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The effect of an elementary school-based physical activity intervention on student
engagement among fourth graders in Georgia

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University of North Carolina Wilmington
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Abstract

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Introduction: Physical activity (PA) is a well-known health priority to prevent obesity. Additionally, studies have shown exercise is associated with increased cognitive and affective student engagement. This relationship is important because student engagement is a predictor for academic achievement and school completion. However, there have not been any studies using an objective measure of PA or assessing cognitive, affective, and behavioral engagement at the same time. The purpose of this study was to examine the association between changes in PA due to a school-based intervention and student engagement.

Methods: Fourth grade students from three metro-Atlanta districts participated in this study and 2,578 were included in this analysis. Data were collected on PA levels using pedometers to count daily steps and student engagement using the Student Engagement Instrument-Elementary Version (SEI-E). Paired t-tests were used to assess changes in engagement from pre- to post-test. Linear regressions were used to assess the relationship between average number of steps taken per day and average engagement scores for both intervention and control schools combined, and to assess possible confounding and effect modification by gender, race, and socioeconomic status.

Results: Students at intervention schools showed significant changes from pre- to post-test for average overall engagement (4.4 to 4.3), average cognitive engagement (4.5 to 4.4), average future goals and aspirations subscale (4.7 to 4.6), and average family support for learning subscale (4.7 to 4.6). Students at control schools did not have any significant changes in any engagement measures from pre- to post-test. Intervention schools showed a significant increase in steps from pre- to post-intervention (3,214 to 3,710); whereas, control schools showed a significant decrease in average steps from pre- to post-test (3,277 to 3,044).

Discussion: This study showed that participation in the intervention resulted in significant decreases on several subscales of student engagement; however, steps during the day, regardless of participation in the intervention, did not have a significant effect on engagement. As the primary program objectives are increasing student PA and improving student health, it is relevant to note that this can successfully be accomplished within the school setting.

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Chapter I: Review of the Literature

Physical Activity in Schools

Physical activity (PA) has become an increasingly important topic in the United States as a way to prevent obesity and reduce the prevalence of chronic conditions. In 2014, 17% of the population aged 2-19 was obese (1). Childhood obesity can lead to type 2 diabetes, increased incidence of metabolic syndromes, obesity in adulthood, and likelihood of cardiovascular disease and several cancers, so it is important to create healthy habits at a young age (2). Improving the physical fitness of children and adolescents may help to lessen this burden (3). Children that participate in physical activities have shown improved cardiorespiratory and muscular fitness, improved bone health, and favorable body composition (3).

The national recommendation by the U.S. Department of Health and Human Services is that children and adolescents participate in 60 minutes or more of daily PA (3). This includes aerobic, muscle-strengthening, and bone-strengthening exercises. Over 95% of youth in the United States are enrolled in schools, but the majority of the eight to nine hour school day is spent sedentary (4). In 2014, only 3.6% of elementary schools, 3.4% of middle schools, and 4.0% of high schools required daily physical education (PE) for all students (5). Schools can serve as a way to reach a large number of youth and increase PA during the day by incorporating before and after school programs such as clubs and intramural sports. PA can also be incorporated during the school day in the form of recess or integrated into class lessons (4).

PA before and after school allows children to practice what they learned in PE classes, meet daily PA recommendations, become prepared for learning, engage in safe

and supervised activities, and identify activities they might want to engage in long term (4). These programs help to keep students moving instead of waiting in sedentary for the school day to begin or end. These offerings might include walking or biking to school, intramural sports, and informal play on school grounds. Another method to increase PA among children is to incorporate programs during the school day (4). Recess allows students of all grade levels to participate in semi-structured PA during the school day and to practice skills they learned in PE. Integrating PA into classroom lessons is another way to increase PA throughout the day by using movement to teach academic subjects. Not only do these activities increase PA, they also enhance students' learning experience and improve time-on-task and attentiveness (4). In-class PA breaks can also be done without integrating movement into class materials; Instead, students can be given a 5-minute stretch break or allowed to take a few laps around the classroom. All of these are viable options to increase PA while taking advantage of the school setting as a way to reach a large number of youth.

Several studies have shown that school-based physical activity interventions can serve as an effective way to increase PA among youth (6-8). A systematic review of 129 studies that implemented PA interventions in a school setting concluded that the majority of studies showed that the intervention had significant effects on motor performance, PA, and knowledge (6). Of the 129 studies, 69.7% achieved positive differences among the intervention group with no negative effects regarding motor performance, 56.8% achieved positive results for increased PA with only 6.8% reporting negative effects, and 87.5% found positive results for student knowledge of PA effects (6). This review also

concluded that interventions that consisted of both PA and cognitive components more strongly influenced students' levels of PA.

Another review article examined studies that implemented physically active lessons, which incorporated PA into the classroom educational elements (7). Six out of seven of the reviewed studies found significant improvements in PA levels following physically active lessons. One study found a 20% improvement in on-task behavior following physically active lessons, and another study showed that students participating in physically active lessons scored higher on academic tests than control students (7).

Levels of PA in schools have been shown to vary by demographic characteristics, such as gender, race/ethnicity, and socioeconomic status (SES). Several studies have shown that boys engage in more moderate to vigorous physical activity (MVPA) than girls (40.4% vs. 30.8%) (9) and (32.1% vs. 23.7%) (10). Similarly, girls engaged in significantly more sedentary activity (24.8% vs. 21.8%) (9) and recorded less activity measured in mean daily steps, mean daily activity counts, and counts per minute of registered time than boys ($p<0.0001$) (11). PA interventions may impact genders differently, with boys experiencing greater increases than girls in MVPA during recess (5.3 min vs. 3.6 min) and the rest of the school day (27.2 min vs. 23.1 min) (12).

Differences in PA levels by race/ethnicity have been explored in various studies. Among fourth graders, Hispanic children are engaged in significantly more sedentary behavior than Caucasian children (56.4% vs. 39.4%) (9). Additionally, Caucasian children engage in more MVPA than African-American and Hispanic children (45.4%vs. 32.3%, 28.3%) (9). A study of 9-10-year-old children showed that South Asian children record fewer steps than their white counterparts (9,315 vs. 10,220), as well as, fewer

minutes in MVPA and more time in sedentary activity (11). Among girls, African-American students are significantly less active than Caucasian students for both vigorous PA and MVPA (p<0.001) (13).

In terms of SES differences in PA, children from low SES engage in significantly more light PA (+4.5%) and very high PA (+1.7%), but significantly less moderate PA (-2.6%), vigorous PA (-3.0%), and moderate to very high PA (-4%), compared to high SES children (10). In this study, SES was determined using various socioeconomic factors, such as unemployment rate, number of families living in the area, proportion of foreign-born residents, and housing density (10). Another study used area deprivation as a measure of SES of the community in which each child lived and found that boys from economically deprived areas engaged in less MVPA than boys from economically advantaged areas (14). The opposite was seen for girls: average minutes of weekly MVPA were significantly lower among girls from areas of low economic deprivation compared to girls from highly deprived areas (14).

<u>*Student Engagement*</u>

Although 95% of youth are enrolled in school, in the 2013-2014 school year, about 14% of students were chronically missing school in the United States (15). Student engagement has become an important topic of interest to foster learning and increase the likelihood of graduation (16). Student engagement has been divided into three subcategories: behavioral engagement, emotional engagement, and cognitive engagement (17). Behavioral engagement refers to positive conduct and participation in classroom activities; emotional engagement is the emotions associated with class such as interest,

boredom, and anxiety; and cognitive engagement is the psychological investment in learning.

Levels of engagement in schools are related to several factors, such as available resources and teacher support. For example, access to study resources and personal resources is associated with positive student engagement (18). Autonomy support, a teacher's actions that motive students and acknowledge students' emotions, and autonomy structure, a teacher's actions that provide clear directions, strong guidance, and constructive feedback are both significant predictors of self-reported engagement (19). Outside of school, communication between teachers and families is also an important predictor of student engagement (20). More frequent communication between teachers and families is associated with a 40% increase in the odds of homework completion, a 15% increase in participation rates, and a 25% decrease in teachers having to redirect students' attention. Communication helps to strengthen student-teacher relationships, expand parental involvement, and increase student motivation (20).

In addition to teacher support, characteristics of specific classes have an influence on student engagement. More challenging classes that are perceived to have high relevance are associated with higher engagement ($p<0.001$); high challenge and skill conditions are significantly associated with increased attention ($p<0.001$); high sense of control over situations is associated with improved engagement, higher self-esteem, and better moods ($p<0.001$) (21). Highest levels of engagement are found in art and computer science classes, followed by vocational education and social studies classes (21).

Engagement has been significantly associated with several outcomes including academic performance, substance use, mental health problems, and school completion

(16). A study of students that attended Gatehouse Project schools in Victoria, Australia showed an association between social and school connectedness with future substance use, mental health, and academic outcomes (16). Students that reported low school connectedness in eighth grade were more likely to have depressive symptoms, to be regular smokers and drinkers, and to use marijuana by twelfth grade. Low school connectedness was a more important predictor of substance abuse. Students that reported poor school connectedness but good social connectedness were more likely to have anxiety or depressive symptoms compared to those that reported good school and social connectedness (OR=1.34, p=0.026). These students were also more likely to be regular smokers (OR=2.0, p=0.001), regular drinkers (OR=1.87, p=0.001), and marijuana users (OR=2.02, p<0.001). Students that reported poor schools connectedness, as well as poor social connectedness during year eight were less likely to complete year 12 than those that reported good school and social connectedness (OR=0.35, p<0.05) (16). Additionally, among youngsters from the US Department of Education's National Educational Longitudinal Study of 1998, struggling students were more likely to remain in school if they had high self-esteem compared to those with low self-esteem (22). Increased engagement not only helps to retain children in school until completion, it also reduces the number of disciplinary referrals (23). It is important to prioritize increasing engagement at a young age to prevent problems later on in a child's life.

The relationship between engagement and academic achievement may be different for students that are struggling learners versus non-struggling learners (24,25). Both struggling and non-struggling students are more likely to have poorer social or emotional climate and worse instructional quality if there is student-teacher conflict (24).

For struggling students, psychological engagement is positively associated with academic achievement (OR=0.2, p<0.05) (24). Specifically, students with high cognitive engagement perform better than children with low cognitive engagement (p=0.044) (25).

Similar to PA, student engagement differs by gender, race/ethnicity, and SES. Overall, boys are less engaged than girls (p<0.001) (22,26). Girls have significantly higher behavioral engagement (t=-5.16, p<0.0001) and emotional engagement (t=-3.14, p<0.01) than boys, but lower behavioral disaffection (t=4.88, p<0.0001) (27). However, there is no difference in emotional disaffection or differentiated disaffected emotions. The amount of support received by students varies by gender, as well. Girls report significantly higher levels of support than boys from teachers, classmates, close friends, and school personnel (28). For girls, the highest perceived level of support came from close friends, followed by teachers; for boys, the highest level of support was from teachers and parents, followed by close friends (28).

Race/ethnicity differences exist for student engagement. For example, a study of middle and high school students' attachment, measured by reports of feeling close to people at school, feeling part of school, and feeling happy to be at school, and engagement, measured by reports of skipping school, having trouble paying attention, and having trouble getting homework done, showed that African Americans were the least attached compared to whites and Hispanics (p<0.05) (26). Conversely, African Americans were more likely to be engaged (p<0.05) (26). The opposite finding was reported in another study. African American students were less likely to engage in school than their European-American counterparts (29).

There is limited literature on the association between SES and student engagement. One study used parental education level as a proxy for SES and found that the highest levels of engagement were reported among students whose parents highest level of education was university (mean=1.47, SD=0.87) (30). Lowest levels of engagement were reported among students whose parents did not complete secondary school (mean=1.18, SD=0.76) (30).

Association between Physical Activity and Student Engagement

There is evidence to link exercise with increased cognitive and affective engagement. This association could be based upon a variety of direct and indirect physiological, cognitive, emotional, and learning mechanisms (31). PA can impact the brain's physiology by increasing cerebral capillary growth, blood flow, oxygenation, neurotransmitter levels, production of neurotrophins, growth of nerve cells in the hippocampus (center of learning and memory), the density of the neural network, as well as brain tissue volume (31-34). These changes may be associated with improved attention, information processing, storage, and retrieval, as well as, an enhancing coping and enhanced positive affect (31).

Several studies have shown an association between PA and student engagement. Schools that have high-functioning recess, defined by having appropriate games, apace, and equipment available, experienced 87% less conflict at the end of the school year compared to schools that did not have as well-functioning recess (56%) (35). Additionally, 88% of teachers reported that students felt a greater sense of belonging and 84% reported a deeper connection to school when they were exposed to high-functioning recess (35). Along with affective engagement, recess is also positively associated with

cognitive engagement. Classroom behavior is better when children have some recess compared to none or a minimal break (p<0.001) (36). When students do not have recess they are less engaged (85% of time) with classroom tasks and more fidgety (16%), compared to when they do have recess (90% and 7%, respectively) (37). Specifically, fourth grade students are less attentive during long confinement periods (38).

PA integrated into the classroom showed similar results for time-on-task and academic motivation (39-41). An intervention study that incorporated "FUNtervals", a four-minute, high intensity interval exercise, into the classroom found that participation in classroom-based PA led to a decrease in passive off-task behavior by 9% (p<0.01), a decrease in verbal off-task behavior by 3% (p<0.05), and a decrease in motor off-task behavior by 15% (p<0.01) (39). Another study had similar results indicating that students were more cognitively engaged when given a 10-minute exercise break during class (p<0.01) (40). Additionally, students showed significant increases in enjoyment (p<0.01), perceived competence (p<0.05), and effort (p<0.05), when ten-minutes of moderate intensity PA was incorporated into a 45-minute lesson (41).

Gaps in the Literature

Various studies have examined the association between PA and student engagement and have provided important evidence indicating an association between PA and classroom behavior, school connectedness, and time-on-task (35-41). Five of the previously mentioned studies were interventional, however, only one intervention lasted an entire school year as opposed to a few weeks. All of these studies had a small sample size and did not use an objective measure of PA. There have not been any studies that examined all three dimensions of student engagement (42). Considering the limitations of

previous research, this study aims to assess the association between PA and student engagement on all three subscales: behavioral, cognitive, and emotional using an objective measure of PA and a large sample of students from several schools in Georgia. The specific goal of this study is to examine the association between an intervention to increase PA in schools, measured by average step counts pre- and post-intervention, and average self-reported student engagement scores, while considering other covariates such as gender, race/ethnicity, and SES.

Chapter II: Manuscript

Introduction

While the health benefits of physical activity (PA) are well-known and a public health priority (3,43,44), most youth in the United States do not meet the recommended 60 minutes of daily PA. Serving more than 95% of U.S. children ages 5-17, the school environment serves as a way to reach a large number of youth and engage students in PA throughout the day (4). Several studies have shown that school-based interventions are an effective way to increase PA among youth (6-8). Several factors affect the levels of PA students participate in at school, such as gender, race/ethnicity, and socioeconomic status (SES). Studies show that boys are typically more active than their girl counterparts and spend more time in moderate to vigorous PA (MVPA) during the day (10-12). Students of racial/ethnic minorities are less active and spend more time in sedentary activity than their white counterparts (9,11,13). The literature on the impact of SES on PA varies. One study showed that children from low SES engaged in more light PA and very high PA, but less moderate PA, vigorous PA, and moderate to very high PA compared to their high SES counterparts (10). Another study showed a gender and SES interaction where boys from low SES engaged in less MVPA compared to boys from high SES, but girls from low SES engaged in less MVPA than girls from high SES (14).

Student engagement, which has been associated with PA in children (35-41), is another aspect of the school environment. Student engagement is divided into three subcategories: behavioral engagement (positive conduct, participation in class), emotional engagement (emotions associated with class, such as interest, boredom, anxiety), and cognitive engagement (psychological investment in learning) (17). Student

engagement is an important predictor of future substance use, mental health, academic performance, and school completion (16). Similar to PA, student engagement differs by gender. Overall, boys are less engaged than girls (22,26). The effect of race/ethnicity on student engagement varied between studies. One study showed African Americans least likely to skip school, have trouble paying attention, and having trouble getting homework done, but least likely to feel part of school, feel happy to be at school, and feel close to people at school compared to whites and Hispanics (26). Another study showed that African American students were less likely to be engaged than their white counterparts (29). Additionally, students from low SES report less engagement than students from high SES (30.

There is evidence to link exercise with increase cognitive and affective engagement. This association could be based upon a variety of direct and indirect physiological, cognitive, emotional, and learning mechanisms (31). Several studies have shown an association between PA and student engagement (35-41). Specifically, these studies looked at the impact of school-based PA on classroom behavior, time-on-task, and enjoyment. Most of these were short, interventional studies lasting only a few weeks and reaching a small sample of students. There have not been any studies that examined all three dimensions of student engagement simultaneously.

The primary purpose of this study is to examine the association between an intervention to increase PA in schools, measured by average step counts at pre- and post-intervention, and average self-reported student engagement scores. Furthermore, it will assess covariates such as gender, race/ethnicity, and SES, measured by percent of students who are eligible for free and reduced lunch.

Methods

<u>Study Design</u>

Health Empowers You! is a fully developed intervention designed to impact school-level PA practices and policies, as well as student PA and fitness levels. The intervention was built using evidence-based strategies identified by the Centers for Disease Control and Prevention (CDC) for improving healthy eating and PA in schools using a Comprehensive School Physical Activity Program approach (CSPAP). A pilot intervention during the 2012-2013 school year demonstrated improvements in classroom PA, physical fitness, and BMI percentiles.

<u>School Recruitment</u>

Twenty-eight schools in two metro-Atlanta districts were recruited for the intervention (17 in one district, 11 in another district). Seven schools in a third metro-Atlanta district were added to the study as controls.

District-level Health and PE Coordinators facilitated school recruitment and worked directly with HealthMPowers staff to secure participation. The coordinators obtained a convenience sample of schools by contacting PE teachers in their respective districts. The PE teachers spoke with fourth grade teachers and/or school principals, who ultimately decided whether the school would participate. Once a school consented, all fourth grade classrooms within that school participated. HealthMPowers staff was available to any schools that requested more information regarding the study.

Intervention and control schools were recruited by similar methods but on slightly different timelines. Recruitment of intervention schools began in August of 2015 and all 28 schools were enrolled by the kick-off training in October 2015. Since funding for

control schools was obtained later, enrollment and data collection for those schools did not occur until January 2016. Although the initial target was to have ten control schools, only seven schools volunteered to participate. For the control schools, HealthMPowers staff requested that teachers not change anything in their classrooms since the purpose of the controls was to obtain data on typical physical activity behavior.

Study Population

Fourth grade was chosen as the target population because both standardized academic scores and Fitnessgram data are state-mandated and students typically are not changing classes throughout the day. Teachers distributed hard copy consent forms to the students in their classes and requested that the form be signed by each student's parent or guardian and returned. Signed parental consent allowed the school system to provide the research team with individual student information. The consent form included the parent's name, student's name, and student's ID number for researchers to request student records from the Department of Education (DOE) and Fitnessgram. Incomplete or unreturned consent forms prohibited inclusion of some students for analytic purposes, due to the inability to link PA and engagement data, but did not affect students' participation in in-school PA programs.

Intervention Program

The intervention consisted of five components: establish a school health team, obtain physical activity data, implement trainings, provide resources, and provide technical assistance. The purpose of the school health team was to redeliver training information and to act as a point of contact. The team consisted of three staff members,

one physical education teacher, one fourth-grade teacher, and one other staff member designated by the principal.

Three trainings were offered throughout the year. The first face-to-face training took place in October 2015, at which all equipment was distributed to the schools. Half of the schools participated in asynchronous monthly virtual trainings, and the other half participated in two additional face-to-face trainings. These training sessions focused on how teachers could include PA in the classroom, strategies to increase moderate to vigorous physical activity (MVPA) during PE classes, and activities that could be used in recess or before- and after-school programs.

Each school was provided with three PA videos (Classrooms in Action, Mind-in-Motion 1, and Mind-in-Motion 2) for each fourth grade classroom; Mathtivity, an integrated curriculum that teaches the specific grade level Georgia Core Curriculum Performance Standards for math using PA; equipment to use at recess (one jump rope for every two students, poly spot markers, six basketballs, footballs, kick balls, soccer balls, flying discs, cones, mesh equipment bags); 35 Pebble pedometers to be shared between classrooms; and four Fit Step Pro devices used for data collection and retained by the PE teachers.

Throughout the year, technical assistance was provided to give teachers advice on integrating movement into the classroom and how to transition students back into traditional schoolwork, as well as, to troubleshoot data collection devices (changing out batteries, assisting in download of Pebble or Fit Step Pro data). Technical assistance was provided via email, website link, or face-to-face meetings at the school.

HealthMPowers conducted brief in-person tutorials for teachers at both control and intervention schools on the data collection devices. Each teacher received a stipend for their assistance during the study, which included serving as the research team's point of contact at the schools, collecting and uploading physical activity data, coordinating logistics with the data collection devices, and sending student-level data to the research team.

Data Sources

Prior to any data collection efforts, Institutional Review Board (IRB) approval was completed in each of the three school districts participating in the study. Data sources for the study measures included in this analysis are described in detail below.

Pebble Pedometers. Daily steps were collected using Pebble pedometers. A pedometer is a wearable device that records the acceleration and deceleration of movement in one direction (45). Pedometers provide accurate, objective measures of physical activity in both free-living populations and in research settings (46,47). The Pebble pedometer was evaluated as the ideal pedometer for this study because of its ease of use and Bluetooth uploading capability. The device is worn upright with the clip facing down on a belt or waistline. The student placed the pedometer on his or her waist as he or she walked into class at the beginning of the school day and removed the device as they left the classroom at the end of the school day. The pedometers were then docked and stored for use on the following school day. Students in a particular classroom wore the Pebbles for five consecutive school days, after which the set was given to the next classroom in the school. All fourth grade classrooms in a participating school shared a set of 35 Pebble pedometers, using a rotating schedule to ensure students in a classroom

were measured approximately one week per month. A set of pedometers was shared between three to four classrooms in intervention schools, and no more than two classrooms in control schools. The devices have the capability of storing the data for 21 days. Each Friday, the data from the pedometers were downloaded via Bluetooth and the set of pedometers were given to the next teacher on the rotational calendar. The students had the opportunity to wear the devices for a minimum of five complete weeks (one week per month) during the intervention. Students at intervention schools were measured between October 2015 and May 2016, while students at control schools were measured between January 2016 and May 2016. Steps were measured for a student five times per week, for five weeks in the school year, and therefore each student produced 25 total step measures for the study.

Student Engagement Instrument – Elementary Version (SEI-E). Students' level of engagement was calculated using the SEI-E.[48] The SEI-E is a 35-item self-report measure that assesses students' level of engagement characterized by three affective engagement themes (teacher-student relationships (TSR), peer support at school (PSS), family support for learning (FSL)) and three cognitive engagement themes (control and relevance of school work (CRSW), future aspirations and goals (FGA), intrinsic motivation (IM)). This survey was chosen because the largest school district participating in this study was already using the SEI-E at the beginning and end of each year. The SEI-E was administered at baseline (October 2015 for intervention schools; January 2015 for control schools) and post-test (May 2016 for both intervention and control schools). Teachers received an e-mail containing an Internet link to a SurveyMonkey version and a PDF hard copy. Teachers decided whether to administer the surveys via online or hardcopy. If

the teacher decided to use paper surveys, a HealthMPowers staff member picked up the hard copies from the school's front office once they received an e-mail that the surveys were completed.

Classroom Teacher Reports. Classroom teachers were responsible for reporting student gender. Upon initial contact with participating school teachers, the research team obtained all of their students' ID numbers, genders, and dates of birth.

Department of Education. The number of students from each racial/ethnic group and the proportion of students at each school who were eligible for Free and Reduced Lunch (FRL) were reported by each school. FRL rate was based on the Ten-Day Count: a count on the 10th day of school of the number of students on FRL divided by the total number of students. Race/ethnicity distributions and FRL rates for each school were obtained from the DOE website.

Data Measures

The primary outcome variable was average engagement score overall on the SEI-E. Responses to the 35-question SEI-I were coded from 1 to 5 (1 = *Strongly Disagree* to 5 = *Strongly Agree*). SurveyMonkey and hard copy versions of the SEI were slightly different, so only questions deemed equivalent were analyzed. Eleven questions were considered different resulting in 24 questions left for analysis and the elimination of the CRSW subscale and two questions from the FGA subscale. Included questions on the survey can be found in Appendix I. Average overall engagement was calculated at baseline and post-intervention by summing the responses to each question and dividing by 35. The two reverse-coded questions on the intrinsic motivation subscale were re-coded (1 = *Strongly Agree* to 5 = *Strongly Disagree*) so that higher scores would indicate

higher engagement. Additional outcome variables were created for the following subscales of engagement: overall affective engagement, overall cognitive engagement, TSR, PSS, FGA, FSL, and IM. Average scores for each subscale at baseline and post-intervention were calculated by summing responses to the corresponding questions and dividing by the total number of questions in each theme (Appendix II). Variables for change from pre- to post-test were created for overall engagement and each subscale by subtracting the average engagement score at pre-test from the average engagement score at post-test. All engagement variables were treated as continuous.

The exposure variable of interest was participation in the Health Empowers You! intervention, a dichotomous variable coded 1 for intervention schools and 0 for control schools. A second exposure variable of interest for intervention and control schools combined was PA, measured by the average number of steps at pre- and post-test. This continuous variable was calculated by summing the number of steps per day, at week 1 for baseline and at week 5 for post-test, and dividing by 5. A variable was created to indicate change in average steps per day from pre- to post-test by subtracting the average steps at week 1 from the average steps at week 5.

The covariates of interest were gender, percent of school population that was white, and percent of school population eligible for free and reduced lunch (FRL). Gender was a dichotomous variable coded 1 for female and 0 for male. The percent white at each school was calculated by dividing the number of white students at a school by the total school population. Because individual-level race/ethnicity data was not available, the percent white at each school was assigned to all students within a school. A dichotomous variable was created to represent a low percentage of white students, coded

1 for percent white under 25% and 0 for greater than or equal to 25% white. Twenty-five percent was chosen as the cut-point because it was the median value for percent white out of all schools. FRL rate was a school-level variable provided by the DOE. Because individual-level FRL eligibility was unavailable, the FRL school rate was assigned to all students within a school. A dichotomous variable was created to represent high FRL rate, coded 1 for FRL rate greater than or equal to 65% and 0 for under 65%. Sixty-five percent was chosen as the cut-point because it was the median value for FRL rate out of all schools.

Data Management

Six schools did not provide adequate data and were dropped from the analysis, resulting in 22 intervention and seven control schools included in this analysis. Data were available for a total of 4,872 fourth grade students (3,869 intervention, 1,003 control) (Figure 1). PA and engagement data were manually linked to unique student ID numbers from DOE. PA and engagement data were available from 4,141 students (3,386 intervention, 755 control). Students that did not have student ID numbers were excluded because the data for PA and engagement could not be linked. For the purpose of this analysis, only students with both PA and engagement data were examined. Ninety-eight students were excluded because they were missing step values for the entire first or last week of data collection (23 intervention, 75 control), two observations were excluded because they had implausible step values of less than 500 steps on at least one day in the first or last week of data collection (2 control), and 472 observations were excluded because they were missing engagement data for at least one question on the SEI-E at pre-

or post-test resulting in a final (262 intervention, 210 control), analytic dataset with 2,578 students.

<u>Analysis</u>

Descriptive statistics were calculated at baseline. Paired t-tests were performed to explore the significance of changes in agreement to engagement questions, average engagement scores and average steps from pre- to post-test within intervention and control schools, as well as to examine the difference between change from pre- to post-test between intervention and control schools. Two sample t-tests were performed to compare the difference in the change from pre- to post-test between intervention and control schools for all engagement variables and average steps.

Bivariate analysis was performed between all engagement subscale variables and average steps, as well as between all engagement subscale variables and potential covariates (gender, proportion of white students, proportion of FRL eligible students), accounting for correlation within schools. Bivariate analysis was also performed between change in average steps and all covariates. Results of these analyses determined which variables were included in multiple linear regression models. Multiple linear regression models were built adjusting for covariates that had significant relationships with the outcome in bivariate analyses. Stratified bivariate analyses were used to assess effect modification of gender, race, and SES. A significance level of 0.05 was used for all statistical analyses. All analyses were performed using Statistical Analysis Software, Version 9.4 (Cary, NC).

Results

Among the 2,578 students included in this analysis, the percentage of students that were female was not significantly different at intervention and control schools (47.9%; 47.2%, respectively) (Table 1). The proportion of white students and the FRL rate at intervention schools was significantly different from control schools (p<0.001). The average total school proportion of white students at intervention schools was 19.8% and 25% at control schools. The average total school proportion of students eligible for FRL was 71.2% at intervention schools, which was significantly different from 51.4% at control schools. The average overall engagement scores at baseline at intervention and control schools were not significantly different from each other (mean=4.4, SD=0.4; mean=4.3, SD=0.5, respectively. The average number of steps at week one was 3,214 steps (SD=710.3) at intervention schools which was significantly different from 3,277 steps (SD=582.4) at control schools.

For intervention schools, at both pre- and post-test, percentage of students reporting that he or she agreed to a statement on the SEI-E were highest for questions in the FGA subscale (91.3%% to 97.1%%) and lowest in the PSS subscale (60.8% to 94.8%) (Table 2). The strongest agreement out of all questions for intervention schools was "I am hopeful about my future" with 97.1% at pre-test and 93.9% at post-test. At both pre- and post-test, the lowest percent agreement at intervention schools was for the statement "Students here respect what I have to say" (60.8%; 69.7%, respectively). This was the only question that showed a significant increase in percent agreement from pre- to post-test. There was a significant decrease in agreement from pre- to post-test on 14 statements for intervention students. One of these, "I'll learn, but only if the teacher gives

me a reward" was a reverse-coded question from the IM subscale, so a decrease in agreement actually indicates higher engagement (17.9% to 13.6%).

For control schools the highest percentages of agreement at both pre- and post-test were in the FGA subscale (92.5% to 95.9%), and the lowest percentages of agreement at both pre- and post-test were in the PSS subscale (53.6% to 91.2%) (Table 2). The strongest agreement out of all questions for control schools was "I am hopeful about my future" with 94.7% at pre-test and 95.9% at post-test. At pre-test, the lowest agreement was for the statement "Students here respect what I have to say" (53.6%), but at post-test the question with the lowest agreement for control schools was "Other students here care about me" (59.4%). There were no significant changes from pre- to post-test for control schools.

Students at intervention schools showed significant changes from pre- to post-test for overall engagement (4.4, SD=0.4 to 4.3, SD=0.6), cognitive engagement (4.5, SD=0.5 to 4.4, SD=0.7), FGA (4.7, SD=0.4 to 4.6, SD=0.8), and FSL (4.7, SD=0.4 to 4.6, SD=0.7) (Table 3). For all engagement subscales, except IM, the average score remained the same at both collection periods for control schools. Intervention schools experienced significant decreases in average engagement scores compared to control schools for FGA and FSL (diff = -0.12, p=0.0002; diff =-0.90, p=0.0124, respectively).

Students at intervention schools showed a significant increase in average steps from pre- to post-intervention (3,214, SD=710.3 to 3,710, SD=586.3) (Table 3). Whereas, control schools showed a significant decrease in average steps from pre- to post-test (3,277, SD=582.4 to 3,044, SD=456.4). The average change in steps from pre- to post-test was significantly greater among students at intervention schools than students at

control schools (diff =728.1, p<0.0001). These results indicate that the Health Empowers You! intervention was effective in increasing the amount of PA students participated in during the school day.

Bivariate relationships were examined between all change in engagement variables and the exposure variable change in steps, as well as potential covariates, accounting for correlation within schools (Table 4). There were no significant associations.

Bivariate relationships were also examined between the exposure variable average change in steps and potential covariates, accounting for correlation within schools (Table 5). There were no significant associations. None of the covariates were significantly associated with engagement nor steps, so there is no evidence of confounding.

Bivariate analyses assessing differences in the associations between steps and engagement based on gender, race, and SES, accounting for correlation within schools, are shown in Table 6. There were no significant associations, indicating that there is no effect modification by any of the covariates.

Discussion

This was the first study to assess the association between a school-based PA intervention and all three subscales of student engagement using an objective measure of PA. Results indicate that participation in the PA intervention produced small, but significant, decreases in average engagement scores for overall engagement, cognitive engagement, FGA, and FSL. One question, "Students here respect what I have to say", showed a significant increase in percent agreement for students at intervention schools. This question was expected to be more directly relevant to the intervention and is

consistent with previous research relating exercise and a sense school belonging (35).

Several other questions in the TSR, PSS, and FSL subscales were also expected to be

more closely related to the intervention, but there were no other significant increases in

percent agreement for these questions. When accounting for within school correlation and

looking at increases in steps regardless of participation in the intervention, there was no

significant association between PA and student engagement. This is not consistent with

previous research that showed positive associations between PA and both cognitive and

affective engagement (35-41). However, the majority of these studies looked at the effect

of recess on engagement, rather than PA integrated into classroom lessons and other

times throughout the school day.

<u>Strengths and Limitations</u>

This study has at least three strengths. First, the Health Empowers You!

intervention reached a large number of students compared to previous studies. This study

also benefitted from having control schools to assess the effect of the intervention.

Second, this was a year-long intervention, which allowed time for change to occur. The

majority of other studies assessing this relationship looked at short-term interventions

lasting a couple weeks (37,39-41). Finally, there was a lot of available data on the

individual student level. This study used an objective measure of PA to more accurately

look at the effect of the intervention on PA levels, as well as administered surveys to the

students to capture socio-behavioral variables. This allowed for individual-level

comparisons from pre- to post-test.

Despite the strengths of this study, there are a few limitations. First, control

schools were not added to the data collection until January, so they had a shorter follow-

up time compared to the intervention schools. Intervention school data was only collected at the beginning and end of the school year, with no midpoint collection date, so the changes from baseline to post-test might not be equivalent for comparison. Second, the main outcome variable for this analysis, responses to the SEI-E, was collected via self-report. Students may have incorrectly responded to survey questions which could lead to biased results in this study. Third, survey versions differed between SurveyMonkey and hardcopy. The majority of questions on the two versions were deemed equivalent, however, data was lost due to differences in the CRSW and FGA subscales. Fourth, this study took place in only three districts in Georgia, which limits the generalizability of these results. Finally, race and SES data were only available at the school level as opposed to the individual-level.

<u>Future Directions and Public Health Implications</u>

Future research is needed to explore other questions of interest for this study, such as the effects of the intervention on other socio-behavioral outcomes, such as screen time, PA outside of school, and healthy eating choices. It would also be interesting to look at the associations between PA and academic achievement or absences using student engagement as a mediator because student engagement has previously been associated with academic achievement and school completion (16). Additionally, it would be beneficial to have student-level data on race and SES to more accurately assess the confounding and modifying effects of these covariates.

This study adds to the limited research on the effect of PA on student engagement and supports the need for continued research. Even though the intervention did not appear helpful in increasing student engagement, there was a significant increase in the average

number of steps taken per day for intervention schools compared to control schools. This type of intervention is still beneficial for increasing PA during the school day.

References

1. Ogden CL, Carroll MD, Kit BK, M FK. Prevalence of childhood and adult obesity in the United States, 2011-2012. *J Am Med Assoc*. 2014;311(8):806-814.

2. Biro FM, Wien M. Childhood obesity and adult morbidities. *Am J Clin Nutr*. 2010;91(1):1499-1505.

3. Physical Activity Guidelines Advisory Committee. Physical Activity Guidelines Advisory Committee Report, 2008. *U.S. Dept HHS.* 2008.

4. Centers for Disease Control and Prevention. Comprehensive School Physical Activity Programs: A Guide for Schools. *U.S. Dept HHS.* 2013.

5. Centers for Disease Control and Prevention. Results from the School Health Policies and Practices Study 2014. *U.S. Dept HHS.* 2015.

6. Demetriou Y, Höner O. Physical activity interventions in the school setting: A systematic review. *Psychol Sport Exerc*. 2012;13:186-196.

7. Norris E, Shelton N, Dunsmuir S, Duke-Williams O, Stamatakis E. Physically active lessons as physical activity and educational interventions: A systematic review of methods and results. *Prev Med (Baltim)*. 2015;72:116-125.

8. Dobbins M, Husson H, DeCorby K, LaRocca R. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18 (Review). *Cochrane Database Syst Rev*. 2013;(2):CD007651.

9. Ridgers ND, Saint-Maurice PF, Welk GJ, Siahpush M, Huberty J. Differences in physical activity during school recess. *J Sch Health*. 2011;81:545-551.

10. Baquet G, Ridgers ND, Blaes A, Aucouturier J, Van Praagh E, Berthoin S. Objectively assessed recess physical activity in girls and boys from high and low

socioeconomic backgrounds. *BioMed Cent Public Heal*. 2014;14:192-197.

11. Owen CG, Nightingale CM, Rudnicka AR, Cook DG, Ekelund U, Whincup PH. Ethnic and gender differences in physical activity levels among 9-10-year-old children of white European, South Asian and African-Caribbean origin: The Child Heart Health Study in England (CHASE Study). *Int J Epidemiol*. 2009;38:1082-1093.

12. Siahpush M, Huberty JL, Beighle A. Does the effect of a school recess intervention on physical activity vary by gender or race? Results from the Ready for Recess pilot study. *J Public Heal Manag Pract*. 2012;18(5):416-422.

13. Felton GM, Dowda M, Ward DS, et al. Differences in physical activity between black and white girls living in rural and urban areas. *J Sch Health*. 2002;72(6):250-255.

14. Pabayo R, Belsky J, Gauvin L, Curtis S. Do area characteristics predict change in moderate-to-vigorous physical activity from ages 11 to 15 years? *Soc Sci Med*. 2011;72:430-438.

15. Civil Rights Data Collection. Chronic absenteeism in the nation's schools. *Dept Educ*. 2016.

16. Bond L, Butler H, Thomas L, et al. Social and school connectedness in early secondary school as predictors of late teenage substance use, mental health, and academic outcomes. *J Adolesc Heal*. 2007;40:357.e9-357.e18.

17. Fredricks JA, Blumenfeld PC, Paris AH. School engagement: Potential of the concept, state of the evidence. *Rev Educ Res*. 2004;74(1):59-109.

18. Bakker AB, Sanz Vergel AI, Kuntze J. Student engagement and performance: A

weekly diary study on the role of openness. *Motiv Emot*. 2014;39:49-62.

19.   Jang H, Deci EL, Reeve J. Engaging students in learning activities: It is not autonomy support or structure but autonomy support and structure. *J Educ Psychol*. 2010;102(3):588-600.

20.   Kraft MA, Dougherty SM. The effect of teacher-family communication on student engagement: Evidence from a randomized field experiment. *J Res Educ Eff*. 2013;6(3):199-222.

21.   Shernoff DJ, Csikszentmihalyi M, Schneider B, Shernoff ES. Student engagement in high school classrooms from the perspective of flow theory. *Sch Psychol Q*. 2003;18(2):158-176.

22.   Finn JD, Rock DA. Academic success among students at risk for school failure. *J Appl Psychol*. 1997;82(2):221-234.

23.   Gage NA, Larson A, Sugai G, Chafouleas SM. Student perceptions of school climate as predictors of office discipline referrals. *Am Educ Res J*. 2016;53(3):492-515.

24.   Dotterer AM, Lowe K. Classroom context, school engagement, and academic achievement in early adolescence. *J Youth Adolesc*. 2011;40:1649-1660.

25.   Schmidt M, Benzing V, Kamer M. Classroom-based physical activity breaks and children's attention: Cognitive engagement works! *Front Psychol*. 2016;7:1474.

26.   Johnson MK, Crosnoe R, Elder GH. Students' attachment and academic engagement: The role of race and ethnicity. *Sociol Educ*. 2001;74(4):318-340.

27.   Skinner E, Furrer C, Marchand G, Kindermann T. Engagement and disaffection in the classroom: Part of a larger motivational dynamic? *J Educ Psychol*.

2008;100(4):765-781.

28. Rueger SY, Malecki CK, Demaray MK. Relationship between multiple sources of perceived social support and psychological and academic adjustment in early adolescence: Comparisons across gender. *J Youth Adolesc*. 2009;39:47-61.

29. Downey DB, Ainsworth-Darnell JW. The search for oppositional culture among black students. *Am Sociol Rev*. 2002;67(1):156-164.

30. Fullarton S. Student engagement with school: Individual and school-level influences. *Longitud Surv Aust Youth Res Reports*. 2002.

31. Centers for Disease Control and Prevention. The Association between School-Based Physical Activity , Including Physical Education , and Academic Performance. *U.S. Dept HHS*. 2010.

32. Hillman CH, Castelli DM, Buck SM. Aerobic fitness and neurocognitive function in healthy preadolescent children. *Med Sci Sports Exerc*. 2005;37(11):1967-1974.

33. Rosenbaum DA, Carlson RA, Gilmore RO. Acquisition of intellectual and perceptual-motor skills. *Annu Rev Psychol*. 2001;52:453-470.

34. Sibley BA, Etnier JL. The relationship between physical activity and cognition in children: A meta-analysis. *Pediatr Exerc Sci*. 2003;15:243-256.

35. London RA, Westrich L, Stokes-Guinan K, Mclaughlin M. Playing fair: The contribution of high-functioning recess to overall school climate in low-income elementary schools. *J Sch Health*. 2015;85(1):53-60.

36. Barros RM, Silver EJ, Stein REK. School recess and group classroom behavior what's known on this subject. *Pediatrics*. 2009;123(2):431-436.

37. Jarrett OS, Maxwell DM, Dickerson C, Hoge P, Davies G, Yetley A. Impact of

recess on classroom behavior: Group effects and individual differences. *J Educ Res*. 1998;92(2):121-126.

38. Pellegrini AD, Davis Huberty P, Jones I. The effects of recess timing on children's playground and classroom behaviors. *Am Educ Res J*. 1995;32(4):845-864.

39. Ma JK, Le Mare L, Gurd BJ. Classroom-based high-intensity interval activity improves off-task behaviour in primary school students. *Appl Physiol Nutr Metab*. 2014;39:1332-1337.

40. Howie EK, Beets MW, Pate RR. Acute classroom exercise breaks improve on-task behavior in 4th and 5th grade students: A dose-response. *Ment Health Phys Act*. 2014;7(2):65-71.

41. Vazou S, Gavrilou P, Mamalaki E, Papanastasiou A, Sioumala N. Does integrating physical activity in the elementary school classroom influence academic motivation? *Int J Sport Exerc Psychol*. 2012;10(4):251-263.

42. Owen KB, Parker PD, Van Zanden B, MacMillan F, Astell-Burt T, Lonsdale C. Physical activity and school engagement in youth: A systematic review and meta-analysis. *Educ Psychol*. 2016;51(2):129-145.

43. National Association of State Boards of Education. Fit, Healthy, and Ready to Learn: A School Health Policy Guide. 2006.

44. Centers for Disease Control and Prevention. Promoting Better Health for Young People through Physical Activity and Sports. *U.S. Dept HHS*. 2002.

45. Saris WHM, Binkhorst RA. The use of pedometer and actometer in studying daily physical activity in man. Part I: Reliability of pedometer and actometer. *Eur J Appl Physiol Occup Physiol*. 1977;37(3):219-228.

46. Sequeira MM, Rickenbach M, Wietlisbach V, Tullen B, Schutz Y. Physical activity assessment using a pedometer and its comparison with a questionnaire in a large population survey. *Am J Epidemiol*. 1995;142(9):989-999.

47. Tudor-Locke C, Williams JE, Reis JP, Pluto D. Utility of pedometers for assessing physical activity. *Sport Med*. 2004;34(5):281-291.

48. Carter CP, Reschly AL, Lovelace MD, Appleton JJ, Thompson D. Measuring student engagement among elementary students: Pilot of the Student Engagement Instrument—Elementary Version. *Sch Psychol Q*. 2012;27(2):61-73.

Tables

Table 1. Baseline characteristics of fourth grade students in three metro-Atlanta school districts, measured in October 2015 for intervention schools and January 2016 for control schools (n=2,578)

Variable	Intervention (n=2,110) n (%) or mean (SD†)	Control (n=468) n (%) or mean (SD)	p-value*
Female	1,011 (47.9%)	221 (47.2%)	0.7793
White**	19.8%	25.0%	<0.0001
FRL†***	71.2%	51.4%	<0.0001
Overall Engagement	4.4 (0.4)	4.3 (0.5)	0.1232
Cognitive	4.5 (0.5)	4.6 (0.6)	0.0003
Affective	4.5 (0.5)	4.3 (0.5)	0.0060
TSR†	4.3 (0.6)	4.3 (0.6)	0.0997
PSS†	4.1 (0.8)	4.0 (0.8)	0.0029
FGA†	4.7 (0.4)	4.7 (0.5)	0.8820
FSL†	4.7 (0.4)	4.6 (0.5)	0.0808
IM†	4.1 (1.1)	4.3 (1.0)	<0.0001
Steps	3,214 (710.3)	3,277 (582.4)	0.0436

†Abbreviations: SD, standard deviation; FRL, free and reduced lunch rate; TSR, teacher-student relationships; PSS, peer support at school; FGA, future goals and aspirations; FSL, family support for learning; IM, intrinsic motivation (reverse-coded)

*p-value for test of significant difference between intervention and control baseline characteristics; chi-square test for categorical variables (gender), two-sample t-test for continuous variables (white, FRL, engagement, steps)

**Mean percent of total school population that is of white race/ethnicity

***Mean percent of total school population that is eligible for FRL

Table 2. Percent agreement to statements on the student engagement instrument for fourth grade students in three metro-Atlanta districts (n=2,578)

	Intervention		Control	
Question	Pre (%)	Post (%)	Pre (%)	Post (%)
Teacher-Student Relationships (Affective)				
My teachers are there for me when I need them.	86.6	85.5	85.0	85.3
Adults at my school listen to the students.	80.4	81.6	75.0	74.1
The school rules are fair.	80.3	78.7	76.5	74.8
Most teachers at my school are interested in me as a person, not just as a student.	77.3	79.2	81.4	83.1
Overall, my teachers are open and honest with me.	89.4	87.5	88.7	88.7
Overall, adults at my school treat students fairly.	84.5	82.2*	67.1	70.3
I enjoy talking to the teachers here.	81.7	77.4*	68.4	67.5
I feel safe at school.	79.8	80.1	76.1	76.1
At my school, teachers care about students.	92.6	90.3*	89.1	89.5
Peer Support at School (Affective)				
Other students here like me the way I am.	78.3	72.0*	67.1	69.2
Other students here care about me.	73.5	70.6*	59.0	59.4
Students at my school are there for me when I need them.	71.9	72.7	59.4	61.5
Students here respect what I have to say.	60.8	69.7*	53.6	66.6
I enjoy talking to the students here.	88.0	83.8*	80.3	79.9
I have some friends at school.	94.8	89.0*	90.0	91.2
Future Aspirations and Goals (Cognitive)				
My education will create many future opportunities for me.	96.7	91.3*	92.5	93.4
School is important for achieving my future goals.	95.7	92.2*	94.4	94.4
I am hopeful about my future.	97.1	93.9*	94.7	95.9
Family Support for Learning (Affective)				
My family/guardian(s) are there for me when I need them.	95.3	91.8*	91.2	90.4
When something good happens at school, my family/guardian(s) want to know about it.	93.4	92.0	90.8	90.4
When I have problems at school, my family/guardian(s) are willing to help me.	94.0	91.7*	86.3	86.8
My family/guardian(s) want me to keep trying when things are tough at school.	96.1	91.1*	94.2	94.0
Intrinsic Motivation (Cognitive)				
I'll learn, but only if the teacher gives me a reward.	17.9	13.6*	10.0	10.0
I'll learn, but only if my family/guardian(s) give me a reward.	15.4	13.3	9.0	9.0

*Significant change in student agreement to a statement from pre- to post-test (p<0.05)

Table 3. Results of paired t-tests looking changes from pre- to post-test within intervention or control groups and changes from pre- to post-test between intervention and control groups among fourth grade students in three metro-Atlanta school districts (n=2,578)

Variable	Intervention		Control		Intervention Effect	
	Pre mean (SD†)	Post mean (SD)	Pre mean (SD)	Post mean (SD)	Estimate (CI†)	p-value
Overall engagement	4.4 (0.4)	4.3 (0.6)*	4.3 (0.5)	4.3 (0.3)	-0.04 (-0.1021, 0.0203)	0.1900
Cognitive	4.5 (0.5)	4.4 (0.7)*	4.6 (0.6)	4.6 (0.5)	-0.06 (-0.1443, 0.0210)	0.1434
Affective	4.5 (0.5)	4.3 (0.7)	4.3 (0.5)	4.3 (0.4)	-0.04 (-0.1021, 0.0313)	0.2980
TSR†	4.3 (0.6)	4.3 (0.5)	4.3 (0.6)	4.3 (0.5)	-0.01 (-0.0833, 0.0711)	0.8768
PSS†	4.1 (0.8)	4.1 (0.9)	4.0 (0.8)	4.0 (0.6)	-0.04 (-0.1409, 0.0600)	0.4293
FGA†	4.7 (0.4)	4.6 (0.8)*	4.7 (0.5)	4.7 (0.4)	-0.12 (-0.1870, -0.0571)	0.0002
FSL†	4.7 (0.4)	4.6 (0.7)*	4.6 (0.5)	4.6 (0.4)	-0.90 (-0.1672, -0.0203)	0.0124
IM†	4.1 (1.1)	4.1 (1.1)	4.3 (1.0)	4.4 (1.0)	0.03 (-0.1175, 0.1752)	0.6991
Steps	3,214 (710.3)	3,710 (586.3)*	3,277 (582.4)	3,044 (456.4)*	728.1 (648.6, 807.6)	<0.0001

†Abbreviations: SD, standard deviation; CI, 95% confidence interval; FRL, free and reduced lunch rate; TSR, teacher-student relationships; PSS, peer support at school; FGA, future goals and aspirations; FSL, family support for learning; IM, intrinsic motivation (reverse-coded)

*Significant change from pre- to post-test using paired t-test (α=0.05)

Table 4. Bivariate analysis of average change in engagement subscale scores and average change in steps and potential covariates, taking into account within-school correlation, for fourth grade students in three metro-Atlanta school districts (n=2,578)

Variable	Parameter estimate (SE[†])	p-value
Overall engagement		
Steps	-0.0000 (0.0000)	0.3755
Female	-0.0240 (0.0302)	0.4272
%White (c)*	-0.0015 (0.0019)	0.4482
%White (2)**	0.0280 (0.1059)	0.7917
%FRL[†] (c)*	0.0004 (0.0014)	0.7692
%FRL (2)***	-0.0295 (0.0900)	0.7430
Cognitive engagement		
Steps	-0.0000 (0.0000)	0.9226
Female	-0.0116 (0.0371)	0.7538
%White (c)	-0.0018 (0.0019)	0.3345
%White (2)	0.0382 (0.1114)	0.7313
%FRL (c)	0.0008 (0.0014)	0.5597
%FRL (2)	-0.0255 (0.0952)	0.7890
Affective engagement		
Steps	-0.0000 (0.0000)	0.2727
Female	-0.0272 (0.0323)	0.4000
%White (c)	-0.0014 (0.0020)	0.4893
%White (2)	0.0252 (0.1070)	0.8135
%FRL (c)	0.0003 (0.0014)	0.8344
%FRL (2)	-0.0306 (0.0913)	0.7378
TSR[†]		
Steps	-0.00001 (0.0000)	0.2053
Female	-0.0338 (0.0414)	0.4140
%White (c)	-0.0011 (0.0022)	0.6099
%White (2)	0.0243 (0.1178)	0.8366
%FRL (c)	0.0003 (0.0016)	0.8670
%FRL (2)	-0.0369 (0.0996)	0.7114

[†]Abbreviations: SE, standard error; FRL, free and reduced lunch rate; TSR, teacher-student relationships

*Continuous variable for percent of total school population that is white or percent of total school population eligible for FRL

**Dichotomous variable indicating percentage of total school population less than 25% white

***Dichotomous variable indicating percentage of total school population greater than or equal to 65% eligible for FRL

Table 4, cont.

Variable		Parameter estimate (SE†)	p-value
PSS†			
	Steps	-0.0000 (0.0000)	0.4347
	Female	-0.0308 (0.0380)	0.4169
	%White (c)*	-0.0022 (0.0015)	0.1236
	%White (2)**	0.0552 (0.0986)	0.5755
	%FRL† (c)*	0.0007 (0.0012)	0.5604
	%FRL (2)***	-0.0094 (0.0928)	0.9195
FGA†			
	Steps	-0.0000 (0.0000)	0.3558
	Female	-0.0334 (0.0392)	0.3943
	%White (c)	-0.0013 (0.0027)	0.6302
	%White (2)	0.0057 (0.1304)	0.9654
	%FRL (c)	0.0002 (0.0018)	0.9235
	%FRL (2)	-0.0290 (0.1053)	0.7828
FSL†			
	Steps	-0.0000 (0.0000)	0.3232
	Female	-0.0068 (0.0352)	0.8479
	%White (c)	-0.0006 (0.0026)	0.8167
	%White (2)	-0.0176 (0.1254)	0.8883
	%FRL (c)	-0.0002 (0.0018)	0.8992
	%FRL (2)	-0.0482 (0.1007)	0.6323
IM†			
	Steps	0.0001 (0.0000)	0.1686
	Female	0.0210 (0.0562)	0.7090
	%White (c)	-0.0026 (0.0016)	0.1099
	%White (2)	0.0871 (0.1462)	0.5411
	%FRL (c)	0.0018 (0.0016)	0.2704
	%FRL (2)	-0.0201 (0.1294)	0.8764

†Abbreviations: SE, standard error; FRL, free and reduced lunch rate; PSS, peer support at school; FGA, future goals and aspirations; FSL, family support for learning; IM, intrinsic motivation

*Continuous variable for percent of total school population that is white or percent of total school population eligible for FRL

**Dichotomous variable indicating percentage of total school population less than 25% white

***Dichotomous variable indicating percentage of total school population greater than or equal to 65% eligible for FRL

Table 5. Bivariate analysis of average change in steps and potential covariates, taking into account within-school correlation, for fourth grade students in three metro-Atlanta school districts (n=2,578)

Variable	Parameter estimate (SE[†])	p-value
Steps		
Female	50.790 (49.356)	0.3035
%White (c)*	3.077 (8.279)	0.7102
%White (2)**	-179.547 (409.181)	0.6608
%FRL[†] (c)*	-0.922 (5.772)	0.8731
%FRL (2)***	-7.293 (343.423)	0.9831

[†]Abbreviation: SE, standard error; FRL, free and reduced lunch rate

*Continuous variable for percent of total school population that is white or percent of total school population eligible for FRL

**Dichotomous variable indicating percentage of total school population less than 25% white
***Dichotomous variable indicating percentage of total school population greater than or equal to 65% eligible for FRL

Table 6. Stratified bivariate analysis examining the association between average change in engagement scores and average change in steps and the differences for gender, race and SES, taking into account within-school correlation, for fourth grade students in three metro-Atlanta school districts (n=2,578)

Variable	Gender		Race*		SES†**	
	Male	Female	High white	Low white	Low FRL†	High FRL
Overall engagement						
Steps	-0.0000 (0.3272)	-0.0000 (0.5762)	-0.0001 (0.2185)	-0.0000 (0.8175)	-0.0001 (0.2540)	-0.0000 (0.9661)
Cognitive						
Steps	-0.0000 (0.5434)	0.0000 (0.4075)	-0.0001 (0.3474)	0.0000 (0.2266)	-0.0001 (0.3436)	0.0000 (0.1717)
Affective						
Steps	-0.0001 (0.2836)	-0.0000 (0.3768)	-0.0001 (0.1988)	-0.0000 (0.5400)	-0.0001 (0.2389)	-0.0000 (0.6474)
TSR†						
Steps	-0.0001 (0.2897)	-0.0000 (0.2648)	-0.0001 (0.3349)	-0.0000 (0.2437)	-0.0001 (0.3210)	-0.0000 (0.3117)
PSS†						
Steps	-0.0000 (0.4303)	-0.0000 (0.5357)	-0.0001 (0.1462)	0.0000 (0.9578)	-0.0001 (0.2097)	0.0000 (0.9271)
FGA†						
Steps	-0.0001 (0.1593)	0.0000 (0.8342)	-0.0002 (0.0514)	0.0000 (0.7083)	-0.0001 (0.0719)	0.0000 (0.5166)
FSL†						
Steps	-0.0001 (0.2046)	-0.0000 (0.7058)	-0.0001 (0.0931)	0.0000 (0.8541)	-0.0001 (0.1659)	0.0000 (0.8040)
IM†						
Steps	0.0001 (0.2650)	0.0001 (0.2103)	0.0001 (0.5052)	0.0001 (0.0805)	0.0000 (0.6461)	0.0001 (0.0837)

All numbers in table are parameter estimate (p-value)

†Abbreviations: SES, socioeconomic status; FRL, free and reduced lunch rate; TSR, teacher-student relationships; PSS, peer support at school; FGA, future goals and aspirations; FSL, family support for learning; IM, intrinsic motivation (reverse-coded)

*Race was dichotomized so that low white indicated less than 25% of the school population was white

**SES was dichotomized so that high FRL indicated greater than 65% of the school population was eligible for free and reduced lunch

Figures

Figure 1. Flow diagram of exclusion criteria for analysis of data from fourth grade students in Georgia
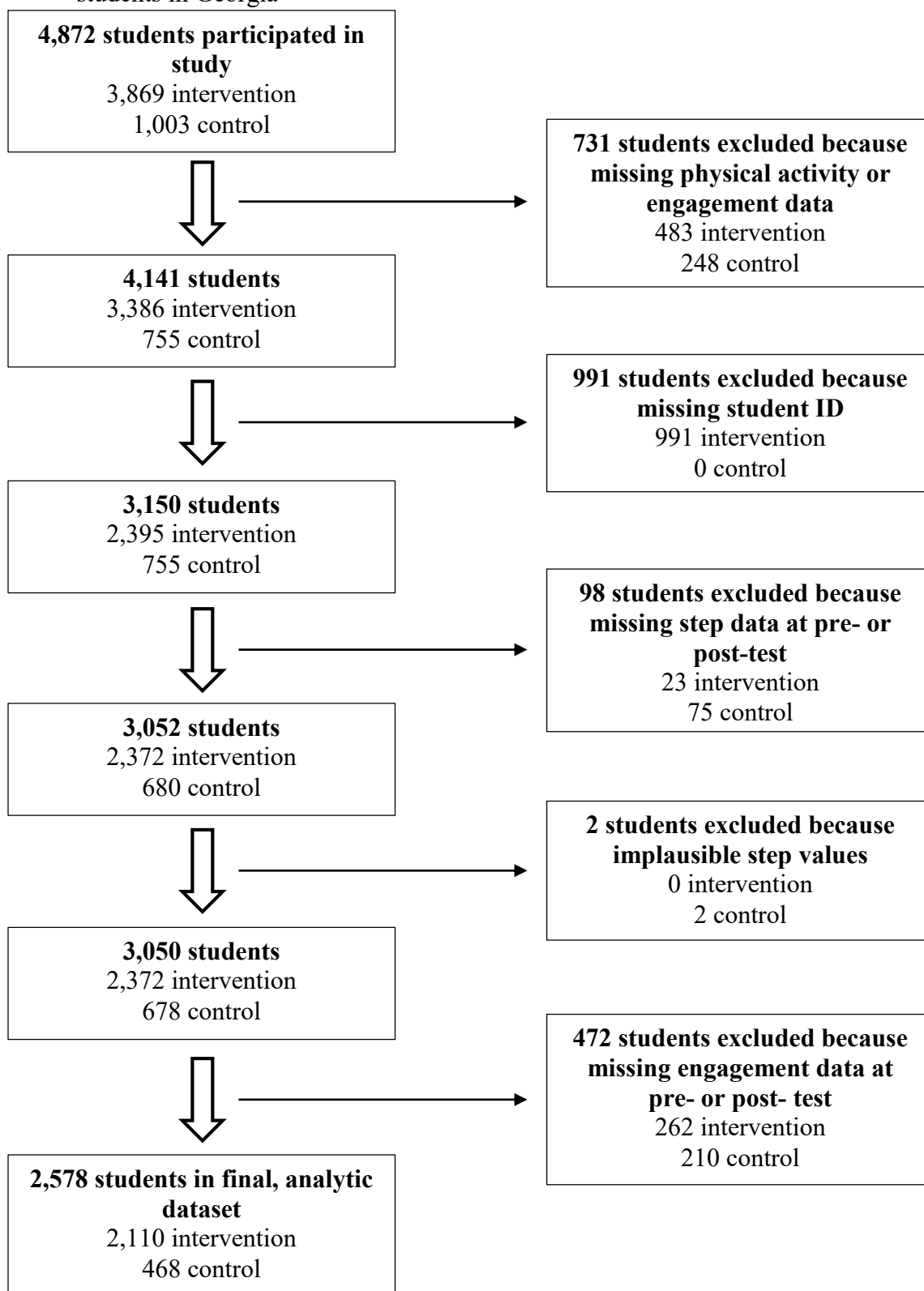
Chapter III: Summary, Future Directions, and Public Health Implications

Although this study did not indicate a strong association between PA and student engagement, it added to the limited research on this relationship. These results were not consistent with previous research (35-41). However, the present study utilized a large sample of students and assessed the impact of a year-long PA intervention, so this analysis was important in expanding previous research and guiding future directions. It also shed light on subscales of engagement that students are most struggling with, which could impact the target of future interventions.

It should be noted that intervention students had small, but significant, decreases in overall engagement, cognitive engagement, FGA, and FSL, but this analysis did not take into account correlation within schools. When looking at both intervention and control schools combined and accounting for within school correlation, there were no significant associations between any engagement subscales and steps. On the other hand, students at intervention schools showed a significant increase in average steps from pre- to post-test; whereas, students at control schools showed a significant decrease in average steps. This indicates that integrating more PA during the school day was effective at increasing average steps. As the primary program objectives are increasing student PA and improving student health, it is relevant to note that this can successfully be accomplished within the school setting.

There are at least three directions for future research to address the limitations of this study and explore other factors that could be related to student engagement. First, studies should use individual-level demographic data to more clearly assess the relationship race and SES have on the association between PA and engagement. Second,

further analysis should look at the effects of the intervention on other health-related socio-behavioral outcomes, such as screen time, PA outside of school, and healthy eating choices. It would also be interesting to look at the associations between PA and academic achievement and absences, using student engagement as a mediator because student engagement has previously been associated with academic achievement and school completion (16). Lastly, future studies should take into account subscales of engagement where students have reported lowest levels of engagement when designing interventions to specifically target these areas.

This study added to the limited research on the effect of PA on student engagement and supports the need for continued research. Even though the intervention did not appear helpful in increasing student engagement, there was a significant increase in the average number of steps taken per day for intervention schools compared to control schools, and no detrimental decreases in engagement. Therefore, school-based PA interventions should still be utilized as a way to increase student PA and improve health outcomes.

Appendix

Appendix 1. Student Engagement Instrument-Elementary version marked with questions that are equivalent to SurveyMonkey version

= Same ? for both Gwinnett + Survey Monkey

Gwinnett County Public Schools

Elementary Student Engagement Instrument

Used by permission

Student Number

Your honest answers to this questionnaire will be important for understanding what you think of your school and how to keep improving it. Your answers will be confidential - that means nobody at your school will see what you put for any of the below items. School staff will only see information for groups of items or students.

Please use a pencil. Write your "Student Number" in the "Student Number" boxes provided on this form, and then darken the circles corresponding to each digit of your Student Number.

Do not begin marking your answers until your teacher starts reading the items aloud.

	STRONGLY AGREE	AGREE	IN THE MIDDLE	DISAGREE	STRONGLY DISAGREE
1. My family/guardian(s) are there for me when I need them. *					
2. If I don't do well in school it's because I'm not smart.					
3. My teachers are there for me when I need them. *					
4. Other students here like me the way I am. *					
5. Adults at my school listen to the students. *					
6. Other students care about me. *					
7. Students at my school are there for me when I need them. *					
8. My education will create many chances for me to reach my future goals. *					
9. I don't pay attention during class.					
10. The rules at my school are fair. *					
11. Continuing to learn after high school is important.					
12. My family/guardian(s) want to know when something good happens at school. *					
13. Most teachers care about me as a person, not just a student. *					
14. Students here respect what I have to say. *					
15. I don't like school.					
16. My teachers are honest with me. *					
17. I plan to go to college after I graduate from high school.					
18. I will learn only if teachers give me a reward. *					
19. School is important for reaching my future goals. *					
20. When I have problems at my school, my family/guardian(s) are ready to help me. *					
21. Adults at my school are fair towards students most of the time. *					
22. I like talking to the teachers here. *					
23. I enjoy talking to the students here. *					

*Questions included in analysis

	STRONGLY AGREE	AGREE	IN THE MIDDLE	DISAGREE	STRONGLY DISAGREE
24. I have friends at school.*					
25. I feel nervous when I'm at school.					
26. I don't understand why I get the grades I do.					
27. I feel safe at school.*					
28. I feel upset when I don't do well in school.					
29. My family/guardian(s) want me to keep trying when things are tough at school.*					
30. I am hopeful about my future.*					
31. Teachers at my school care about the students.*					
32. I will learn only if my parent/guardian(s) give me a reward.*					
33. My grades show how hard I work.					
34. I am responsible for the grades I get.					
35. I am easily distracted in class.					

	Never	Once in a while	About half of the time	Often	Usually
36. How often do you feel bored at school?					
37. How often did you come to class and find yourself:					
(a) without pencils or paper					
(b) without books					
(c) without your homework done					

	Terrible	Unhappy	Mostly Dissatisfied	Mixed	Mostly Satisfied	Pleased	Delighted
38. I would best describe my satisfaction with my family life as:							
39. I would best describe my satisfaction with my friendships as:							
40. I would best describe my satisfaction with my school experience as:							
41. I would best describe my satisfaction with myself as:							
42. I would best describe my satisfaction with where I live as:							
43. I would best describe my satisfaction with my overall life as:							

*Questions included in analysis

Appendix II. Student Engagement Instrument Subscales and Excluded Questions

Item #	SEI Themes and Item Text
	Teacher-Student Relationships (Affective Engagement)
3	My teachers are there for me when I need them.
5	Adults at my school listen to the students.
10	The school rules are fair.
13	Most teachers at my school are interested in me as a person, not just as a student.
16	Overall, my teachers are open and honest with me.
21	Overall, adults at my school treat students fairly.
22	I enjoy talking to the teachers here.
27	I feel safe at school.
31	At my school, teachers care about students.
	Control and Relevance of School Work (Cognitive Engagement)
2	After finishing my schoolwork I check it over to see if it's correct.
9	Most of what is important to know you learn in school.
15	When I do schoolwork I check to see whether I understand what I'm doing.
25	When I do well in school it's because I work hard.
26	The tests in my classes do a good job of measuring what I'm able to do.
28	I feel like I have a say about what happens to me at school.
33	Learning is fun because I get better at something.
34	What I'm learning in my classes will be important in my future.
35	The grades in my classes do a good job of measuring what I'm able to do.
	Peer Support at School (Affective Engagement)
4	Other students here like me the way I am.
6	Other students here care about me.
7	Students at my school are there for me when I need them.
14	Students here respect what I have to say.
23	I enjoy talking to the students here.
24	I have some friends at school.
	Future Aspirations and Goals (Cognitive Engagement)
8	My education will create many future opportunities for me.
~~11~~	~~Going to school after high school is important.~~
~~17~~	~~I plan to continue my education following high school.~~
19	School is important for achieving my future goals.
30	I am hopeful about my future.
	Family Support for Learning (Affective Engagement)
1	My family/guardian(s) are there for me when I need them.
12	When something good happens at school, my family/guardian(s) want to know about it.
20	When I have problems at school, my family/guardian(s) are willing to help me.
29	My family/guardian(s) want me to keep trying when things are tough at school.
	Intrinsic Motivation (Cognitive Engagement)
18	I'll learn, but only if the teacher gives me a reward. *(Reversed)*
32	I'll learn, but only if my family/guardian(s) give me a reward. *(Reversed)*