

**RESEARCH ARTICLE**

## **Primary Prevention of Obesity: Active Interventions in School Age Populations**

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Email: [aperry@miami.edu](mailto:aperry@miami.edu)**Abstract**

The current review focuses on the importance of primary prevention of obesity in youth. In several elementary school programs such as Texas I-Can and the Physical Activity Across the Curriculum initiatives, physical activities are integrated into the academic lessons to help offset sedentary time during seated learning while also increasing academic performance. The purpose of such programs is to attenuate gains in body mass index and adiposity while increasing physical activity levels. In some cases, increases in physical activity were translated to after-school and weekend activities. In other cases, improvements in time on task and academic courses were also observed. In schools monitoring BMI, those increasing physical activity levels > 75 min/wk evidenced significant decreases in BMI. At the middle school level, programs such as Planet Health and another novel middle school curriculum in the sciences, resulted in beneficial changes in health behaviors and metabolic risk factors. These changes were accompanied by decreases in adiposity, particularly in girls. In the most recent translational health in nutrition and kinesiology (THINK) program, a stand-alone curriculum featuring hands-on clinical experiences rooted in STEM education, resulted in significant gains in physical fitness and curricular-based knowledge with favorable but non-significant decreases in adiposity. These studies illustrate the importance of implementing innovative programs that may increase academic performance while also empowering students to increase physical activity and improve metabolic health, both of which are often accompanied by favorable reductions in adiposity. Physically active interventions that are integrated into the academic curriculum may be the best direction to take in the primary prevention of obesity. More randomized clinical trials are needed to determine the extent to which such active interventions significantly reduce adiposity in youth.

**Keywords:** physical activity, obesity prevention, novel curriculums, metabolic health, active learning, academic performance, youth

## Introduction

Most research has shown that current efforts to curtail obesity and its' adverse metabolic sequelae have not been very successful. The majority of weight loss studies have reported a low efficacy rate as many ultimately show weight regain over time.<sup>1-3</sup> In fact, many researchers agree that the primary prevention of obesity may be key to reducing the current obesity pandemic and its associated co-morbidities. It is estimated that 32.1% of children and adolescents in the United States are overweight or obese.<sup>4</sup> Therefore, if prevention is key, then greater emphasis should be directed towards programs that focus on youth in this country. Childhood and early adolescence represent a critical period of growth and maturation when youth are transitioning toward making their own decisions regarding personal lifestyle behaviors. This includes food choices as well as physical activity selection and participation. It also reflects a time of significant physical, physiological, and mental development before behaviors become so ingrained they cannot change. Therefore, targeting lifestyle behaviors during childhood or early adolescence may be critical for interventions aimed at reducing the detrimental impact of obesity on metabolic health and fitness later in life.

Schools provide an excellent opportunity to influence our nation's youth because of the great amount of contact and infrastructural support they provide to nurture and educate students. They can also communicate the right health messages to youth. However, schools may also present a barrier to increasing physical activity. Facing significant pressure to improve language arts, math, and science scores, the attention to physical activity and obesity prevention has taken a back seat. The President's Council of Advisors on Science and Technology has called for an increase of one million more Bachelor of Science Degrees in science,

technology, engineering, and mathematics (STEM) each year<sup>5</sup> and this college trend has trickled down to the public schools.

Furthermore, most students spend six or more hours per day during seated learning. Studies have shown prolonged sitting can lead to increased postprandial glycemia<sup>6</sup> impaired micro- and macrovascular dilator function<sup>7</sup>, and adverse changes in insulin sensitivity and serum triglycerides<sup>8</sup> all of which can be reversed by light intermittent exercise. Therefore, public schools must learn how to be creative in integrating physical activity into the academic classroom to advance cognitive gains without sacrificing active behaviors and improved metabolic health and fitness. By balancing both elements, schools can get the right health messages across to students and empower youth to maintain active, healthy lifestyle behaviors.

## Elementary Schools

To address the need to increase physical activity participation in elementary school-aged children, the "Take 10" program<sup>9</sup> was developed to integrate physical activity with academic learning. This initiative was based upon previous research indicating that students were more active during structured activity breaks than during unstructured recess.<sup>10</sup> Teachers from several elementary schools were selected to participate in training sessions designed to increase student physical activity and learn about grade-specific activities that could be integrated with core curriculum objectives in mathematics, science, social studies, and language arts. The program was implemented in three elementary schools that were predominately African-American and encompassed 10-min physical activities interspersed with academic concepts and skills learned in the classroom. Using accelerometers, the program demonstrated an increase in energy expenditure from

moderate to vigorous exercise during the 10-min sessions. Overall the program was shown to be a useful strategy for increasing physical activity in the moderate intensity range throughout the full duration of the session. However, no information was reported on adiposity or body mass index (BMI).

The “Physical Activity Across the Curriculum” (PAAC) program<sup>11</sup> was a 3-year expansion of the Take 10 curriculum which included both experimental and control schools. Minutes of moderate-vigorous activity were greater in PAAC schools compared to controls. Weekend physical activity levels were also greater in PAAC compared to control schools. In those programs providing >75 min/week of physical activity, BMI declined more than control schools after three years. Furthermore, 21.8% of students at risk for obesity at baseline in PAAC schools moved to the normal range compared to 16.8% in the control group. Therefore, in the long-term analysis, high levels of physical activity translated into reduced adiposity compared to control subjects. Interestingly, there were significant improvements in reading, math, spelling, and composite academic scores in the PAAC group compared to controls. The improved academic outcomes in this study supports the positive association between physical activity and cognitive function in other studies<sup>12,13</sup> and more specifically in those students at the lower level of academic performance.<sup>14</sup> In a 10-year review of Take 10 programs, Kibbe and colleagues<sup>15</sup> noted significant and long-term positive outcomes on reading, math, and spelling scores of students.

Using accelerometers to quantify physical activity, the Texas-I Can study<sup>16</sup> included eight total schools, (four experimental and four control) and 47 teachers (25 Texas I Can; 22 control). Elementary school students of low socioeconomic status participated in physical

activity lessons that were integrated into the classroom. For example, in their *Cardiac Relay* lesson, students were handed red and blue disks that represented oxygenated and deoxygenated blood and had to run past various bodily structures where they learned about circulation through the heart and lungs. In *Spelling Freeze Tag*, students were actively running and when tagged, had to spell certain words correctly before being released to run again. Results showed that students in the Texas I Can group increased activity by 300 steps per day while the control group decreased their steps by the same amount. In a sub-analysis, it was shown that 20% of the lessons encompassed moderate-vigorous physical activity. Since neither BMI nor adiposity levels were reported, it is unknown whether increasing physical activity levels translate into reductions in BMI. Interestingly, time on task (TOT) and attention to the academic lessons were improved following the physical activity sessions. This was done by having trained staff analyze the behavior of students at 5-second intervals during traditional sedentary instruction. This information revealed added benefits of physical activity not only from the exercise itself but from increasing student focus and attention to academic materials. Whether or not this would translate to improved academic performance remains to be seen.

One’s TOT is generally measured through momentary time sampling using research staff to conduct a series of observational sweeps across the classroom. On task behavior is considered any behavior where the student is attentive to the teacher or actively engaged in the appropriate task designated by the teacher. Off-task behavior is presented when students are distracted or disengaged from the task, gazing off, putting their head on the desk, talking to or looking at others or reading unassigned materials. In a study by Grieco<sup>17</sup>, TOT was evaluated after

a traditional sedentary lesson, a sedentary game, a low-moderate physically active game and a moderate -vigorous physically active game. To ensure equal time per child, raters were provided with an MP3 file that signaled each 5-sec interval so that evaluations were performed at similar intervals for each student. Results showed that TOT actually decreased after a standard lesson, did not change following a sedentary game, but significantly increased following moderate or vigorous physical activities. This is supported by a larger systematic review showing classroom behaviors are improved following classroom breaks and interventions providing light or moderate-vigorous activities.<sup>18</sup> In another structured curriculum, significant improvements in academic achievement scores were observed in 3<sup>rd</sup>-5<sup>th</sup> grade students who participated in active math or language lessons compared to those who were not exposed to physically active interventions.<sup>19</sup> It is not entirely clear however, whether aerobic movement breaks unrelated to academic learning may be equivalent to or different than those using academic-based movement breaks.<sup>20</sup>

### **Middle Schools**

Research shows the volume and intensity of physical activity has declined the last 30-40 years with fewer youth meeting the current standard of 60 minutes of moderate-vigorous physical activity daily. Furthermore, the proportion of children meeting these guidelines has declined with age indicating that less adolescents in middle school meet guidelines than children in elementary school.<sup>21</sup> Because the greatest declines in physical activity are seen during transition from elementary to middle school,<sup>22</sup> this is a critical time period to establish active, healthy lifestyle behaviors. Planet health<sup>23</sup> was an interdisciplinary middle school curriculum designed to reduce obesity in middle school youth by

emphasizing four focused health goals: 1) increasing physical activity 2) decreasing television viewing 3) increasing fruit and vegetable consumption and 4) reducing fat consumption. The curriculum incorporated several theories of health behavior change that were integrated into a series of lectures taught by middle school language arts, math, science and social studies teachers. The behavioral intervention was integrated into major subject areas in the classroom and in physical education classes where students participated in physical activities. In an ethnically diverse population of five intervention and five control schools, there was a greater reduction of obesity in girls in the experimental versus control groups due mainly to a reduction of television viewing and increased fruit and vegetable consumption. No differences in adiposity or any other health behaviors were seen in boys. Planet Health<sup>24</sup> was the first field-based randomized controlled clinical trial using school-based approaches for obesity prevention. Although results appear promising, it is unknown what the long-term effects of Planet Health are on obesity prevention.

In a similar study done in a predominately Hispanic group of 8<sup>th</sup>-grade youth, a 4-month program encompassing health promotion, nutrition, and exercise was integrated into a science-based curriculum targeting diabetes prevention. A total of 73 students were divided into experimental and control groups with the experimental group receiving lifestyle education in diabetes epidemiology/ pathophysiology, nutrition education, and exercise education along with either physical exercise or the option to take regular physical education classes. The primary goal was to decrease risk factors associated with Type2 diabetes, therefore reduction of obesity, insulin resistance, and inflammatory markers were key outcome variables reflective of improvements in

metabolic health. Results in insulin resistance, inflammatory markers such as IL-6 and C-reactive protein were observed in addition to reductions in adiposity. Since positive changes were observed after just one semester, investigators recommended this type of program be implemented as part of the regular school curriculum.<sup>25</sup>

The translational health in nutrition and kinesiology (THINK) pilot program<sup>26</sup> is its' own stand-alone curriculum. Using nutrition and exercise science rooted in STEM education, the program seeks to empower youth to improve lifestyle behaviors through active learning, hands-on laboratory experiences, and physical activity. The program is based upon the premise that students get more excited about physical activities if it can be translated in a way that relates to how their own bodies function and respond to exercise. Research demonstrates increased student performance in STEM using an active learning model.<sup>27</sup> Hands-on laboratory experiences built upon self-awareness and problem solving follow each active learning segment that is reinforced by structured physical activities using innovative drills, relays, and brain games to get students moving.

During laboratory segments, students learn how to use goniometers, dynamometers, calipers, tapes, blood pressure cuffs and other laboratory -based items that helped them learn more about their bodies function. Some of the laboratories also feature a competitive element such as "Simon says" where students point to the correct bone (ulna, femur, or acromium process) or muscle (deltoid, gastrocnemius, or triceps) to stay in the game. Physical activities reinforce health-related themes. For example, following the nutrition unit, students must sprint to a bag containing groceries, pick up an item from the shopping bag, then sprint to the My Plate poster and place it under the correct food group. Points are awarded for the fastest team

with the most accurate placement of food items. Results showed significant improvements in curricular information and physical fitness including strength, power, cardio-respiratory fitness, and muscular endurance, all of which were related to metabolic fitness. Curricular information in nutrition and exercise science significantly improved. Although favorable reductions in BMI and adiposity were also found in participants, they did not reach statistical significance.

One of the largest studies to date encompassing 1.7 million adults indicates that higher levels of both aerobic and skeletal muscle fitness, both critical elements of physical fitness, are inversely related to obesity in adults.<sup>28</sup> Therefore, programs aimed at improving physical fitness early on in youth, are important considerations if they are to become healthy adults. Perhaps more research following participants longitudinally may be necessary to determine long-term effects of physically active, school-based physical interventions on adiposity.

### **Additional Considerations**

It is important to consider the fact that programs implementing physical activity aimed at improving metabolic health, may also benefit psychosocial health. Studies consistently show higher self-esteem, self-worth, and body satisfaction in physically active compared to sedentary boys and girls.<sup>29,30</sup> A higher BMI is often associated with a greater risk of eating disorders, poorer body image, and quality of life.<sup>31,32</sup> Therefore, blunting the age-related decline in physical activity may be a significant factor for maintenance of psychological health.

Physical literacy is the term used to describe the confidence, competence, and motivation to pursue an active healthy lifestyle along with knowledge of the benefits of an active lifestyle. Improving physical

literacy and the confidence to exercise is consistent with psychosocial health. Faigenbaum, et al.<sup>33</sup> recently proposed the pediatric Physical Inactivity Triad to address the complex interrelationships that predispose youth to obesity. In his model, lack of confidence, competence, and motivation to exercise (physical illiteracy) leads to reduced physical activity participation (exercise deficit disorder,) and ultimately muscular weakness (pediatric dynapenia). This model may help to explain the low levels of physical fitness observed in youth today and the high levels of overweight and obesity not only in the United States but globally.

Finally, cognitive learning involves an elaborate network of information integration and processing in the brain. Both visual and motor processes in the brain are involved during cognitive tasks. Including relevant movements during learning rather than relying upon visual observation or auditory cues only, tends to create a richer memory trace in the long-term and facilitates more expedient recall. When new information is embellished with sensorimotor experiences using kinesthetic as well as visual and auditory faculties, it results in higher quality mental representations or cognitive schema that facilitate faster memory performance. All physical activity programs should include aforementioned elements for the most efficacious evaluation of their curriculums.<sup>34, 35</sup>

### **Summary**

The aforementioned review focuses on how active lessons integrating physical activity and health-related information into the classroom can be interfaced into public school settings to promote metabolic fitness, reduce adiposity, and provide a better

education for youth. Results consistently report improvements in physical activity and metabolic fitness following active learning programs. Evidence tends to support favorable reductions in adiposity and BMI especially in girls and in programs eliciting physical activity levels >75min/wk. More work is necessary to determine to what extent improvements in physical activity result in decreases in BMI and/or adiposity. Finding creative solutions that integrate active lifestyle interventions into both elementary and middle schools should be the primary goal. Active programs break up prolonged seated during academic learning while increasing physical activity and physical fitness and may also increase TOT and attention to academic materials and academic performance. The evaluation of psychosocial health, physical literacy, and cognitive performance should also be included in programs encompassing physical activity. Innovative physically active programs should be supported and continue to move forward using control groups in randomized clinical trials to determine their efficacy. Improving metabolic health and habitual physical activity in youth at these critical junctures when activity levels are declining, may be key to reducing the obesity epidemic. This may help pave the way for improved metabolic health as adults. Failure to support such programs and/or reducing physical education or physical activity requirements in public schools sends the wrong health message. It's important to continue to move forward and support randomized control clinical trials that quantify the extent to which positive physical and behavioral activities improve metabolic health and reduce obesity levels.

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