

Childhood Obesity Intervention Programs: A Systematic Review

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Purpose: The purpose of this study was to identify theoretical frameworks that drive childhood obesity prevention programs and identify successful components of childhood preventive intervention programs.

Methods: PubMed and Google Scholar databases was searched for community, school and home settings obesity interventions with anthropometric measures in children and adolescents between the ages of 6 and 12 years from 2004 to 2009. Studies were reviewed by intervention type, duration, outcomes measures and significance of intervention aspects, resulting in a yield of 22 intervention studies. **Results:** The interventions were arranged in ascending order by age group. In total, 22 interventions from around the world were found to tackle the critically important issue of childhood obesity. Among the 22 published studies, ten interventions focused on individual level behavior change and twelve included some nutrition policy changes. With respect to individual behavior, components included cooking classes for families, training on food selection, and health education session on disordered eating. In terms of measurement of behaviors, the majority of the studies (n=22) measured changes in lifestyle. Many of these studies were able to show positive outcome towards progress of healthy behaviors. From the 22 published studies, six interventions relied on secondary prevention while fifteen interventions used a primary prevention method. Only one intervention used both types. Out of 22 published studies, only nine showed significant outcomes. **Conclusions:** Schools are the best settings for childhood obesity interventions because children form libeling eating and physical activity habits at a young age. School-based interventions should focus on childhood obesity prevention. They must target enhancement of physical activity and healthy nutrition in order to decrease BMI. Finally, future interventions should seek to incorporate individual behavior change strategies with policy and environmental changes in order to make a substantial and sustainable impact on children's health and well-being.

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Keywords: Obesity prevention and control, Physical activity interventions, Health promotion, Elementary school; Childhood obesity.

INTRODUCTION

Childhood obesity has become a global epidemic. Both developed and developing countries face the crisis of rising trends of overweight and obesity among children (Flynn et al., 2004). Ten

percent of school-children worldwide are overweight and in the United States alone, 25% of children are overweight while 11% of them are obese (Sharma, 2007). Table (1) shows the prevalence of obesity in developed countries around the world.

Table 1: Change in the prevalence of obesity rate by year and age group in developed countries around the world (Sharma, 2007).

Country	Year/year range	Age group	Change in Rate of obesity/current rate
Japan	1974-1993	6-14 yrs	5 % to 10%
England	1984-1998	7-14 yrs	8% to 20%
Spain	1985- 1998	6-7 yrs	25% to 35%
France	1992-1996	5-12 yrs	10% to 14%
Australia	1985-1997	6-12 yrs	27%
Greece	1984-2000	6-12 yrs	7% to 12%
Thailand	2000	----yrs	11-14%
New Zealand Pacific	-----	3-7 yr	34-49%

The highest prevalence rates of childhood obesity have been observed in developed countries; however, its prevalence is increasing in developing countries as well. The prevalence of childhood obesity is high in Central and Eastern Europe and pacific

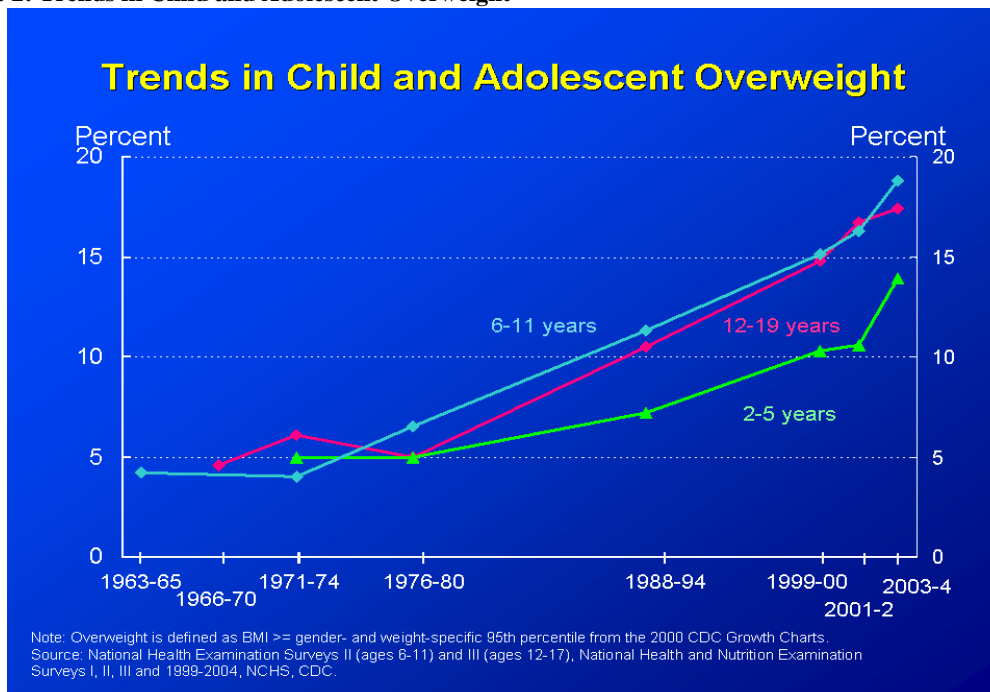
Bases. For instance in 1998, The World Health Organization project monitoring of cardiovascular diseases (MONICA) reported Iran as one of the seven countries with the highest prevalence of childhood obesity at 10 % (Dehghan et al., 2005). This reported

also notes that in Saudi Arabia one in every six children aged 6 to 18 years old is obese. Moreover worldwide, there are proportionately more girls overweight than boys, particularly among adolescents (Dehghan et al., 2005).

Surveys conducted by NHANES (National Health and Nutrition Examination) over the years 1976-1980 and 2003-2006 show that the trend in

childhood obesity has been rising alarmingly. The prevalence of obesity among children aged 2-5 years has increased from 5% to 12.4% in this time period and for the age group 6-11 years, it has increased from 6.5% to 17%. Among adolescents 12-19 years, the prevalence of obesity increased about 12% (5% to 17.6%) (Centers for Disease Control and Prevention [CDC], 2009).

Table 2: Trends in Child and Adolescent Overweight



Source: (http://www.cdc.gov/nchs/products/pubs/pubd/hestats/overweight/overweight_child_03.htm)

Childhood obesity is a health condition that has a tendency to continue into adulthood. A study conducted by Whitaker et al., (1997) assessed the link between childhood obesity and the risk of obesity in adulthood. They found that the risk odds ratio for obesity ranged from 1.3 at 1 or 2 years old to 17.5 at 15 to 17 years old.

More than 70% of individuals with a history of childhood obesity grow up to become obese adults (Dehghan et al., 2005). In fact, childhood obesity is not just a disease in itself but in the long term it is responsible for social disabilities and the risk of adult diseases for an individual suffering from it (Flodmark et al., 2005). The most common and highly documented risk of childhood obesity is maturity-onset diabetes in the young (MODY). Sharma (2007) reported that childhood obesity increases the risk of adult obesity, development of metabolic syndrome and MODY by 10 to 30 times. Other related health problems include cardiovascular disease with high blood cholesterol and high blood pressure (Cunnane, 1993). In addition, obese children have abnormal glucose tolerance, digestive disorders and infertility (Sharma, 2007). The childhood obesity epidemic has been projected to result in a decrease in life expectancy of 2-5 years in the 21st century; in what

would be the first decrease in life expectancy since data started being collected in 1900 (Olshansky et al., 2005).

Various factors contribute to overweight and obesity in children. In a literature review by Keller and Stevens (1996), obesity in children was linked to prenatal, genetic, familial and environmental influences. Parents not only contribute genetically but also parental dietary and life-style behaviors critically affect obesity in children (Hodges, 2003).

Obesity means an excess amount of body fat. No general agreement exists on the definition of obesity in children as it does adults. Most professionals use published guidelines based on the body mass index (BMI), or a modified BMI for age, to measure obesity in children. Others define obesity in children as body weight at least 20% higher than a healthy weight for a child of that height, or a body fat percentage above 25% in boys or above 32% in girls (Dehghan et al., 2005). The Center for Disease Control and Prevention defined overweight as at or above the 95th percentile of BMI for age and "at risk for overweight" as between the 85th to 95th percentile of BMI for age. European researchers classified overweight as at or above the 85th percentile and obesity as at or above the 95th percentile of BMI (Sharma, 2007). Waist to hip ratio,

waist-circumference (WC) and skin fold thickness (the sums or ratios of abdominal, subscapular, suprailiac and triceps) and fat mass determined by bioimpedance etc. have also been used to measure obesity (Sharma, 2007).

The body weight of an individual is a result of various factors and the interplays between these factors. Some like the familial, genetic and to some extent, metabolic factors cannot be controlled. Moreover, it is difficult to counteract cultural and socio-economical influences that contribute to obesity. But, the majority of cases involving overweight and obesity are the result of excess calorie/energy consumption and inadequate energy usage i.e., low levels of physical activity and a more sedentary life style (Sharma, 2007). Therefore, any attempts at fighting this growing epidemic of childhood obesity must focus on changing these two behavioral tendencies, that is, reduce energy consumption and increase energy usage (Sharma, 2007).

Obesity takes a toll on the healthcare system as well. Two to six percent and sometimes as high as seven percent of total healthcare costs are spent in combating obesity and obesity related diseases in many of the developed countries. Public Health strategies commonly suggest combating obesity in early childhood. Childhood is considered a priority population for programs because (a) forming good dietary habits and losing weight is easier in childhood than in adulthood and (b) school settings are feasible for group interventions. The emphasis on physical activity and weight stabilization in years of growth is better achieved when the values of health and healthy habits are inculcated during early childhood. Public health strategies suggest combating obesity by interventions aimed at promoting breast feeding, limiting television viewing and involving children in outdoor physical activities. Other interventions have focused on encouraging a balanced diet with more vegetable and fruit intake and at the same time, controlling the portion size and reducing consumption of carbonated and other high calorie soft drinks (Sharma, 2007).

Interventions to fight childhood obesity can be directed at two levels.

In terms of primary prevention, interventions may be targeted or universal. Universal (e.g. school-based interventions) aim at the community level, with the goal of stabilizing or reducing the mean BMI within a population. Selective interventions (e.g. family-based intervention, children of obese parents) target high risk individuals at the interpersonal level. This strategy is concerned with improving the knowledge and skills of individuals to increase competence and personal autonomy and thus prevent excessive weight gain.

1. With respect to secondary prevention, interventions focus on overweight and obese children and seek to prevent further weight gain and/or to reduce body weight (Muller et al., 2005).

2. This study reviewed articles published between 2004 and 2009 that were based on interventions aimed at obesity prevention. The purpose of this study was to identify theoretical frameworks that drive childhood obesity prevention programs and identify successful components of childhood preventive intervention programs. This information will be used to create a profile of successful childhood obesity prevention intervention programs.

METHODS

Research Design

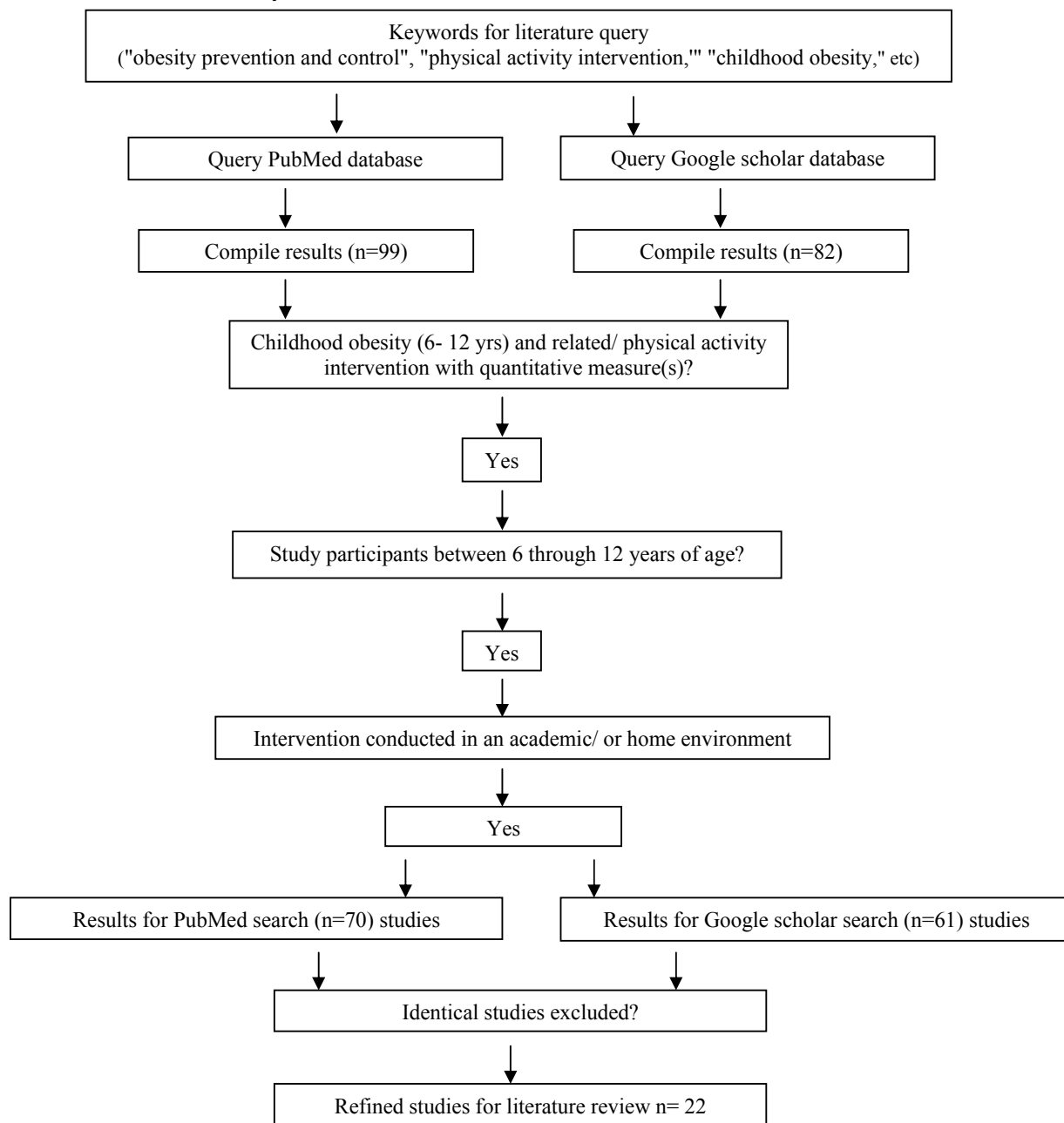
This study is a qualitative research study. A secondary data collection technique was utilized and conducted through a search of articles published between 2004 in PubMed and Google Scholar databases. The criteria for selecting publications for inclusion in the study were as follows:

1. Articles published between 2004 and 2009.
2. An obesity related intervention.
3. Involving children between 6 through 12 years of age.
4. Implementation of the intervention in a community, school and/ or home setting.
5. A content analysis was then conducted based on specific topics: childhood obesity, obesity-related intervention and implementation of the intervention in a community, school and/ or home setting.

Subjects

PubMed and Google Scholar Search Result:

Separate queries were conducted in PubMed and Google Scholar databases. The initial PubMed-based literature query used a cross reference of 5 keyword identifiers including: "obesity prevention and control," "physical activity interventions," "health promotion," "elementary school" and childhood obesity which produced 99 compiled results. A review of the abstracts was conducted utilizing our selection criteria. In total, 18 articles did not address childhood obesity prevention programs nor did they include interventions. Another 11 articles included subjects above the age of 12 or under the age of 6 years. A total of 70 studies from the PubMed search remained for examination. Separately, the Google Scholar -based query used a cross-reference of 4 keyword identifiers as mentioned above and produced 82 compiled results. A review of the abstracts was conducted to further refine the results using the aforementioned inclusion criteria. Excluded were 21 studies that did address childhood obesity intervention programs. As a result, the Google Scholar -based search produced 61 abstracts. PubMed and Google Scholar results were further examined to identify identical intervention studies published under differing titles and time periods. In the end, 22 studies were identified for review by intervention type, duration, outcomes measures and significance of intervention aspects.

Figure 1: Selection Process for Systematic Review**Instruments**

For this study, interventions aimed at obesity prevention were measured through reviewing articles and categorizing them into 5-year periods by the area of importance.

A data gathering sheet was designed to identify the area of importance of each article. This gathering sheet has nineteen variables as the following:

- 1- Article title.
- 2- Article citation
- 3- Journal title.
- 4- Total number of the target population.
- 5- Participants' age or age group.
- 6- Participants' ethnic race.

- 7- Participants' socio-economic standard (SES).
- 8- Participants' gender.
- 9- Parental involvement in the study- Yes or No.
- 10- Study environment
- 11- Types of prevention
- 12- Study Design
- 13- Description of the intervention
- 14- Intervention Outcome
- 15- Limitation of the study
- 16- Theoretical framework used.
- 17- Dose and duration of the intervention
- 18- Content components of the intervention
- 19- Study outcomes.

Data Collection Procedures

For this study, data were collected through an article review. In the first step, articles that addressed childhood obesity prevention programs were selected. Articles were reviewed to determine whether they focused on our criteria or not. The next step was to abstract information from each article and reports it on the data collection sheet. For data quality assurance, the article review process was conducted twice. This process was used to increase authenticity and accuracy of the systemic review. After these procedures were completed, data were entered into SPSS for data analysis. Frequencies were conducted to identify trend and describe the number of articles focusing on each area under investigation so we could provide a profile of successful childhood obesity prevention intervention programs

RESULTS

The interventions have been arranged in ascending order by age group, and have been summarized in Table 1. The first intervention described is called the *Fit Kids/Fit Families (FKFF)* in children ages 5-16 and their families from Washington County in Wisconsin. Using a non-experimental design, 68 children and their families from Washington County participated in this 12-week program, which promoted healthy lifestyle changes (Joose et al., 2008).

For this intervention, pre- and post data were gathered, on age, height, weight, BMI, body circumference measurements, child and family habits, and child self-esteem. A once-a-week nutrition, physical activities and behavioral log captured behaviors. In addition, two hour meetings using a dietician, behaviorist, and exercise specialist were held weekly in a community setting. At the result, both parents and children showed improved knowledge and attitudes regarding healthy lifestyle changes. Logs

report that 56 % of the children increased their physical activity and 32% reduced their sedentary activity. While 81% improved and 13% maintained BMI, 74% of the children showed decreased total body circumferences. Nearly two-thirds shown clearly enhanced self-esteem on the Rosenberg Self-Esteem Scale (Joose et al., 2008).

The second intervention is called SWITCH, and included a rationale, design, and implementation of a community, school, and family-based intervention. The study districts are found in Lakeville, Minnesota and Cedar Rapids, Iowa. Lakeville is a community of about 50,000 and is the southern-most suburb of Minneapolis- St. Paul. Cedar Rapids, has approximately 125,000 residents and is located in east-central Iowa. There were ten randomly selected schools used while implementing the intervention, which five schools assigned to the control group and the other five assigned to the experimental group. The control and experimental schools corresponded on socio economic status as well as the area of community (Eisenmann et al., 2008).

There were four consecutive phases to SWITCH, and the intervention was based on social ecological model. During the initial phase of SWITCH, each child created a service line with their parent's help, which identified present health behavior exercises as well as measuring feelings and attitudes toward making changes in the main elements (do, view and chew). After families discovered their present exercises they created short term as well as long-term destinations, which fit within their lifestyle (Eisenmann et al., 2008).

The second phase of the program concentrated on establishing additive advancements strengthened by self-rewards. All advancements in behavior in the direction of reaching a self-discovered destination were rewarded with activity points or goal points (Eisenmann et al., 2008).

Table 3: Summary of school-based interventions for prevention of overweight and obesity

Study/ grade/age/ year/ country	Theory	Intervention	Duration	Major findings
Fit Kids/Fit Families (FKFF) K-11 The mean age is 10.4 years (age range, 5-16) Published in 2008 The United State of America	No known theory	Health educational sessions. Create nutrition plan Increase physical activities Behavioral lessons: eating disordered, self care and self esteem.	12-week sessions (3 times per year)	59% of the children increased their physical activity 32% reduced their sedentary activity 81% improved and 13% maintained BMI 74% of the children showed decreased total body circumferences Two-thirds demonstrated improved self-esteem on the Rosenberg Self-Esteem Scale.
SWITCH: rationale, design, and implementation of a community school, and family-based intervention 3rd through 5th grade 8-11 year olds	Social ecological models	Physical activities sessions. Public education/training workshops for parents, teachers, health care providers, religious leaders and business leaders in the	Academic year approximately 8 months.	Enhance children attribute such as knowledge about physical activity and food selections; their values about health, physical.

2005-2006 The United State of America		community at large.		activity, and nutrition; and their sense of personal control over their choice.
Gold Medal Schools Program First, third, and fifth-grade Elementary school students 5-11 year olds 2005-2006 The United State of America	No known theory	Improve eating habits, Increase physical activity Decrease sedentary activity Measure parent perceptions of school nutrition policies.	One year	Children in the Gold Medal Schools group drank fewer soft drinks per day. Gold Medal Schools children walked or biked to school more often at baseline and 1 year.
A Family-based Intervention to promote Healthy Lifestyles in an Aboriginal Community in Canada K-12 5-18 year olds Published in 2007 Canada	The protection motivation theory, the social learning theory, normative influences and theories of persuasion	Behavioral Change: dietary; provision of goods; physical activity. Health education session.	6- month	Changes in daily energy intake & physical activity Changes in knowledge and attitudes toward healthy lifestyles, self/response efficacy, body fat, BMI, abdominal fat, blood pressure, glucose, and lipids.
Evaluation of a classroom-based physical activity promoting program Elementary school students(*) 6-12 year olds 2004-2005 China	No known theory	Increase physical activity: from Moderate to Vigorous range	8-month	Significant increases in the average daily physical activity energy expenditure and duration among the students in the intervention school.
Evaluation of a pilot hospital based community program implementing fitness and nutrition education for overweight children 3rd through 6th grade 8-12 year olds Published in 2008 The United State of America	No known theory	Weekly exercise programs Monthly nutrition education BMI and waist circumference measures Daily diaries Participant completion of food and activity study diaries The wearing of pedometers	24- week	BMI decreased between baseline and weeks 12 and 24. The overall mean waist circumference (inches) also decreased between baseline and weeks 12 and 24.
Physical Activity and Healthy Eating in the After-School Environment 4th through 7th grade 9-13 year olds Published in 2008 The United State of America	No known theory	After-school settings had 4 sessions per day: Academic Enrichment: Moderate and Vigorous Physical Activities (MVPA) Recreational (active and non active) Healthy snack	Academic year approximately 8 months.	Children were spending approximately 47 minutes of after-school time in active recreation, with 49% of this time in organized activities and 51% in free play. The study found that children in an after-school setting were spending significantly more time in MVPA while in free play than when in organized activities.
Outcomes of a group-randomized trial to prevent excess weight gain, reduce screen behaviours and promote physical activity in 10-year-old children: switch-play All grade 5 students 10-11 year olds Published in 2008 Australia	principles from social cognitive theory: self-efficacy and behavioral capability behavioral choice theory: preference, reinforcement	Decrease sedentary behavior Self-monitoring Increasing physical activity Decision-making 'Switch-Play' games Perform advocacy plays	March to November 2002 (Academic year in Australia)	Significant decrease in BMI among those in the combined BM/FMS group compared with the control group.

Policy-Based School Intervention to Prevent Overweight and Obesity 4 th through 5 th grade 11.20-11.13 year old Published in 2008 The United State of America	No known theory	School self-assessment Nutrition education Nutrition policy Social marketing Parent outreach Measure dietary Intake Increase physical activity Decrease sedentary behavior	9- month	Significant decrease in BMI Significant increases in the average daily physical activity energy expenditure and duration among the students in the intervention school Changes in knowledge and attitudes toward healthy lifestyles Enhance parent and children values about health, physical activity, and nutrition.
Preliminary Findings from an Evaluation of the USDA Fresh Fruit and Vegetable Program in Wisconsin Schools 4 th , 7 th , and 9 th grade 11-15 year old 2006-2007 The United State of America	No known theory	Try new fruit at school Try new vegetable at school Try new fruit at home Try new vegetable at home Choose fruit as snack instead of chips/candy Choose vegetable as snack instead of chips/candy	3 months of program implementation	40% indicated they would choose a fruit Only 21% would choose a vegetable. 33.8% of students said they would try a new vegetable. At home 55.6% of students indicated they would try a new fruit and 32.9% said they would try a new vegetable. Students were more willing to eat fruits than vegetables and also more willing to try both fruits than vegetables at home versus at school. There was significant opportunity for students to move in a positive direction from either "would not" or "might" in terms of willingness eat fruits and vegetables.
Preventing childhood obesity: two year follow-up results from the Christchurch obesity prevention programme in schools (CHOPPS) 2 nd - 5 th grade 7-11 year old 2001 The United Kingdom	No known theory	To discourage the consumption of "fizzy" drinks (sweetened and unsweetened) with positive affirmation of a balanced healthy diet One hour of health education session Improve overall wellbeing and reducing the consumption of diet carbonated drinks so they would benefit dental health.	12- month school based intervention 3-year follow-up	There was no significant difference in the baseline z scores between children in the control and intervention groups who were present or missing at the final measurements.
Increasing activity and improving nutrition through a schools-based programme: Project Energize. Design, programme, randomisation and evaluation methodology 1 st - 4 th grade 5 -10 years old Published in 2008 New Zealand	No known theory	Physical activity Nutritional diet Dental health care	2- year	Reduced sedentary time Increased children's activity levels Improved dental health Improved body composition.

<p>Healthy Buddies: A Novel, Peer-Led Health Promotion Program for the Prevention of Obesity and Eating Disorders in Children in Elementary School K- 7th grade 5-13 year old Published in 2007 Canada</p>	<p>No known theory <u>Note:</u> The study used the role model and self-esteem as a component in their intervention</p>	<p>Regular Physical Activity: Aerobic fitness sessions Healthy Eating: Students learned about nutritious and non-nutritious foods and beverages. Healthy Body Image, Self-esteem, and Social Responsibility: Addressed body-image and disordered eating issues</p>	<p>10-month (Academic year)</p>	<p>Increased health knowledge, health behaviors, and health attitudes in children Increased physical activities.</p>
<p>Reducing unhealthy weight gain in children through community capacity-building: results of a quasi-experimental intervention program, Be Active Eat Well K- 6th grade 4-12 year old 2003-2006 Australia</p>	<p>No known theory</p>	<p>Nutrition strategies Physical activity Reduce screen time</p>	<p>3-year</p>	<p>The program was effective at slowing the rate of weight gain (by about 1 kg) and waist gain (about 3 cm) in primary school-aged children, in a manner that was safe. They saw some evidence of this upstream impact through reduction in the social gradient with weight gain, and this implies that community-wide interventions should not increase health inequalities in relation to child overweight.</p>
<p>YMCA Program for Childhood Obesity: A Case Series K- 8th grade 3.6-14 year old 2007 The United State of America</p>	<p>No known theory</p>	<p>Group counseling Nutrition education Physical activity Gift card incentives</p>	<p>6-month</p>	<p>15 of the 35 active participants (43%) experienced a clinically significant change in weight gain compared with controls Results suggest that community programs can be successful in addressing the problem of childhood obesity in families that are motivated.</p>
<p>L.I.F.E.: A School-Based Heart-Health Screening and Intervention Program 5th grade 10 year old Published in 2008 The United State of America</p>	<p>Hierarchy of needs Social cognitive theory Ecological perspective Health belief model Stages of change PRECEDE-PROCEED</p>	<p>Awareness/knowledge tactics Pedometers for teachers Teacher training for e-learning unit HealthyHearts4Kids Incentive-based programs Family-based walking/physical activity programs No-TV week Parent-child cooking classes</p>	<p>3-year</p>	<p>Increased physical activity and healthy nutrition choices A team approach within the school setting, with families and community partners, is essential in addressing current and future health concerns of today's youth.</p>
<p>Louisiana (LA) Health: Design and methods for a childhood obesity prevention program in rural schools 4th-6th grade 8-12 year old Published in 2008 The United State of America</p>	<p>Social Learning Theory</p>	<p>Healthy diet promotion. Physical activity promotion Program for families Classroom curriculum Internet counseling and education</p>	<p>3-year</p>	<p>Policy decisions are made by a five-person committee that includes scientists and community and state education leaders. Also, recruitment goals for the randomized controlled trial (RCT) and observation control group were met.</p>

<p>Pilot Study of an Individually Tailored Educational Program by Mail to promote Healthy Weight in Chinese American Children 3rd-5th grade 8-10 year old 2005-2006 The United State of America</p>	<p>Ecological Model- Ecological System Theory (EST)</p>	<p>Knowledge related to children's dietary and physical activity Classes for food choices</p>	<p>One year</p>	<p>The discrepancies seen in the children's and mothers' levels of knowledge are not well understood. It is possible that children learned knowledge regarding physical activity and nutrition at school or through media because there has been a lot of attention given to childhood obesity prevention. Although mothers were asked to share the information with their children, it is uncertain whether they shared the information.</p>
<p>Reducing weight gain in children through enhancing physical activity and nutrition: the APPLE project 1st-6th grade 5-12 year old Published in 2006 New Zealand</p>	<p>No known theory</p>	<p>Increasing physical activity Increasing the intake of fruit and vegetables Reducing the intake of sugary drinks Curricular-based activities Provision of cooled water filters in each school</p>	<p>2-year</p>	<p>Intervention children were spending on average 26 more minutes per day in activities of a moderate or vigorous nature than control children The mean BMI <i>Z score</i> was significantly lower in intervention children than in control children by 0.09 after 1 y and 0.26 at 2 y. Waist circumference was also significantly lower at 2 y in intervention children (1.0 cm), and systolic blood pressure was lower at 1 year, although this was no longer significant at 2 y.</p>
<p>Two-year follow-up of an Obesity prevention initiative in children: the APPLE project 1st-6th grade 5-12 year old Published in 2008 New Zealand</p>	<p>No known theory</p>	<p>Increasing physical activity Increasing the intake of fruit and vegetables Reducing the intake of sugary drinks Curricular-based activities Provision of cooled water filters in each school</p>	<p>2-year</p>	<p>Reduced the risk of excessive weight gain in children. Enhanced extracurricular physical activity (during and after the end of the school day). Promoted healthy eating to pupils, and teachers The mean BMI <i>Z score</i> was significantly lower in intervention children than in control children.</p>

<p>Family-Based Weight Management with Latino Mothers and Children 2nd- 11th grade 6-17 year old Published in 2008 The United State of America</p>	<p>No known theory</p>	<p>Workbooks weekly reading assignments, goal setting, and evaluation. Chapter content focuses on nutrition, behavioral change, activity, increased speaking up, and improving parenting skills Families established individual behavioral goals for nutrition, physical activity, and family support Increase daily activity (e.g., play for 60 min on most days) and decrease inactivity (e.g., less TV, computer, and/or video games)</p>	<p>8-week</p>	<p>The majority of the mothers (84.6%) endorsed the idea that they can influence their child's food choices. The mothers also felt they were able to influence physical activity levels (92.3%). These mothers had a strong concern about their children's weight (71%); and the mothers seemed to understand the likelihood that remaining overweight would lead to increased risk for diseases associated with obesity (71%). Additionally, the mothers agreed that their own exercise and eating habits could influence their children's (69%). Seventy-eight percent of the mothers intended to get 30 min of physical exercise at least 5 days per week, with more than 20% indicating they already did this.</p>
<p>Walking the Talk: Fit WIC Wellness Programs Improve Self-Efficacy in Pediatric Obesity Prevention Counseling 51 WIC's staff members 34-45 year old Published in 2004 The United State of America</p>	<p>No known theory</p>	<p>Increase consumption of fresh fruit or vegetables Increase physical activity Increase daily consumption of water</p>	<p>One year</p>	<p>The Fit WIC experience illustrates that supporting staff in achieving their own healthy eating and physical activity goals significantly increases staff commitment and enthusiasm for addressing healthful behavior patterns with clients in the WIC setting. Staff participating in Fit WIC achieved a high degree of personal satisfaction and felt more skilled in communicating about nutrition and physical activity with WIC clients.</p>

The third phase of the program was designed to make it easier for families to plan healthy snacks and healthy meals that included vegetables and fruits, by supplying mealtime as well as shopping planners (Eisenmann et al., 2008).

The fourth phase of the program concentrated on the upkeep of each family's healthy behavior over the period of 8 months. This intervention made it possible to improve children's knowledge regarding selection of foods, physical activities, and nutrition. This program also facilitated children's goal-setting as well as self-monitoring to improve their current habits, in addition, it proposed ways of strengthening their intention to advance healthy behaviors for their families as well as themselves (Eisenmann et al., 2008).

The third intervention was the Gold Medal Schools Program. This study took place at four schools in Tooele County, Utah that served as either intervention or control sites. Every student in the first, third, and fifth grades and their parents were given study packets containing a study letter, parental consent form and parent survey. Parents completed consent forms and surveys. Anthropometric information was collected for every student who was contributing to the survey, but only third- and fifth- grade pupils finished the survey. The parent surveys showed at year one that children in the Gold Medal Schools group drank fewer soft drinks daily (Jordan et al., 2009). Furthermore, variations in dietary habits showed significant differences between the intervention and control groups at year one. Parent surveys also showed that Gold Medal Schools' children increased their

physical activity by walking or biking to school more often at baseline and one year. Finally, longitudinal investigations were suggested to assess the long-term influence of Gold Medal Schools on anthropometric, dietary, sedentary behavior and personal activity (Jordan et al., 2009).

The fourth intervention was a Canadian family-based intervention to promote healthy lifestyles which was published in 2007. Kindergarten to 12-grade students from 50 households were recruited. This study's design was open randomized controlled trial. The intervention was based on protection motivation theory, social learning theory, normative influences and theories of persuasion. Further, this study included an intervention that was made up of several components. The first component was health messaging/education about healthy lifestyles mediated by a key messenger referred to the "health counselor". The second component was physical activity goals, which increase the daily physical activity of all members to a minimum of 150 minutes/week. The last component emphasized increased intake of water or low-fat milk as the usual beverage of choice, as a replacement for soda pop and fruit juices. This was selected as a key component of the intervention. Families participated in a 30-minute introductory meeting and were supplied written material, including Canada's Food Guide to Healthy Eating and Canada's Physical Activity Guide to Healthy Active Living, which are summary plans for healthy living (Anand et al., 2007).

The primary results of the intervention were changes from baseline in daily energy intake, and changes in physical activity. Secondary results included changes in knowledge and attitudes toward healthy lifestyles, self/response efficacy, body fat, BMI, abdominal fat, blood pressure, glucose, and lipids from baseline to the end of intervention (Anand et al., 2007).

The fifth intervention was a Chinese evaluation of a classroom-based physical activity promotion program. The study design was a prospective cohort study. This included elementary school children from grades 1 to 5, with a total of 328 students (150 boys and 178 girls) from the intervention school and 425 students (207 boys and 218 girls) from the control school. The study implemented an intervention that included a classroom-based physical activity program. Many protected and age- and space-appropriate personal activities were included in the program materials. The program was coordinated and applied by teachers, taking about ten minutes at the least once every school day from October 2004 to June 2005. Information on age, gender, height, weight and physical activity patterns of all subjects were collected before and after involvement. Important increases in the average daily physical activity energy expenditure and duration among the students in the intervention school were discovered after the end of the intervention. In addition, there were important dissimilarities in the change in energy expenditure and duration of physical activity between the intervention and control schools. Finally, the BMI of boys in both the intervention and control schools and girls in the control school expanded considerably after the intervention (Liu et al., 2008).

The sixth intervention was an evaluation of a pilot hospital based community education program implementing fitness and nutrition education for overweight children in Leesburg, Virginia. Study participants were a convenience sample comprising of community members who responded to study advertisements to participate in the Kids Living Fit (KLF) program offered at the hospital. There were a total of 185 self-selected participants in the two study groups, KLF intervention group (n= 80) and the no intervention/contrast group (n=105), all of whom were in the second to fifth grades at one of four local elementary schools. The study implemented an intervention that included weekly exercise programs, monthly nutrition education, study questionnaires and daily diaries. The intervention lasted for 24 weeks. At the end, the overall mean BMI decreased between baseline and week 12 (-0.4) and week 24 (-0.6). In addition, the overall mean waist circumference (inches) decreased as well between baseline and week 12 (-0.5) and week 24 (-0.7). Finally, the advantage of a hospital-based program may be the proficiency to target overweight populations that otherwise might not take part in an after-school program for worry of being recognized as overweight by their classmates (Speroni et al., 2008).

The seventh intervention was a Physical Activity and Healthy Eating in the After-School Environment with 9-13-year-olds in Lawrence, Kansas. This study is the first to systematically describe moderate and vigorous physical activities (MVPA) and health education during the after-school environment, independent of outside intervention. Findings from these seven after-school sites indicated that children were spending approximately 47 minutes of after-school time in active recreation, with 49% of this time in organized activities and 51% in free play. The study found that children in an after-school setting were spending significantly more time in MVPA while in free play than when in organized activities (Coleman et al., 2008).

The eighth intervention was an Australian intervention called Switch-Play, which was implemented among fifth-grade students between 10 and 11 years of age. The intervention was based on several theories, social cognitive theory (such as, self-efficacy and behavioral capability) and behavioral choice theory (such as, preference and reinforcement), using techniques for example self-monitoring, behavioral contracting to "switch off" the TV, reinforcement and skill-building. Behavioral modification (BM) condition and an improve children's fundamental movement skills (FMS) condition were two intervention components that been used. These intervention components were delivered in addition to the usual physical education and sports classes. Each of the intervention conditions consisted of 19 lessons (40-50 minutes each), which were delivered by a qualified physical education teacher from March to November 2002 -one school year in Australia (Salmon et al., 2008).

There was a significant intervention outcome between baseline and post intervention on children's

BMI among those in the combined BM/FMS group compared with the control group. Also, there were significant intervention effects between baseline and post intervention for children's TV viewing among children in the BM group compared with those in the control group. Moreover, there were significant average differences in physical activity enjoyment between baseline and post intervention, with children in the FMS group reporting higher average enjoyment scores over time compared with those in the control group. However, there were no significant intervention outcomes on FMS z-scores between baseline and post intervention. Finally, from baseline to post intervention, there were no specific conclusion or outcomes of the intervention such as children's satisfy with their body shape and body weight, or eating to gain weight or lose weight in the last month (Salmon et al., 2008).

The ninth intervention is a Policy-Based School Intervention to Prevent Overweight and Obesity, which has multiple components such as school self-assessment, nutrition education, nutrition policy, social marketing, and parent outreach. Participants were 1,349 students in grades 4 through 6 from ten schools in the Mid-Atlantic region of the USA. Heights and weights were measured annually on a digital scale and wall-mounted stadiometer by a trained research team with a standardized protocol. Dietary intake, specifically total energy consumed (kilojoules), fat consumption (grams), and the number of fruit and vegetable servings, was measured with the Youth/Adolescent Questionnaire, a self-administered 152-item food frequency questionnaire has been used to measure dietary intake. Measurements were collected twice at baseline in the spring semester and again at year two in the spring semester. The study demonstrated that a multi-component school-based intervention can be useful in preventing the overweight among children in grades 4 through 6 in urban public schools (Foster et al., 2008).

The tenth intervention was an Evaluation of the USDA Fresh Fruit and Vegetable Program in schools in Wisconsin. Students in the 4th, 7th, and 9th grade across 25 intervention schools and 10 matched control schools in Wisconsin participated in this study. It was a non-randomized controlled trial study. This intervention aimed to evaluate whether the Wisconsin Fresh Fruit and Vegetable Program (FFVP) is an effective method of introducing school-age children to fresh fruits and vegetables as a healthy food choice. Specifically, the study sought to determine whether the program resulted in positive changes in attitudes and behaviors related to fruit and vegetable consumption. Overall, findings indicate that students were more willing to eat fruits than vegetables and also more willing to try both fruits than vegetables at home versus at school (Jamelske et al., 2008).

The eleventh intervention was performed by James and colleagues in the United Kingdom and included two years of follow-up on the Christchurch obesity prevention program in schools (CHOPPS). This project was started in August 2001 and was completed over one school year. It was based in six

junior schools in southern England and included children aged 7-11. The intervention focused on discouraging children from consuming carbonated drinks and involved one hour of additional health education during each of the four school terms. Results showed that no significant difference in the baseline z-scores between children in the control and intervention groups at the final measurement (James et al., 2007).

The twelfth intervention is Project Energize, from New Zealand, which aimed to increase children's activity levels, reduce sedentary time, and optimize nutritional intake through changes in the school environment and culture. There were sixty-two primary schools with sixty-two control schools participating in this study. The benefits of the intervention include improved body composition, improved dental health, and improvements in a range of associated health measures. The project's evaluation provided evidence in the school setting of what is effective, practical and affordable. At the same time determining what was unproductive, unfeasible or uneconomic, thus helping direct public money and effort into best practices (Graham et al., 2008).

The thirteenth intervention was a Canadian intervention called Healthy Buddies which consisted of three main components of healthy living: being physically active, eating healthy foods, and having a healthy body image. The intervention consisted of twenty-one healthy-living lessons which been planned and educated over the course of the study school year. Students in 4th through 7th grade were matching with kindergarten through 3rd grade buddies. In addition, students in 4th through 7th grade at the intervention school weekly received a 45-minute healthy-living lesson from the intervention teacher. The students gave the opportunity to act as peer educators by teaching a 30-minute lesson to their kindergarten through 3rd grade buddies. Buddy lessons were being provided by range of techniques (e.g., presentations, games, art activities, etc). At the results, this pilot study recommended that peer-led teaching can be a successful instrument to increase health knowledge, health behaviors, and health attitudes in children in elementary school. In addition, combination classes and classroom teachers could increase reliability and provide sustain for the program. Having all students and teachers participated in the intervention impacted the culture of the whole school (Stock et al., 2007).

The fourteenth intervention was Be Active Eat Well from Australia. Children ages 4 through 12 were eligible to participate in the study. It was quasi-experimental with nonrandomized intervention and control groups and measures taken pre- and post-intervention in the same children. It was successful at decreasing the weight gain (about 1 kg) and waist gain (about 3 cm) in elementary school. This intervention was considered as the first obesity prevention program to show significant reductions in the social gradient in weight gain, and as a result this approach may be very important for reducing obesity-related health disparities in children (Sanigorski et al., 2008).

The fifteenth intervention was the YMCA Program for Childhood Obesity a retrospective cohort study implemented in 2007 in the general pediatric clinic at UTMB at Galveston, Texas. At clinic appointments and Fit N Fun sessions, heights were measured. After that, data were entered into the electronic medical record. Then, sessions were arranged weekly during the evening at a local church. These sessions included behavior and stress management and healthy food preparation. In this intervention parents were involved in all sessions. The results showed that active participants (43%) had a clinically significant change in weight gain compared with controls. However, the analysis did not show any correlation between change in weight and risk factors for success or failure in Fit N Fun, such as age, ethnicity and number of evening sessions attended (McCormick et al., 2008).

The sixteenth intervention, is from West Virginia called L.I.F.E., was based on several behavioral theories such as hierarchy of needs, social cognitive theory, ecological perspective, health belief model, stages of change, and PRECEDE-PROCEED. The intervention consisted of awareness/knowledge tactics, school newsletter articles, a poster contest, pedometers for teachers, teacher training for e-learning unit *Healthy Hearts 4 Kids*, incentive-based programs, school-based walking programs, family-based walking/physical activity programs, No-TV Week, parent-child cooking classes, parent-child exercise classes and adult smoking cessation classes (Northrup et al., 2008).

As part of the programs philosophy the school, as the educational institution of the community is a place to learn and an avenue of outreach to parents. School nurses were chosen to offer intervention components because they are centrally situated to address both the health risks connected with obesity and the health promotion behaviors that may prevent the situation. During L.I.F.E., the school was shown to be part of the solution, addressing the health risks connected with childhood obesity (Northrup et al., 2008).

The seventeenth intervention is the Louisiana (LA) health childhood obesity prevention program, which took place in rural schools. Based on social learning theory, the intervention lasted three years and included elements of primary and secondary prevention. This randomized controlled trial consisted of healthy diet promotion, physical activity promotion, a program for families, a classroom curriculum, and Internet counseling and education. The main result of the intervention was policy decisions made by a five-person committee that includes scientists and community and state education leaders (Williamson et al., 2008).

The eighteenth intervention was performed by Jyu-Lin Chen and colleagues in the USA and aimed to test the feasibility and impact of an individually tailored educational intervention to promote healthy weight in Chinese-American children ages 8–10. The intervention was based on the ecological model of childhood obesity prevention, and was focused on the

improvement of Chinese American children's obesity-related health behaviors (such as physical activity and food preference), their knowledge, and their BMI over six months. Components were delivered through postal mail, and at the intervention's end mothers' knowledge regarding their children's dietary and activity needs was examined. The results demonstrated that an individually tailored program via mail helps reduce BMI scores in overweight children and improve children's levels of physical activity, usual food choices, and knowledge of nutrition and physical activity (Chen et al., 2008).

The nineteenth intervention was the APPLE project from New Zealand. A total of 384 children and their families participated in this intervention study. APPLE was a multifaceted intervention that consisted of increasing the levels of physical activity, increasing the intake of fruit and vegetables, and reducing the intake of sugary drinks by providing cooled water filters in each school. The intervention lasted two years and resulted in significant changes to mean BMI z-scores among intervention children, which were 0.09 less than in control children after one year and 0.26 at two years. Waist circumference was also significantly lower at two years in intervention children (1.0 cm), and systolic blood pressure was lower at one year, although this was no longer significant at two years. Although the prevalence of overweight was lower in intervention children, differences were not significant once adjusted for baseline values (Taylor et al., 2006).

The twentieth intervention was a two-year follow-up of the APPLE project. In this follow up, efforts were made to re-contact all children living within a 200-km the original study site via existing study addresses, the electoral roll, telephone directories, and information from participating schools. All children with at least one measurement of height and weight in the first study were qualified to participate in the follow-up measurements. The follow-up of the APPLE study, showed the continuing benefit of a relatively low-cost program aimed at reducing the risk of excessive weight gain in children almost two years after the conclusion of an official intervention phase during the follow-up period. The follow-up results showed the initial decrease in adjusted BMI z-score (0.22-0.30 units) in the intervention children relative to the control children. Nineteen percent significantly reduction in the prevalence of overweight has been showed in children who were present for the full two years of intervention (Taylor et al., 2008).

The twenty-first intervention targeted Latino mothers and children in grades 2 through 11. The Families on the Move (FOTM) lasted for eight weeks, and included distribution of workbooks, pedometer demonstration and distribution to parents and children, weekly reading assignments, goal setting, and evaluation. The intervention found that majority of the mothers (84.6%) approved the idea that they can influence their child's food choices. The mothers also believed they were able to influence physical activity levels (92.3%) for their children. This intervention lasted for 8-week program and was shown to be

achievable but it is too early to say whether will be significant (James et al., 2008).

The final intervention was the Walking the Talk effort aimed to improve staff self-efficacy in counseling Women, Infants, and Children (WIC) clients about childhood overweight. The California Fit WIC developed this multilevel intervention to prevent pediatric overweight and the effect included staff training sessions on a variety of topics, the addition of new classes for WIC clients, and the organization of community-wide coalitions to address the issue. The intervention lasted for a year and showed that support from the Fit WIC team helped staff achieve their own healthy eating and physical activity goals and significantly increased staff obligation and enthusiasm for addressing healthful behavior patterns with clients (Northrup et al., 2008).

DISCUSSION

The purpose of this study was to identify theoretical frameworks that drive childhood obesity prevention programs and identify successful components of childhood preventive intervention programs. Based on a review of these interventions, it is evident that there is a need for more primary prevention programs, 22 interventions from around the world were found to tackle the critically important issue of childhood obesity. Of the 22 interventions, thirteen were performed in United State of America, two in Canada, three in New Zealand, one in China, two in Australia and one in England (Untied Kingdom).

The majority of the interventions (n=13) were developed and implemented in elementary schools. Two interventions were implemented in elementary, middle and high schools, and four were carried out at all levels, from preschool to high school. In addition, one intervention was conducted in workplace.

Most of these interventions (n =18) targeted health behaviors aiming to increase physical activity, decrease BMI, and improve nutrition behaviors. However, there were some interventions that focused on only one element, such as increasing physical activity time in the school or community or creating nutrition plans and policies in schools. Efforts were also made by (n=12) programs to reduce TV viewing time for children and their families.

Although comprehensive programs are valuable, single-component programs demonstrated significant results. Examples include the classroom-based physical activity promoting program targeting physical activity behaviors and the Fresh Fruit and Vegetable Program intervention targeting nutritional behaviors (Stock et al., 2007). However, there is no evidence showed that single component interventions are better than comprehensive interventions. Consequently, it is necessary to consider both comprehensive and single-component intervention programs. In terms of theory, a small number of interventions (n = 6) were based on behavioral theory, but the majority of the published interventions were not based on behavioral theories. The six interventions that did apply a behavioral theory used the social ecological model, the protection motivation theory,

social learning theory, normative influences and theories of persuasion, social cognitive theory, behavioral choice theory, hierarchy of needs, ecological perspective, health belief model, PRECEDE-PROCEED, and the ecological model-ecological system theory (EST). In addition, one of the six interventions used role models and self-esteem as a component in the program. Some of these six interventions utilized more than one theory, despite the fact that it is beneficial to apply only one theory in order to test the effectiveness of an intervention and see which components or constructs of the theory are most effective. From the 22 published studies, only nine were able to show significant outcomes, while 13 were not able to show any impact. Seven of the non-theoretical based interventions showed significant result, while only two of the project based on specific behavioral theories.

The majority of the interventions (n = 5) were one academic year in duration. Four were short lasted only eight weeks, three were 32 weeks in length, one was 12 weeks long, four were 24 weeks, two lasted 36 weeks, and three lasted two full years. This finding emphasizes the need to design behaviorally healthy interventions for the diverse target populations and also measure significant outcomes. As a whole, no conclusions can be drawn regarding the impact duration of the intervention on effectiveness. For example, among the three longest interventions, two were effective while the other one was not. Similarly, for the five interventions that were one academic year long, four showed significant changes in diet, physical activity and BMI, while one did not.

Six interventions relied on the participation of parents in helping with behavior change. All had significant positive outcomes related to diet, physical activity and BMI. This is an important finding, and one that emphasizes the role of parental participation in school interventions. Parents play vital and important role in the lives of their children, including their influence on dietary and physical activity behaviors (James *et al.*, 2008). Childhood obesity prevention programs could have more significant outcomes by involving parents in developing healthy behaviors for them and their children (Northrup et al., 2008).

Among the 22 published studies, ten interventions focused on individual level behavior change and twelve included some nutrition policy changes. With respect to individual behavior, components included cooking classes for families, training on food selection, and health education session on disordered eating.

In terms of the methodology, five studies used pre-experimental designs, ten studies used quasi experimental designs, six studies used experimental designs and only one study used both on experimental and quasi experimental design. Many studies (n=7) focused on measuring long-term changes at least one year after the baseline which is beneficial because often take interventions a long time to show effects. The majority of the intervention studies (n=21) included baseline assessments and post assessments as

well. Finally, four studies are ongoing and more outcome data are expected from these studies.

In terms of measurement of behaviors, the majority of the studies (n=22) measured changes in factors (such as times spent being physically active, fruit/vegetable intake, and reductions in TV viewing. Many of these studies were able to show positive outcome towards progress of healthy behaviors. However, some of the studies only assessed the knowledge among participants, rather than looking at changes in behavior, which is not ideal. There is a need to create better scales to evaluate behavior change, particularly for studies that are based on specific behavioral theories.

From the 22 published studies, six interventions relied on secondary prevention while fifteen interventions used a primary prevention method. Only one intervention used both types.

LIMITATIONS

There are a number of limitations to this study. First, some studies (n=14) focused on childhood obesity in general and were excluded as a result. Second, some interventions were published in other languages such as German and Italian, and were not able to be reviewed. Third, only interventions published in two databases (PubMed and Google Scholar) were included. While these databases are reasonably broad, they do not include all the health literature about childhood obesity prevention around the world. As a result of these interventions, a conclusive meta-analysis cannot be achieved with these studies and explanations cannot be made concerning the effect size of the interventions.

RECOMMENDATIONS

Schools are the best settings for childhood obesity interventions because children form lifelong eating and physical activity habits at a young age. School-based interventions focused on childhood obesity prevention must target enhancement of physical activity and healthy nutrition in order to decrease BMI. In changing physical activity behaviors, increasing the duration and types of different activities are important aspects. Increasing fruit and vegetable intake and reducing the intake of sweetened drinks is of critical importance in changing nutrition behaviors. As these studies demonstrate, parental participation plays an important role in school-based interventions. It is essential to involve parents in all school-based interventions for childhood obesity prevention. While many of the studies included in this review were not based on theory all intervention should utilize behavioral theories. Interventions should also include both baseline assessments and post-intervention assessments to make it easy to evaluate the impact of the intervention. As part of this there is a need to create a valid scale that can identify and measure changes in the constructs of any behavioral theories used. Schoolteachers are very useful for implementing the interventions because though their teaching they can encourage the students to eat healthy and be active. In addition, different health professionals such

as nurses and social workers are very important resources for implementing school-based interventions. Finally, interventions should seek to incorporate individual behavior change strategies with policy and environmental changes in order to make a substantial and sustainable impact on children's health and well-being.

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