SCHOOL-BASED PHYSICAL ACTIVITY INTERVENTIONS TO PREVENT OR TREAT CHILDHOOD OVERWEIGHT

A Summary of Research and Findings

January 2005

Credits and Acknowledgements

This research paper has been prepared to assist state policy makers, public health leaders, educators, clinicians, and researchers in better understanding the relationship between physical activity and childhood overweight and to outline possible school-based interventions based on current research and evidence-based findings. A companion policy brief, ***Addressing Overweight: The Role of Physical Activity in Schools,*** has been prepared specifically for use by policy makers, educators and advocates. The policy brief may be found at the website of Healthcare Georgia Foundation, www.healthcaregeorgia.org, and the website of the Georgia Prevention Institute of the Medical College of Georgia at www.mcg.edu/institutes/gpi. For information, contact PLAY project director Rodney Lyn at rlyn1@gsu.edu or (404) 651-2209.

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Policy Leadership for Active Youth (PLAY) is a three-year policy research initiative of the Georgia State University Institute of Public Health in partnership with the Georgia Center for Obesity and Related Disorders (GCORD) of the University of Georgia and the Medical College of Georgia. PLAY collaborates with other stakeholders to identify promising strategies to increase physical activity, decrease sedentary behaviors and prevent childhood overweight. Investigators are Dr. Michael Eriksen, Valerie Hepburn and Dr. Ike Okosun, Georgia State University; Dr. William Kanto, Dr. Paule Barbeau, Dr. Frank Treiber and Dr. Andrew Muir, Medical College of Georgia; and Dr. Rebecca Mullis, Dr. Richard Lewis and Dr. Emma Laing, University of Georgia. PLAY is partially funded by a competitive grant from Healthcare Georgia Foundation.

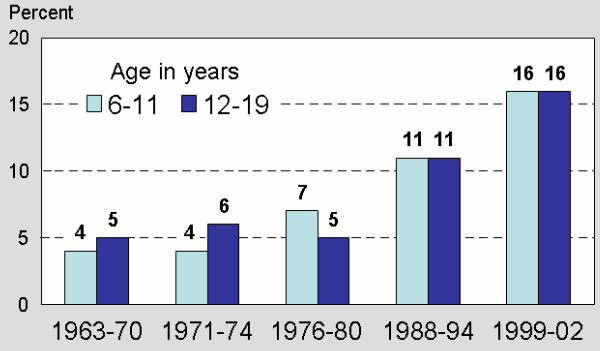
Table of Contents

1. Childhood Overweight in the United States and Georgia

a. Prevalence and Trends

The prevalence of childhood overweight[a] has increased dramatically in the last 25 years [1-4], and it is estimated that 119 million adults in the United States are overweight or obese [5]. Fifty-nine percent (59%) of adults in Georgia are overweight or obese, and the state is ranked as having the sixth highest prevalence of obesity in the country [6]. The seriousness of this trend is illustrated by the recent increases among children in conditions formerly thought of as "adult" diseases, such as obesity-associated Type 2 diabetes [7-9] and hypertension [10]. Individuals with diabetes incur medical costs that are two to three times higher than that of individuals without diabetes [11]. Data from the National Health and Nutrition Examination Survey (NHANES) conducted by the Centers for Disease Control (Figure 1) indicate that the prevalence of childhood overweight has increased from about 5-7% in the late 1970's to 16% at the turn of the century. Prevalence data in the state of Georgia have only recently become available. Estimates based on self-reported height and weight indicate that 13-14% of middle school children and 11% of high school children are overweight [12, 13]. Although these values are lower than those estimated based on the NHANES 1999-2000 data [2], this underestimation probably stems from the use of self-reported height and weight [14]. A study conducted recently in 39 schools from 10 counties across Georgia found that about 20% of children and adolescents were overweight and 16% were at-risk-for-overweight [15]. The prevalence of overweight was higher in boys, participants in rural growth or rural decline areas, and African Americans and other minorities. Most disturbingly, the extent or degree of overweight in overweight children was very high, such that body mass index (BMI) for an overweight child exceeded his/her 95th percentile BMI-for-age value by an average of 4.3 units. The extent of overweight was similar in all grades, but was higher in boys compared to girls, in rural and suburban regions compared to urban regions, and in African Americans and other minorities compared to whites. These alarming numbers and trends speak to the urgency of addressing the problem of childhood overweight.

Figure 1. Prevalence of overweight among children and adolescents ages 6-19 years



NOTE: Excludes pregnant women starting with 1971-74. Pregnancy status not available for 1963-65 and 1966-70. Data for 1963-65 are for children 6-11 years of age; data for 1966-70 are for adolescents 12-17 years of age, not 12-19 years.
SOURCE: CDC/NCHS, NHES and NHANES

b. Etiology

[a] In adults, the term overweight refers to a body mass index of 25-30 kg/m^2, while obesity refers to a body mass index greater than 30 kg/m^2. In children, at-risk-for-overweight refers to a body mass index between the 85th and 95th percentile for age and gender, and overweight refers to a body mass index over the 95th percentile for age and gender. However, in the literature, obesity and overweight are often used interchangeably when referring to children. This report will also use the terms overweight and obesity interchangeably when referring to children.

The increases in childhood overweight are likely a consequence of "obesogenic" environments [16] that favor increased energy intake and decreased energy expenditure, with decreases in the latter more likely to be the culprit [17]. The decreases in energy expenditure are due both to decreased moderate to vigorous physical activity (PA) - including decreased physical education (PE), and increased sedentary behavior, including computer activities, watching television, and playing videogames [18, 19]. Other factors involved in reducing PA include a reduction in the number of schools requiring daily PE [20], the perception that neighborhoods are perceived as unsafe for outside play [21] and lack of facilities and supervision for after-school PA [22]. Recognizing the recent decline in PA and increases in child and adolescent overweight, it is important to intervene through programs that may prevent as well as treat the problem by reaching a majority of the targeted population [23, 24]. This is particularly important because overweight children and teenagers are more likely to be overweight or obese adults, and to suffer from type 2 diabetes [25].

2. Role of Schools in Preventing and Treating Childhood Overweight

Most children spend a significant portion of their time attending school. Therefore, efforts to promote school-based PA have the potential to positively affect most young people. However, schools are increasingly faced with academic and budgetary pressures, which must be kept in mind when approaching school administration about increasing PA in their schools. In addition, it is important to acknowledge that schools do not bear the sole responsibility for ensuring healthy weight and nutrition practices. Nonetheless, the school serves a vital role in assuring that children achieve the daily recommended quantity and quality of PA. The existing evidence, as discussed in the following sections, supports the implementation of PA, particularly in schools, as a primary means by which to combat unhealthy weight levels among children and adolescents. Details of the studies reviewed are found in the Appendix.

For the purpose of this report, the term "school-based" includes interventions that occur before, during, and after school and that use school as the site for the intervention, or as the recruitment base. These interventions may be broad-based, aimed at the prevention of childhood overweight, or targeted, aimed at the treatment of childhood overweight. Several excellent reviews [26-34] were used as a starting point for this report. Finally, although this report focuses on PA interventions, it should be noted that several of the studies reviewed also included nutritional interventions, such as changing what was being offered in school meals, and introducing competitive pricing for healthful foods.

a. Current Guidelines for Physical Education in Georgia Schools

Until 2001, PE was required in all elementary, middle, and high schools in Georgia [35]. However, as a result of House Bill 1187 passed in 2000, PE requirements were decreased and changed to a discretionary item for local School Boards. PE is still required in elementary school, but not in middle or high schools (although they are authorized to offer it if they wish). Additionally, there are no requirements for the screening of height and weight and cardiovascular fitness levels. Thus, even if schools offered PE on a regular basis, it would be difficult to know whether the PE was efficacious at increasing or maintaining healthy weights and fitness levels.

b. Levels of Physical Activity in Children in the United States and Georgia

Current recommendations from National health organizations are that children of all ages should accumulate at least 60 to 90 min of moderate to vigorous PA every day [36, 37]. Moderate to vigorous PA includes activities that elevate energy expenditure to several times the resting metabolic rate, such as brisk walking, swimming, basketball, and field games [38]. A 2001 review of 26 published studies from around the world in 3-17 year olds that used heart rate monitoring to measure free-living PA concluded that on average children accumulate ~30 min/day of moderate to vigorous PA [39]. In addition, data obtained from the Youth Risk Behavior Surveillance System conducted by the Centers for Disease Control indicate that in 2003, only 25% of teenagers in the United States engaged in moderate PA for at least 30 minutes at least five days in the last seven days, and 59% engaged in 20 minutes or more of vigorous PA three or more days of the week [40].

The statistics for Georgia are equally distressing. In a recent survey, over 36% of Georgia's adolescents reported not participating in a sufficient amount of PA over the prior seven days.[40]. Although 65% of middle school students attend PE at least once a week, only 29% attend PE daily [12]. The enrollment and participation rates decline in high school, where only 37% of students attend PE at least once a week, and 29% attend PE daily. Furthermore, in high school, boys tend to attend PE more than girls, and the number of students who attend PE decreases significantly from 9th to 10th grade. Thus, there is ample opportunity for schools to play a role in increasing PA levels in children, and in preventing or retarding the decrease in PA that is now occurring through the adolescent years.

c. Georgians' Opinions on the Importance of Overweight and Physical Activity

The Healthcare Georgia Foundation recently conducted a statewide poll of over 1200 randomly selected Georgia residents. The findings indicated that 97% of respondents identify overweight and obesity as a serious problem, and further believe that, next to parents, schools have the most significant responsibility in preventing childhood overweight. Furthermore, 95% of Georgians believe that PE should be required in schools, and 97% believe that after-school sports are very important (73%) or somewhat important (25%). Sixty-two percent (62%) of Georgians were in favor of a special 1-cent tax, and 65% were in favor of increases in alcohol and tobacco excise taxes to support PE programs. The results of the survey were similar across race, income, education, and rural/urban demographics. These findings, in combination with the increasing prevalence and the known burden of childhood overweight, underscore the merits of more and better school-based physical education.

d. Promoting Physical Activity in Schools

School-based overweight prevention interventions have generally utilized the existing curricular structure to teach health knowledge and lifetime fitness skills, and to increase the effectiveness of PE classes (e.g., [41-43]). To a large degree, these interventions were based on the idea that once participants develop self-efficacy, social support networks and sports skills, they will be able to engage in PA during their free time. As discussed below, these studies yielded mixed results.

A recent report from the Centers for Disease Control [44] reviewed many ways of promoting PA and recommended six strategies that had been shown to be effective, including

school-based PE. A consensus report that emanated from the "Summit on Promoting Healthy Eating and Active Living: Developing a Framework for Progress" [45] classified a large number of environmental factors that influence PA as to changeability and impact. After-school PA was the only item that was both easy to change and would be expected to have a high impact. Although these two reports recommend slightly different strategies, both suggest that the school setting is an important component to focus on when designing PA interventions in children.

3. Results of Physical Activity Interventions in Schools

a. Elementary Schools

Most of the PA interventions that aimed at preventing or treating childhood overweight were conducted at the elementary school level. Types of intervention varied, including those that: (1) focused primarily on increasing the amount or intensity of PA received during PE, (2) were knowledge-based and delivered in the classroom, and (3) targeted PA outside school. Primary outcomes included time spent doing PA, knowledge of healthy PA behaviors, body composition (e.g., BMI, body fat), and cardiovascular risk factors (e.g., cholesterol).

Several PA intervention studies of varying lengths (eight weeks to two years) that targeted PE resulted in increased amounts of moderate to vigorous PA during PE classes [42, 43, 46, 47] or increases in daily PA [48, 49]. However, most of these interventions did not result in significant changes in body composition [43, 47, 50, 51]. Moreover, few studies showed a significant improvement in cholesterol levels [47, 49, 52], and one a decrease in capillary glucose [51]. Thus, although PE interventions have been shown to increase PA, it has been harder to demonstrate improvement in body fatness, fitness, or cardiovascular risk factors. It is possible that the increases in PA, although significant, were not large enough to elicit significant changes in fatness. Alternately, it may be that the intensity of the PA was not high enough, the duration long enough, or of the proper type (i.e., aerobic), to elicit increases in fitness.

Some PA studies in elementary schools deserve closer analysis. The Sports, Play, and Active Recreation for Kids (SPARK) project was a two-year quasi-experimental trial conducted in fourth grade students in seven elementary schools in California [42]. The design included three tiers of PE (i.e., led by PE specialists, led by trained classroom teachers, or usual program) and self-management education in the classroom. The minutes per week of moderate to vigorous PA during PE were greatest in the specialist-led schools (40 min) and trained classroom teacher-led schools (33 min) compared to control schools (18 min). However, there were no significant differences between the three conditions for out-of-school PA or body fatness. Furthermore, girls increased in fitness while boys did not. This suggests that PA interventions may need to be tailored differently to boys and girls.

The Child and Adolescent Trial for Cardiovascular Health (CATCH) was a 3-year comprehensive PA and nutrition project conducted in grade 3 students in 96 elementary schools in California, Minnesota, Texas, and Louisiana. CATCH included school-based (school food services, PE, classroom curricula) and family-based (home curricula, family fun nights) components [43]. The amount of time spent in moderate to vigorous PA during PE increased significantly in the intervention schools compared to the control schools. Students in the intervention schools also reported more vigorous PA compared to students in the control schools. However, there were no significant differences in BMI, body fatness, or total cholesterol between the two treatment groups. At the three-year follow-up, the students from the

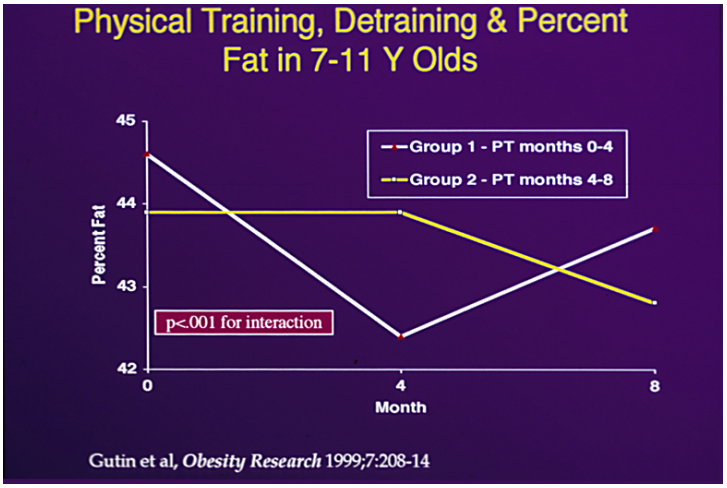
intervention schools still reported significantly greater amounts of PA compared to students from control schools, although the difference between the two groups was smaller [53]. Therefore, although CATCH, like SPARK, was successful in increasing PA, there were no significant improvements in body fatness. It is unknown whether small changes in body fatness, although statistically not significant, may have long term effects on health in children.

Three studies conducted outside of the United States also deserve mention. The Kiel Obesity Prevention Study (KOPS) in Germany is an ongoing eight-year cohort study of children aged five to seven years [54]. The intervention included four basic messages that were delivered to the children in classroom settings and to the parents at school parent meetings. The messages were: (1) eat fruits and vegetables each day, (2) reduce the intake of high-fat foods, (3) keep active at least one hour per day, and (4) decrease television viewing to less than one hour per day. In addition, families with overweight children and/or parents were offered a face-to-face counseling and support program within the family setting. Preliminary results from the first four years indicate that the children in the intervention schools decreased their body fatness more than children in the control schools. These preliminary results provide evidence that even very young children can benefit from PA and nutrition interventions. It will be interesting to see whether the favorable changes in body fatness are maintained as the children move through elementary school.

An overweight prevention study targeted elementary schools in different areas of Chile [55]. This 6-month intervention included nutrition and PA components. The PA components included classroom education (1st to 8th grade), an extra 90 min per week of PA (3rd to 8th grade), and active recess. The results showed significant improvements in BMI, waist circumference, and fitness in the intervention schools compared to the control schools. This study provides evidence that the school environment can be modified to provide greater amounts of PA and improved nutrition which, as in the KOPS study, can lead to favorable changes in body fatness and fitness.

Finally, a 6-year intervention in Crete, Greece, targeted grade 1 to 6 students [56]. The intervention components included classroom education and enhanced PE for the children, and educational seminars for the parents. After the first three years of the intervention, the children in the intervention schools had significant improvements in BMI, body fatness, and cholesterol, reported more leisure-time PA, and increased their health knowledge more compared to the children in the control schools. This is a significant study because it shows that a long-term school-based intervention can be implemented, and that it can have a beneficial impact on body fatness and cardiovascular risk factors.

Figure 2



Some studies have targeted the 2-hour after-school time block. One such study was conducted in Richmond County, Georgia. The study targeted overweight 9-11-y old children. Children were recruited in elementary schools, bused after school to a central location at the Medical College of Georgia (MCG). In this cross-over design, children were

randomized to a group that exercised for four months then ceased to exercise for another four months, or to a group that served as a control during the first four months then exercised during the second 4-month period. The PA was vigorous, the children keeping their heart rates above 150 beats per minute. Children in the intervention group had a decrease in body fatness [57] during the first four months compared to those in the control group (Figure 2). Of note, during the second 4-month period, body fatness rebounded in the group that stopped exercising, suggesting that the effects of the intervention did not continue after the children stopped exercising, and that the children either were not motivated enough to continue exercising on their own, or were unable to do so. This was the first project to show that the after-school period could be used successfully to decrease body fatness in overweight children. Providing bus transportation to the program from school, and back home each day was an important factor in the success of the project.

The MCG Exercise Project was a generalization of the afore-mentioned project. Approximately 300 African American girls in grades three to five were recruited for a 10-month after-school PA project that was conducted in the school gyms. The 90-min PA program included mastery-oriented and ego-oriented activities in a controlled environment. Preliminary results indicate that subjects in the PA intervention group had significant improvements in body composition, adiposity [58], CV fitness, and increased their MVPA compared to subjects in the control group (all p values < 0.05). They decreased in %BF, compared to an increase in the control group, and increased less in WC and BMI compared to those in the control group. The subjects in the intervention group had an increase in CV fitness levels, while those in the control group had a decrease. The amount of MVPA per day increased more in subjects in the intervention group compared to those in the control group. Furthermore, there was a significant difference between the two groups for change in %fat intake in the diet ($\chi^2=3.85$, $p<0.05$). In the intervention group subjects, 48% decreased and 52% increased their dietary fat intake. In the control group subjects, 35% decreased and 65% increased their dietary fat intake.

Preliminary results also suggested that in young African American girls: participation in a PA intervention was related to decreased reports of distress and improved interpersonal relations, self-acceptance and identity development [59], (2) lower increases in %BF were associated with being able to choose more PA rather than sedentary activities [60], (3) higher increases in CV fitness were associated with being better able to overcome barriers related to PA and to PA being perceived as having better social outcomes [60]. The success of this project demonstrated that facilities available in the schools (i.e., classrooms and gyms) can be used after-school to implement PA intervention programs. Thus, the intervention used in this project could be implemented in elementary schools across Georgia.

b. Middle Schools

There are far fewer PA interventions that have been conducted in middle schools. The major studies are summarized here, although several others showed positive effects of PA interventions on adiposity [61-64]. The Cardiovascular Health in Children and Youth Study (CHIC II) was an 8-week study that randomized four schools to the control, education only, PA only, or education and PA group [65]. The PA consisted of 30 min of aerobic activity three days a week delivered during PE, while the education component was delivered in the classroom. Although body fatness increased less in the PA groups compared to the education only and control groups,

there was no significant difference between the groups for change in BMI. This suggests that BMI may not always be sensitive enough to detect improvements in adiposity.

Dance for Health was a 12-week pilot study that compared participation in a dance program three times per week and health education twice per week with regular PE [66]. The students in the dance intervention group had a greater decrease in BMI than the education group.

The Class of 1989 Study, a sub-study of the Minnesota Heart Health Program, was a 7-year study conducted in grades six through 12 [41]. The first PA intervention, implemented in grade 8, consisted of a school-based community-wide competition which encouraged the students to be active outside of school. The second PA intervention, implemented in grade 10, consisted of a peer-led curriculum designed to promote healthy eating and regular PA. Girls from intervention schools had higher levels of PA throughout the follow-up period compared to girls from the control schools. There was no significant difference in the two groups for boys, again suggesting that some types of interventions may work better with boys or girls.

The Middle School Physical Activity and Nutrition (M-SPAN) study was a two-year program that focused on changing school policy and environment [67]. There were several nutrition and PA components. The PA components were designed to increase the amount of PA during PE, and make environmental changes that would encourage PA at school during leisure time (i.e., before school, at lunch, after school). Policy changes were created and sustained using health policy meetings that included school administrators and staff, parents, and students, and student health committees. PA increased significantly more in intervention schools compared to control schools, although this effect seems to be restricted to boys. This increase in boys was due about equally to increases in PA during PE as well as during leisure time. *Self-reported* BMI decreased in boys in the intervention schools compared to boys in the control schools.

Planet Health was a two-year project that consisted of a nutrition and PA curriculum [68, 69]. The PA curriculum aimed to decrease television viewing and increase moderate to vigorous PA. The prevalence of overweight was decreased in the girls in the intervention schools compared to the girls in the control schools. There were no significant differences for boys. There were no significant differences in PA between intervention and control schools, although television viewing decreased in boys and girls in the intervention schools compared to those in the control schools.

Two studies have targeted the after-school hours in middle school children. Active Winners was a complex study conducted in South Carolina that included after-school, summer camp, home, school, and community components [70]. The project started with a series of summer camps for students who had just graduated from fifth grade. This was followed by one year of school and after-school interventions, another summer camp after graduating from sixth grade, and a one semester follow-up during the fall of seventh grade. The home and community components were ongoing. Limited resources resulted in some components (i.e., school, home, community) not being implemented as planned, thus limiting the effect the project might have had. There were no significant differences in self-reported PA between the intervention and control groups.

The MCG DOSE study was a 10-month project that compared two intensities of PA with a control group. All three groups received lifestyle education. Subjects were overweight teenagers recruited from middle and high schools who were bused to a central facility. Favorable effects of the PA intervention were found for body fatness (Figure 3), fitness (Figure

Figure 3

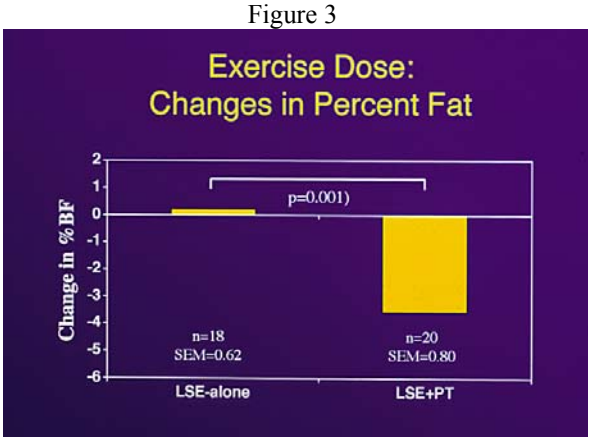
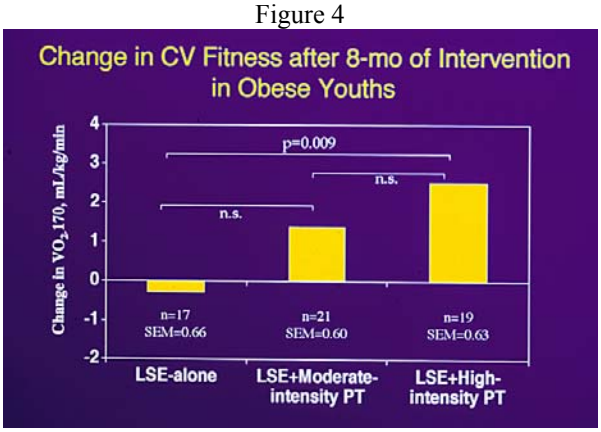


Figure 4



4), and cardiovascular risk factors such as triglycerides and cholesterol [71, 72]. Although the high-intensity PA group did not decrease significantly more in body fatness than the moderate-intensity group, there was a clear dose-response relationship for fitness, such that the high-intensity group increased more in fitness than the moderate-intensity group. This study showed that overweight teenagers are willing to spend the after-school hours participating in a PA program. Thus, after-school hours provide a large block of time during which children and teenagers could take part in a PA program that would be beneficial for their health.

c. High Schools

There are even fewer PA intervention studies in high schools. Interestingly, however, most of these studies include a follow-up component that assesses the long-term sustainability of the intervention. The studies conducted in high schools are limited by the same factors as those in elementary and middle schools (i.e., measurement of body fatness, intensity of PA, etc.).

Project FAB was a four-month study implemented in grade 10 and 11 girls in two high schools [73]. The intervention consisted of an enhanced PE program that was offered only to the girls in the project. The PE program included a variety of activities selected on the basis of focus groups, and one class per week which was devoted to a lecture or discussion on the health benefits of PA and strategies for becoming more active. Compared to the girls in the control school, the girls in the intervention school had favorable changes in self-reported moderate PA levels and fitness, but there were no differences in body fatness.

New Moves was a 16-week study implemented in grade 9 and 10 girls [74] in six schools in the Minnesota Twin Cities area. The main component of the intervention was enhanced PE, offered four times per week. Of these four days, one was devoted to a community guest

instructor, one to strength training, and the other two for self-selected activities. The program also included an 8-month follow-up. There were no significant differences between the girls in the intervention and control schools for change in self-reported PA or BMI. Interestingly, there was no significant difference in the readiness of the subjects in either group to engage in PA during the intervention. However, during the follow-up period girls in the intervention schools had an increase in their readiness to engage in PA, while the girls in the control schools did not. These results are particularly interesting, because they suggest that although an intervention may not have immediate effects on PA, there is the possibility that the effects may occur at a later time, when the subjects are in a better state of readiness.

The Lifestyle Education for Activity Program (LEAP) was a 2-y intervention study implemented in 24 high schools in South Carolina [75]. The participants were grade 9 girls. The intervention consisted of several components that were designed to create an environment that encouraged PA in teenage girls. These components included health and behavior education, as well as a 1-year PE program aimed at developing motor skills, and modeling success, encouragement, and moderate PA. The intervention resulted in an increase in the subjects' self-efficacy which led to increased PA. Showing this causal relationship was a significant finding in that it validated the theoretical framework underlying most behavioral change studies.

An interesting study in Canada compared the effects of three types of follow-up of a weight control program [76]. Participants were slightly overweight girls (12-38% above ideal body weight) who were recruited from a large high school. The initial weight control program lasted 8 weeks, and consisted of PA education and practice, and behavior control of eating and diet therapy delivered in two 1-h sessions every week. The girls were then randomized into one of three 1-y follow-up groups: (1) monthly measurements coupled with reinforcement sessions, (2) monthly measurements only, or (3) annual measurement. Mean weight loss after the 1-y follow-up was 5.7 lbs and 3.0 lbs for groups 1 and 2, respectively, while group 3 gained an average of 5.4 lbs. This study was significant because it suggests that girls who received relapse prevention continued to engage in the desired behaviors (i.e., PA and healthy eating) after the initial intervention.

d. Psychological Well-Being

A detailed review of the effects of PA on psychological well-being is beyond the scope of this report. However, the cross-sectional relationship between PA behavior and self-efficacy has been documented [77, 78], although causal relationships are not well established. Some of the PA interventions mentioned in the preceding sections did not show any changes in self-efficacy for PA [73, 74], while others showed increases in self-efficacy [43, 75, 79]. The LEAP project was the first to show that changes in self-efficacy brought about by a PA intervention were in the causal pathway to changes in PA levels [75]. However, results from the CATCH study suggest that initial increases in self-efficacy were not maintained over a period of three years [43].

Cross-sectional studies have indicated that higher levels of PA are related to better measures of wellness, including less sadness, greater self-image, greater body-image, and lower levels of suicide attempts [80-84]. Some PA interventions have resulted in improved well-being (e.g., decreased depression) [77, 85-89]. The SHAPEDOWN study, a 3-month intervention in teenagers, is particularly interesting because the improvements in depression and self-esteem were still significantly improved one year after the end of the intervention [86]. The positive

effects of PA on psychological well-being will be of interest for school principals and teachers, because it may translate into better behaved and more attentive students.

e. Academic Outcomes

The positive association between PA and academic outcomes is more tentative, although evidence suggests that physically active students perform better academically and have fewer incidences of disruptive behavior [90]. Some studies showed a positive relationship between PA and academic performance, mostly to memory, problem-solving, reading, and math (see [88, 91-93]), while other studies found no relationship between the two variables. However, it is important to note that PA has not been associated with a decrease in academic performance. Studies conducted in this area are generally not recent. Furthermore, the inconsistency in the results may be attributable to the varying methods used in assessing academic performance. SPARK, a more recent study reviewed above, used the Metropolitan Achievement Tests (MAT6, MAT7), which are common measurements of academic performance in the United States [94]. It is important to note that although the intervention groups spent twice as much time in PE compared to the control group, the intervention did not interfere with academic performance in elementary school children. In one study, perception of higher academic rank predicted increased PA [95]. A recent state-wide study conducted in California in fifth, seventh, and ninth grade found that: (1) higher achievement was associated with higher levels of CV fitness, (2) the relationship between academic achievement and CV fitness was greater for math than reading, particularly at higher CV fitness levels, and (3) students who met minimum fitness CV levels in three or more physical fitness areas showed the greatest gains in academic achievement at all three grade levels [96]. Therefore, there is evidence that PA may be associated with better academic outcomes, although the evidence is not yet strong, and further research needs to be conducted.

f. Summary

The results from school-based PA intervention studies are encouraging, although several limitations, as discussed below, are apparent. Most studies were conducted in elementary schools, and the fewest in high schools. Several of the interventions in elementary and middle schools focused on increasing PA during PE, although some focused on the after-school time period. These studies resulted for the most part in increases in PA. Beneficial effects on body fatness and cardiovascular risk factors were shown by some studies. Many interventions comprised multiple components, including direct dietary interventions (e.g., modification in cafeteria offerings), and educational components. Despite some contradictory results, interventions in elementary and middle schools are encouraging, and suggest that programs can be successfully implemented to benefit children's health. Far fewer school-based studies were available in high schools. In these also, increased PA was the most consistent successful outcome. Importantly, the results of several studies in high schools, mostly cross-sectional, indicated that PA was associated with beneficial effects on psychological well-being and academic outcomes. Thus, the implementation of school-based PA interventions that aim to increase PA, and favorably impact body fatness and cardiovascular risk factors is supported by scientific data. Studies conducted during the after-school hours were particularly successful.

Therefore, efforts should be made to take advantage of this time period when considering how to increase the availability of PA at school.

4. Limitations of School-Based Physical Activity Interventions

There are several limitations associated with school-based PA intervention studies. For the most part, these studies used simple measures of body fatness, such as BMI and skinfolds, as the main outcome variable. Such measures may not have been sensitive enough to detect changes in body fatness. However, BMI measurements are the most practical when measuring large numbers of children at school. Future studies may want to consider performing more sophisticated measurements (e.g., dual-energy x-ray absorptiometry) on a sub-sample of the subjects. Another measurement issue related to PA is that a majority of studies used self-reports of PA, which are largely dependent on memory, and have been shown to be unreliable and inaccurate, especially in young children. On the other hand, self-reports of PA are easy to obtain, relatively inexpensive, and easy to administer among large numbers of participants. Future studies may want to consider doing more sophisticated measurements of PA (e.g., heart rate monitoring, accelerometry) on a sub-sample of subjects.

Most studies were of short duration, and/or did not include vigorous PA. It is doubtful whether studies of short duration and low PA intensity can lead to significant changes in body fatness. It follows then, that even if levels of PA were significantly increased, that this would not necessarily be associated with improvements in body fatness, fitness, or cardiovascular risk factors. Furthermore, PA of vigorous intensity rather than moderate intensity may be needed to impart significant changes, especially in normal weight children.

PE was targeted by a majority of the studies. One the advantages of this, is that students are a captive audience during PE. However, typical PE classes are of rather short duration, and it is difficult to increase the amount of PA to much more than 20 minutes. Although PE classes are important and should be targeted for PA interventions, one must keep in mind that they represent only a small amount of time during which children can be active. Attention should also be given to the after-school hours, recess, and lunch time.

Results from some of the studies above suggest that different types of interventions may be effective in boys and girls. It also follows that cultural differences would also need to be considered when designing interventions for various ethnicities. The age of the subjects also needs to be considered, as well as any disabilities that the students may have that might preclude them from being active in a conventional setting.

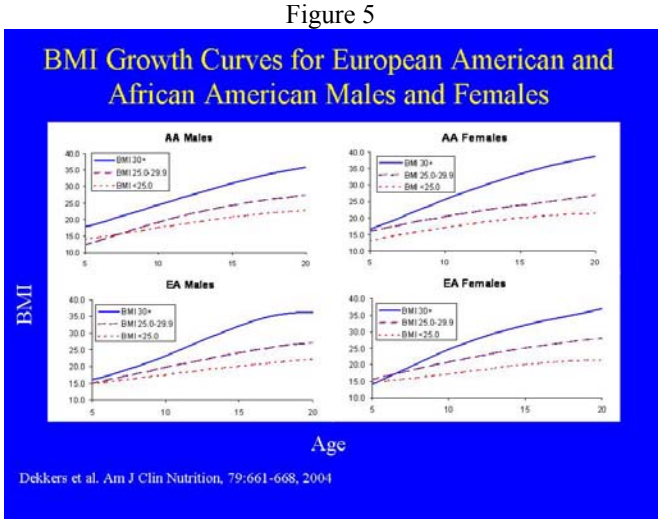
Few studies took into account the initial body fatness or BMI of the subjects. Children with higher body fatness levels or BMI values would be more likely to benefit from PA interventions. Thus, a study that includes a greater proportion of lean subjects may not show an overall effect on fatness or BMI. However, the subjects with higher fatness or BMI may have had significant and favorable changes, and that important result would be overlooked.

Few of the studies had follow-up periods, therefore it is unclear whether the effects of the intervention can be sustained or whether the intervention needs to be continuous. It is also uncertain from the current studies whether multi-component interventions are needed, and if so, what those components should be and also whether parents and family should be involved and to what extent they can be in a school-based program. The extent of the family involvement would probably be largely influenced by the age of the subjects, such that young subjects would benefit more from having parental involvement compared to adolescents.

5. Other Considerations

a. Pre-schools

Figure 5



The problem of overweight can begin in early childhood, possibly before children enter elementary school. The prevalence of overweight in preschool age children has been increasing over the past three decades [97]. This increase is especially apparent in children from low socio-economic backgrounds [98, 99], where the prevalence of overweight was reported to be approximately 10% in 1995 [98]. Longitudinal data from the MCG collected on children from the Augusta area indicate that already at the age of five years BMI begins to differentiate the children who will become obese adults (Figure 5), particularly in African-American boys. Unfortunately very few studies have targeted this age group in relation to overweight. An early study in preschoolers implemented 30 minutes of aerobic activity daily for eight weeks compared to regular playground freeplay [100]. Fitness and self-esteem increased more in the children in the intervention group compared to those in the control group. A study conducted in kindergarten children in Thailand implemented an extensive 30-week PA intervention [101] which consisted of a 15-minute walk before class in the morning and a 20-min aerobic dance session after the afternoon nap. Prevalence of overweight decreased in the intervention school, but not in the control school. In addition, girls in the intervention school had a smaller increase in BMI compared to girls in the control school. Thus, overweight may be present in very young children, and even pre-school children may benefit from a PA intervention.

b. Walk-to-School Initiatives

There has been a decline in active commuting in recent decades [102]. This is yet another example of how changes in society and environmental factors may lead to decreased PA. At this time, there are very few studies available on this topic. Therefore, the impact of this situation in terms of childhood overweight is not known. Data collected by the Centers for Disease Control indicate that 19% reported children walking and 6% reported children biking to or from school at least once a week during the preceding month [103]. Reported barriers to walking and biking to school included long distances, traffic, adverse weather conditions, crime, and opposing school policy. Only 16% of respondents reported no barriers to their children walking or biking to school. Initiatives are needed to provide safe walking and biking routes to school.

6. Ongoing School-Based Physical Activity Interventions and Programs in Georgia

The Washington-Wilkes Community Health Promotion Project is a community-based program to reduce overweight and related chronic diseases. The project targets children 4-18 y old and adults of all ages. Measured walking trails have been mapped at various community locations. Activities include community walking clubs for all ages that meet at the Department of Parks and Recreation, a Business Walking Challenge in which employee teams from participating business compete to walk the most miles in a 12-w period, and Tiger Tracks, a 14-w program in which students in primary, elementary, middle, and high schools log all their PA on a weekly basis. Students receive small incentives for each five miles of walking or equivalent activity.

The MCG FitKid Study is an after-school PA intervention project where sessions are led by trained PE teachers who employ exclusively mastery-oriented activities [104]. Subjects (68% African American) reside in urban, suburban, and rural regions in the Augusta area. Eighteen elementary schools were randomly assigned to either "health screening only" (n=301 subjects) or an after-school PA program (n=305 subjects). The after-school program consists of 40 min for a healthy snack and academic enrichment/tutoring and 80-min of moderate to vigorous. School buses are used to transport the subjects home after the program. The retention rate for year 1 was 89%. The project is currently half way through the second year. Preliminary results from the first year revealed a significant reduction in %BF (-0.7%) in subjects who attended at least 40% of the after-school PA sessions compared to no change in subjects in control schools (0.004%; $p<0.005$) [105]. Changes in secondary outcomes (i.e., BMI, waist circumference, cardiovascular fitness, resting systolic and diastolic blood pressure, and total cholesterol) also showed trends favorable for subjects in the intervention schools. The MCG FitKid Project has the potential to be institutionalized in elementary schools across Georgia as an effective tool to prevent childhood overweight.

The MCG PLAY Project is testing the effects of 20- and 40-min PA sessions on adiposity, insulin sensitivity, and executive function (i.e., cognition control, intentionality, self-regulation) in overweight children from elementary schools in the Augusta, Georgia area. Preliminary results from 30 subjects suggested that PA was associated with improvements in executive function [106]. These finding may address some of the current barriers to PA in schools. The comparison of 20 min with 40 min is particularly relevant because favorable results obtained from the 20-min sessions could lead to a program that could easily be implemented during regular PE sessions.

Following are some examples of programs that are already being implemented in Georgia. Take 10! Is an innovative teaching tool for kindergarten through fifth grade, that was developed by the International Life Sciences Institute Center for Health Promotion (ILSI CHP www.ilsi.org). The activities link academic curriculum requirements in math, science, language arts, and social studies with 10-minute periods of PA. Another set of programs, Healthy Start, Animal Trackers, and Healthy Hops (www.healthy-start.com), offers a comprehensive preschool health education program. Jump Rope for Heart, sponsored by the American Heart Association (www.americanheart.org), is a program that teaches students how exercise and diet affect their risk for heart disease while learning innovative and fun activity with jump ropes. There are also initiatives aimed at promoting active commuting, such as "Safe Routes to School", available in Atlanta, Georgia (www.peds.org/prog_kidswalk.htm). Other school-based childhood overweight prevention and PA initiatives are part of larger programs, such as *Steps for a Healthier US* (http://www.healthierus.gov) in DeKalb county (grant from the Department of Health and

Human Services), and Georgia's Collaborative Initiative for the Prevention of Obesity and Other Chronic Diseases (grant from the CDC).

7. Conclusions and Evidence-Based Recommendations

The economic cost of adult obesity is on the rise. From 1987 to 2001, the increase in the prevalence of adult obesity accounted for 12% of the growth in health spending [107]. This does not include the increased rate of medical care costs for obesity-related conditions such as type 2 diabetes (38%) and cardiovascular disease (41%). The annual U.S. obesity-attributable medical expenditures were estimated at $75 billion in 2003 dollars [108]. The medical costs associated with obesity in Georgia in 2003 were estimated at $246 per person [109]. With the continued increase of overweight in childhood, the medical care costs associated with adult obesity are likely to keep increasing. Thus, it is imperative that measures be taken immediately to combat the growing epidemic of childhood overweight.

As discussed above, school-based interventions have met with varying degrees of success in increasing PA and effecting favorable changes in body fatness, fitness, and cardiovascular risk factors. However, properly structured school-based PE program have positively impacted the health and well-being of students. Furthermore, the after-school hours were consistently found to be a significant time period when students could engage in PA and reap health benefits. Based on the results of the studies presented in this report, the following recommendations try to capture the main time periods during the school day when PA can be available to students. The recommendations take into account the changing academic and social needs of students as they transition from middle to high school.

(1) The overall goal is for students to accumulate at least 60 minutes of PA every day.

(a) PE (30 minutes) should be required in elementary, middle, and high schools.
- should be delivered by trained teachers
- should be delivered in appropriate and safe environments
- should be delivered daily
- should include a full 30 minutes of moderate to vigorous PA
- some flexibility in how PE is delivered may be warranted in high schools

The PE curriculum should emphasize health, weight, PA knowledge, and life skills management that will promote lifelong PA.

(b) After-school PA (>30 minutes) should be available in elementary, middle, and high schools.
- should be adequately supervised
- should take place in appropriate and safe environments
- should include at least 30 minutes of moderate to vigorous PA
- can take the form of extracurricular activities, intramural activities, clubs, and competitive sports teams
- transportation home after the program should be provided where possible

Although students should be encouraged to stay after school to participate in these programs, there should be some mechanism to monitor PA that some students may participate in outside of school. One possibility may be offering credit for participating in after-school PA, whether it is at school or in some community program.

(2) To assess the impact of efforts to address childhood overweight, students' progress over the years should be monitored by measuring weight, height, BMI, and CV fitness level at the beginning and end of each school year.

These recommendations reflect: (1) the components of published studies that have been shown to be effective for increasing PA, and in several cases, improving body composition and CV fitness, and (2) the importance of monitoring and evaluating implemented programs.

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APPENDIX[b]

ELEMENTARY SCHOOLS								
Authors	**Control Group**	**Subjects**	**Intervention**				**Results**	**Follow up**
			PA	**Nutrition**	**Education**	**Other**		
Sasaki et al. [52]	Yes	N=82 Boys & Girls Asian 11 y Overweight	20 min 7X/week 2 y				↓ overweight index ↓ weight ↓fat mass ↑ fat-free tissue ↑ HDL ↓ TC in girls	
"SHAPE" Dwyer et al. [93]	Yes	N=519 Boys & Girls 5th grade	75 min/day 14 weeks				↑ fitness ↓ adiposity ↑ math scores improved behavior in class	
Tuckman & Hinkle [110]	Yes	N=154 Boys & Girls 4th-6th grade	running 30 min 3X/week 12 weeks				↑ fitness ↑ academic test performance ↓ adiposity in boys ↑ creativity in girls	5 months ↑ fitness in boys
"Pathways" Caballero et al. [50] Stevens et al. [79] Going et al. [111] Davis et al. [112] Steckler et al. [113]	Yes	n=1704 Boys & Girls 3rd-5th grade AI	30+ min 3X/week 3 years	Education for food service staff	2X/week 8-12 weeks	Family involvement	Δ adiposity - NS ↓ dietary fat intake Δ PA - NS ↑ PA self efficacy in girls ↑ intent to eat healthful foods & participation in PA ↑ knowledge of nutrition and PA	
"SPARK" Sallis et al. [42, 94]	Yes	n=1538 Boys & Girls W, AA, H, Asian 4th grade	30 min 3X/week 2 y		Self management program		↑ PA ↑ fitness in girls PE did not interfere with academic performance	
"CHIC" Harrell et al [48, 49]	Yes	n=422 & n=1274 Boys & Girls W, AA, Other 3rd-4th grade	3X/week 8 weeks	Nutrition class for subjects with ↑ TC and/or overweight 8 weeks	American Heart Association guidelines 8 weeks		8 health knowledge 8 self reported PA Trends for 9TC, 8 fitness, 9 adiposity	

[b] Δ = change, AA = African American, AI = American Indian, BMI = body mass index, BP = blood pressure, FV = fruit and vegetable, H = Hispanic, HDL = high density lipoprotein cholesterol, MVPA = moderate to vigorous physical activity, NS = non-significant, PA = physical activity, PE = physical education, TC = total cholesterol, W = white

ELEMENTARY SCHOOLS								
Authors	**Control Group**	**Subjects**	**Intervention**				**Results**	**Follow up**
			PA	**Nutrition**	**Education**	**Other**		
"CATCH" Luepker et al. [43]	Yes	n=5106 Boys & Girls 3rd-5th grade	8 MVPA in PE class	Food service modifications	Health curriculum 15-24 lessons/y		8 PA in PE class 9 dietary fat intake from school lunch Δ BP – NS Δ adiposity - NS Δ BMI - NS Δ fitness – NS	
"Eat Well & Keep Moving" Gortmaker et al. [68]	Yes	n=479 Boys & Girls 4th-5th grade			Classroom-based 13 lessons on PA and nutrition		Δ PA - NS 9dietary fat intake 8 FV intake	
"Active Winners" Pate et al. [70]	Yes	N=436 Boys & Girls AA, W 11 y	After-school Summer camp				Δ MVPA – NS	
Warren et al. [114]	Yes	N=213 5-7 y			20 weeks PA only Nutrition only PA+nutrition		PA, nutrition, PA+nutrition: ↑ knowledge ↑ FV intake Δ overweight rate – NS	
Stephens & Wentz [115]	Yes	n-=99 Boys & Girls 4th grade	30 min 3X/week 15 weeks		Health education during cool down period		↓ adiposity ↑ fitness	
Kain et al. [55]	Yes	N=3086 Boys & Girls 1st-8th grade	Extra PA added to school curriculum	Healthier snacks offered at school	Nutrition Education in 4th-6th grade		↑ fitness ↓ adiposity	
Manios et al. [56]	Yes	N=471 Boys & Girls 1st-3rd grade	45 min 2X/week 3 y		13-17 hours nutr/health lessons	At home workbook exercises to involve parents	↑ health knowledge ↑ MVPA ↓ TC	
"KOPS" Muller et al. [54]	Yes	N=2440 Boys & Girls 5-7y			Health and nutrition education	Parent meetings to encourage ↑FV & ↓ high fat food intake	↑ FV ↑ knowledge ↑ PA ↓ TV viewing	
Crews et al. [85]	Yes	N=66 Boys & Girls H 4th grade	Aerobic activity 6 weeks				↓ depression ↑ self esteem ↑ fitness	
"Go For Health" Simons-Morton et al. [46]	Yes	N=4 schools 3rd-4th grades	Vigorous PE 5X/week 6-8 weeks	Lower fat and sodium content in school lunch	Health education		↓ dietary fat intake ↓ sodium ↑ vigorous PA in PE classes	

ELEMENTARY SCHOOLS								
Authors	**Control Group**	**Subjects**	**Intervention**				**Results**	**Follow up**
			PA	**Nutrition**	**Education**	**Other**		
"Bienestar" Trevino et al. [51, 116]	Yes	N=1419 H, Other 4th grades	PE curriculum	School Cafeteria program	Health education	Family program and after-school club	↓ fasting glucose ↑ fitness ↑ fiber intake ↓ dietary fat ↑ FV intake	
Donnelly et al. [47]	Yes	N=2 school districts 3rd-5th grades	Enhanced PA	Nutrition education & lower fat and sodium school lunch			↓ sodium intake ↑ PA during school ↑ HDL	
Roemmich et al. [117]	Yes	N=18 Boys & Girls	Feedback + reinforcement 6 weeks				↑ PA ↓ TV time ↑ TV time related to ↑ BMI	
Boyd & Hrycaiko [84]	Yes	N=181 Girls	Enhanced PE class		Posters, wt management, exercise, nutrition lessons	Self esteem surveys	Subjects with low self esteem benefited the most from the intervention	

MIDDLE SCHOOLS								
Authors	**Control Group**	**Subjects**	**Intervention**				**Results**	**Follow up**
			PA	**Nutrition**	**Education**	**Other**		
"CATCH III" Nader et al. [53]	Yes	n=3714 Boys & Girls 6th-8th grade						3 y 9 dietary fat intake 8 PA (self reported) Δ BMI - NS Δ BP- NS Δ Lipids- NS
"Planet Health" Gortmaker et al. [68, 69]	Yes	N=1295 Boys & Girls 6th-7th grade			16 lessons/y 2 y 8PA, 8FV & 9dietary fat intake, 9 TV time		9 TV 8 FV intake in girls 9 overweight prevalence in girls	

MIDDLE SCHOOLS								
Authors	**Control Group**	**Subjects**	**Intervention**				**Results**	**Follow up**
			PA	**Nutrition**	**Education**	**Other**		
"Dance for Health" Flores [66]	Yes	N=81 Boys & Girls AA, H, Other 7th grade	50 min 3X/week		Health education 30 min 2x/week		8 fitness in girls 9 BMI in girls	
"M-SPAN" Sallis et al. [67]	Yes	N=1109 6th-8th grade	8 PA in PE class and throughout day	Low fat foods marketed at school food sources			8 PA for total group and boys	
"CHIC II" McMurray et al. [65] Ex= exercise only Ed= education only ExEd= Ex + Ed Control = nothing	Yes	N=1140 Boys & Girls 11-14 y	30 min 3X/week 8 weeks		2x/week 8 weeks		8 fitness (ExEd>Ed) 8 BP in Control 8 adiposity (ExEd<Ed<C)	
"DOSE" Gutin et al. [71]	Yes	N=81 Boys & Girls 13-16 y Overweight	5X/week 8 months				8 fitness 9 adiposity	
"MN Heart Health Program" Kelder et al. [41]	Yes	N=2376 Boys & Girls 6th grade	Peer led PA outside of normal PE class	Nutrition education				7 y ↑ PA in girls
Alexandrov et al. [62]	Yes	N=1005 Boys & Girls 12 y Russian			Health education	Counseling for subjects and parent on diet, PA, and smoking	↓ TC ↓ TG ↓ BP ↓ BMI ↓ smoking rate	
"TAP" Leslie et al. [89]	No	N=50 Girls AA, H 11-13 y	30-40 min 3X/week 10 weeks			Nutrition, fitness, body image discussions 20-30 min 3x/week	↑ knowledge ↑ skill in choosing healthier foods ↑ self esteem	
Vandongen et al. [61]	Yes	N=1147 Boys & Girls 10-12 y	15 min of PA daily		6 30-min sessions on PA 10 1-h sessions on nutrition	5 newsletters aimed at nutrition	↑ fitness ↓ BP ↓ adiposity ↓ dietary fat intake in girls ↓ sugar intake in boys	
Colchico et al. [63]	No	N=30 Girls AA, H 11-14 y	3X/week 12 weeks				↓ BMI ↓ adiposity ↑ fitness	

MIDDLE SCHOOLS								
Authors	**Control Group**	**Subjects**	**Intervention**				**Results**	**Follow up**
			PA	**Nutrition**	**Education**	**Other**		
"Weight Winners" Hoerr et al. [64]	No	N=12 Girls 12-15 y	1.5 h 2X/week 3 months (alternated between components) Aerobic exercise	Food tasting		Behavior modification Parent involvement	↑ low calorie food ↓ speed of eating ↓ frequency and amount of food ↓ rate of weight gain ↓ body weight	
"TEENS" Schmitz et al. [95]	Cross-sectional	N=3878 Boys & Girls 7^{th}-8^{th} grade				Self report PA and Sedentary Leisure Habits (SLH)	8 academic rank predicted 8 PA and 9 sedentary leisure habits Depressive symptoms predicted 8 sedentary leisure habits 8 health and achievement predicted 8PA and 9 SLH	

HIGH SCHOOLS								
Authors	**Control Group**	**Subjects**	**Intervention**				**Results**	**Follow up**
			PA	**Nutrition**	**Education**	**Other**		
"New Moves" Neumark-Sztainer et al. [74]	Yes	N=201 Girls 9^{th}-12^{th} grade	1 h 4X/week 16 weeks		1 h instruction every 2 weeks	Psychology sessions 1 h every 2 weeks	Percieved positive impact on PA, eating pattern and self image	8 months ↑ stage of change for PA
De Wolfe & Jack [76]		N=29 Girls 14-20 y	8 weeks		1 h 1X/week 8 weeks behavioral control of eating and diet and PA		↓ weight	1 y ↓ weight in subjects seen monthly ↑ weight in subjects seen after 1 y
"LEAP" Dishman et al. [75]	Yes	N=2087 Girls Teenagers	PE instruction methods were adapted to meet needs/interests of girls 2 y				↑ self efficacy ↑ goal setting ↑ PA	

HIGH SCHOOLS								
Authors	**Control Group**	**Subjects**	**Intervention**				**Results**	**Follow up**
			PA	**Nutrition**	**Education**	**Other**		
"Project FAB" Jamner et al. [73]	Yes	N=47 Girls Teenagers	40 min 4X/week 4 months		Health benefits of PA 1X/week		↑ fitness ↑ self reported lifestyle PA	
Allison et al. [78]	Cross-sectional	N=1041 Boys & Girls				Self efficacy surveys	PA self efficacy is predictive of PA participation	
Steptoe & Butler [82]	Cross-sectional	N=5061 Boys & Girls 16 y				Questionnaire and malaise inventory	Vigorous PA positively related to emotional well-being Non-VPA assoc with ↑ psychological & somatic symptoms	
Daley & Ryan [91]	Cross-sectional	N=232 Boys & Girls 13-16 y				Survey	NS correlations between academics and PA (weak negative correlations with English and Science)	
Kirkcaldy et al. [83]	Cross-sectional	N=1000 Boys & Girls 14-18 y				Survey	PA related to ↑ self-image ↑ PE related to ↑ psychological well-being	
Ferron et al. [81]	Cross-sectional	N=9268 Boys & Girls 15-20 y				Survey	Athletic teenagers have ↓ suicidal tendency & ↑ body image	
Brosnahan et al. [80]	Cross-sectional	N=1870 Boys & Girls 14-18 y				Survey	↑ PE related to ↓sadness ↑ PA related to ↓ suicide consideration ↑ Vigorous PA related to ↓ suicide planning	