

Dietary Education in School-Based Childhood Obesity Prevention Programs^{1,2}

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ABSTRACT

The purpose of this article was to review school based interventions designed to prevent childhood and adolescent obesity that focused on modifying dietary behavior and were published between 2000 and May 2009. A total of 25 interventions met the criteria. The grade range of these interventions was from K to 12; 13 studies exclusively targeted elementary school, 2 targeted both elementary and middle school, 9 exclusively targeted middle school, and 1 targeted high school. The majority of the interventions focused on both dietary and physical activity behaviors, whereas 8 interventions focused exclusively on dietary behaviors. Approximately one-half of the interventions were based on a behavioral theory. In terms of duration, 13 were longer than 6 mo, 4 were less than 1 mo, and 8 had a duration between 1 and 6 mo. The majority of the interventions were implemented by teachers. In terms of activities, almost all interventions had a curricular component except 2 that distributed free fruit or vegetables. Besides curricular instructions, parental and family involvement was also utilized by several interventions. Environmental and policy changes were used in 7 interventions. For evaluation, the 2 most popular designs were experimental design with random assignment at group level and quasi experimental design, both of which were used by 9 interventions each. In terms of impact on adiposity indices, only 14 interventions measured it and only 6 of those were able to demonstrate significant changes. Recommendations for enhancing the effectiveness of school based dietary education interventions for childhood obesity prevention are presented. *Adv. Nutr.* 2: 2075–2165, 2011.

Introduction

All over the world, obesity has reached epidemic proportions with over 1 billion overweight people and at least 30% of those as obese (1). The prevalence of overweight and obesity in children and adolescents in both

industrialized and developing countries has also increased to a considerable level (2–4). Globally, ~10% of the school aged children are overweight (5). Childhood and adolescent overweight and obesity are particularly detrimental because they often persist in adulthood (6,7). The hazards of being overweight or obese in childhood and adolescence have been well researched. The Bogalusa Heart Study found that 60% of the overweight children by the time they reach 10 y have at least 1 biochemical or clinical cardiovascular risk factor and 25% overweight children have more than 2 (8).

Childhood overweight and obesity are also associated with a number of long term negative consequences. Some of these include increased risk of developing hypertension, type 2 diabetes mellitus, hypercholesterolemia, stroke, hepatic steatosis (fatty liver), arthritis, sleep apnea, gall bladder disease, and bronchial asthma (9). Childhood overweight and obesity are also linked to a variety of psychological issues. Some of these include depression, discrimination, low self-esteem, peer rejection, and stigmatization (10,11).

There are a number of factors that contribute to the epidemic of childhood overweight and obesity. Body weight is

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shaped by a combination of genetic, metabolic, behavioral, environmental, socio-cultural, and socioeconomic factors. For a large majority of individuals, overweight and obesity result from excess energy consumption and/or inadequate physical activity (12). Unhealthy eating habits and physical inactivity are early to become established and contribute in a major way toward development of childhood overweight and obesity. Commonly suggested modifiable public health strategies to combat childhood obesity are promotion of breast-feeding, limiting television viewing, encouraging physical activity, increasing fruit and vegetable intake, controlling portion sizes, and limiting sweetened drink consumption (13). Dietary modification is a very important part of all strategies aimed at combating childhood overweight and obesity. For addressing childhood obesity, school based interventions are a major channel. Children spend many hours in school and schools serve as important channels through which important behavior changes to reduce childhood obesity can be addressed.

It was within this backdrop that the aims of this study were to review existing school based interventions designed to prevent childhood and adolescent obesity that focused on modifying dietary behavior and suggesting ways of enhancing these interventions. It was decided to focus on interventions that were published between 2000 and May 2009. The choice was also made to focus on interventions conducted in the general population of children and adolescents as opposed to programs that focused solely on overweight and obese children.

Materials and Methods

To collect the materials for the study, a search of the CINAHL, ERIC, and MEDLINE databases was done for the time period 2000 to May 2009. The criteria for inclusion of the studies were: 1) publication in the English language; 2) publication between 2000 and 2009 (however, also included were any studies conducted prior to 2000 but published in the specified time period); 3) focus on general population as opposed to overweight or obese children; and 4) having an explicit dietary component in the school based program for prevention of obesity. Exclusion criteria were publications in languages other than English, publications prior to 1999, studies that did not have a school component (such as those that focused only on after school programs), and studies that focused solely on overweight/obese children or adolescents. Only 1 researcher retrieved the articles. The search words used were “dietary” or “nutrition” and “interventions” or “programs” and “childhood obesity.” A total of 189 articles were located and abstracts read.

Results

A total of 25 studies met the criteria. The 25 interventions starting from lower grades to higher grades and summarizing age range of children, country of the study, use of theory, dietary components of the intervention, duration, and salient findings are presented in **Table 1**. **Table 2** summarizes the types of evaluation designs used in the chosen intervention studies.

Discussion

The purpose of this article was to review school based interventions for preventing childhood and adolescent obesity that had a dietary component and were published between

2000 and May 2009. Based on a review of these interventions, it is evident that there is a need for more school based prevention programs, because there was a total of only 25 interventions that were found and the problem of obesity in childhood is quite enormous. The majority (15) of the interventions have been from the United States (14,28–36,38–42), followed by 4 from the United Kingdom (17,18,25,27), 2 from Germany (15,19), and 1 each from China (20), Greece (21), Chile (24), and Norway (37). The grade range of these interventions has been from K to 12, with a majority (13) exclusively targeting elementary school (15,17–21,25,27–32), 2 targeting elementary and middle school (14,24), 9 exclusively targeting middle school (33–41), and 1 targeting high school (42). The emphasis on elementary school of most interventions seems to be justified, because the dietary behaviors are forming in this age group and are more malleable, and changing behaviors to healthy ones can go a long way in addressing the problem of childhood overweight and obesity. There has been only 1 intervention conducted in high school. This could be due to the emphasis on academics in higher grades. Healthy dietary behaviors are more important in high school, because adolescents often adopt unhealthy practices such as eating junk food, skipping breakfast, not eating fruits and vegetables, drinking sweetened beverages, and eating unhealthy snacks. Future interventions should aim at targeting high school kids as well. Ideally, there should be sequential K-12 dietary education that would target all children.

Most of the interventions (17) focused on both dietary and physical activity behaviors, whereas 8 interventions focused on only dietary behaviors. From those 8 interventions (17,18,27,30,34,37,40,41), only 3 (17,27,30) measured adiposity indicators such as BMI, and of these, only 2 (27,30) demonstrated a decrease in adiposity measures. Hence, it can be concluded that although interventions that focus only on dietary behaviors can be successful, it would be better to focus on both physical activity and dietary behaviors to reduce childhood overweight and obesity.

Approximately one-half (13) of the interventions were based on a behavioral theory and approximately one-half were atheoretical. Using a theory helps in discerning measurable program outcomes, specifies methods for behavior change, helps in identifying the timing for interventions, helps in choosing right mix of strategies, enhances communication between professionals, improves replication, and improves program efficiency and effectiveness (44). Hence, in the future, more interventions should use behavioral theories. Among the theories that have been used, social cognitive theory is the most popular theory, which was used by 6 interventions (3,7,11,14,15,25). Social cognitive theory has been evaluated with a number of behaviors and a variety of target populations (45). It is especially useful in school based settings with children and adolescents. Future interventions might reify it and improve this theory further. A major weakness noted in the interventions that used this and other theories is that very few of those have measured changes in behavioral constructs of the theory they have

Table 1. Summary of school-based childhood obesity prevention interventions with a dietary component

n	Study/grade/age/year/country	Theory	Dietary components of the intervention	Duration	Salient findings
1.	<i>Fit for Life</i> (14)/K-8th grade/ 5-14 y olds/1997-2003/ United States	No known theory	AHA's Heart Power kits. Work booklets to track physical activity and nutrition choices. Involvement of parents and grandparents. Community activity through fairs and festivals. Counseling, education, and social support for nutrition and physical activity. Emphasis on knowledge, self monitoring, building self esteem, and autonomy Family intervention comprising of home visits for those overweight and obese	4 y	Outcome measures did not show significant improvement in knowledge or BMI
2.	<i>Kiel Obesity Prevention Study</i> (15,16)/1st grade/5-7 y olds/1996-2005/Germany	No known theory	Emphasized short-term benefits of healthy eating Provided opportunity to taste healthy foods. Used incentives such as verbal praise and small prizes. Developed practical skills Involved parents.	8 h nutrition education 4-5 home visits	Increase in nutrition knowledge ($P < 0.05$). Less increase in triceps skinfold thickness ($P < 0.01$). Less increase in % fat mass ($P < 0.05$). Improvement in nutrition knowledge ($P < 0.01$). Improvement in fruit ($P < 0.01$) and vegetable intake ($P < 0.05$). No significant change in overweight/ obesity.
3.	<i>Be Smart</i> (17)/1st-2nd grade/5-7 y olds/2000- 2001/United Kingdom	Social cognitive theory	Emphasized short-term benefits of healthy eating Provided opportunity to taste healthy foods. Used incentives such as verbal praise and small prizes. Developed practical skills Involved parents.	4 school terms (14 mo)	Improvement in nutrition knowledge ($P < 0.01$). Improvement in fruit ($P < 0.01$) and vegetable intake ($P < 0.05$). No significant change in overweight/ obesity.
4.	<i>Peer Modeling and Rewards</i> (18)/1st-3rd grade/5-11 y olds/Published in 2004/ United Kingdom	Rewarding behavior and modeling	Six 6-min videos: Food Dudes, who were 2 boys and 2 girls aged 12-13 y who ate fruits and vegetables and encouraged others to also do the same. Customized Food Dude items. Home packs to involve parents. Rewards to children for eating fruits and vegetables. Step 1: Health education and physical activity by regular school teachers. Step 2: Special cooked meals and 60- to 90-min physical activity with overweight and obese kids. Parental involvement for 6 evenings	5 mo	Compared to control group, lunch time ($P < 0.001$), snack time ($P < 0.001$), and at home ($P < 0.05$) fruit and vegetable intake increased. Adiposity indices not measured.
5.	<i>StEP TWO program</i> (19)/1st-4th grade/ 5-12 y olds/2003- 2004/Germany	No known theory	Nutrition education for children through 10 themes in 10 lessons, 1 per fortnight. Nutrition education for parents through 1 lecture per semester and educational materials. Once a semester meeting for overweight and obese children. Also aimed at increasing physical activity. Based on <i>Know Your Body</i> curriculum developed in United States. Focused on both physical activity and nutrition. Involved parents.	One academic year	Changes in dietary behavior not observed. No changes in prevalence of overweight or obese children in intervention or control groups ($P > 0.05$).
6.	<i>Obesity intervention in Beijing</i> (20)/1st-5th grade/Mean age 8.4 y/ Published in 2007/China	No known theory	Nutrition education for children through 10 themes in 10 lessons, 1 per fortnight. Nutrition education for parents through 1 lecture per semester and educational materials. Once a semester meeting for overweight and obese children. Also aimed at increasing physical activity. Based on <i>Know Your Body</i> curriculum developed in United States. Focused on both physical activity and nutrition. Involved parents.	3 y	Nutrition behaviors not measured. Prevalence of overweight (9.8 vs. 14.4%, $P < 0.01$) and obesity (7.9 vs. 13.3%, $P < 0.01$) were lower in intervention schools than in control schools.
7.	<i>Cretan Health and Nutrition Education Program</i> (21-23)/1st-6th grade/6-15 y olds/1992- 2002/Greece	Social cognitive theory	Nutrition education for children through 10 themes in 10 lessons, 1 per fortnight. Nutrition education for parents through 1 lecture per semester and educational materials. Once a semester meeting for overweight and obese children. Also aimed at increasing physical activity. Based on <i>Know Your Body</i> curriculum developed in United States. Focused on both physical activity and nutrition. Involved parents.	10-y study	Lower BMI increase in intervention group ($P < 0.05$). Higher intake of potassium ($P = 0.018$) and magnesium ($P = 0.011$) in intervention compared to control.

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Table 1. (Continued)

<i>n</i>	Study/grade/age/year/country	Theory	Dietary components of the intervention	Duration	Salient findings
8.	<i>Diet and Nutrition Intervention</i> (24)/1st–8th grade/5–15 y olds/2002–2003/Chile	No known theory	Nutrition education for children through curricula. Selling of healthier food items at school kiosks. Involvement of parents. Contest in which stickers were given to kids for eating healthy snacks. Physical activity was also targeted.	One academic year	Improvement in BMI and waist circumference for boys ($P < 0.001$) but no change for girls.
9.	<i>Active Program Promoting Lifestyle Education in School (APPLES)</i> (25,26)/2nd–4th grade/7–11 y olds/1996–1997/United Kingdom	No known theory	Targeted students, parents, teachers, catering staff, and school environment. Schools developed individual action plans. Modification of school meals.	One academic year	No change in BMI or dieting behavior. Vegetable consumption higher in the intervention group (0.3 portions/d)
10.	<i>Carbonated Drink Reduction</i> (27)/2nd–5th grade/7–11 y olds/2001–2002/United Kingdom	No known theory	Decrease consumption of carbonated drinks by a simple message.	One hour session for each class each term for 1 y	Carbonated drinks decreased in the intervention group (by 0.6 glasses). The percentage of overweight and obese children decreased in the intervention group (by 0.2%).
11.	<i>Pathways</i> (28)/3rd–5th grade (American Indians)/8–11 y olds/1997–1998/United States	Social cognitive theory	Classroom curricula modified to promote healthy nutrition and physical activity. Modifications in food service to reduce fat. Family involvement to support healthy behaviors.	Two 45-min lessons for 12 wk	Knowledge ($P < 0.001$), attitudes ($P < 0.05$), and behaviors ($P < 0.001$) positively changed. No significant reduction in body fat.
12.	<i>SWITCH</i> (29)/3rd–5th grade/8–11 y olds/2005–2006/United States	Social ecological model	Community, school, and family based intervention for nutrition, physical activity, and screen time. First phase: Child and parents identify behaviors to change. Second phase: Plan changes based on self rewards. Third phase: Plan meals, plan healthy snacks, increase shopping of fruits and vegetables. Fourth phase: Maintenance of healthy behaviors. Five components: self-assessment; 50 h nutrition education per student per school year using <i>Planet Health</i> and <i>Know Your Body</i> curricula; nutrition policy; social marketing; family outreach	Academic year (9 mo)	Results not yet published
13.	<i>Policy-based School Intervention</i> (30)/4th–6th grade/Mean age 11.3 y/2005–2006/United States	Social marketing and other theories	Primary prevention program that focuses on modification of environmental cues; improving social support, and building self-efficacy for healthy eating and physical activity. Secondary prevention program that focuses on behavior modification, uses synchronous internet counseling, and e-mails.	2 y	A 50% reduction in the incidence of overweight. After 2 y only 7.5% children in the intervention group were overweight compared to 14.9% in the control group.
14.	<i>Louisiana Health</i> (31)/4th–6th grade/10–13 y olds/2006–2009/United States	Social cognitive theory	Primary prevention program that focuses on modification of environmental cues; improving social support, and building self-efficacy for healthy eating and physical activity. Secondary prevention program that focuses on behavior modification, uses synchronous internet counseling, and e-mails.	30 mo	Results awaited
15.	<i>Social Cognitive Theory based Intervention</i> (32)/5th grade/11 y olds/2006–2007/United States	Social cognitive theory	Four modules: 3 sessions of physical activity, 3 sessions of increasing fruit and vegetable consumption, 3 sessions of limiting TV usage, and 3 sessions of replacing sweetened beverages with water.	12 wk	Increase in expectations for drinking water ($P = 0.049$). Increase in number of glasses of water consumed ($P = 0.022$).

(Continued)

Table 1. (Continued)

<i>n</i>	Study/grade/age/year/country	Theory	Dietary components of the intervention	Duration	Salient findings
16.	<i>Pilot Community Prevention Program</i> (33)/6th grade/11–12 y olds/2004–2005/United States	Trans-theoretical model	Instruction in nutrition, fitness, self-efficacy, goal setting, and stages of change. Families were involved. Family fun night was organized.	Five 40-min sessions over the course of 6 wk	No significant changes from pre- to post-test in students' individual health attitudes and behaviors. Mean family ratings improved in importance of goal setting for eating ($P < 0.05$). Students in garden based nutrition education increased their intake of fruits and vegetables compared to control ($P < 0.001$).
17.	<i>Nutrition in the Garden</i> (34)/6th grade/10–13 y olds/Published in 2007/United States	No known theory	12-wk curriculum that combined nutrition education with horticulture. Hands-on garden based activities.	12 wk	Post-test % fat in food was less ($t = 2.06, P = 0.04$). Duration of exercise was higher ($t = 2.925, P = 0.004$).
18.	<i>Stage-based Intervention</i> (35)/6th–8th grade/12–17 y olds/2000–2001/United States	Pender's health promotion model Trans-theoretical model	Four 45-min sessions using consciousness raising and self-re-evaluation for fat control and physical activity. Graduate nursing students implemented. Delivered in physical education classes. First 20–30 min discussion on food labels, portion size, food pyramid, and food decision making.	4 classroom sessions	Only formative evaluation done
19.	<i>School-based Obesity Prevention Program</i> (36)/6th–8th grade/12–15 y olds/Published in 2008/United States	No known theory	20–30 min physical activity session. Free fruit in 9 schools. Paid fruit in 9 schools. No fruit in 20 schools	16 classroom sessions	Free fruit school had higher intake of fruits and vegetables ($P < 0.001$).
20.	<i>Nonwegian School Fruit Program</i> (37)/7th grade/11–12 y olds/2001–2002/Norway	No known theory	Classroom curriculum in science classes. Units included: getting right amount of energy, use of personal data, importance of healthy food choices, role of food and activity environment, and maintaining skills as a competent eater.	One academic year	Adiposity indices not measured. Improvement in eating ($P < 0.05$) and physical activity ($P < 0.05$) behaviors.
21.	<i>Choice, Control, and Change</i> (38)/7th grade/11–13 y olds/2006/United States	Theory of planned behavior	Two 30-min Power Point presentations available commercially. Topics included causes and health problems of obesity, body image, benefits of healthy body weight, healthy food choices, food label reading, controlling portion size, changing unhealthy habits, increasing physical activity, and overcoming barriers.	24 sessions over a period of 7–8 wk	Changes in dietary knowledge ($P < 0.001$) and dietary intentions to eat fewer fried foods, fewer sweets, and examine food labels ($P < 0.001$). Program satisfaction significantly linked with behavioral intentions.
22.	<i>Present and Prevent</i> (39)/Middle school/Mean age 14.5 y/2008/United States	Evaluation based on theory of reasoned action	Eight lesson plans: nutrition knowledge about food groups, food pyramid, food labels, advertising, body image, increasing fruit and vegetable consumption, healthy eating at fast food places. Provision of fresh fruit and vegetable snacks every day.	1 wk	Improvements in nutrition knowledge, eating behaviors, and efficacy expectations regarding healthy eating.
23.	<i>Michigan Model Nutrition Curriculum</i> (40)/Middle school/Mean age 12.5 y/2005/United States	No known theory		8 lessons over a period of 1 mo	Intervention group showed an increased willingness to try new fruits compared to control group (24.8 vs. 12.8%, $P < 0.01$) and new vegetables (25.1 vs. 18.4%, $P = 0.01$).
24.	<i>USDA Fresh Fruit and Vegetable Program</i> (41)/4th–9th grade/9–14 y olds/2005–2007/United States	No known theory		Two academic years	

(Continued)

Table 1. (Continued)

<i>n</i>	Study/grade/age/year/country	Theory	Dietary components of the intervention	Duration	Salient findings
25	<i>New Moves</i> (42,43)/9th–12th grade/14–17 y olds/2000–2001/United States	Social cognitive theory	Girls-only alternative PE program that focused on environmental, personal, and behavioral factors for nutrition and physical activity. Nutrition sessions focused on building skills and self-efficacy for eating behaviors.	16 wk	Majority of outcomes were not significant.

reified and followed those over time. To improve any theory, it is important to find out which components or constructs of that theory are working and to what extent. Hence, it becomes very important to operationalize the constructs of a theory and document changes in these constructs as a result of the intervention. Future researchers and intervention evaluators could develop psychometrically robust instruments that measure the changes in constructs of the theory that is being used in the intervention and track those over time.

In terms of the impact of the program, most programs have measured changes in antecedents of childhood obesity such as dietary knowledge, dietary attitudes, dietary behavior, etc. Six interventions (20,24,29–31,36) did not measure these antecedents. From the 19 interventions that measured antecedents of childhood obesity, 15 interventions (15,17,18,21,26–28,32,34,35,37–41) showed significant changes in the favorable direction for these antecedents, whereas 4 (14,19,33,42) could not demonstrate any significant change. It is important that all interventions measure changes in antecedents of childhood obesity. Psychometrically valid and reliable instruments must be developed to measure these antecedents and reported by all interventions. When it comes to measuring changes in adiposity indices such as BMI, waist circumference, skinfold thickness, etc., slightly more than one-half, only 14 interventions, measured these. From these 14 interventions, only 6 (15,20,21,24,27,30) were able to demonstrate significant changes in adiposity indices or could be considered successful in affecting childhood obesity. The characteristics of the successful programs are not straightforward. From these 6 interventions, 4 (15,20,21,24) focused on both physical activity and dietary behaviors and 2 (27,30) focused on only dietary behaviors. From these 6 interventions, only 2 (21,30) used behavioral theories and 4 (15,20,24,27) did not explicitly focus on any behavioral theory.

In terms of duration, approximately one-half of the interventions (13) were longer than 6 mo. Four interventions (15,35,39,40) were <1 mo long and 8 interventions (18,28,32–34,36,38,42) were between 1 and 6 mo. Of the 6 interventions that measured adiposity indices and were successful in altering them, the study durations were 8 h [nutrition education (15)], 3 y (20), 10 y (21), 1 academic year (24), 1 y (27), and 2 y (30). From this it is evident that, although short duration interventions can be successful, it is usually the interventions that are longer than 6 mo that tend to be more successful. For behavior change to take place, usually 6 mo is considered a minimum time (44). Future research must aim at designing interventions that are at least 6 mo in duration.

In terms of activities, all interventions except 2 (37,41) focused on a curricular component related to dietary education. The 2 interventions that did not use a curricular component distributed free fruit (37) or provided fruit and vegetable snacks (41). Although neither of these interventions measured changes in adiposity, they did demonstrate significant changes in antecedents of behavior, particularly consumption of fruits and vegetables. Hence, it can be said that there is some merit to providing fruits and

Table 2. Summary of designs used in evaluation of school based childhood obesity prevention interventions

n	Study	Design
1.	<i>Fit for Life</i> (14)	Quasi experimental
2.	<i>Kiel Obesity Prevention Study (KOPS)</i> (15,16)	Quasi experimental
3.	<i>Be Smart</i> (17)	Experimental with random assignment at individual level
4.	<i>Peer Modeling and Rewards</i> (18)	Quasi experimental
5.	<i>StEP TWO program</i> (19)	Quasi experimental
6.	<i>Obesity intervention in Beijing</i> (20)	Experimental with random assignment at group level
7.	<i>Cretan Health and Nutrition Education Program</i> (21–23)	Experimental with random assignment at group level
8.	<i>Diet and Nutrition Intervention</i> (24)	Quasi experimental
9.	<i>Active Program Promoting Lifestyle Education in School (APPLES)</i> (25,26)	Experimental with random assignment at group level
10.	<i>Carbonated Drink Reduction</i> (27)	Experimental with random assignment at group level
11.	<i>Pathways</i> (28)	Experimental with random assignment at group level
12.	<i>SWITCH</i> (29)	Not yet evaluated
13.	<i>Policy-based School Intervention</i> (30)	Experimental with random assignment at group level
14.	<i>Louisiana Health</i> (31)	Experimental with random assignment at group level
15.	<i>Social Cognitive Theory based Intervention</i> (32)	Pre-test post-test design
16.	<i>Pilot Community Prevention Program</i> (33)	Pre-test post-test design
17.	<i>Nutrition in the Garden</i> (34)	Quasi experimental
18.	<i>Stage-based Intervention</i> (35)	Quasi experimental
19.	<i>School-based Obesity Prevention Program</i> (36)	Only formative evaluation done
20.	<i>Norwegian School Fruit Program</i> (37)	Experimental with random assignment at individual level
21.	<i>Choice, Control, & Change</i> (38)	Pre-test post-test design
22.	<i>Present and Prevent</i> (39)	Experimental with random assignment at group level
23.	<i>Michigan Model Nutrition Curriculum</i> (40)	Quasi experimental
24.	<i>USDA Fresh Fruit and Vegetable Program</i> (41)	Quasi experimental
25.	<i>New Moves</i> (42,43)	Experimental with random assignment at group level

vegetables for initiation of behavior. Most of the interventions that used curricula developed their own, but some of the interventions used existing curricula such as the AHA’s Heart Power kits (14), Know Your Body (21,30), and Planet Health curriculum (30). The topics in dietary education curricula have included: nutrition knowledge about food groups, information about the Food Pyramid, food label reading, advertising, body image, ways to increase fruit and vegetable consumption, healthy eating at fast food restaurants, self-monitoring of food consumption, building self-esteem, modification of environmental cues, building self-efficacy for healthy eating, controlling portion size, consuming an appropriate amount of energy, healthy food choices, causes and health problems of obesity, and benefits of healthy body weight. Future curricula can focus on some or all of these areas for building a dietary component in childhood obesity prevention programs. Besides providing dietary education in the classroom, other activities used by interventions included involvement of parents and grandparents (14,18–21,24,28–30,33), organizing fairs and festivals (14), counseling (15,31), home visits (15), food tasting (17), giving incentives (17,18), customized videos (18), selling healthier food at school kiosks (24), modification of school meals (25,28), contests (24), developing nutrition policy (30), social marketing of healthy foods (30), improving social support (31), and garden based activities (34). This is quite an exhaustive list of potential activities that future intervention planners can consider incorporating. Of particular importance is parental and family involvement, which many interventions have used and has a greater potential to influence dietary behaviors.

Most of the interventions (18) focused on individual level behavior change strategies and only 7 (15,25,28–31,42) focused on environmental and policy level changes. Only 2 (15,30) of the 7 interventions that focused on environmental approaches were effective in significantly influencing adiposity indices. Some of the environmental and policy strategies included development of social support (15), changes in school environment (25), modification of school meals (25,28,29), changes in nutrition policy (30), and modification of environmental cues (31,42). Future interventions need to develop stronger strategies to influence environmental and policy level constructs and also measure changes in these constructs.

In terms of the design used in the evaluation of these interventions, the predominant designs were an experimental design with random assignment at the group (class, school, or cluster) level, which was used by 9 studies (20,21,25,27,28,30,31,39,42), and a quasi experimental design, which was also used by 9 interventions (14,15,18,19,24,34,35,40,41) (Table 2). Three studies used a pre-test post-test design (32,33,38) and 2 studies (17,37) used an experimental design with random assignment at individual level. The pre-test post-test design is a rather weak design and does not provide much evidence toward causality. The experimental design with random assignment at the individual level is a pretty robust design, but, unfortunately, in school settings it is often not possible to randomly assign students to 2 groups. The students are already divided into classes and breaking them into separate groups is often too disruptive. The experimental design with random assignment at the group level has been a popular design and is also useful in establishing causality. Of the 6

interventions that demonstrated significant changes in adiposity indices, 4 (20,21,27,30) used an experimental design with random assignment at the group level. This design could be used by future evaluators. However, in this design the unit of randomization is group and unit of analysis is individual data and therefore adjustment must be made during analysis.

In terms of the person implementing the intervention, the majority of the interventions (18) were implemented by teachers. In addition to teachers, some interventions were implemented by guest teachers comprising education majors from a local university (14), a team of nutritionists and school teachers (15,24), researchers (17,27,33), graduate nursing students (35), and school lunch personnel (37,41). Teachers seem to be the most logical choice, because they are certified to teach, know the students, are present in the school, and can be easily trained in the curriculum and other aspects of the intervention. Using trained nutritionists or dietitians is also a good idea. Both the interventions that used a team of nutritionists and teachers were successful in changing adiposity indices. Interventions could at least use the nutritionists or dietitians in planning the intervention. None of the interventions used trained health educators in implementing the intervention and these functionaries that are available in countries like United States can also be used by future interventions, because they have systematic training in planning, implementing, and evaluating health education programs.

Only 8 interventions conducted process evaluation or measured aspects of quality of intervention implementation (17,25,28,30,36,37,39,42). The majority of the interventions (17) did not conduct process evaluation, which is an important precursor to impact and outcome evaluation (46). If the process is not good, then there will be no impact. Of the interventions that did conduct process evaluation, most focused on satisfaction or attendance in the program. Very few interventions documented the degree of fidelity in implementation of the planned curriculum. Developing instruments that measure degree of fidelity and implementing those instruments help in reassuring that the curriculum was indeed implemented the way it was designed.

Limitations

There are some limitations in this review. First, only interventions published in the English language were included and many interventions, especially in international settings, are published in other languages. Second, only interventions published in 3 databases (MEDLINE, CINAHL, and ERIC) were included. Although these databases are quite extensive, they do not tap into all the health literature from every country. Third, many of the interventions, especially those conducted in international settings, often did not meet the rigors of being published in peer-reviewed journals and were thus excluded. Fourth, only 1 researcher retrieved and examined the studies and this could cause some bias. Ideally, 2 or more researchers should have independently worked on this review. This is not a systematic review and

no quality assessment was conducted. Fifth, this review focused on nutrition education alone and it seems, nutrition education in combination with physical activity is more effective than nutrition education only, but we cannot draw any conclusions regarding physical activity components alone. Finally, differing evaluation methodologies and outcome indices were used in the chosen studies. In the selection criteria, attempts were not made to filter studies based on methodology or outcome indicators, but effort was made to be more inclusive of various interventions. As a result, conclusive meta-analysis type of work cannot be done with these studies and comments cannot be made regarding the effect size of the interventions.

Implications for practice

A summary of recommendations for future school based childhood obesity prevention dietary interventions is presented in **Table 3**. Sequential K-12 school based interventions that focus on dietary education could be planned to address the issue of childhood overweight and obesity. If K-12 programming is not feasible, then upper elementary and lower middle school grades would be most appropriate targets for changing dietary behaviors and could be focused. Childhood obesity interventions can focus solely on changing dietary behaviors, but in order to enhance their impact these must be coupled with changing physical activity behaviors also. If the intervention is based on a behavioral theory, then it has several advantages. Social cognitive theory is a popular theory that works well with children and could be used in planning and evaluating interventions. Most interventions use a behavioral theory but do not measure the changes in constructs of that theory. Absence of such data prevents advancement of our understanding about what works and what does not. There is need to develop psychometrically robust instruments that can discern the changes in the constructs of various behavioral theories being used by intervention researchers.

Table 3. Summary of recommendations for future school based childhood obesity prevention dietary interventions

Summary of recommendations
Focus on upper elementary and lower middle school grades
Coupling dietary behaviors with physical activity behaviors
Use of behavioral theory (such as social cognitive theory) in planning and evaluation
Measurement of impact at 3 levels: 1) constructs of behavioral theory; 2) dietary behavior; 3) adiposity indices
Duration of at least 6 mo
Use of curriculum coupled with parental/family involvement
Inclusion of environmental and policy approaches such as building social support, modification of school meals, and changes in nutrition policies
Use of teachers for implementation coupled with nutritionists/dietitians or health educators
Utilization of experimental design with random assignment at group level
Utilization of process evaluation to assess degree of fidelity of implementation and satisfaction

To assess the impact of the dietary component of childhood obesity prevention programs, efforts must be made to measure changes at 3 levels. First, as discussed in the previous paragraph, assessment of the changes in constructs of the behavioral theory must be made. Second, changes in dietary behavior such as fruit and vegetable consumption, portion size, consumption of sweetened beverages, etc. could be measured. Finally, changes in adiposity indices such as BMI, skinfold thickness, waist circumference, etc. could be measured and reported. It is very important that all interventions could systematically measure and document changes at all 3 levels. Such practice would help in estimating effect sizes of interventions and improving efforts at addressing the issue of childhood obesity.

It can be recommended that interventions be at least 6 months long, and introduction of education through a curriculum seems to be the best approach. This should be complemented by other approaches such as parental and family involvement. Further individual approaches to behavior change should be complemented with environmental and policy approaches such as building social support, modification of school meals, and changes in nutrition policies. In terms of the person implementing the intervention, teachers are most appropriate. They can be complemented by employing nutritionists/dietitians or health educators.

For evaluation of interventions, the most useful design is experimental with random assignment at the group level. If this is not possible, then quasi experimental designs can also be instituted. Finally, all interventions must utilize process evaluation and assess degree of fidelity of implementation and satisfaction.

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