.

School- and Community-Based Nutrition-Education Interventions. Three recent reviews examined for the Academy's 2009 evidence analysis on school-based interventions to prevent child overweight[43-45] included a total of three nutrition-education−only interventions (Figure 1). These studies were generally limited in sample size and scope (eg, focused solely on reduction in carbonated beverages or adding school breakfast). Only the Norwegian ASK pilot study (n=54 adolescents) reported significant differences in BMI between the school breakfast intervention class (which received nutrition education and a healthy school breakfast) and the control class (which received nutrition education only).[46] The evidence analysis conclusion is that there is insufficient evidence to determine the

effectiveness of school-based nutrition-education interventions alone to address overweight and obesity in children (Grade III; see Figure 1 for grade definitions). In contrast, there was only one review with a study that addressed the effects of school-based nutrition education on diet-related behaviors related to overweight and obesity in children[45]; thus, there is also insufficient evidence for this statement (Grade III; Figure 1).

There have been only two studies published since these reviews that examined the impact of a diet-only intervention on body composition among children or adolescents. Fulkerson and colleagues[47] conducted a community-based pilot study designed to increase the quality of foods in the home and at family meals, and Muckelbauer and colleagues led a randomized, controlled environmental and educational intervention to promote water consumption.[48] Muckelbauer and colleagues reported a decreased incidence (3.8% vs 6% in control group) of obesity at the end of the school-year-length intervention.[48] However, neither intervention reported long-term effectiveness.

There is a growing movement to include gardens in nutrition-education programs. A comprehensive review suggests that garden-based nutrition-education programs, which have been evaluated in school, afterschool, and larger community settings, are promising for increasing children's fruit and vegetable preferences and intakes.[49] In a recent meta-analysis, Langelloto and Gupta found that garden-based programs had a stronger impact on vegetable consumption among school-aged children than more traditional nutrition education, hypothesizing that gardening increased children's access to vegetables and reduced their reluctance to try new foods.[50] However, most studies to date have not included a measure of adiposity as an outcome; changes in fruit and vegetable intake alone might not be sufficient to induce weight change.

School- and Community-Based Physical-Activity Interventions. Analysis of results from three of four recent reviews[43,45,51,52] of school-based primary prevention interventions indicated that school-based physical-activity interventions may be successful in increasing the time children spend being physically active and reducing screen time (Grade I) (Figure 1). Although limited because of diversity in study design, types of physical-activity interventions, intervention duration, and school demographic characteristics, the evidence does suggest that school-based physical-activity interventions alone are insufficient to bring about improvement in measures of adiposity in school-aged children (Grade I). Consistent with these reviews, in a meta-analysis[52] involving 15 studies inclusive of approximately 18,000 school-aged children, the difference in change in BMI was not statistically significant between children who received school-based physical-activity interventions and those who did not. These reviews included a combined total of 51 studies, approximately half of which focused on elementary school years and the remainder focused on secondary schools. Studies were varied and included physical education and the promotion of reduced time spent in sedentary pursuits, self-monitoring, family involvement, classroom health or nutrition education, and changes to the school environment.

Since these reviews, studies of both school-based[53-59] and afterschool-based[60-63] interventions involving primarily a physical-activity component have had similarly mixed findings. Of interest, Beets and colleagues, in a review of 11 studies of afterschool programs, found evidence of a small improvement in body composition, suggesting that augmenting the physical activity that children get in school can provide a benefit in terms of obesity prevention.[64]

Participation in extracurricular sports, whether part of a school program or affiliated with another organization serving youth, has also been examined with respect to child obesity. Nelson and colleagues,[65] in a systematic review of 19 studies, did not find a consistent association between body weight and sport participation. Furthermore, although sport participation was related to higher levels of physical activity, it was also related to increased energy intake. However, most studies to date have been cross-sectional observational studies rather than longitudinal or intervention studies. Additional research is also needed to examine impact by type of sport. Those such as football, for example, may favor a larger body size compared with others, such as gymnastics. Furthermore, different sports may be related to different levels of energy expenditure (eg, shot put vs running). The authors also recommended future evaluations using different measures of body composition because most previous studies relied solely on BMI, which cannot differentiate increased weight due to muscle from increased weight due to adipose tissue.

Active means of getting to school (eg, walking and biking) as compared with passive means (eg, riding in a car or bus) has also been examined in relation to child obesity. Active commuting to school has decreased over the time period that childhood obesity rates have risen; nearly half of kindergarten through grade 8 students walked or biked in 1969 compared with <13% in 2009.[66] Active commuting has also been associated with an increase in children's level of physical activity.[67] However, a recent systematic review of 18 studies (16 cross-sectional, 2 prospective in design) on mode of transport to school in relation to a measure of body composition found inconsistent results: no significant association (n=9); inverse association in a subgroup or for limited measures (n=5); consistent inverse association (n=3); and positive association (n=1).[68] In a recent study of >9,000 7th- and 9th-grade students in low-income communities in California, active commuting was associated with greater fitness (as measured by mile run time), but also greater BMI *z* scores and a greater likelihood of purchasing food while in transit.[69] A student's environment (eg, access to the purchase of unhealthy foods) while walking or biking to schools may be one factor explaining disparate findings on active commuting and weight. More intervention studies are needed before active transport to school can be recommended as a means for preventing child obesity.

Limiting sedentary activities can have an impact distinct from promoting physical activity. Most cross-sectional and longitudinal studies that examined television viewing have found a positive association with overweight or obesity, while epidemiological studies, albeit fewer in number, have failed to find an association between video

game or computer use and obesity risk.[70] Intervention studies aimed at reducing screen time provide much less compelling evidence. A meta-analysis of six studies (three of which were conducted in school[71,72] or preschool settings[73]) did not demonstrate evidence of any impact of child obesity for interventions aimed at limiting screen time.[74] It should be noted, however, that the meta-analysis also did not find an intervention effect on reducing screen time, suggesting that it can be a challenge to reduce screen time in children. Therefore, based on existing intervention evidence, it is not clear whether a measurable decrease in screen time can impact child BMI.

In conclusion, more intensive physical-activity interventions may be required to observe impacts over short periods of time. Many in-school–based interventions lasted for less than a single school year and after-school–based programs tended to have an even shorter duration and, per usual practice, targeted only a portion of the total school population. Trials aimed at younger school-aged children tended to have a greater likelihood of an impact on adiposity than trials targeting older children. For example, 44% (15 of 34 total) of interventions focusing on children (ages 5 to 11 years) included in the review articles and supplemental studies had a significant adiposity impact vs 25% (4 of 16 total) for studies focusing on adolescents (ages 12 to 18 years). At present, however, interventions that target physical activity alone cannot be recommended.

School- and Community-Based Multicomponent (Nutrition and Physical-Activity) Interventions. Analysis of five systematic reviews,[43-45,52,75] one of which was also a meta-analysis,[52] focused on 50 unique school-based interventions to address childhood overweight that included both nutrition and physical-activity interventions. The evidence analysis review concluded that these interventions may be successful in improving adiposity measures in children, although the effects seem to be variable and depend on factors such as population, design, and context (Grade II). In addition, results from one review[45] concluded that school-based multicomponent interventions were effective in changing behaviors related to overweight and obesity, such as television watching, fruit and vegetable consumption, and physical activity (Grade II, Figure 1).

A recent Cochrane review of interventions to prevent obesity in children[76] reviewed 55 studies and showed a wide range of heterogeneity in study design, age of child, and intervention elements, with most studies conducted in children aged 6 to 11 years. In a meta-analysis of 37 of these studies, the standardized mean reduction in adiposity across all studies was −0.15, with the strongest overall evidence for school-aged children (6 to 12 years), and promising effects for children aged 0 to 5 years. No adverse effects, such as increased dieting behaviors, were noted in studies that examined such behaviors. The Cochrane Review recommended the implementation of obesity-prevention interventions, especially among children ages 6 to 12 years and that more studies be conducted in preschool children and adolescents to provide more definitive recommendations for those age groups.

Recent studies have expanded the focus of multilevel interventions and have included a greater focus on the environment, including evaluation of policies for obesity prevention,[77,78] and incorporation of community-based efforts to reinforce and complement school-based interventions.[79,80] It has become increasingly clear that children's behaviors, regardless of weight status, are influenced strongly by their environment. Meaningful and sustainable behavior change is unlikely to occur without environmental support through policies and programmatic efforts.[77-80] In addition, measuring the effects and possibilities of incorporating aspects of the social environment, such as media and social networking, into pediatric obesity prevention is crucial and opens new opportunities for intervention research.[81]

A summary of recommendations from the primary prevention interventions reviewed can be seen in Figure 3.

Secondary Prevention

In contrast to primary prevention approaches, secondary prevention programs focus on children who are already overweight and/or obese. Secondary prevention programs include strategies that are similar to those used in both primary and tertiary programs (eg, behavioral strategies), but are more intensive and targeted than primary prevention approaches, and generally do not require the more extensive medical supervision or monitoring necessary for tertiary prevention.

Behavioral Approaches to Secondary Prevention. The most recent systematic literature review of the effectiveness of behavioral weight-management interventions for overweight and obese children and adolescents was conducted by the US Preventive Services Task Force.[82] This comprehensive review identified 15 fair- to good-quality trials published through June 2008 that reported outcomes in weight status for youth ranging in age from 4 to 18 years. Multicomponent behavioral interventions that offered medium- (26 to 75 hours) to high-intensity (>75 hours) contact time were the most effective and consistently resulted in small to moderate improvements in weight status (mean difference in BMI change=2.4). However, evidence is more limited for long-term maintenance of this BMI improvement at or beyond 12 months post treatment. Finally, this review found no evidence of adverse effects on growth, eating disorder pathology, or mental health with behavioral interventions in a limited number of reports.

Clinical-Based and Clinical-Linked Approaches to Secondary Prevention. Secondary prevention intervention strategies are analogous to and overlap with the stages of the proposed continuum of care for pediatric obesity (Figure 2).[22] In terms of clinical practice, the current paradigm for pediatric obesity treatment is proposed to begin in the primary care provider's office, and uses a staged approach (Stages 1 to 4) based on BMI percentile (85th to 94th; 95th to 99th; >99th percentile), child's age (2 to 5 years; 6 to 11 years; 12 to 18 years), presence of comorbidities, and the family's motivation to engage in care.[22] Each stage is designed with increasing intensity and structure to improve eating habits, increase level of physical activity, decrease sedentary behavior, and promote family support and involvement in these lifestyle changes. After 3 to 6 months of treatment, the decision to advance to the

next stage is made when a child or adolescent is not making sufficient progress in improving weight status and/or resolving obesity-related medical complications. Stages 1 to 3 rely exclusively on behavioral strategies, such as goal setting, self-monitoring, and incentives to promote healthy lifestyle changes, whereas Stage 4 includes more intensive interventions, such as pharmacotherapy and bariatric surgery. When these recommendations were formulated, the expert panel acknowledged that although the staged approach had not been tested, it integrated sufficient elements of care that were evidence-based and supported by expert clinical opinion.[32] For this review, strategies and protocols used in Stages 1 to 3 will be discussed under Secondary Prevention and Stage 4 will be discussed under Tertiary Prevention.

In the proposed continuum of care for pediatric overweight and obesity, Stage 1 interventions are offered by a primary care provider in an office-based setting. The effectiveness of this approach has been investigated in a limited number of trials. Two trials that tested the efficacy of pediatric obesity primary care guidelines within a research setting found significant improvement in weight status.[83] However, two clinical trials using a Stage 1 intervention in actual primary care settings reported no effect on weight status.[16,84] These negative findings may be accounted for by the low intensity (<10 hours of contact time) of these programs. These studies only targeted families with younger children ages 2 to 10 years, so it is not known whether this approach works with older children and adolescents. Because there are so few studies evaluating Stage 1 interventions, it is difficult to draw any definitive conclusions at this time.

Stage 2 for the management of pediatric obesity offers more structure and support by enlisting the services of professionals with specific skills in promoting lifestyle behavior changes, but within the context of the primary care setting. Two recent studies that met the Stage 2 intervention criteria involved primary care providers and registered dietitians (RDs).[85,86] These studies varied in age and racial/ethnic diversity of the target population, program format, dietary approach, treatment intensity, study design, and duration. Despite these differences, both studies reported significant improvement in BMI and comparable rates of attrition. A follow-up of subjects in the study using a low-carbohydrate diet reported a significant rebound in BMI 6 months post intervention,[87] underscoring the short-term effects of a Stage 2 approach. It was speculated that the absence of continued follow-up with an RD was a factor in this relapse. More research is clearly needed to evaluate the added value that RDs with specialized training in pediatric weight management can provide for Stage 2 interventions.

Another recent prospective cohort study of a Stage 2 approach involved primary care providers and health psychologists.[88] The 15-week family-based behavioral weight-management program included individual follow-up scheduled once every 3 months for up to 24 months post baseline. Completers reported significant mean change in BMI *z* score compared with a wait-list control group who had no significant change in BMI *z* score. At the 24-month post-baseline assessment, subjects who completed the 15-week intervention maintained their improvement in weight status. Stage 2 approaches may also be effective using community-based models that link to health care systems: the Mind Exercise Nutrition Do It! (MEND) trial evaluated a 9-week multicomponent, community-based program that involved parent and child sessions, followed by child physical activity and parent-only group sessions,[89] led by trained theory leaders under the supervision of RDs and linked with UK health practitioners; this program showed significant decreases in BMI *z* score at 6-month follow-up compared with controls.

Stage 3 approaches have been shown to be effective when they include multiple components, such as nutrition, physical activity, supportive parental involvement, and behavioral strategies that promote healthy lifestyle changes. Recent research has focused on establishing the generalizability of this approach when offered to patient populations that differ in age, ethnic/racial diversity, and severity of obesity. Other researchers have investigated the efficacy of specific intervention strategies, such as dietary approaches, program format, and other innovations within the context of a Stage 3 intervention.

There is considerable evidence supporting a Stage 3 intervention model with overweight and obese children using a family-based approach, but this design has been less successful with adolescents.[90] In a recent clinical trial of obese youth, participating families were randomly assigned to a 10-week group or individual behavioral lifestyle intervention program, with follow-up at 1-year post treatment.[90] This family-based approach, regardless of group or individual format, was effective only for younger children. With adolescents, their BMI *z* score showed no improvement post treatment and at the 1-year follow-up had increased significantly.

Another clinical trial tested whether a more developmentally appropriate intervention designed to account for an adolescent's increasing autonomy and less parental influence would be more effective.[91] In this study, adolescent girls were randomly assigned to either a 5-month medium-intensity, multicomponent behavioral intervention with separate teen and parent groups (intervention) or usual care consisting of educational handouts and internet resources on evidence-based weight-management strategies during a single encounter with a primary care provider (control). The interdisciplinary team conducting the group sessions consisted of master's level RDs, doctoral-level clinical psychologists, and health educators. Primary care providers received training in promoting health behavior change and met with subjects in the intervention group at study onset and 6 months later. At 6 months post baseline, adolescents in the intervention group, when compared with the control group, had a significantly greater improvement in mean BMI *z* score, which was sustained at 12-month follow-up.

Effective weight-management interventions for children aged 2 to 5 years is a growing concern given the prevalence of obesity in this age group.[1] However, evidence is limited on how best to approach preschool children for weight management. In a recent 6-month clinical trial,[92] obese preschool children were randomized to either a Stage 3 multicomponent family-based behavioral intervention

that alternated between group-based clinic sessions and individualized home visits, or a Stage 1 intervention offered in a primary care setting (control). This medium-intensity intervention (40 contact hours per family) included parent group sessions conducted by a clinical psychologist, concurrent group sessions for the children led by a pediatric psychology postdoctoral fellow and a research coordinator, and individual home visits conducted by psychology postdoctoral fellows. Upon completion of the 6-month intervention, preschool children in the intervention group had a significantly greater improvement in BMI *z* score, which was sustained at 12-month follow-up when compared with the control group.

Another concern raised regarding the effectiveness of Stage 3 interventions is whether they can be applied to more ethnically and economically diverse obese youth. In a recent clinical trial,[93] subjects were randomly assigned to either a high-intensity (80 contact hours), multicomponent lifestyle intervention offered by a multidisciplinary team in a school setting (intervention), or traditional clinical care consisting of a very low intensity (5 contact hours) approach with a multidisciplinary team at a pediatric obesity clinic where they received general diet and exercise counseling (control). At 12 months, the intervention group had a significant improvement in BMI *z* score compared with the control group, which was sustained at 24-month follow-up. This study demonstrated that a high-intensity multicomponent lifestyle intervention using a multidisciplinary clinical team that includes an RD can have a sustained treatment effect, even with disadvantaged ethnically diverse obese youth.

Another issue is whether severely obese children (BMI >99th percentile) can also experience improvements in weight status when participating in a Stage 3 multicomponent, family-based behavioral intervention. A randomized clinical trial[94] was conducted with severely obese children to compare the effectiveness of a medium-intensity multicomponent Stage 3 intervention with usual care (control). A modified version of the Stoplight Diet for Children[95] was provided with a targeted range for daily energy intake based on baseline body weight. Sedentary behavior (watching television, playing computer games) was limited to <15 hours/week. A lifestyle coach was responsible for reviewing self-monitoring records and setting goals with parent and child together. Children and parents in the control group were offered two nutrition-consultation sessions to develop an individualized eating plan, which was also based on the modified Stoplight Diet for Children.[95]

At 6 months, the intervention group had a significant decrease in percent overweight compared with the control group, but there was no significant difference in the change in percent overweight between the two groups at 12 and 18 months. However, when accounting for attendance at group sessions, subjects in the intervention group who attended ≥75% of group sessions were found to maintain their improvement in weight status at 18 months follow-up. Developing strategies to improve intervention engagement and adherence of severely obese youth who participate in multicomponent Stage 3 interventions may be important for long-term success.

Dietary Approaches to Secondary Prevention. When recommendations were made regarding the staged approach to the treatment of pediatric obesity for improving eating habits, there was insufficient evidence to identify the optimal macronutrient composition or dietary approach to achieve a healthier weight.[96] At that time, the dietary approaches in successful interventions with obese children within the context of a multicomponent, family-based behavioral intervention were balanced-macronutrient, reduced-energy diets. In some studies, the daily caloric intake targeted was lower than required to maintain weight, but not fewer than 1,200 kcal/day.[96] Trials that used the Stoplight Diet for Children[95] initially ranged from 900 to 1,200 kcal/day, with later studies liberalizing intake to 1,000 to 1,500 kcal/day.[97] With the Stoplight Diet for Children foods are grouped according to nutrient-density:

- GREEN: low energy, high nutrient; eaten often
- YELLOW: moderate energy, mostly grains; eaten in moderation
- RED: high energy, low nutrient; eaten sparingly

Because these studies were not designed to determine the relative contribution of the dietary approach to improvements in weight status, the optimal dietary prescription could not be identified. In more recent clinical trials reviewed, other dietary approaches have been evaluated, including modified Stoplight Diets for Children, reduced glycemic load diets, low-carbohydrate diets, and "non-diet" approaches.

Low-Carbohydrate Diet. The rationale for weight management using a low-carbohydrate diet is that the resulting state of ketosis leads to a decrease in appetite, resulting in decreased caloric intake.[98] Low-carbohydrate diet trials with obese youth vary in the target level of carbohydrate restriction, fat composition, caloric restriction, age of the target population, duration of intervention, post-treatment follow-up, and whether comparison group(s) were included that followed a different dietary prescription. In all of these studies, the interdisciplinary team included an RD who instructed subjects and their families on their assigned dietary intervention and assessed their adherence. Compared with baseline, all studies reported a significant improvement in weight status at the completion of the intervention.[85,99-101] However, longer-term effects were inconclusive.

Reduced Glycemic-Load Diet. High-glycemic-index foods are associated with a greater increase in blood glucose levels, followed by a rapid decline leading to increased hunger sooner and resulting in increased caloric intake.[102] Four trials that were reviewed used a reduced glycemic load diet that varied in age of target population, study design, size of intervention group, treatment duration, program intensity, and post-treatment follow-up. In all of these studies, the interdisciplinary team included an RD. All studies reported a significant improvement in weight status at completion of the intervention compared with baseline.[86,101,103,104] The two trials with post-treatment follow-up reported that

improvements in weight status were maintained.[101,104]

Non-Diet Approaches. A non-diet approach to healthy eating emphasizes low-fat, nutrient-dense foods of moderate portions without a prescribed caloric intake or nutrient composition. The effect of a non-diet approach used as part of Stage 3 multicomponent family-based behavioral intervention was investigated in three clinical trials (two low intensity and one high intensity).[90,93,105] Two of the three trials included an RD as part of the multidisciplinary intervention team.[90,93] Compared with baseline, both low-intensity studies found a significant improvement in weight status with children at completion of the intervention, which was sustained at post-treatment follow-up.[90,105] In the low-intensity trial that included adolescents, participants experienced a significant increase in BMI *z* score at completion of the 10-week family-based intervention, irrespective of intervention format.[90] In contrast, adolescents and children in the high-intensity trial both had a significant decrease in BMI *z* score, which was sustained at 12 months post treatment.[93] It should be noted that this high-intensity trial was designed so that subjects assigned to the intervention group were further randomized to either the non-diet approach (better food choices) group or to a structured meal plan group. However, after 6 months, the structured meal plan group was discontinued due to an 83% dropout rate. This suggests that less restrictive dietary interventions, emphasizing selection of healthier foods, are more likely to be sustained.

Modified Stoplight Diet for Children. The concept of a less restrictive dietary approach was also investigated in two trials using various modifications of the Stoplight Diet for Children.[95] These modifications included a more liberal caloric restriction based on initial body weight[94]; increased emphasis on eating healthy foods, such as fruits, vegetables, and low-fat dairy products[106]; or decreasing intake of high-energy-dense foods.[106] These two randomized clinical trials varied in size of intervention group, treatment duration, and post-treatment follow-up. However, these studies targeted children aged 8 to 12 years using a medium-intensity program and had no RD on the intervention team. From baseline to completion of the intervention, all modifications of the Stoplight Diet for Children were associated with significant improvement in weight status, which were sustained long term.

Summary. Of the trials previously discussed, only five directly compared the efficacy of different dietary approaches.[100,101,103,104,106] Two trials that compared low-carbohydrate vs calorie-restricted low-fat diets reported no significant difference in their improvements on weight status with children[101] and adolescents.[100] Inconsistent outcomes were reported by studies comparing reduced glycemic load vs calorie-restricted low-fat diets. The reduced glycemic load diet was found to be more effective than calorie-restricted low-fat diets in both a large retrospective cohort study[103] and a small randomized clinical trial.[104] However, a larger randomized clinical trial found the effects of these diets on improvements in weight status to be comparable.[101] Such findings suggest that a variety of dietary approaches can be effective in helping overweight and obese youth achieve a healthier weight.

Lastly, the trial that compared two modifications of the Stoplight Diet for Children reported that emphasis on increasing intake of "healthy foods" became more effective over time in improving weight status than a focus on reducing intake of high-energy-dense foods.[106] This finding was also correlated with less parental restriction over the child's eating behaviors and less concern about their child's weight. These positive changes resulting from parents emphasizing increased consumption of healthy foods were associated with an absence of a weight-gain relapse, which was observed with the group focused on decreasing high energy-dense foods.

Tertiary Prevention (Treatment)

The use of very-low-calorie diets (VLCDs), meal replacements, weight-loss medications, and bariatric surgery can be considered for a select population of severely obese youth with obesity-related health complications (Figure 2). For those who have experienced limited improvement during a 3- to 6-month period while participating in a medically supervised, comprehensive lifestyle-intervention program, these more aggressive adjunct therapies, referred to as Stage 4 level of pediatric obesity treatment,[22] may be a reasonable next step for managing their obesity.[107,108]

Very-Low-Calorie Diets. The effectiveness of VLCDs ($\leq$1,000 kcal/day) with severely obese youth was reviewed as part of the Academy's Evidence Analysis Library on Pediatric Weight Management,[109] and was further critiqued by the 2007 Expert Committee on the treatment of childhood and adolescent overweight and obesity.[109] The VLCDs evaluated with children and adolescents included the protein-sparing modified fast (PSMF) and a hypocaloric balanced diet.[110,111] The PSMF is a calorie-restricted (600 to 800 kcal/day) diet high in lean protein (1.5 to 2.0 g/kg ideal body weight), low in carbohydrate (20 to 25 g/day) and supplemented with water or other calorie-free fluids (2 L/day) and a daily multivitamin/mineral supplement. In contrast, the hypocaloric balanced diet (800 to 1,000 kcal/day) did not include a nutritional supplement, but instead encouraged the intake of milk and vegetables to ensure micronutrient needs were met. These dietary interventions were used as part of comprehensive weight-management programs to bring about rapid weight loss during the initial phase of treatment (10 to 20 weeks), followed by nutrient-balanced diets with less caloric restriction (1,000 to 2,000 kcal/day).

Clinical outcome studies reported significant improvements in weight status short-term (6 to 12 months), but did not examine the longer-term effects of these dietary interventions. In addition, there was some evidence of a slower growth velocity for stature,[110,112] although this was not a consistent finding.[113] One study comparing the PSMF and hypocaloric balanced diet with obese children found those following the PSMF had significantly greater improvement in weight status at 10 weeks and 6 months post intervention. Although a significant improvement in weight status compared with baseline was sustained long term for both diet groups, the effect was attenuated at

14.5 months post intervention with no significant difference between the two diet groups.

The evidence on these VLCDs can be viewed as extremely limited due to lack of rigorous study designs. Three of the five cited studies only reported on clinical outcomes with no comparison group,[111-113] whereas the other two were nonrandomized clinical trials.[110,114] In addition, all studies were conducted with the same treatment program except for one that evaluated the feasibility of using a similar clinical intervention but implemented in a school setting.[114] Also, the contradictory findings on the negative effects of these VLCDs on growth velocity have not been resolved because no additional research on these diets with obese youth has been published in the past 10 years. In conclusion, the absence of additional research on the efficacy and/or safety of VLCDs indicates the Academy's 2007 Evidence Analysis Library recommendation that a PSMF diet could be utilized in a short-term intervention (typically 10 weeks) under the supervision of a multidisciplinary team of health care providers who specialize in pediatric obesity is still valid.[109] This recommendation was based on research that found short-term use of a PSMF brings about short-term and longer-term improvement in weight status and body composition when part of a medically supervised, multicomponent program.

Meal Replacements. There is consistent evidence with obese adults that partial meal replacements are an effective and safe strategy to produce significant sustainable weight loss.[115,116] However, to date there are no published studies with obese youth and the use of meal replacements for weight management.

For the meta-analysis of randomized controlled clinical trials with obese adults,[115] a partial meal-replacements plan was defined as a program that prescribed a low- or reduced-calorie diet (800 to 1,600 kcal/day) whereby one or two meals per day were replaced by commercially available, vitamin/mineral-fortified, energy-reduced product(s), and included at least one meal of regular foods. The findings were that the partial meal-replacements group (using a liquid meal replacement) lost significantly more weight at 3-month and 1-year evaluation time points in comparison with a group following a conventional reduced-calorie diet. The retention of both diet groups was comparable at 3 months; however, the dropout rate at 12 months was significantly less for the partial meal-replacements group. In addition, no reported adverse events were attributed to the adherence to either dietary approach.

Despite the absence of evidence on using meal replacements with severely obese youth, consideration can be given to the inclusion of these products in Stage 4 interventions, given the consistently positive outcomes reported by adult studies.[115,116] However, research with obese youth is still needed to definitively include this approach as part of evidence-based care for Stage 4 interventions.

Pharmacotherapy. Currently, orlistat (Xenical; Roche Products) is the only prescription weight-loss medication in the United States that is approved by the US Food and Drug Administration (FDA) for obesity treatment with adolescents 12 years of age and older.[117] Orlistat blocks absorption of fat in the intestine by inhibiting lipase activity. In 2007, a reduced-strength, nonprescription version of orlistat (Alli; GlaxoSmithKline) was FDA-approved and available over-the-counter in pharmacies; however, it is not approved for children or adolescents under age 18 to prevent the use of orlistat by youth in the absence of medical supervision.

The use of orlistat combined with a lifestyle intervention was investigated with adolescents in a large randomized clinical trial involving 32 centers in the United States. After 1 year, BMI significantly decreased in the orlistat group compared with the placebo group, who experienced an increased BMI. Mild to moderate gastrointestinal side effects, such as fatty or oily stools, were reported more often by patients in the orlistat group than the placebo group. Other side effects noted included fatty leakage and fecal urgency as a result of an excess of undigested dietary fats in the intestines.[118] These adverse effects are more likely to occur if dietary intake exceeds the recommended 30% calories from fat at any given meal or snack. In addition, there is concern about reduced absorption of fat-soluble vitamins, particularly for vitamin D, in adolescents who have not completed their linear growth.[119] As a safety measure, the FDA recommended the drug be packaged with a multivitamin supplement that consists of 400 IU vitamin D, 300 IU vitamin E, 5,000 IU vitamin A, and 25 μg vitamin K.

Currently, there are no evidence-based guidelines specific for the use of orlistat with obese adolescents. However, reasonable considerations for its use include the severity of the obesity, presence of comorbidities, and continued weight gain, despite a year-long effort to adhere to a behavioral lifestyle treatment intervention.[120] In addition, a thorough understanding of the potential gastrointestinal side effects is needed so that they can be minimized by adhering to recommended guidelines for dietary fat intake. This underscores the importance of involving an RD who can provide medical nutrition therapy to help these patients optimize their adherence to an age-appropriate, nutritionally balanced, reduced-calorie diet with every meal having no more than about 30% of calories from fat.

Metformin (Glucophage; Bristol-Myers Squibb), although not FDA-approved for the treatment of obesity, is approved for the treatment of type 2 diabetes in children 10 years of age and older. Metformin is an anti-hyperglycemic drug, the action of which can reduce insulin resistance and hyperinsulinemia, helping to reduce hunger and decrease fat storage.[107] A meta-analysis of five trials with metformin of at least 6 months duration with nondiabetic obese children and adolescents reported a moderate improvement in weight status, even though three of the trials were not designed to include a lifestyle intervention.[121]

More recent clinical trials using metformin as an anti-obesity drug in combination with a lifestyle intervention were conducted with nondiabetic obese children and adolescents.[122,123] The trial with younger children used metformin (1,000 mg/day), and the drug used in the adolescent trial was the long-acting, metformin hydrochloride XR (2,000 mg/day). Both trials reported modest, but statistically significant improvement in BMI and found the drug to be safe and well-tolerated. Although these findings are promising, longer trials are needed to

further establish metformin's effectiveness and safety.

Sibutramine, which was FDA-approved in 2009 for use in obese adolescents age 16 years and older, was found in a large randomized clinical trial to significantly decrease BMI.[124] Although cardiovascular side effects of increased heart rate and systolic and/or diastolic blood pressure were reported, it was believed the benefits in improving weight status outweighed potential long-term health risks. However, a large multicenter adult trial of sibutramine reported an increased risk of adverse cardiovascular events (need for resuscitation, nonfatal stroke, nonfatal myocardial infarction, and cardiovascular death) with patients who had a history of cardiovascular disease or type 2 diabetes.[125] Consequently, sibutramine was taken off the market in October 2010.

Weight-Loss Surgery. Weight-loss surgery is increasingly an accepted option reserved for a select group of severely obese adolescents, often with serious comorbidities, who have failed to benefit from more conservative medically supervised treatment of at least 6 months. For selecting appropriate adolescent candidates for weight-loss surgery, a conservative approach was initially adopted for the BMI thresholds: BMI >40 with serious obesity-related comorbidity(s) (eg, type 2 diabetes, sleep apnea, pseudotumor cerebrii, severe steatohepatitis) or BMI ≥50 with less severe comorbidity(s) (eg, dyslipidemia, hypertension, gastroesophageal reflux disease, nonalcoholic steatohepatitis, psychosocial handicaps).[126] More recently, it was recommended the BMI thresholds for obese adolescents be revised to match the lower criteria for obese adults (BMI >35 with serious comorbidity or BMI ≥40 with less severe comorbidity),[127] which was later endorsed by the American Society of Metabolic and Bariatric Surgery.[128] This change was based in part on the evidence that bariatric surgery in adolescent patients has been shown to consistently result in sustained and clinically significant weight loss.[129] In addition, it was influenced by findings that obese adolescents who met adult BMI criteria for weight-loss surgery were functionally impaired and required specialized health services.[130]

Other recommended criteria used in the selection process include having reached physiologic and skeletal maturity, evidence of a willingness to adhere to postoperative nutritional guidelines, demonstration that the adolescent and family have the ability and motivation to comply with postoperative treatment, plus an understanding of potential health risks and benefits.[126]

The weight-loss surgery most widely used for severely obese adolescents is laparoscopic Roux-en-Y gastric bypass.[131] This restrictive procedure creates an egg-sized pouch that drastically limits the amount of food that can be consumed at any one time, followed by an extended state of satiety. Because this procedure reconfigures the gastrointestinal tract to bypass the stomach and duodenum, it also contributes to malabsorption of many micronutrients.[107] In addition, there is the potential for other more serious complications, such as severe malnutrition, pulmonary embolism, intestinal obstruction, and staple-line leak.[132]

The adjustable gastric band is another laparoscopic surgical procedure used to promote weight loss. This exclusively restrictive procedure involves the placement of a band around the part of the stomach located just below the junction of the esophagus, resulting in a small gastric pouch. The extent of restriction by the inserted band can be adjusted as needed after surgery by injecting a saline solution via a port surgically implanted on the abdominal wall beneath the skin. The advantage of this procedure is that it does not interfere with the absorption of micronutrients.[107] However, the most frequent complications with this procedure include band slippage and micronutrient deficiency.[132] Although the FDA has only approved the gastric band for obese individuals aged 18 years and older,[132] this procedure has been performed with obese adolescents younger than 18 years of age participating in clinical trials to assess its safety and effectiveness. A recent study reported a trend that this procedure is being selected less often for weight-loss surgery with obese adolescents.[131]

During the past 3 years, an alternative weight-loss surgical procedure that is being used with increasing frequency for obese adolescents is the laparoscopic sleeve gastrectomy.[131] With this restrictive procedure, the stomach is reduced to about 20% of its original size by surgical removal of a large portion of the stomach. The open edges are then stapled together to form a sleeve or narrow banana-shaped tube. As a result the size of the stomach is permanently reduced and cannot be reversed.[133]

To determine the effectiveness of weight-loss surgical procedures, changes in absolute weight, BMI, or BMI *z* score are often reported. In addition, percent excess weight loss, a common outcome measure reported for obese adults after weight-loss surgery, has also been used. Percent excess weight loss is determined by the change between preoperative and follow-up weights divided by the difference between preoperative and ideal body weights. Extrapolated from adult findings for those under age 40,[134] a percent excess weight loss >50% can be indicative of a successful long-term outcome for adolescents, given presurgery BMI is <50[135]; however, more long-term studies with adolescents are needed to confirm this predictor for successful weight-loss operations.

A recent systematic review of studies on weight-loss surgery with obese adolescents[136] found that both laparoscopic Roux-en-Y gastric bypass and laparoscopic adjustable gastric banding resulted in clinically significant improvement in weight status, resolution of comorbidities (sleep apnea, hypertension, type 2 diabetes, insulin sensitivity, metabolic syndrome, dyslipidemia), and improvement in quality of life. However, this review reported that 17% of the Roux-en-Y patients had moderate to severe complications after surgery, whereas 33% of the laparoscopic banding patients had a second surgery to correct complications.[137] In addition, a retrospective cohort study of 11 obese adolescents (baseline BMI=50.4±5.9) with type 2 diabetes who had undergone a Roux-en-Y procedure reported a mean percent weight loss of 60% along with evidence of remission of diabetes in all but one subject.[138]

For the laparoscopic sleeve gastrectomy, outcomes were reported for a 2-year retrospective cohort study of obese adolescents (baseline BMI=38.5±3.7).[138] At 1 year post surgery,

patients experienced a mean percent excess weight loss of 96.2%, which was largely sustained at 2 years post surgery. With regard to the 76% of patients who had comorbidities (insulin resistance, dyslipidemia, nonalcoholic steatohepatitis, and type 2 diabetes), all conditions were resolved or improved after surgery. In addition, only 1 of the 51 patients in this cohort experienced moderate to severe complications immediately after surgery. As a result of this reduced rate of postsurgical complications combined with positive health outcomes reported with adults, the laparoscopic sleeve gastrectomy provides another option for obese adolescents who meet the criteria for weight-loss surgery.[137] However, more evidence is needed to further confirm the efficacy and longer-term safety of the laparoscopic sleeve gastrectomy procedure.

Nutrient-related outcomes of weight-loss surgery were examined by two recent studies. The nutrient intake of obese adolescents was studied 1 year post surgery after the laparoscopic gastric bypass surgical procedure.[139] Although mean caloric intake was low (1,015±182 kcal/day), the macronutrient composition was comparable with what they reportedly ate before surgery. However, nutrient intake 1 year post surgery was found to be deficient in calcium, protein, and fiber when compared with the recommended intake for these nutrients.

In regard to bone health, one study with obese adolescents reported that weight-loss surgery was associated with significant bone loss up to 2 years post surgery.[140] Despite this loss, the subjects' bone density was still within the normative range. Because it is not known whether bone loss will continue over time and result in a clinically significant decrease, more research is needed in this area.

The nutritional management of obese adolescents undergoing weight-loss surgery, both before and after the operation, is critical to ensure optimal outcomes. The dietary guidelines currently recommended for obese adolescents are primarily based on best practices in adult surgical weight-loss interventions due to limited research. In the absence of evidence-based protocols of care for the nutritional management of obese adults and adolescents undergoing weight-loss surgery, the Academy published a guide on weight-loss surgery that provides a framework for accepted nutrition practices across this age span.[141] These recommendations were recently updated and expanded to address the varying nutritional requirements and dietary progression for the different surgical procedures, focusing exclusively on adolescents.[136]

The nutritional challenge these surgical procedures present is obtaining adequate nutrient intake in the face of a dramatically altered gastrointestinal anatomy and physiology, as well as changes in hunger and satiety. As the patient heals from the surgical procedure, the recommended dietary regimen (high protein, low carbohydrate, modified fat intake) progresses in the type, consistency, and amount of food consumed, with emphasis placed on daily fluid intake and nutritional supplements to meet micronutrient needs. Although a calorie-defined diet is not emphasized, energy intake after surgery for the first month will range from 500 to 600 kcal/day due to restrictions on the type (high-protein liquids/foods with a smooth consistency), volume (0.5 cup/meal), and frequency of meals (3 to 4/day). By 1 year post surgery, the desired energy intake increases to 800 to 1,000 kcal/day, which reflects the adolescent's ability to consume a wider variety of foods and larger volume (1 to 1.5 cups/meal) without adverse effects. Adolescents who sustain a portion-controlled nutrient-balanced eating plan (≥60 g protein/day), meet their daily fluid goal (64 to 90 oz), comply with taking daily nutritional supplements, adopt a physically active lifestyle, and avoid repetitive snacking or grazing on energy-dense foods, will optimize their health outcomes and reduce the risk of weight regain.

Preoperative nutrition education and counseling is another important component. The goals are to help patients achieve some weight loss before surgery, while introducing behavioral tools that increase the likelihood of staying on track with targeted goals to improve eating habits and increase physical activity.

The complexity of the recommended postoperative dietary regimen, nutritional assessments, and long-term monitoring underscores the need to have an experienced RD trained in both pediatric weight management and weight-loss surgery as part of a multidisciplinary team, which has been consistently endorsed by best-practice guidelines.[129]

CHALLENGES

Although significant progress in prevention and treatment of child and adolescent obesity has been made, several challenges remain, including identification of methods to effectively employ systems-level approaches; reimbursement for RDs and medical nutritional therapy for pediatric obesity treatment; optimal roles for dietetic technicians, registered (DTRs) in child obesity-prevention and treatment efforts; changes in the macroenvironment of food availability and marketing to reinforce obesity prevention and treatment messages; and further delineation of the responsibility of the profession in addressing parenting issues or child neglect. Each of these challenges is described briefly.

Employment of Systems-Level Approaches

Although systems-level approaches, in which broad and consistent organizational changes and messages across sectors, such as schools, communities, and worksites, are increasingly proposed to be a solution for ameliorating child obesity[19] in practice, these approaches are difficult to implement. For many sectors, child obesity rates may very likely lead to financial and performance problems in the future, but are not immediate priorities, and it may be difficult to determine how the components are inter-related. In addition, there have been few comprehensive evaluations of a systems-level approach. It is widely believed that increased awareness and political action may be the most likely avenues to these changes, and several nongovernmental organizations, such as the Robert Wood Johnson Foundation, are focusing on advocacy efforts.

Engaging families and parents in child-obesity prevention and treatment efforts can also be difficult. Families, especially those who are low-income, are faced with multiple challenges, especially in difficult economic times. Effective parenting skills and

feeding practices to cope with children's requests for high energy-dense food or refusal of healthy foods may not be consistently practiced by the adults in a child's early environment. As children develop through adolescence, parents often focus on health issues with more immediate consequences, such as drug use and sexual health, and dietary intake and physical activity become less important. Finally, parental efforts at home are often not reinforced in schools, where nutrition education is often limited and healthy messages might not be reinforced, or in communities, where food marketing and availability of high energy-dense foods promote unhealthy food choices.[142]

Reimbursement

Although evidence strongly supports a multicomponent, moderate-intensity treatment intervention for the management of obese children and adolescents,[22,108] health insurance coverage is limited, with RDs seldom being reimbursed for their services as part of this multidisciplinary team.[143] The recommendations of the White House Task Force on Childhood Obesity 2010 stated, "Federally funded and private insurance plans should cover services necessary to prevent, assess and provide care to overweight and obese children."[144] However, the First Year Progress Report on this broad national initiative to address the problem of childhood and adolescent overweight and obesity[144] did not include any progress made specific to the recommendation on health insurance coverage.

The challenge for the future is to reach consensus on the services that are necessary, frequency of contact, treatment format, and cost–benefit of this intervention. In addition, further research efforts should specifically state whether an RD or DTR was involved with the study, as well as level of involvement, so that the evidence base is clearly established.

Changes in Food Availability and Marketing

A growing field of evidence points to the ubiquitous promotion of high-energy foods of low nutritional value to poor dietary choices.[142] Fast-food restaurants have been found in high concentrations around schools,[145] and high-energy, low-nutrient foods are still available in school cafeterias. Recent efforts to change food availability and food marketing have been proposed,[19,142] and important regulations for foods available at schools have recently been established[146]; however, until these efforts are fully in place, it is difficult to address child obesity in a consistent and coordinated manner. Further discussion of these issues can be found in other position papers from the Academy.[8,9]

Recommendations for changes in the school-meal patterns as part of the Healthy, Hunger Free Kids Act of 2010 were implemented beginning July 2012 and include increased amounts of fruits and vegetables, increased requirements and standards for whole-grain products, and changes in milk offered.[146] Proposed rules for competitive foods served at schools were released in February 2013, and are currently being revised after the comment period; further rules for the Child and Adult Care Food Program are forthcoming. It is expected that these changes will provide significant progress toward increasing healthy food availability for children in school and child-care settings, and reinforce current prevention and treatment efforts for child obesity.

Medical Neglect

The issue of medical neglect by parents/guardians of severely obese children has received increasing attention, particularly when health is seriously compromised by obesity-related comorbidities.[147] The legal issue of medical neglect needs to be considered when (1) health complications contribute to high risk of serious imminent harm; (2) interventions to address health conditions have failed due to the parent/guardian's lack of adherence; and (3) an alternative to the biological home exists for effectively addressing the health emergency.[148]

Before any legal action is taken to remove a child from their biological home, it is important to exhaust all avenues for promoting sufficient weight loss to alleviate the imminent health risk. This may include the involvement of home health and school nurses, social workers, and community-based social service agencies, plus mandated behavioral interventions and weight checks.[148]

RDs involved in the multidisciplinary treatment of these severely obese children and adolescents facing serious health risks have an important role in helping to determine the appropriate course of action needed. Documentation by the RD should include: (1) how well a parent/guardian is adhering to recommended age-appropriate dietary guidelines to promote needed weight loss for their child; (2) extent to which the home environment supports needed changes in the types and amount of food consumed by the child; (3) attendance at scheduled nutrition follow-up visits; and (4) the child's weight trajectory during this closely monitored intervention period.

SUMMARY AND RECOMMENDATIONS

For prevention of child and adolescent overweight and obesity, school-based evidence reviews, recent studies, and current recommendations all indicate the importance of multilevel approaches that involve various components or sectors of influence. Consistent messages across these sectors are critical and can be reinforced through community-level interventions and social marketing. For weight management, comprehensive, multicomponent interventions that include diet, physical activity, behavioral counseling, and parent or caregiver engagement are recommended. For children between 2 and 5 years of age, active participation of the parent or caregiver is necessary, and weight goals should be monitored closely to encourage adequate growth and development. For an older child (older than 6 years) or adolescent who is extremely obese (≥99th percentile), the child and family should be evaluated to determine the course of treatment, which may include more intensive therapies, such as more structured nutrition prescriptions as well as pharmacologic agents or bariatric surgery for adolescents. Dietary assessment and intervention efforts for both obesity prevention and treatment should focus on foods and eating patterns known to be associated with risk of development of obesity in addition to parental and family factors, sedentary

activity, and physical activity.* Throughout the entire prevention and treatment spectrum, RDs and, when applicable, DTRs, should be actively involved and engaged as an integral part of the obesity management team.

The deceptively simple primary cause of obesity is energy imbalance—too many calories consumed and too few calories burned. However, this is actually a complex, multifaceted problem that requires innovative solutions. The forces that lead to energy imbalance on a population level are numerous and pervasive. Of the myriad interventions that have attempted to reduce childhood obesity, relatively few have achieved modest long-term success. Integrating educational messaging with environmental change to make healthy choices easier is essential, as is a focus on programs that teach food purchasing and preparation skills, as well as parenting practices regarding food and activity. Furthermore, interventions must be sustained over the long term. There is not likely to be any quick-fix solutions to pediatric obesity.

Further research, with RDs as integral team members, is needed to continue to determine the effectiveness of obesity programs, policies, and environmental change efforts, focusing on all age groups (preschool to high school), among different subpopulations, involving more synergy between messaging and environmental changes, and longer durations. Factors that affect program and policy implementation and sustainability need to be determined to develop interventions that can be easily incorporated into different systems or sectors, such as health care or the educational system,[76] and including media and social networking. In particular, obesity-prevention interventions that demonstrate the effectiveness of behaviorally based nutrition education across the age groups are needed to reinforce the importance of teaching our children food preparation skills, menu planning, food shopping, and food selection skills. These skills, previously taught in home economics courses, have largely been phased out of school curricula, and it is time to re-examine their importance as a necessary life skill.[149] IOM recommendations for national nutrition-education curriculum standards for prekindergarten through 12th grade are forthcoming[150] and will be important for promoting evidence-based academic content and strategies in support of child health promotion and obesity prevention.[9]

Finally, because pediatric obesity treatment is still in its infancy, it is necessary to build the evidence base for effective and safe options for children. Intensive therapies should be evaluated in more rigorous trials, with long-term follow-up periods to determine the safety and overall efficacy of the treatments, especially with regard to physiologic growth, mental health, and development of the child. Although additional research is needed, several recommendations can be made based on the available evidence (Figure 3).

In summary, prevention and treatment of pediatric overweight and obesity require synergy between personal and public responsibility in an integrated systems-level approach that includes consistent messages and environmental support across all sectors of society to achieve sustainable behavior change for life.

Role of the RD and DTR

With the multifaceted approaches to prevention and treatment of child and adolescent obesity, RDs and DTRs should be involved in screening, assessment, programming, environmental changes, and evaluation that span the spectrum from developing obesity-related policies to serving on school wellness committees to functioning as part of a medical team for obese children undergoing tertiary prevention (RDs only). Therefore, it is important for RDs and DTRs to receive training in skills that prepare them for the challenges presented by the child-obesity epidemic. These skills include:

- knowledge of weight-management strategies and healthy food preparation;
- knowledge of physical-activity interventions;
- assessment of body size, diet, and physical activity;
- competency in behavioral-science strategies that work with parents and children at all developmental levels and from varied cultural backgrounds;
- knowledge of parenting and child-feeding practices to promote healthy weight;
- knowledge of child and adolescent growth and development;
- knowledge of research to conduct and interpret new studies; and
- knowledge of methods of advocacy for policies that promote healthy living.

In addition, RDs need to have the physiologic and metabolic training that enables them to effectively serve as a resource on the treatment team for children who are extremely obese.

No other profession is as skilled and ready to be on the forefront of pediatric overweight and obesity prevention and treatment. RDs and, when applicable, DTRs, should seize these current challenges and opportunities to expand their sphere of influence, shape current policies and environments, and impact the lives of millions of children, both now and in the future.

*For more information on the determinants of childhood obesity, the reader is referred to the Academy's Evidence Analysis Library (www.adaevidencelibrary.com/topic.cfm?cat=3013&auth=1).

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