

## GENERAL ARTICLE

# School-Based Obesity Interventions: A Literature Review

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## ABSTRACT

**BACKGROUND:** Childhood obesity is an impending epidemic. This article is an overview of different interventions conducted in school settings so as to guide efforts for an effective management of obesity in children, thus minimizing the risk of adult obesity and related cardiovascular risk.

**METHODS:** PubMed and OVID Medline databases were searched for school-based obesity interventions with anthropometric measures in children and adolescents between the ages of 7 and 19 years from June 1986 to June 2006. Studies were reviewed by duration, type of intervention, and defined qualitative and quantitative measures, resulting in a yield of 51 intervention studies.

**RESULTS:** The interventions ranged from 4 weeks in length to as long as 8 continuing years. In total, 15 of the intervention studies exclusively utilized physical activity programs, 16 studies exclusively utilized educational models and behavior modification strategies, and 20 studies utilized both. In addition, 31 studies utilized exclusively quantitative variables like body mass indices and waist-to-hip ratios to measure the efficacy of the intervention programs, and another 20 studies utilized a combination of quantitative and qualitative measures that included self-reported physical activity and attitude toward physical activity and the tested knowledge of nutrition, cardiovascular health, and physical fitness. A total of 40 studies achieved positive statistically significant results between the baseline and the follow-up quantitative measurements.

**CONCLUSIONS:** No persistence of positive results in reducing obesity in school-age children has been observed. Studies employing long-term follow-up of quantitative and qualitative measurements of short-term interventions in particular are warranted.

**Keywords:** childhood obesity; school prevention programs; cardiovascular risk.

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## BACKGROUND

Obesity remains a public health epidemic the United States is facing.<sup>1-3</sup> Children and adolescents in the United States have not escaped from the obesity epidemic. The prevalence of overweight has doubled for US children aged 6-11 years—and tripled for American teenagers over the past 2 decades. Approximately 17% of children and adolescents between the ages of 2 and 19 years are considered overweight and 34% are at risk for becoming overweight.<sup>4,5</sup>

Childhood obesity is associated with many health risks. It is the leading cause of pediatric hypertension and associated with type 2 diabetes mellitus, orthopedic complications, increased risk of coronary heart disease, and increased stress on weight-bearing joints.<sup>6-10</sup> Hospital cost for diseases/conditions related to childhood obesity has increased dramatically in the past 20 years. Wang and Dietz analyzed the economic burden of obesity in youths 6-17 years of age and found that obesity-related annual hospital costs (based on 2002 constant dollar value) increased more than 3-fold over the 2 decades between 1979-1981 and 1997-1999 from \$35 million to \$127 million.<sup>11</sup>

Excess weight in childhood and adolescence may persist into adulthood. One study found that overweight children, aged 10-14 years, with at least 1 overweight or obese parent (body mass index [BMI]  $\geq 27.3$  kg/m<sup>2</sup> for women and  $\geq 27.8$  kg/m<sup>2</sup> for men as reported), have a reported 79% likelihood of overweight persisting into adulthood.<sup>12</sup>

In addition, obesity or overweight can have an adverse effect on a child's psychosocial status. Studies have shown a relationship between childhood obesity, lowered self-esteem, discrimination, stigmatization, and peer rejection particularly in educational settings.<sup>13-15</sup>

A number of school-based interventions have aimed at modifying the dietary guidelines of meals and increasing exercise and physical activities of school-age children. These interventions vary to a great extent in terms of intervention type, duration of the intervention, outcome measures, and significance of the results. However, there is a lack of understanding of the sustainability and efficacy of different types of interventions across the board. Meanwhile, children still continue to exhibit poor health outcomes. Thus, consolidating resources and having a comprehensive understanding of obesity-related, school-based interventions that have been done to date are warranted, particularly for improving outcomes in children. The purpose of this study was to conduct a literature review of school-based interventions based on their duration, type of intervention, and outcomes. The primary intention was to conclude with suggestions and guidance for future school-based interventions and research that lead to effective management of obesity in children.

## LITERATURE REVIEW

Separate searches of the available English language literature from June 1986 to June 2006 were conducted utilizing the PubMed and OVID Medline databases. In order to maximize the yield of the search for studies that conducted an obesity intervention in school-age children, several keyword identifiers such as "school-based intervention," "obesity intervention," "nutritional program," "physical activity," and "parent-child partnership" were utilized (Table 1). Abstracts were reviewed to select studies that met the selection criteria. The compiled and refined Medline and PubMed results were further scrutinized to exclude identical studies. The final sample of the studies was identified and compiled in a database recording the reference information, the intervention type (physical activity program, dietary/nutritional regimen, health/fitness education model, or combination), the number of treatment arms (schools or subjects), the age range of subjects, study design, study duration, study variables, and positive statistically significant results.

### Inclusion Criteria

Studies were selected based on meeting the following standards: (1) an obesity-related intervention, (2) an age criterion where subjects are between 7 and 19 years, (3) use of pre- and postmeasures of anthropometric variables (ie, BMI, tricep skin folds, etc), and (4) implementation of the intervention in a school setting. No specific conditions were set for controlled studies. Therefore, excluded were studies whose primary aim was not to intervene on obesity or related health and fitness measures (ie, interventions for the prevention of cardiovascular disease, type II diabetes, etc) or those studies that did not use anthropometric measures (Figure 1).

### OVID Medline and PubMed Search Result

Separate queries were conducted in OVID Medline and PubMed databases (Figure 1). The initial OVID

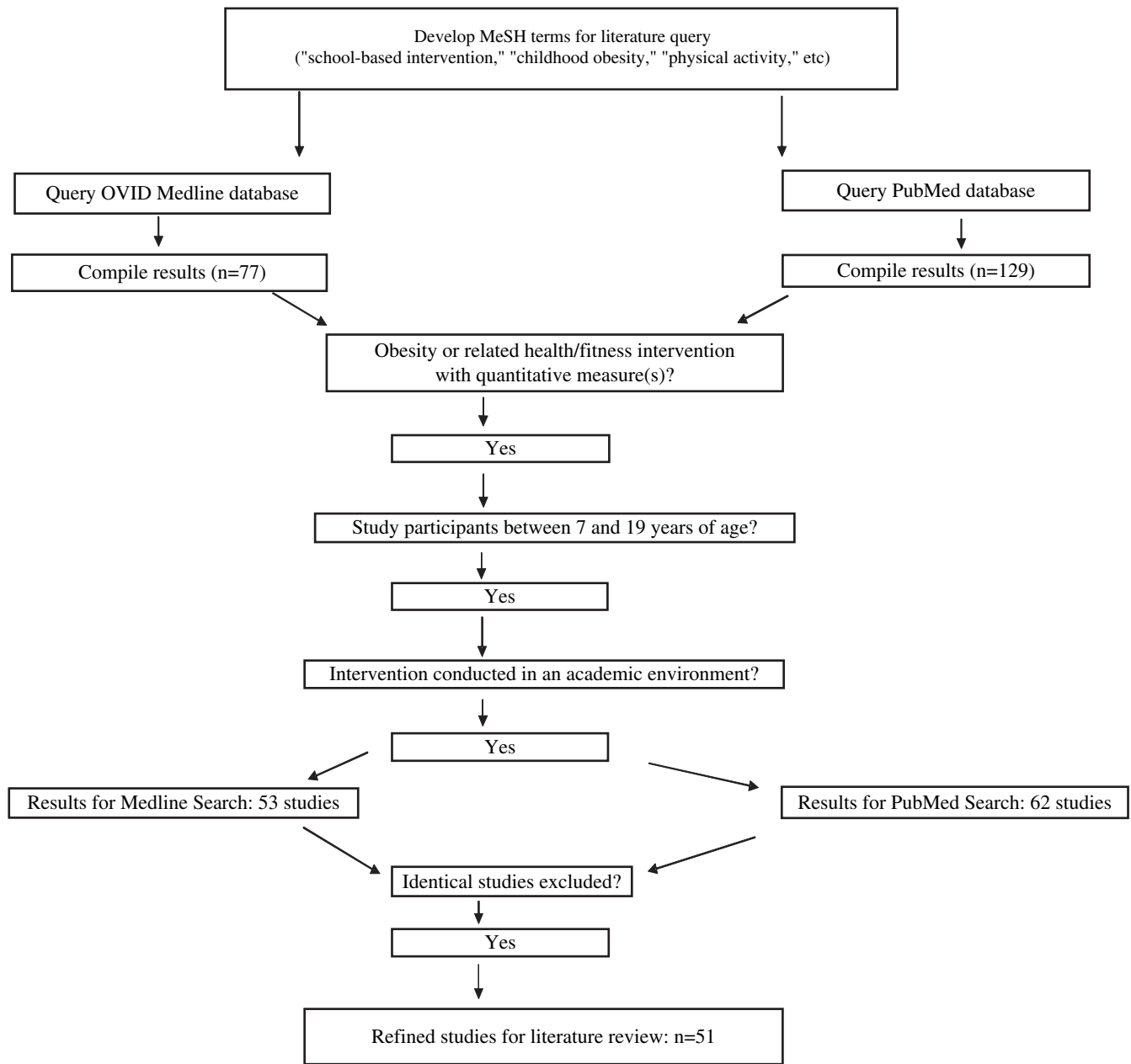
Table 1. Medical Subject Heading (MeSH) Terms for Literature Search

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School-based intervention
Obesity intervention
School-aged
Parent-school partnership
Fitness intervention
Cardiovascular disease risk
Youth intervention
School health education
Physical activity
Childhood obesity
Health behavior
Physical education
Nutrition program

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Figure 1. Selection Steps for Literature Review



Medline-based literature query using cross-reference of the 13 Medical Subject Heading (MeSH) terms or keyword identifiers as mentioned above produced 77 compiled results. A review of the abstracts was conducted to further refine the results using the aforementioned inclusion criteria. In total, 14 study protocols did not utilize obesity-related anthropometric measures, and 10 study protocols did not implement school-based interventions. A total of 53 studies from OVID Medline search remained for examination (Figure 1).

Separately, the PubMed-based literature query using cross-reference of the 13 separate mesh terms or keyword identifiers produced 129 compiled results.

A review of the abstracts was conducted utilizing our selection criteria. Excluded were 58 studies that did not implement school-based obesity interventions and 9 studies that did not utilize obesity measurements. As a result, the PubMed-based search produced 62 abstracts.

The compiled and refined Medline and PubMed results were further scrutinized to refine identical intervention studies published under differing titles and time periods. Finally, 51 total school-based intervention studies were identified for review by intervention type, duration, outcomes measures, and significance of intervention aspects.

## FINDINGS

### Intervention Type

The 51 studies utilized a variety of obesity-related interventions in school-age children as subjects (Table 2). Of these interventions, 15 only utilized an implementation or a modification of an existing physical activity program or an in-school physical education class.<sup>16-32</sup> Another 17 intervention protocols only used health and fitness educational models, dietary regimens, or physical activity behavior modification strategies.<sup>33-48</sup> The remaining 19 intervention studies utilized combinations of physical activity programs, health/fitness educational models, and/or dietary/nutritional regimens.<sup>49-68</sup>

### Duration

The intervention program studies ranged from as few as 4 weeks in length to as long as 8 continuing years (Table 2). A total of 10 studies took place or examined intervention programs that were less than 12 weeks in length.<sup>22,31,32,37,48,51,53,54,64,65</sup> Another 18 studies examined intervention programs that were 12 weeks to 1 year in length, many of which took place over the course of 1 academic school year (9 months).<sup>21,24,26,28,30,35,36,40,46,49,52,55,58,59,66</sup> Finally, 20 of the intervention studies examined long-term or continuing intervention programs in excess of 1 year in length.<sup>18-20,27,33,34,38,39,41-43,45,47,50,56,57,60-62,67</sup>

### Direct and Self-Reported Measures

Only 31 of the total studies utilized exclusively quantitative variables to measure the efficacy of the intervention programs.<sup>19-21,25-28,30,35,36,38,42,43,46,48,50-57,59-65,67</sup> The quantitative measures included a large variety of clinical anthropometric and adiposity-specific

variables such as BMIs, ponderosity indices, tricep and subscapular skin folds, body fat, and waist-to-hip ratios (Table 2). Other quantitative measures examined obesity-related physiological variables utilizing body composition absorptiometry techniques to measure blood lipids (high-density lipoproteins, triglycerides), fasting insulin levels, and blood glucose concentrations. Additionally, systolic and diastolic blood pressure measurements were recurrent study variables. All other quantitative measures examined various facets of fitness and dietary intake including flexibility (sit and reach), aerobic capacity (VO<sub>2</sub> Max), endurance (shuttle runs, mile run), vegetable and fruit consumption, television consumption, muscle strength (standing broad jump, abdominals), and overall application to physical activity (incidence and duration).

Another 20 studies utilized different methods for the measure of qualitative variables. These included self-reported physical activity, attitude toward physical activity, and the tested knowledge of nutrition, cardiovascular health, and physical fitness. A total of 16 studies utilized some combination of the aforementioned quantitative and qualitative variables to measure the efficacy of the interventions.<sup>18,22-24,29,31-34,37,39-41,44,45,47,49,58,66,68</sup>

### Significance of Intervention Aspects

As reported in Table 2, 40 of the studies achieved positive statistically significant results in some or all the quantitative measures between the baseline and the follow-up.<sup>18,20-31,33,35,37-39,41,42,44,46-59,61,63,65,67,68</sup> Of the 15 obesity intervention studies that employed protocols exclusively geared toward implementing physical activity regimens or manipulating existing physical education programs, 13 studies observed positive statistically significant changes in quantitative anthropometric or adiposity-related measures.<sup>18,20-31</sup> Of the 16 total studies that exclusively employed educational intervention programs aimed at manipulating dietary, physical activity, and health/fitness knowledge of study participants, 12 studies reported positive statistically significant results in their clinical measures.<sup>20,33,35,37-39,41,42,44,46-48</sup> Finally, 15 of the 20 total studies that employed both aforementioned protocols in obesity intervention observed positive statistically significant results.<sup>50-59,61,63,65,67,68</sup>

## DISCUSSION

Our query of school-based interventions to prevent obesity has shown that 13 of the 15 intervention studies that employed exclusively physical activity programs reported positive statistically significant results with some or all their quantitative measures. Of the 16 studies that exclusively employed educational curricula geared toward fitness, health, and nutritional

**Table 2. Distribution of Studies by Duration, Outcome Measures, and Type of Intervention**

	Number of Studies	
	Total (n = 51)	With Significant Results* (n = 40)
Duration		
<12 weeks	10	
12 weeks to 12 months	18	
>12 months	20	
Information not available	3	
Measures		
Qualitative	Excluded	
Quantitative	31	
Quantitative and qualitative	20	
Intervention type		
Physical activity only	15	13
Educational/behavioral only	16	12
Combination	20	15

\*p < .05.

knowledge and behavior modification, 12 studies reported statistically significant results with quantitative measures. Finally, 15 of the 20 physical activity and education combination studies reported positive statistically significant results in their quantitative measures.

The physical activity–geared obesity interventions of this literature review illustrate the remarkably high efficacy of physical activity in reducing obesity-related measures and increasing overall physical fitness of school-age subjects.<sup>23</sup> Carrel et al and Stephens and Wentz have demonstrated positive statistically significant results in adiposity and fitness measures such as BMIs, sit-and-reach flexibility, and aerobic capacity with children enrolled in short-term physical activity interventions.<sup>21,26</sup> The majority of these programs succeed only in limiting the negative health effects of sedentary lifestyle and fail to provide long-term results to their short-term interventions.<sup>60</sup>

There are many economic and environmental limitations to the long-term success of persistent physical activity in children both during and following interventions. Budget cuts to school systems are often correlated to reduction of nonacademic programs in general (after-school sports programs) and physical education classes. This can result in any or all of the following: reduction of physical education materials, the suspension of facility and class material maintenance, and shorter class periods.

The economic limitations of the student subject's community can limit the physical activity opportunities he/she may encounter. The opportunity to participate in extracurricular sports programs may be limited by availability, public funding, or the economic constraints of the subject's family. Limitations to the public funding in communities may also limit the construction and maintenance of parks, fields, and other spaces appropriate for physical activity. Therefore, a major caveat to physical activity–based and fitness education obesity interventions is the availability of materials and facilities suitable for the persistence of physical activity by student subjects.

Educational interventions geared toward the modification of dietary and health-related behaviors have also enjoyed positive short-term results with the retention of curricula as the primary objective and subsequent behavior modification as the secondary objective.<sup>36,39,40,44,45</sup> Some educational interventions have been successful in reducing quantitative measures of adiposity with short- and long-term results.<sup>35,38</sup> Intervention studies employing educational curricula report follow-up testing of BMIs with statistically significant results.<sup>43</sup> An impressive integration of knowledge concerning healthy dietary intake, physical activity habits, and smoking and drug prevention is often achieved through special or modified school curricula; however, there are many environmental and

economic limitations for the success of the secondary educational objectives.

Oftentimes, cash-strapped academic institutions will opt to incorporate cafeteria menus with poor nutritional options and/or “fast-food” kitchens in the absence of school nutritional guidelines set by their Department of Education. Even with nutrition and fitness education for student subjects, nutritional food options may remain undesirable due to environmental factors such as the quality and diversity of food products at area food markets and restaurants and the overall nutrition and health knowledge of parents and caretakers.

The statistically significant positive results in the primary objectives of both physical activity–based and fitness and health education–based obesity interventions make the overall putative efficacy of 2-pronged combination interventions attractive; however, the comprehensive nature of the combination obesity intervention may be more limited by institutional economics. There are no statistics available that demonstrate that combination interventions are any more effective in limiting long-term obesity than single-faceted programs.

Short-term interventions lasting less than 6 months in duration enjoyed positive statistically significant results in reducing diastolic blood pressure, increasing physical activity incidence, and reducing tricep skin folds of study participants.<sup>22,51,54</sup> Nevertheless, the persistence of positive results in reducing obesity (ie, sustained levels of physical activity, persistence to modified dietary intake, etc) in subjects has not been observed. Studies employing long-term follow-up measurements of these short-term interventions are needed.

Accordingly, long-term obesity interventions have the advantage of ensuring sustained and regular physical activity and continued reiteration of nutritional and fitness education in subjects with the hope of instilling the retention of positive fitness and health-related behaviors; however, the implementation of long-term interventions in most school districts may not be economically feasible at present. Longitudinal studies of students throughout their academic careers are necessary for determining the efficacy of school-based obesity interventions.

Utilization of quantitative measures of obesity and physical fitness such as BMIs, skinfold measurements, and body composition absorptiometry remains more desirable than that of qualitative measures in determining the efficacy of reducing childhood obesity by the intervention program; however, qualitative measures are integral in determining the efficacy and incorporation of educational protocols by students. Qualitative measures can be important in determining the satisfaction and cultural suitability of the intervention protocol for students and their families.

The efficacy of including parents in short-term school-based nutrition and health education interventions has been demonstrated to significantly increase at-home dietary and nutritional knowledge; however, positive results correlating at-home health knowledge and domestic dietary habits have not been produced.<sup>65</sup> Manios et al and Kafatos et al have demonstrated that a long-term (6-year intervention with 10-year follow-up) school-parent partnership and educational intervention model can produce positive statistically significant results in overall physical activity incidence and adiposity and fitness measures such as BMIs, sit-and-reach flexibility, and the 20-m shuttle run.<sup>38,43</sup> Future interventions aimed at partnering the school and home might seek to incorporate physical activity curricula and dietary modification into the shared curriculum.

Beyond the physical education classroom and nutrition or health fitness curricula, opportunities exist to modify current curricula, such as home economics and biology, to assess and educate student subjects in healthy dietary and fitness behaviors. One study looked at an obesity intervention that implemented a pragmatic curriculum in a home economics class to teach students how to cook healthy and affordable meals. This study observed a positive statistically significant decrease in student subject blood cholesterol levels in the duration of 12 weeks.<sup>46</sup>

The positive and negative effects of peer pressure (ie, adolescent drug use, etc) are well documented. The development of a sensitive and an inclusive intervention program that incorporates peer progress assessment through competition, peer-led education, or physical activity sessions may positively correlate to modification in dietary intake and/or physical activity participation. One study utilized a specialized board game to educate students in nutritional knowledge and reported positive statistically significant results in nutritional knowledge and vegetable intake.

Mentorships between adolescent students and students in lower grades have similarly enjoyed success in reducing unwanted behavior and increasing academic achievement. Mentorships are a viable and an economical option for both physical activity and educational programs. One possible intervention might pair students in appropriate sports or physical education programs that include student-led seminars in health, nutrition, and sports skills.

Collaborations among schools may be effective in invigorating current interventions. Competition, where appropriate, between schools may invigorate overall student involvement in interventions and motivate increased individual involvement in physical activity events. Additionally, collaborative "health fairs" between schools may provide a more comprehensive health education for students that offers addi-

tional perspectives, thereby maximizing the success of secondary education objectives.

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