School-Based physical activity interventions: A meta analysis

by

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ABSTRACT

School-based interventions have been proposed as a key strategy in reducing childhood obesity and type 2 diabetes, addressing cardiovascular disease and increasing physical activity. Numerous studies have examined the impact of interventions focusing on physical activity and nutrition education. Twenty published school-based interventions, which included a control group were identified. These studies were reported in 110 individual publications. Meta analysis was used to examine the outcomes of twelve interventions; eight interventions were excluded because the data was not available (e.g., confidence intervals or means and standard deviations) to estimate effect sizes. The included studies reported data from 12,930 children and were reported in fifteen of the 110 publications.

Two methods were used to calculate effect sizes for nineteen dependent variables. One method was the pre to post where the pre test mean was subtracted from the post test mean for both the intervention and control groups and divided by the control group pre standard deviation. This method produced one effect size for each level of the intervention and control for each dependent variable, yielding 168 effect sizes. Three variables were declared statistically significant; those were moderate-to-vigorous physical activity, mile walk/run, and knowledge. However the effect size for the mile run was small. Intervention and control was the independent variable in two t-tests for the remaining effect sizes of MVPA and knowledge. Knowledge was significantly better for intervention than control groups, MVPA was not. A second method of calculating the effect size was to

compare the intervention to the control at post-test using the control post-test standard deviation. This produced 96 effect sizes. Four were statistically different from zero; mile walk/run, pull-ups, knowledge and total skinfolds. Of those four, only knowledge had a moderate effect size.

While each of these effect sizes represented multiple effect sizes, some were from a single study. Therefore, effect sizes were combined to categories of cardiovascular outcomes (e.g., cholesterol, blood pressure), physical activity (e.g., fitness, mile run) and knowledge. For all studies, knowledge was greater in intervention participants (ES=0.90) as was physical activity (ES=0.76). The composite physical activity effect size (fitness and MVPA) was used as the dependent variable in a regression with total intervention time and CSHP components as predictors. The regression and both predictors were significant. Further analyses determined that grade (age) and gender were not significant categorical variables influencing the outcomes of interventions.

Considering both methods of calculating effect sizes knowledge and physical activity are efficacious dependent variables because these are sensitive to change. Clearly, schools are well suited to influence both when given the resources to do so. Further, multifaceted approaches to increasing physical activity, such as the CSHP, produce larger effect sizes than single approaches. Future studies of school-based physical activity interventions should consider reporting data so that effect sizes can be calculated, focus on long term outcomes, and explore a variety of components of the Coordinated School Health Program.

CHAPTER 1.

INTRODUCTION

Obesity and type 2 diabetes are at epidemic proportions in children (Mokdad, Bowman, Ford, Vinicor, Marks, & Koplan, 2001). Physical inactivity is an independent controllable health risk factor that often contributes to obesity and diabetes (Centers for Disease Control, 2008). Children and adolescents are not getting enough physical activity, with physical education and physical activity declining (Centers for Disease Control, 2008). These patterns continue in the adult population and may be established during childhood. As type 2 diabetes is a relatively new challenge in the childhood population fewer strategies are available specifically directed at preventing or reducing the disease in children. Therefore, understanding how to increase physical activity is critical.

For every 100 children entering through the school doors each day in the United States today 14 are obese. The prevalence of overweight among children aged 6-11 years has more than doubled in the past 20 years and among adolescents aged 12-19 has more than tripled (US Department of Health and Human Services, 2001). Childhood and adolescent overweight and obesity are related to health risks, medical conditions, and increased risk of adult obesity, with its attendant effects on morbidity and mortality rates (Whitlock, Williams, Gold, Smith, & Shipman, 2005). Most children attend school, so school is a logical place to impact children's health, including obesity and overweight.

Type 2 diabetes was considered an adult onset disease, typically after age 40 years. However, this disease has increased in children, in part due to the increase in obesity in children, and prenatal exposure to diabetes in the mother. Physical inactivity is a key contributing factor to type 2 diabetes among children and youth (Bloomgarden, 2004; Centers for Disease Control, 2008).

The Centers for Disease Control and Prevention (CDC) recommends 10 strategies for schools to use to fight the childhood obesity epidemic. The first of these strategies is to implement the Coordinated School Health Program (United States Department of Health and Human Services & Centers for Disease Control, 2006). Obesity prevention and treatment is a complex problem that requires a multifaceted approach. Interventions to treat childhood obesity typically have more than one component. Thus, considering interventions in view of the components included in the intervention is logical. The one model endorsed by the Centers for Disease Control is the Coordinated School Health Program (CSHP).

The CSHP is a Centers for Disease Control program with eight components designed to influence student health and learning (Centers for Disease Control, 2005a). The eight components of the CSHP are health education, physical education, health services, nutrition services, counseling and psychological services, the healthy school environment, staff health promotion, and community/family involvement.

Physical inactivity is at epidemic proportions. Twenty-five percent of high school students reported no physical activity in the last seven days and only 30% of high school students report daily physical education (Centers for Disease Control, 2008). The World Health Organization (World Health Organization, 2008) reports that 60% of people fail to meet the recommendations for physical activity and one-third of young people world wide do not meet the 60 minute per day recommendation. Physical inactivity increases risk for obesity, diabetes, cardiovascular disease and other health problems. Therefore, increasing physical activity is a critical challenge.

More successful interventions are likely to be complex with multiple components. However, multiple components of the studies on which recommendations have been based could not be evaluated separately and the effects of specific intervention components could not be determined. The *Guide to Community Preventive Services* examined interventions among children and adolescents including combinations of physical activity and nutrition interventions; physical activity interventions alone; nutrition interventions alone; and behavioral interventions without nutrition or physical activity information or focus (Community Guide, 2005). In all cases, evidence was insufficient to determine whether or not the interventions are effective in helping to control weight. Therefore, further research is recommended to determine the effects of specific components of these interventions. None of the interventions tested in randomized trials used the CSHP, yet most had one or more components from the CSHP. Since the Centers for Disease Control endorses this model, and several states currently use the CSHP model, it is logical to consider this model as we look at school based interventions to increase physical activity and thereby reduce and prevent childhood obesity and diabetes.

At the initiation of this study, 12 randomized interventions including physical activity were identified. The expectation was that additional interventions to reduce obesity and/or increase physical activity would be identified. Neither the most efficacious components nor the dependent variables of these interventions have been identified.

Long term effects have not been identified and are important for researchers to evaluate the studies for this component to know if it is worth funding. This is important because childhood obesity, diabetes and physical inactivity among children is a rising concern for communities across the United States.

The purpose of this study was to conduct a meta-analysis on school-based interventions that include physical activity and to identify the most efficacious components and dependent variables of the interventions, specifically relating those components to the coordinated school health model. A meta-analysis is a technique of literature review that contains a definitive methodology and quantifies the results of various studies to a standard metric that allows the use of statistical techniques as means of analysis (Thomas, Nelson, & Silverman, 2005). The data are combined into a standard deviation unit called an effect size (ES). This is a way to interpret and compare results across studies where a variety of dependent measures have been used. For example, one study might use body mass index (BMI) to assess the results from physical activity while another study uses minutes of moderate to vigorous physical activity. This thesis is written in a paper format and all tables will appear at the end of the thesis.

CHAPTER 2.

METHOD

Selection of Studies

Only published studies were included in this meta-analysis. Studies were found by conducting a literature search using four techniques. First, studies were located using computer databases (Web of Science and Pubmed). Second, reference lists from these papers were examined for additional studies. Third, a search of all issues for 2005 and 2006 from *Journal of Public Health, Research Quarterly for Exercise* and *Sport*, *American Journal of Preventive Medicine, Journal of School Health,* and *Journal of Nutrition Education and Behavior* to identify additional studies. Finally, a search from the reference section of Health Is Academic was done to find additional studies. In some cases, the same data from an intervention study were published in multiple articles. For this meta-analysis the same data were used only once, regardless of how many publications for that intervention included the data.

Coding Characteristics

For each study, a number of characteristics were recorded and coded. Items recorded include name of intervention, first author, year of publication, number of coauthors, number of participants, location, length of intervention in minutes, duration of intervention in months, and type of intervention. Items coded were components of CSHP in intervention (Table 1), gender, age and ethnicity (See coding sheet for additional information Appendix B). Because the interventions were school-based, interventions were typically applied to selected grades (e.g., grades 4 and 5 or grade 9). These grades were further categorized as elementary (grades k-5), middle (grades 6-8) and high school (grades 9-12). Some interventions focused on one gender, others applied the treatment to both genders. Outcomes were reported separately for males and females in some studies and together in other studies, thus gender was coded to represent the data as reported. Measures of external validity were grades, number of participants in study and gender. Reliability of coding was conducted by recoding 1 article out of 10 for accuracy. The dates were recorded for every article read, and then placed in groups of 10 by date. One article from each group was re-evaluated by the investigator and an additional coder. There was 90% or greater agreement. In addition, articles read early (based on date) were checked for "drift" in the coding at a rate of 2 per 10. If necessary, the articles were reevaluated.

Dependent variables and calculating effect sizes

Dependent variables from the studies were grouped into cardiovascular measures, body composition, physical activity/fitness and knowledge. Physical activity measures were minutes of physical activity in a week, moderate-to-vigorous activity, step test, max $V\hat{o}_2$ and mile walk/run .Non-cardiovascular fitness measures were sit ups, pull ups, and sit-and-reach. Knowledge tests health knowledge, physical activity, nutrition and physical fitness topics. Body composition measures included body mass index, triceps skin folds, subscapular skin folds, total skin folds, mass (weight) and percent body fat. Effect sizes were calculate using standard procedures (Hedges & Olkin, 1985) using: ES= $(\text{Mean}_{\text{Post}} - \text{Mean}_{\text{Pre}})/\text{SD}_{\text{Pre}}$. In randomized trials the assumption is that the experimental and control groups are the same at the beginning of the intervention. Further, the control group should have been relatively consistent from pre to post testing. One approach to calculating effect sizes is to calculate effect sizes for the experimental groups (pre-post) and control groups. This would allow statistical analysis of the levels of the intervention [control, intervention(s)]. A complicating factor is that these interventions used children, so both the intervention and control participants would grow and develop over the course of the intervention, a fact that was likely to influence the results. Of course, the assumption was that growth was randomly and equally distributed for the intervention and control groups. Therefore, another approach to calculating effect sizes is to compare the experimental to control group means at the post test and divide by the control standard deviation at the post-test. The disadvantage is that statistical analysis is limited in the second approach. In theory, the two approaches should yield similar results, the question was whether this occurs in practice.

Analysis

The effect sizes were examined to determine whether or not the distribution was normal. For non-normal distributions the effect sizes can be ranked and analyzed however, this was not necessary. Effect sizes reaching .5 are considered moderate, .8 large. An examination of average effect sizes identifies meaningful results but only when the effect size is significant. The 95% confidence intervals can be used to judge whether the comparisons are equivalent or statistically different (Lipsey & Wilson, 2001). Thus, confidence interval judge significance and reliability. Statistically significant effect sizes based on the confidence interval were further examined for meaningfulness by examining the distance of the effect size from zero.

Regression analysis to determine whether the length and number of components of the CSHP predict the outcomes were conducted. Further analyses included examining differences between control and intervention groups, gender and age effects using analysis of variance techniques.

CHAPTER 3.

RESULTS

Twenty school based randomized school-based interventions with a physical activity component were identified in the literature. Most included more than one component of the CSHP. Some specified nutrition education as part of or in place of health education. All provided published results, however eight were not used in this meta-analysis. Eighteen of the studies were used in the initial analysis (Table 1). One intervention (CVD) used computer based instruction with no actual physical activity and was therefore eliminated. Another intervention did not have a physical activity component and was eliminated. Seven others did not provide the data necessary for a meta-analysis. These publications typically presented change scores and no means or standard deviations. Therefore, we were unable to calculate effect sizes from the data presented in the publications.

The interventions used 19 different dependent variables (Table 2) that we classified into four categories (cardio vascular, body composition, physical activity and knowledge). Studies also included a variety of categorical variables such as gender and grade. In some studies the intervention and control had additional levels (e.g., 2 levels of control or intervention). These effect sizes represent the performance of 12,930 children. The initial analyses for this meta-analysis used data from 15 publications (Table 2) of the 110 individual publications identified and examined for this study.

Four studies (CATCH, CHIC, Heart Smart & SPARK) had more than three publications each. Approximately one in four of those were process publications documenting internal validity. Data was extracted from seven of the remaining 73 publications presenting outcome data. The data presented in the remaining 65 studies was also published in the eight. A single data point was used once, regardless of how many times it appeared in the literature. The literature search produced eight additional studies (Australia, Go for Health, M-Span, Oslo, PATH, Project Heart, Southwest Cardio-Vascular, Wisconsin) presented in eleven total publications, three or fewer publications per study. Data was extracted from 8 of those 11 publications; the remaining three publications were either for internal validity or provided no unique data. Five parametric statistics were run on the data in this study, so the alpha of .05 adjusted using the Bonferroni technique to .01 to determine significance for regression, t-tests and Anovas.

Analysis of Pre-Post for Effect Sizes

The effect sizes reported in this section were calculated as follows:

$(\text{Post Mean}_{\text{intervention}} - \text{Pre Mean}_{\text{intervention}})/\text{Pre sd}_{\text{control}}$ and

$(\text{Post Mean}_{\text{control}} - \text{Pre Mean}_{\text{control}})/\text{Pre sd}_{\text{control}}$

Effect sizes were calculated for each variable and compared across levels of the intervention (e.g, intervention(s) and control). This process yielded 168 effect sizes. Descriptive statistics (Table 3) for all effect sizes revealed three that met the criteria to be declared statistically different based on the 95% confidence intervals; moderate-to-vigorous physical activity (MVPA), mile walk/run, and knowledge. However, the effect sizes for the mile run were small. Of the three intervention effect sizes above 0.50 (moderate-to-vigorous physical activity, knowledge, and mass) and three control group effect sizes above 0.50 (moderate-to-vigorous physical activity, mass and subscapular skinfold) only MVPA and knowledge were both moderate in size and reliable.

Knowledge t-test was [t (12) = 3.21, p = .007] statistically significant. The t-test on MVPA was not significant [t (8)=-.83, p=.43].

Not all studies included MVPA or knowledge, so were not represented in the previous analyses. Therefore, creating a composite effect size that included all studies was a viable alternative. An average effect size for each area (cardiovascular, physical activity, body composition and knowledge) was calculated, then the four effect sizes were averaged for one overall effect size. Two one-way Anovas were calculated with this overall effect size as the dependent variable and either gender or grade as the dependent variable. Neither gender, [F(2,41)=.136, p=.87], or grade, [F(2,41)=2.27, p=.12], were significant. The final analysis of the pre post effect sizes was a comparison of the control and intervention effect sizes most closely related to the stated purpose of the intervention. Seven studies had the goal of improving cardiovascular outcomes; the effect size for the control (ES=0.01) and intervention groups (ES=0.02) were essentially zero. The five studies with physical activity goals had effect sizes on the physical activity variables (e.g., mile run, step test) of intervention ES=.46 and control ES=0.08.

Analysis of Post-Post Effect Sizes

The effect sizes reported in this section were calculated as follows:

(Post Mean $_{intervention}$-Post Mean $_{control}$)/Post sd $_{control}$

Descriptive data for these effect sizes is presented in Table 4. Twelve school-based interventions were used in the analysis with 19 dependent variables and 96 effects sizes representing the difference between the intervention and control groups at post test.

An effect size of zero represents no difference between the means of the intervention and control groups at the post-test. When the upper and lower boundaries of the confidence intervals (95%) encompass 0, the intervention and control groups are declared the equivalent (e.g., statistically the same). This is analogous to declaring no statistical difference based on an alpha larger than .05 and using confidence intervals to declare the two groups the same. Most of the effect sizes were small and based on the confidence intervals the intervention and control groups were the equivalent at the post test. Variables for which zero does not fall within the confidence interval and that have moderate and large effect sizes were candidates for further analysis. Two additional dependent variables were included in analyses that are not in Table 4 because there was only one effect size. Those two effect sizes were for $V\hat{o}_2$ Max (ES=1.33), step test (ES=.79). Four effect sizes were statistically different from zero; mile walk/run, pull-ups, knowledge and total skinfolds. All other effect sizes were not different based on the fact that 0.0 was inside the upper and lower boundaries of the 95% confidence interval. Of those four variables only knowledge had a moderate effect size the others were small.

The effect size for physical activity (the average effect sizes for situps, pullups, sit and reach, mile run, max vo2, step test and mvpa) was calculated. That effect size was used as the dependent variable in a regression where components of the CSHP and total minutes of the intervention were predictor variables. The regression was significant [F(2,5)=29.41, p=.002] with a significant portion of the variance accounted for (r^2=.89). Both predictors were significant (CSHP t=-4.72, p=.005; minutes t=-6.48, p=.001). The physical activity effect sizes were moderate for the five studies targeting physical activity

(ES=0.50) and essentially zero for the cardiovascular outcomes (ES=0.08). The seven cardiovascular studies produced a very small effect size for cardiovascular outcomes (ES=0.03) and moderate effect size for physical activity (ES=0.60).

The effect sizes within category (cardiovascular, knowledge, body composition and physical activity/fitness) were averaged to create overall effect sizes so all cells were full, thus including all studies in further analysis. This was necessary because some studies used different dependent measures within a category (e.g., mile run versus step test, Table 2). Knowledge was greater in intervention participants (ES=0.90) as was physical activity (ES=0.76).

Descriptive data on overall effect sizes for males, females and mixed groups were examined to determine if the intervention influenced the groups differently. Males (ES=1.09) and females (ES=.98) both improved in the interventions when compared to the control groups. Physical activity was difficult to interpret because the mixed group had a large change (ES=1.23), while modest advantages were observed for the intervention females (ES=0.59) and males (ES=0.42) in single gender groups.

Comparing pre-post and post-post methods

Significant effect sizes were found in both post-post and pre-post methods. Mile run and knowledge were significant regardless of the method of calculating the effect size. One study had particularly small pre-control standard deviations and those impacted the pre-post calculations but not the post-post calculations for moderate to vigorous physical activity. When the effect sizes for MVPA were recalculated without that one study, the effect size for intervention MVPA was similar to the post post MVPA effect size.

Two studies included long term follow-up, however, long term results were difficult to compare. This was because data used in the long term follow-up was not presented in the previous publications or was focused on process aspects of the study. For example, in one study teacher knowledge was reported at the long term follow-up when student knowledge was reported in previous publications.

CHAPTER 4.

DISCUSSION

Generally the effect sizes were small regardless of the dependent variable, components of the CSHP, internal validity, purpose of the study and so forth. Studies using physical activity to improve cardiovascular variables (e.g., reduce cholesterol), or reduce obesity (e.g., reduce BMI) produced virtually no change on those variables. While this is disappointing, it is clear that children do respond to training, at least two dependent variables are sensitive in identifying change and multifaceted approaches are more likely to produce change than single channel interventions. School-based interventions did demonstrate increased physical activity directly through observed moderate-to-vigorous physical activity or indirectly through performance on tests of aerobic performance (e.g., mile run, step test).

The results of this meta analysis are particularly important considering the frequency at which a single data point appeared in the literature. All the effect sizes (Pre post n=168, post post n=96) were calculated from data in fifteen publications, of the 81 publications with outcome data (20%). Sixty-five additional publications reported portions of the data and virtually all of these reported significant results with no reference to corrections (e.g., Bonferroni) for multiple uses of the same data. So, while the information in the studies was important, and there was clear value in providing that information to broad audiences through a variety of journals, the actual weight of a particular outcome was less clear. This was exacerbated by some reports of data where the treatment was applied at the grade or building level but was reported as though the experimental unit was the child. Clearly most studies had the power to find significant differences because of the large number of children and excellent internal validity.

Efficacious dependent variables and components of the CSHP

Most of the studies included physical education and health education/nutrition education. Therefore it was not possible to look at the relative contributions of those components of the CSHP. Similarly, few studies used a parent component independent of nutrition services so those components could not be examined separately. In this analysis studies with more components of the CSHP produced larger effect sizes, thus supporting the multi-faceted model recommended by the Centers for Disease Control (Centers for Disease Control).

Studies targeting physical activity produced moderate changes in physical activity. Studies focusing on cardiovascular outcomes produced moderate changes in physical activity but not in cardiovascular outcomes. Cardiovascular change may be more difficult because children tend to be healthy and are probably within the normal range on variables like blood pressure and cholesterol. Data suggests that children and adolescents are less likely to be as physically active as recommended and therefore are probably more amenable to change. Clearly, when children are “trained”, that is the level of their physical activity is increased, they respond to the training as demonstrated by the mile run and other measures.

Both methods for determining the effect size (pre post and post post) identified knowledge and mile run as important variables. These are efficacious measures, and are likely to detect improvement during school-based interventions. These variables need to be tested against long term physical activity and causality must be explored in future studies.

Gender and age

Gender differences were not significant suggesting the interventions were equally successful with males and females. A barrier to exploring this notion in depth was that most studies did not report male and female data separately. Of course, this was appropriate in designs where class or school were the experimental units, however for many studies the data was reported as individual participant change and could have been reported separately for boys and girls. Other studies included only girls for all or some variables, again limiting the opportunity to study the influence of gender.

Few studies were conducted at the high school level so while no grade level differences were detected, the limited number of studies may have confounded results. Further, most studies were conducted within a grade level (e.g., elementary school or middle school) and therefore afforded less opportunity to understand the role of age/grade in the response to the treatment.

Selecting the best method for calculating effect sizes is an important consideration in meta analyses. In this meta analysis the two methods produced generally similar results. The major exception was for moderate-to-vigorous physical activity (MVPA). Recall that one study had particularly small pre-control standard deviations and those impacted the pre-post calculations but not the post-post calculations. When the effect sizes for MVPA were recalculated without that one study, the effect size for intervention MVPA was similar to the post post MVPA effect size. Even for post post effect sizes, the MVPA was problematic because 0.0 fell within the upper and lower boundary for the confidence interval, while the effect size was large at above 0.8. This suggested that the large effect size was due to chance.

In cases where both the intervention and control groups were expected to change, for example body mass, the post post method does not capture the expected change. One important consideration in developmental studies was assuring that aspects of normal develop are captured. This supports the appropriateness and accuracy of the data.

From a practical perspective, using the post post method was time effective because only three variables for each effect size need be entered. The pre-post method requires six variables be entered into the data set.

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Table 1. Levels of intervention, CSHP components and nutrition education in the twenty intervention studies

	Number of levels of intervention	Physical Education	Health Education	Nutrition Services	Parent Involvement Community	Health Services	Total CSHP Components	Nutrition Education
Australia	6	x	x				2	x
CATCH	2	x	x	x	x		4	x
CHIC	2	x		x			2	
Go for Health	1	x	x	x			3	x
Heartsmart	1	x	x	x	x		4	x
MSPAN	1	x					1	
Oslo	1	x	x		x		3	x
PATH	1	x	x				2	x
Project Heart	1	x	x	x	x	x	5	x
SWCV	2		x				1	x
Spark	2	x	x	x	x		4	
Wisconsin	1	x	x				2	
Total number of Components		**11**	**10**	**6**	**5**	**1**		**8**
Excluded studies								
Eat Well	1	x	x	x	x		5	x
Know Your Body	3		x		x		2	
Leap	2	x	x				2	x
Pathways	1	x	x	x			4	
Planet Health	1	x	x	x	x		4	x
Stanford	1	x	x				2	
Total number of Components		**5**	**6**	**3**	**3**	**0**		

Table 2. Study name, citation used for data extraction, number of children, and effect sizes calculated with pre-post and post-post

Name of study	Text Citation	Number of children	# of ES in Pre Post	# of ES in Post Post	Cardiovascular Health	Body composition	Physical activity	Knowledge
Australia	Vandongen, Jenner, Thompson (1995)	486	14	7	Diastolic BP Systolic BP Total Cholesterol	BMI Triceps Subscapular	Runwalk	
CATCH	McKenzie, Nader, Strikmiller (1996) Luepker, Perry (1996) Luepker (1998)	5106	24	16	Systolic BP Diastolic BP Total Cholesterol HDL Heart Rate	BMI Triceps Subscapular		
CHIC	Harrell, McMurray, Bangdiwala (1996)	2109	18	12	Diastolic BP Systolic BP Total Cholesterol	BMI Total skinfolds Weight		
Go For Health	Parcel, Simons-Morton, O'Hara (1989)	277	8	4			MVPA	

Table 2. Continued
Study name, citation used for data extraction, number of children, and effect sizes calculated with pre-post and post-post

Name of study	Text Citation	Number of children	# of ES in Pre Post	# of ES in Post Post	Cardiovascular Health	Body composition	Physical activity	Knowledge
Heartsmart	Harsha (1995)	280	8	4			Run walk	
MSPAN	McKenzie & Sallis (2004)	430	4	2			MVPA	Health
Oslo	Tell & Vellar (1987)	785	28	14	Diastolic BP Systolic BP Total Cholesterol HDL	BMI Triceps Weight		
PATH	Fardy (1996)	346	12	6	Total Cholesterol		$V\hat{O}_2$	Health
Project Heart	Ewart (1998)	88	10	5	Diastolic BP Systolic BP Heart Rate	BMI	Step test	
Spark	Sallis, McKenzie, Alcaraz (1997) McKenzie, Sallis, Kolody (1997)	955	30	20		Total skinfolds	Run walk Situps Pullups Sit and Reach	
SWCV	Davis (1995)	2018	8	4				Health
Wisconsin	Carrel (2005)	50	4	2		BMI % Body fat		

Table 3. Pre-post effect sizes of dependent variables between intervention and control groups

Dependent Variable	Number of studies	Number of ES	Number of Children	Intervention Mean ES (SD)	95% Confidence Intervals Lower Bound Intervention	Upper Bound Intervention	Control Mean ES (SD)	95% Confidence Interval Lower Bound Control	Upper Bound Control
Physical Activity[1]									
MVPA	1	12	1746	*12.01 (6.89)*	*3.46*	*20.56*	*7.90 (8.28)*	*-2.36*	*18.21*
1 mile run/walk	3	16	3709	*-0.17 (.18)*	*0.04*	*0.32*	*0.04 (.38)*	*-0.39*	*0.32*
Situps	1	6	3820	0.33 (.26)	-0.08	0.74	0.14 (.02)	-0.04	0.31
Sit and Reach	1	6	3820	-0.09 (.15)	-0.33	0.16	0.01 (.05)	-0.47	0.48
Pullups	1	6	3820	0.03 (.06)	-0.07	0.13	0.02 (.02)	-0.18	0.21
Knowledge									
Health	2	14	3547	*0.93 (.70)*	*0.29*	*1.58*	*0.013 (.30)*	*-0.27*	*0.29*
Body Composition									
Mass	2	7	3338	0.65 (.56)	-0.24	1.55	0.84 (.60)	-0.65	2.33
% Body fat	1	2	614	-0.44 (.57)	-5.61	4.73	-0.21 (.28)	-2.73	2.30
Subscapular	2	5	6226	0.29 (.24)	-0.29	0.88	0.59 (.28)	-1.90	3.09
BMI	7	16	9626	0.33 (.32)	0.09	0.57	0.29 (.35)	-0.03	0.61
Triceps	3	9	6768	0.22 (.28)	-0.12	0.57	0.14 (.29)	-0.32	0.59
Total Skinfold	2	9	6615	-0.03 (.05)	-0.09	0.02	0.00 (.04)	-0.09	0.10
Cardiovascular									
HDL	2	7	2933	-0.07 (.31)	-0.56	0.42	0.04 (.28)	-0.65	0.73
Total Cholesterol	5	16	7298	-0.18 (.29)	-0.42	0.06	-0.09 (.22)	-0.14	0.32
Diastolic BP	5	14	9630	-0.08 (.57	-0.56	0.39	-0.23 (.60)	-0.85	0.40
Systolic BP	4	14	7297	0.20 (.54)	-0.25	0.65	0.08 (.53)	-0.47	0.64
Heart Rate	2	5	5747	-0.12 (.47)	-1.30	1.06	-0.19 (.27)	-2.66	2.27

[1] Two additional variables are not included in the table because only one effect size was calculated, those were step test (n=2 ES) and $V\hat{O}_2$ (n=2 ES girls only).

Table 4. Post-post effect sizes for dependent variables

Category/ Dependent Variable	Number of studies	Number of Effect Sizes	Number of Children	Mean Effect Size	Standard Deviation	95% Confidence Intervals	
						Lower Boundary	Upper Boundary
Physical Activity[2]							
MVPA	1	5	1746	1.48	1.38	-0.24	3.20
1 mile run/walk	3	9	3709	-0.37[3]	.42	*-0.70*	*-0.05*
Sit and Reach	1	4	3820	-0.14	.25	-0.53	0.26
Situps	1	4	3820	0.14	.14	-0.08	0.35
Pullups	1	4	3820	0.06	.03	*0.02*	*0.10*
Knowledge							
Health	2	7	3547	0.90	.67	*0.28*	*1.53*
Body Composition							
Mass	2	4	3338	0.17	.25	-0.23	0.57
Subscapular	2	3	6226	-0.17	.30	-0.92	0.58
BMI	7	9	9626	0.08	.22	-0.09	0.26
Triceps	3	5	6768	0.08	.19	-0.15	0.31
% Body fat	1	2	614	0.09	.14	-1.11	1.13
Total Skinfold	2	6	6615	-0.10	.06	*-0.16*	*-0.04*
Cardiovascular							
HDL	2	4	2933	0.09	.11	-0.08	0.27
Total Cholesterol	5	8	7298	0.08	.11	-0.01	0.17
Diastolic BP	5	8	9630	0.06	.18	-0.09	0.21
Systolic BP	4	8	7297	-0.03	.20	-0.20	0.13
Heart Rate	2	3	5747	0.00	.02	-0.05	0.05

[2] Step test and $V\hat{O}_2$ were not included because there was one effect size for each.
[2] Italicized values indicate variables where 0.0 is not within the boundaries of the confidence interval.

Appendix

REVIEW OF LITERATURE

For every one hundred children entering through the school doors each day in the United States today fourteen are obese. The prevalence of overweight among children aged 6-11 years has more than doubled in the past 20 years and among adolescents aged 12-19 has more than tripled (United States Department of Health and Human Services, 2001). Childhood and adolescent overweight and obesity are related to health risks, medical conditions, and increased risk of adult obesity, with its attendant effects on morbidity and mortality rates (Whitlock, Williams, Gold, Smith, & Shipman, 2005). Most children attend school, so school is a logical place to impact children's health, including obesity and overweight.

The Centers for Disease Control and Prevention recommends 10 strategies for schools to use to fight the childhood obesity epidemic. The first of these strategies is to implement the Coordinated School Health Program (United States Department of Health and Human Services & Centers for Disease Control, 2006). Obesity prevention and treatment is a complex problem that requires a multifaceted approach. Interventions to treat childhood obesity typically have more than one component. Thus, considering interventions in view of the components included in the intervention is logical. The one model endorsed by the Centers for Disease Control is the Coordinated School Health Program.

The Coordinated School Health Program (CSHP) is a Centers for Disease Control program with eight components, designed to influence student health and learning

(Centers for Disease Control, 2005a). The CSHP is sequential and planned model including a set of courses, services, policies, and interventions that meet the needs of all students. CSHP allows for flexibility, as the health needs change, the model can address those needs at school. In the past, the program focused on sexually transmitted diseases and substance abuse. The needs of the schools change, and so recently the program focus has turned to overweight and obesity. The eight components of the CSHP are health education, physical education, health services, nutrition services, counseling and psychological services, the healthy school environment, staff health promotion and community/family involvement. The following sections will summarize each component of the CSHP.

The health education component addresses the physical, mental, emotional and social dimensions of health through a curriculum (Centers for Disease Control, 2005a). This component helps students maintain and improve their health, prevent disease, and reduce health-related risk behaviors. Personal health, family health, community health, consumer health, environmental health, sexuality education, mental and emotional health, injury prevention and safety, nutrition, prevention and control of disease, and substance use and abuse are all parts of this component.

The physical education component is a curriculum that is planned, developmentally appropriate, K-12 curriculum that provides cognitive content and learning experiences in a variety of activity areas such as basic movement skills; physical fitness; rhythm and dance; games; team, dual, and individual sports; tumbling and gymnastics; and aquatics (Centers for Disease Control, 2005a). The physical education component promotes physical, mental, emotional, and social development. Part of the focus is developing skills to be used for the life span of the individual.

The health services component involves the promotion of health for students (Centers for Disease Control, 2005a). Services are designed to make certain that children have access or referral to primary health care services. At the heart of this component is the school nurse. Focus is on the prevention and control of communicable disease and other health problems. Schools work towards achieving sanitary conditions for a safe school facility and school environment. Educational and counseling opportunities are provided and for maintaining individual, family and community health. Qualified professionals such as physicians, nurses, dentists, health educators, and other allied health personnel provide these services.

The nutrition services component provides a variety of nutritious and appealing meals that meets the health and nutrition needs of all students (Centers for Disease Control, 2005a). School nutrition programs reflect the U.S. Dietary Guidelines for Americans and other criteria to achieve nutrition standards. The USDA child nutrition programs, commonly known as school breakfast and lunch, typically support this portion of the program.

Counseling and psychological services are available to improve students' mental, emotional, and social health (Centers for Disease Control, 2005a). These services include individual and group assessments, interventions, and referrals. The health of the school environment is affected by the organizational skills of the counselors. Professionals such as certified school counselors, psychologists and social workers provide these services.

A healthy school environment focuses on the culture of the school including the physical and aesthetic surroundings and the psychosocial climate (Centers for Disease Control, 2005a). The school buildings and the area surrounding it are all factors. Biological or chemical agents that are detrimental to health, and physical conditions such as temperature, noise, and lighting are included. The psychological environment includes the physical, emotional, and social conditions that affect not only the well being of students but the staff as well.

Health promotion for school staff members may involve opportunities for school staff to improve their health status through activities such as health assessments, health education and health-related fitness activities (Centers for Disease Control, 2005a). These activities motivate and encourage healthy habits contributing to their improved health status, improved morale, and greater personal commitment to the school's overall coordinated health program. This personal commitment often results in greater commitment to the health of students and creates positive role modeling. Health promotion activities have many benefits, including productivity, attendance, and reduced health insurance costs are areas of improvement.

Family/community involvement is an integrated school, parent, and community approach for enhancing the health and well being of students (Centers for Disease Control, 2005a). School health advisory councils, coalitions, and other organizations for school health can build support for school health program efforts. Schools seek parent involvement and use community resources and services to respond to the health-related needs of students.

The Coordinated School Health Program is designed to help schools build a foundation to promote physical activity and healthy eating. In Maine, the state CSHP, has a funded school health coordinator and school health advisory council. Michigan has developed a research-based health education and physical education curriculum that follows the guidelines established by the Centers for Disease Control. Many other states have tailored their plans to meet the needs of their own states. CSHP provides a framework for schools to meet the needs of their own school community. These specific needs are addressed through interventions to increase physical activity, promote healthy eating, and reduce the risk of cardiovascular disease. Centers for Disease Control funding to school-based programs is most likely to come from the Division of Adolescent and School Health (DASH) and be connected to CSHP. Therefore, understanding interventions in the context of CSHP is important. The next several sections will overview school based interventions that include components related to childhood obesity, for example nutrition and physical activity.

Physical activity improves measures of fitness such as aerobic capacity, muscular strength and endurance, body composition, agility, and coordination (Blair, Kohl, Barlow, Paffenbarger, Gibbons, & Macera, 1995). Regular physical activity is also associated with improved health and quality of life and a reduced risk of all-cause mortality (Kahn, Ramsey, Brownson, Heath, Howze, Powell, Stone, Rajab, & Corso, 2002). Physical education programs are struggling to meet the recommendations of *Healthy People 2010* (United States Department of Health and Human Services, 2000). Approximately half the recommended weekly minutes per week are provided in schools where there is any physical education; many (5-33%) schools have no physical education for their students (Burgeson, Wechsler, Brener, Young, & Spain, 2001). The *Guide to Community Preventive Services* (*Community Guide 2005*) recommendations for increasing physical activity include recommendations applicable to schools (Kahn et al. 2002). Therefore, many school-based interventions include physical education and/or physical activity as part of the intervention and others target physical activity/education as the primary mechanism of the intervention. For example, Sports, Play and Active Recreation for Kids (SPARK), is a school based physical activity intervention involving physical education classes with fitness curriculum; classroom health curriculum,modified school lunch; and teacher training (Sallis, McKenzie, Alcaraz, Kolody, Hovell, & Nader, 1997). The focus of many physical activity interventions is to increase in class instruction time for physical education activities, competence of motor skills and cardiovascular fitness. A family component is part of *Know Your Body* intervention (Manios, Moschandreas, Hatzis, & Kafatos, 1999). Since obesity influences many diseases and is one independent risk factor, interventions often try to reduce obesity. Thus, nutrition as it influences energy balance is an important component or the focus of some interventions. Tables Appendix 1a and 2a summarize twenty school-based interventions with a physical activity component.

Research demonstrates that good nutrition practices can help to lower people's risk for many chronic diseases, including heart disease, stroke, some cancers, diabetes, and osteoporosis. Child Adolescent Trial for Cardiovascular Health (CATCH) was a multicenter, multiethnic, school-based intervention study to promote healthful behaviors in elementary school children and to reduce risk factors for heart disease (Dwyer, Stone, Yang, Webber, Must, Feldman, Nader, Perry, & Parcel, 2000). CATCH focused on decreasing total and saturated dietary fat, increasing physical activity, and preventing the initiation of smoking.

CATCH is an intervention for cardiovascular health. Cardiovascular health is directly related to obesity and overweight. Childhood obesity is a risk factor of critical importance because of its associations both with immediate health risks, such as increased blood pressure and hyperglycemia, and adult morbidity and mortality (Troiano, Fiegal, Kuczmarski, Campbell, & Johnson, 1995). Students are engaged in moderate to vigorous physical activity $\geq$40% of time, while classroom curricula promotes cardiovascular health, including tobacco curriculum and tobacco school policy. There is also a family component with this intervention (Luepker, Perry, McKinlay, Nader, Parcel, Stone, Webber, Elder, Feldman, & Johnson, 1996).

There are barriers to school-based overweight and obesity interventions. The stigma attached to overweight makes the assessment of weight among children a difficult concern for school officials and parents and raises ethical concerns regarding the potential stigmatization of children (Centers for Disease Control, 2005b). An additional challenge is the family component of the interventions. Further, some students were unable to self manage the behaviors they learned. Validity was threatened with some of these studies because implementation of the interventions was sometimes inconsistent from school to school.

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APPENDIX A.

LIST OF TABLES

Appendix Table A1. Description of Studies of school-based interventions including physical activity with sufficient data to include in a meta analysis organized by goal of the study.

Included Studies	Grades	Targeted Population	Geographic Area	Description of Study
Goal of study to improve cardiovascular health				
Catch	3,4,5	White Hispanic African American	Urban (Austin, San Diego, Minneapolis, New Orleans)	Food service program Classroom behavioral health curriculum Physical Education to increase MVPA Parent Involvement
Oslo Youth Study	5,6,7	unknown	Oslo	Nutrition Physical Activity Smoking Alternative Curriculum
Go for Health	3,4	White Hispanic African/American	Urban	Classroom health education Vigorous physical education School Lunch
Southwest CV	5	Native Americans	Rural	Native American Curriculum Behavior Changes with eating and exercise
CV Health in Children (CHIC)	3,4	White African/American Native American Hispanic Asian Other	Rural and urban	Health Curriculum Specially Designed PE
Heart Smart	3,4,5	Unknown	Suburban	Teacher Training Fitness Classes

				Healthy School Lunches Parent Education Risk Factor Screening
Australia	4,5,6	Unknown	Australia	Nutrition Program Fitness Program
Studies with the goal of increasing physical activity				
Sports, Play, and Active Recreations for Kids (SPARK)	4,5	White African/American Hispanic	Suburban	Physical Activity PE Curriculum
Project Heart	9	African/American White	Baltimore, MD (city)	Aerobic exercise
Wisconsin	6,7,8	Unknown	Madison, WI	Fitness program Nutritional component Smaller class sizes and trained teachers
Middle School Physical Activity and Nutrition	6,7,8	Unknown	Southern California	PE program with a classroom curriculum Staff Development
PATH	9	African American Caucasian Hispanic Asian Other	Urban	Circuit Training Health Discussions

Appendix Table A2. Description of Studies of school based interventions with a physical activity component without sufficient data to include in a meta analysis.

Excluded Studies	Grades	Targeted Population	Geographic Area	Description of Study
Know Your Body	1,2,3 4,5,6	Hispanic 60% Black 23% White 11%	Urban (4 schools in New York City and 1 comparison school in Houston)	Skills-based health promotion Health Behavior
Pathways	2,3	American Indians	Baltimore	Reduce Dietary Intake Physical Activity Family Involvement Classroom Curriculum
Eat Well and Keep Moving	4,5	Unknown	Baltimore	School food services Wellness programs for teachers Screen Time Increasing physical activity.
Planet Health	6,7,8	Unknown	Massachusetts	Decreasing television viewing Nutrition Increasing moderate and vigorous physical activity

Lifestyle Education for Activity Project (LEAP)	8,9	African American Other	Unknown	Instructional changes focused on physical and health education. Life long physical activities
Stanford Adolescent Heart Health Program	10	White 69% Hispanic 6% Pacific 4% African American 2% Native American 3% Asian 13% Other 8.9%	Northern California	Alternative Curriculum

APPENDIX B.

RECORDING AND CODING SAMPLE

Recording and coding sheets used in meta analysis

Reference numbers for publications for the study:

CATCH

Process Evaluation	2,4,6,9,10,13,15b, 20,21,22,23,24,28
Implementation and Participation	2
Environment	4
Family	6
Process Evaluation	9,13,20
Physical Activity	15b
Program Design	21,24,28
Food Service	22
Validity (9 mile run and Eat Smart Program)	11,25
PA	7,8,14,15a,16
Nutrition	1,12,17,18,19
Behavior	3
Cardiovascular Risk Factors	26,27
Tobacco	5

Description of Participants

	Children	A#	Teachers	A#	Parents	A#	Adults	A#
# of participants	5106	3						
Gender								

	Males	**Females**	**Children**	**Parents**	**Male**	**Female**	
All	**2645**	**2461**	**5106-A 7,8** 6956-A 3 6527-A 5				
White	**1894**	**1636**	**3530**				
Hispanic	**345**	**363**	**708**				
Pacific							
African/American	**313**	**361**	**674**				
Native American							
Asian							
Other	**93**	**101**	**194**				
Unknown							

Description of Intervention

Number of Sites	4	Length of Intervention (years)	3 years (1991-1994)
Names of Cities	**Austin, Texas San Diego, California Minneapolis, Minnesota New Orleans, Louisiana**	Duration of Intervention (min/wk)	Hearty Heart Curr.
Rural,city,both, country	**urban**	Frequency of Intervention (days per week)	3 times per week for 5 weeks
Number of Schools	**96 total Intervention Schools 14/site** **Control Schools 10/site**	Type of Intervention	Yes No PE Curriculum x □ Nutrition Ed. x □ Food Service x □ Parent Ed. x □ Health Ed. x □
Grades	**3,4,5**	Experimental Unit	Individual Classroom School
		Other Components	

APPENDIX C.

REFERENCES INTERNAL VALIDITY

References
Publications demonstrating internal validity alphabetically by study.

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APPENDIX D.

REFERENCES DATA BASED PAPERS

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Data-based publications by study which were not used because the data was in other publications or not related to physical activity. * Indicates publications not focused on physical activity.

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