INCREASING PHYSICAL ACTIVITY IN ELEMENTARY SCHOOL CLASSROOMS

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ABSTRACT

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The benefits of physical activity (PA) for children are well-researched and extend into the realms of physical health, mental health and executive function (EF). Nonetheless, most U.S. children fail to meet the recommended target of daily PA. Although elementary schools can provide an ideal setting for PA, school-based PA time has been reduced in favor of increased sedentary instructional time. This contradicts research that supports the role of PA in enhancing students' EF and academic achievement. Moreover, low-income and minority populations have inequitable access to school-based PA opportunities. For these reasons, researchers and public health officials have proposed integrating additional opportunities for PA during the school day, including classroom-based active breaks. This dissertation aims to study existing U.S. classroom-based active break programs, examine the feasibility of implementing a classroom-based active break program and analyze the impact of an integrated program on both PA and EF, all among underserved, minority populations.

This dissertation includes four chapters in total. The second chapter is a systematic review that evaluated the impact of school-based PA interventions on

children's PA, with a focus on diverse populations. The third chapter describes a pilot study that assessed the feasibility of implementing a classroom PA program (HYPE) in a diverse urban setting. Teacher and student acceptability of HYPE were evaluated, as well as HYPE's impact on student PA. HYPE was feasible and well-received, although time and space were challenges. Children's median step count/day increased.

The waitlist-control study presented in Chapter IV examined whether a multifaceted program ("POWER") that incorporates both PA and EF would impact fifth graders positively. We also investigated whether POWER could assist teachers with classroom behavioral management. Overall, the positive changes in the intervention group and their favorable reception of POWER demonstrate the ability of POWER to improve children's socioemotional, mental and physical health.

Altogether, these studies highlight the potential for school-based PA interventions to improve the holistic wellbeing of children, particularly low-income, minority youth. Interventions that incorporate a teacher-led, multimodal approach to improving children's PA and EF synergistically may be well-received by administrators, teachers and students and help children adopt healthy, lifelong habits.

DEDICATION

This dissertation is dedicated in memory of my beloved father, Dr. Charles H. Feldman, who inspired me to pursue a career in research with a social justice lens. I like to think that he would have been very proud of my accomplishments today.

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M.F.H.

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Chapter I

INTRODUCTION

Background

The health benefits of physical activity (PA) for children are well-documented and occur in both the short and long term. Children who are physically active may have improved cardiometabolic health, lower rates of obesity, lower systolic blood pressure, more favorable lipid profiles,[1] better executive function,[2] and improved scholastic performance,[3,4] in comparison to their less active counterparts. Importantly, active children are more likely to become active, healthy adults.[5,6] However, less than a quarter (24%) of U.S. children aged 6 to 17 years old meet the current U.S. Department of Health and Human Services' (HSS) *Physical Activity Guidelines for Americans* recommended target of 60 minutes of daily moderate-to-vigorous PA (MVPA). Additionally, PA drops off significantly with increasing age, with less than half (42.5%) of children aged 6-11 years old and only 7.5% of adolescents aged 12-15 years adhering to the guideline.[7] There are also discrepancies between sexes, as only 35% of girls in the 6-11 years age group meet the guideline, compared to 48% of boys.[8] Despite data demonstrating higher levels of PA among non-Hispanic Black youth and Mexican American youth as compared to non-Hispanic White youth, White youth have a lower prevalence of obesity.[9]

Since children spend most of their waking hours at school, schools may serve as an ideal setting for the promotion of PA.[10] The Institute of Medicine recommends that at least 50% of the recommended 60 minutes of daily PA for children be achieved during

the school day.[11] However, most of the time spent in school is sedentary, including time attending class and school-based media use. Children aged 6-11 years spend an average of 6 hours per day in sedentary behavior, both in and out of school. Among 12-15-year-old adolescents, this number increases to 7.5 hours per day.[12] Schools' practice of reducing PA time in favor of increased sedentary instructional time practice contradicts research supporting the role of PA in enhancing students' time-on-task,[13-20] attention,[21,22] concentration,[23] academic achievement,[23-25] mental health[26,27] and executive function (EF).[21-23] EF refers to the set of cognitive skills related to the planning and management of mental processes that enable the control and organization of goal-directed behavior.[28,29] The three primary domains of EF are inhibition, working memory and cognitive flexibility.[28]

Since only 15% of elementary schools and 9% of middle schools require students to take physical education (PE) classes on at least 3 days per week,[7] government agencies and research organizations have proposed integrating alternative opportunities for daily PA during the school day, such as in the classroom or during recess.[11,30] However, only 62% of school districts require elementary schools to provide regularly scheduled recess breaks. Additionally, recess time can be optimized for PA, as research demonstrates that children spend an average of only 20% of recess engaged in PA.[31] Because of the limitations of recess, this dissertation focused on classroom-based opportunities for increasing PA during the school day. These opportunities are intended to supplement existing school PE classes taught by professionally trained PE teachers, who play a crucial role in educating students about PA and health.

Many researchers have studied the effectiveness of school-based PA interventions in promoting children's PA levels, yet much remains unknown about best practices for promoting PA among diverse populations of elementary school age children in the U.S. Because of the discrepancy between higher PA levels and higher obesity rates among non-Hispanic Black youth and Mexican American youth as compared to non-Hispanic White youth, more research is needed on programs that target improving the health of minority youth.

Overview

This dissertation consists of four chapters including three research articles (a systematic review followed by two studies related to increasing PA in the classroom) and appendices with supplementary content. The systematic review evaluated the impact of U.S. elementary school-based PA interventions on children's PA levels, with a particular focus on minority and underserved populations.

Subsequently, a pilot study assessed the overall feasibility of a classroom-based active break program for third through fifth graders in a diverse urban school setting. Both teacher and student acceptability of including PA breaks in the classroom were assessed. A secondary aim was to study the feasibility of measuring the impact of the activity breaks on students' PA levels.

Following the completion of this pilot study, we expanded the concept of the active break program to focus on improving EF and classroom behavior, in addition to student PA levels. Research has demonstrated a positive association between higher levels of PA and enhanced EF in children.[18,19] Research has also demonstrated that an

array of activities can improve children's EF, with strong evidence existing for select school-based programs.[32] A multifaceted program called POWER that incorporates both PA and the teaching of EF skills may have a significant effect on the PA-related health outcomes and EF of elementary school children. The second study evaluated the effectiveness of POWER in improving PA and EF. As a secondary aim, we investigated whether POWER could assist teachers with classroom behavioral management. The multimodal approach of POWER presents a new comprehensive method for teaching both EF and PA, with each component reinforcing the other in a synergistic way.

The specific primary aims of this dissertation are:

1. To evaluate the impact of elementary school-based PA interventions on children's PA levels, with a particular focus on minority and underserved populations.
2. To assess the overall feasibility of a classroom-based active break program (HYPE) for 3rd-5th graders in a diverse urban school setting.
3. To assess teacher and student acceptability of HYPE.
4. To assess differences in PA levels in students who receive a multimodal classroom program (POWER) and students in waitlist control classrooms who receive regular academic instruction.

   H1: Children in the POWER program will have higher PA levels during the school day as compared to children in control classrooms.
5. To assess differences in EF in students who receive POWER and students in waitlist control classrooms who receive regular academic instruction.

   H2: Children in the POWER program will have increased EF scores as compared to children in control classrooms.

The secondary aims of this dissertation are:

1. To study the impact of HYPE on students' PA levels.

   H3: Children who participate in HYPE will have increased PA levels during the study period.

2. To evaluate changes in teacher-reported classroom behavioral management.

   H4: Teachers who participate in the POWER program will report improved levels of classroom behavioral management as compared to teachers in control classrooms.

Dissertation Organization

Chapter II is a systematic review investigating the impact of elementary school-based PA interventions on children's PA levels, with a particular focus on minority and underserved populations. Chapters III and IV are two discrete studies evaluating different types of classroom-based programs that promote PA and EF in children. Each chapter is written in the format of a journal article and includes its own abstract, introduction, methods, results, discussion, tables and figures, followed by references. Appendix A includes a definition of terms and abbreviations used throughout the dissertation. Appendix B includes the search strategy for the systematic review. Appendix C, D and E include approved Institutional Review Board documents from Teacher College, Columbia University for both the HYPE and the POWER studies. Appendix F includes both questionnaires and surveys used in the POWER study.

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Chapter II

PHYSICAL ACTIVITY INTERVENTIONS IN DIVERSE U.S. SCHOOLS: A SYSTEMATIC REVIEW

Abstract

Objectives

Many researchers have studied the effectiveness of school-based physical activity (PA) interventions in promoting children's PA, yet much remains unknown about best practices for promoting PA among diverse populations of school age children in the U.S. The purpose of this systematic review was to evaluate the impact of elementary school-based PA interventions on children's PA levels in minority or underserved populations.

Methods

Studies were identified through a systematic search of electronic databases, related references and additional sources. Inclusion criteria included U.S.-based randomized controlled trials with validated instruments and scales.

Results

A total of ten publications met the inclusion criteria. Included studies had varying settings (classroom, playground, etc.), study population sizes and durations. Five of the ten interventions, including all of the classroom-based interventions, were effective, while the others were equivocal. The effective PA interventions were well-planned and were implemented with fidelity to achieve sustainable results.

Conclusions

Overall, classroom-based interventions improve the PA level of elementary-school aged children. The lack of uniformity and fidelity in implementation across interventions limits the interpretation of the findings. Although a comprehensive search was conducted, only ten studies met the inclusion criteria for this review, indicating a critical need for more research in this area.

Background

The health benefits of physical activity (PA) for children are myriad and occur in both the short and long term. Children who are physically active may have improved cardiometabolic health, such as lower rates of obesity, more healthful systolic blood pressure and favorable lipid profiles,[1] better cognitive function and improved scholastic performance,[2,3] in comparison to their less active counterparts. Importantly, active children are more likely to become active, healthy adults, with studies demonstrating the importance of youth participation in sports and PA as a strong predictor of continued participation in adulthood.[4,5] Additionally, maintaining high levels of aerobic fitness and muscular strength during late childhood is associated with low levels of adiposity during adolescence.[6] However, less than a quarter (24%) of U.S. children aged 6 to 17 years old meet the current U.S. Department of Health and Human Services' (HSS) *Physical Activity Guidelines for Americans* recommended target of 60 minutes of daily moderate-to-vigorous PA (MVPA). Additionally, PA drops off significantly as children get older, with less than half (42.5%) of elementary school-aged children (6-11 years old) and only 7.5% of middle school and high school adolescents ages 12-15 years adhering to the

guideline.[7] There are also discrepancies between sexes, as only 35% of girls in the 6-11 year age group meet the guideline, compared to 48% of boys.[8] Researchers have also documented discrepancies related to race/ethnicity and income level. Despite data demonstrating participation in statistically significantly higher levels of MVPA among non-Hispanic Black youth as compared to their non-Hispanic White counterparts, Black youth also have the highest prevalence rates of overweight/obesity measured by BMI. Additionally, although lower-income children and adolescents participate in higher levels of PA in comparison to both their medium- and high-income peers, high-income children and adolescents also had significantly less adiposity in comparison to their low-income counterparts.[9] These discrepancies and complex relationships between PA and overweight/obesity by race/ethnicity and income highlight the need for additional research related to diverse populations.

Since children spend most of their waking hours at school, schools may serve as an ideal setting for the promotion of PA.[10] Research demonstrates that active children perform better academically in school,[2] so the goal of promoting PA in the school setting aligns with schools' goal of educating children. The Institute of Medicine recommends that at least 50% of the recommended 60 minutes of daily PA for children be achieved during the school day.[11] Nearly all school districts nationwide (92.6%) have adopted a policy stating that elementary schools will teach physical education.[12] However, most of the time spent in school is sedentary, including time attending class and school-based media use. Elementary school-aged children between the ages of 6 to 11 years spend an average of 6 hours per day in sedentary behavior, both in and out of school. Among 12-15-year-old adolescents, this number increases to 7.5 hours per day.[13] Interventions that

promote PA and decrease time spent in sedentary behavior should be implemented in elementary school-aged children, before the steep decline in PA in adolescence. Since only 15% of elementary schools and 9% of middle schools require students to take physical education classes on at least 3 days per week,[7] government agencies and research organizations have proposed integrating alternative opportunities for daily PA during the school day, such as in the classroom or during recess.[11,14] However, only 64.8% of school districts require elementary schools to provide regularly scheduled recess breaks and only 10.7% of school districts require that schools provide regular classroom physical activity breaks during the school day.[12] Additionally, recess time can be optimized for PA, as research demonstrates that children spend an average of only 20% of recess engaged in PA.[15]

Many researchers have studied the effectiveness of elementary school-based PA interventions, such as incorporating physical activity breaks or active recess during the school day, in promoting children's PA levels, yet much remains unknown about best practices for promoting PA among diverse populations of elementary school age children in the U.S. Healthy behaviors established in childhood track into adolescence,[16] highlighting the importance of focusing on younger children for PA interventions. Because of the discrepancy between higher PA levels and higher obesity rates among non-Hispanic Black and lower income youth as compared to non-Hispanic White and more affluent youth, more research is needed on programs that target improving the health of diverse populations, including minority (at least 50% nonwhite, including heterogenous populations that identify as non-Hispanic Black, Hispanic, and/or Asian/Pacific Islander) and low-income (at least 25% of study sample eligible for free or

reduced-price lunch status, a proxy for low-income level, which includes individuals that identify as any race/ethnicity) youth.

The purpose of this systematic review was to evaluate the impact of school-based PA interventions on elementary schoolchildren's PA levels, with a focus on minority and/or underserved youth. Previous studies have evaluated different outcomes of PA interventions, such as the effect on academic achievement[17] or PA enjoyment.[18] Moreover, some previous reviews have included international populations[19] or mixed both younger and older adolescent populations, which is problematic because the needs of each age group differ significantly.[20,21] In contrast, because of the specific geographical scope of the U.S. Physical Activity Guidelines and especially the unique nature of the U.S. educational system and culture compared with other nations, this review was limited to studies of U.S. elementary school-age children (grades K-6) whose primary outcome was student PA level, with a particular focus on either minority and/or underserved study samples. The unique nature of the U.S. education system is evident in many ways. First, in contrast to the majority of other nations, the U.S. education system is highly decentralized, with no nationally mandated curricula; moreover, private schools do not receive government funding.[22] Additionally, more than half of students in U.S. public elementary and secondary schools are nonwhite, while only 20% of teachers in these schools are nonwhite.[23] Finally, socioeconomic status (SES) plays a larger role in the U.S. than in other countries in determining test scores on the Programme for International Student Assessment (PISA), a test that is often used to rank educational outcomes globally.[24]

Methods

Search Strategy

We identified studies through a systematic search of four electronic databases (MEDLINE [Ovid], CENTRAL [part of *The Cochrane Library]*, ERIC and PsycINFO [Ovid]), first conducted in November 2016 by an information specialist (L.F.) with an expertise in research methodology and the retrieval, organization and analysis of information. An updated search was conducted in June 2019. These four databases were considered to be the most relevant for this topic, especially as we were seeking randomized controlled trials. We supplemented these sources by searching PubMed and the Web of Science. All relevant subject headings and free text terms were identified to represent the concepts of physical activity, children, schools, United States and assessment, and were combined with AND. The publication dates were limited from 2008 to 2019. Copies of all search strategies are available in Appendix B.

After two independent reviewers extracted eligible references from the initial search, L.F. conducted a related reference search in two databases (PubMed Similar articles and ISI Web of Science) in June 2017. “Grey” literature, including references from eligible extracted articles that were not identified in the search and references from review articles published by physical activity organizations, were also inspected to identify other possible publications.

Inclusion Criteria

Two independent reviewers assessed the eligibility of references using set inclusion and exclusion criteria. The reviewers applied the inclusion and exclusion

criteria to title review, then to the abstract review and finally to the full-text review. Since the HHS' updated guidelines for 60 minutes of daily PA for children were published for the first time in 2008, only articles published after 2008 were evaluated. The review was also limited to peer-reviewed articles published in English that were based in the U.S. Additionally, the study population was limited to non-clinical, elementary school-aged children (kindergarten through sixth grade, approximately 5-13 years old). Studies that included minority (at least 50% nonwhite) and/or low-income (at least 25% of study sample eligible for free or reduced-price lunch status) participants were included to meet the study aims of examining interventions in diverse populations. Race/ethnicity and SES are separate parameters which can be associated with PA, so it is important to describe both race/ethnicity and SES. In order to study school interventions, the study setting was limited to the school day only, excluding before-, after-school and summertime PA programs. Because we wanted to study the effectiveness of these interventions, we limited the evidence to studies with the strongest level of evidence, which are randomized controlled trials (RCT) with at least one control arm. Data collection was limited to instruments and scales that have been validated against another criterion measure and are considered to be valid and reliable measurement tools, such as accelerometers, questionnaires and direct observation. Because of the subjective nature and inaccuracies of self-report survey methods in children, the use of these methods with children under the age of 10 years is not advisable.[25] Although researchers have been working towards calibrating questionnaires to accurately predict accelerometer data in children,[26] there is still work to be done in this field. Since these methods have lower reliability, this review only included studies that used self-report measures by both students and teachers as

additional measurement tools, but not as primary measurement tools. Primary outcome measures were limited to student PA level, as the variable of interest, excluding studies that focused on academic achievement or anthropometric outcomes as primary outcomes.

Classification of Study Population as Minority or Low-income

In order to compare the racial/ethnic composition of study populations across studies for the determination of whether or not the study population met the inclusion criteria of representing a sufficient percentage of minority and/or low-income participants, z-tests comparing the study population to the surrounding county or city were conducted. This approach allowed us to compare studies that met all other inclusion criteria and analyze the composition of study populations in a standardized manner. The study population for each individual study was compared to the surrounding general population of the study area to assess if the study population was representative of significantly more or less nonwhite populations than the surrounding geographic area. Authors of studies with de-identified city names were contacted for county or city level data. County or city level data for racial/ethnic composition and income status were extracted from the children characteristics reported in the 2012-2016 American Community Survey (ACS) 5-Year Estimates. If the z-test results showed that the study population represented a significantly higher percentage of minority and/or low-income individuals as compared to the surrounding area, the study was classified as one that focused on minority and/or low-income study populations. For example, one study reported that 28% of participants identified as Black, whereas the surrounding city reported that only 15.8% of children identified as Black. The p-value for the z-test comparing these two-sample means was 0, indicating that the study population had a

significantly higher percentage of Black participants than the surrounding city. Therefore, this study was included.

Data Extraction

All references from the search were imported into Covidence online software (Veritas Health Innovation, Melbourne, Victoria, Australia) for screening. The additional references from the related search were reviewed in EndNote (Clarivate Analytics, Boston, MA) or Zotero (Corporation for Digital Scholarship, Vienna, VA) and then exported to Microsoft Excel, where all references were eventually merged and organized by the inclusion criteria, including study design, intervention type, data collection method and outcome variables. See Figure 1 below for PRISMA flow chart.

A total of 5,491 references were retrieved from the first four databases and grey literature. After de-duplication, 3,556 references remained. Of these, 3,486 were excluded based on title and abstract review because they did not meet the eligibility criteria. Seventy references were assessed for full-text eligibility. Of these 70 papers, 12 papers were initially included for the systematic related references search. After further application of the inclusion criteria, the 12 references from the original search were narrowed down to four references included in the review.

The systematic reference search from the 12 original search references yielded an additional 1,629 references. After removing duplicates, 1,365 references remained from the related references search. 1,333 of the 1,365 references retrieved from the related references reviewed were excluded based on title and abstract review because they did not meet the eligibility criteria. Thirty-two of these references were then assessed for full-text eligibility, and three of these were included in the final review. One additional record

was identified through a related authors search. This reference was assessed for full-text eligibility and included in the review. The updated search conducted in June 2019 yielded an additional 1,537 references, of which 1,531 remained after duplicates were removed. 1,509 of the 1,531 references retrieved from the updated search were excluded based on title and abstract review because they did not meet the eligibility criteria. Twenty-two references were then assessed for full-text eligibility, and two of these studies met the eligibility criteria and were included in the review. An overall total of 6,460 references were reviewed and ten studies were included in the final review. A risk of bias assessment for the ten included studies was conducted upon data extraction. See Figure 2 for details.

Results

Intervention Components

Study population. All ten studies included U.S. elementary school students ranging from 1st to 6th grade. Most studies focused on 3rd to 5th grade students.[27-29,31,33,36] Some studies were limited to two schools,[28] whereas others included as many as 27 schools in multiple geographic areas.[30] Studies represented a wide array of geographic areas, including Texas,[29,36] the Midwest,[32] New York state,[35] North Carolina,[27] the Southeast,[28,33] Denver, CO[34] and Northern California.[31]

Sample sizes ranged from 106 to nearly 4,600 participants. All samples were comprised of either ethnically/racially diverse study populations or a substantial number of students eligible for free or reduced-price lunch. The percentage of nonwhite participants ranged from 9% (control)/22% (intervention)[28] to 94.4%

(intervention)/92.5% (control).[31] The percentage of participants eligible for free or reduced-price lunch ranged from 26%[27] to 91%.[32] The results from the z-tests showed that in comparison to the surrounding population, all except one study had study populations that were more representative of minorities. However, the study with the largest percentage of White participants (84.5%), and which was not more representative of minorities than the surrounding county, had a sufficient sample of students eligible for free or reduced-price lunch (26.1%) and so was included in the systematic review.[28] Table 1 presents an overview of the study characteristics and findings of all the included studies.

Intervention approach and details. The studies targeted different contexts and opportunities for PA within schools, as well as different approaches to changing student PA levels. Some focused on the effect of classroom-based activity breaks,[27-29] while others evaluated the effectiveness of training staff to lead PA programming during recess.[30,31] Three studies evaluated the impact of both environmental changes to the recess setting and staff training.[32-34] Two studies focused on different settings and approaches entirely. One evaluated the impact of school gardens on student PA levels;[35] another studied the effectiveness of a pedometer-based goal setting intervention to increase student step counts in PE class.[36]

The classroom-based interventions employed different approaches to increasing student PA level, such as physically active spelling and math lessons,[29] teacher-led aerobic activity break cards,[28] and CD/DVD-based aerobic dance and calisthenics PA breaks.[27] For the active spelling and math lessons study, students received academic lessons in a specific content area (i.e., either math or language arts) enhanced with 10–15

minutes of PA. For instance, in math or spelling freeze tag, two students were designated as taggers and two as questioners. The rest of the students were instructed to run freely within a specific area. If tagged, the child had to stop running, perform an exercise activity such as jumping jacks and raise their hand. They were then approached by a questioner with a question about content from class as selected by the teacher (e.g., vocabulary words, math facts). After answering correctly, the child would be free to run around again, and the questioner moved on to the next tagged student. Students in schools assigned to the control condition learned math and language arts content through traditional, sedentary academic lessons.[29]

In the Erwin et al. study, nine classroom teachers were given a PA curriculum consisting of activity break cards with 5-10 minutes of various movement activities. The teachers were trained on how to implement and teach breaks, and the recommended dose was at least one active break each day.[28] The *Instant Recess* program is another teacher-led PA classroom break program that consists of 10-minute long activity breaks. The breaks consist of a series of basic aerobic dance, calisthenics, and sports movements and are available on CD or DVD.[27]

The pedometer-based goal-setting intervention focused on increasing student step count during standard PE class and included two intervention groups. One intervention group received individualized weekly step goals to reach during PE class based on baseline measures, while the other received standardized goals to achieve during PE class based on recommendations for the age group. The control group did not receive any intervention. PE teachers for all three groups were instructed to teach a typical PE class since the intervention did not include any changes to the curriculum.[36]

The school recess interventions focused on the training of outside staff, like coaches,[30,32] and internal school staff such as PE teachers,[31,34] to increase PA during recess, as well as the impact of environmental modifications like providing new recreational equipment for school playgrounds.[32-34] The three interventions that included the training of outside staff were the *Playworks* program, the *Ready for Recess* program and the IPLAY program. The *Playworks* program is a coach-led intervention designed to increase students' participation in organized games and PA time in low-income areas during school recess.[30] Madsen et al.[31] adapted the *Playworks* program for their intervention titled, "Energy Balance for Kids with Play." As part of this intervention, intervention schools received a full-time *Playworks* coach for two school years. The coach organized games during recess to promote student participation in PA. The *Playworks* coach also led a PA session with individual classes every other week. Additionally, since classroom teachers also led PE classes in this school district, they were trained to implement *Playworks* games and classroom management strategies in PE classes.[31]

Ready for Recess is another school recess intervention. The evaluation of this intervention focused on staff training and the addition of new recreational equipment separately, as well as the combination of both training and equipment together.[32] Mayfield et al.[33] and Nigg et al.[34] also studied the effects of environmental modifications to the school playground such as the addition of new recreational equipment and marked surfaces for organized games.

IPLAY combined three curricula into a single intervention designed to increase PA during recess. The curriculum combined the Sports, Play, and Recreation for Kids

(SPARK), *Active Recreation* (AR) and *Balance First* curricula. The combined curriculum was delivered by trained university students with previous experience working with children for 8 weeks each fall and spring semester for two years. Nigg et al. studied the effect of this recess curriculum on children's PA together with and separate from the addition of new schoolyard equipment.[34]

Study duration. Intervention durations ranged from a single session to two years. Most studies covered an entire school year,[28,30,32,33] but a few studies had shorter timeframes, like eight weeks[36] or one semester.[27] One study spanned an entire year, from one spring to the next,[35] while some studies spanned two years.[31,34]

Study outcomes. Most studies measured student PA behavior as the primary outcome, but a few studies had additional outcomes like weight status, dietary habits,[31] students' social behaviors[33] or children's motivation in PE.[36] One study evaluated overall changes in classroom PA through direct observation.[27]

Most studies used device-based measures like accelerometers or pedometers to assess student PA,[28-32,34-36] but some only used direct observation.[27,33] Some also used self-report measures by students and/or teachers as additional measurement tools.[30,34] One also used the one-mile run as a secondary measure of cardiorespiratory fitness.[31]

Accelerometers used included the ActiGraph GT3X[29,30] and ActiGraph GT1M.[32] A few studies used both ActiGraph models.[31,35] The pedometer-based studies used the Walk4Life LS 2500 pedometer[28] and the Accusplit model.[36] One study switched from the Actical in the first year to the GENEActiv in the second year, though researchers found strong correlation in device output based on calibration data (R = .86).[34]

Wear time for accelerometers and pedometers varied widely with studies using wear times of 1-2 days,[30] 3 days,[35,36] 4-5 days[32,34] and 5 days.[28,29,31] Valid wear time in the studies included durations of ten minutes,[30] five hours,[28] six hours,[35] ten hours,[34] to as much as three or more full school days, with a school day defined as eight hours.[32] One study created a composite day by averaging 15-second epochs from one to five days of data collection. Final analyses only included students with a complete composite day.[31] Epoch sampling time for accelerometers included durations of five seconds,[29,30,32] 15 seconds[31,34] and 30 seconds.[35]

Various cut points were used in different studies. Some used the Evenson cut points,[29-31,35] while others used the Freedson cut points.[32] One study created custom cut points.[34]

Direct observation tools for student PA included the System for Observing Instructional Fitness Time (SOFIT) tool,[27] System of Observing Play and Leisure Activity in Youth (SOPLAY) tool[32-34] and Physical Activity Research & Assessment Tool for Garden Observation (PARAGON) tool.[35]

Student self-report tools included the GEMS (Girls health Enrichment Multi-site Studies) Activity Questionnaire[35] and an adapted Godin Leisure Time Exercise Questionnaire.[34] One study used custom student self-report surveys[30] and a few used custom teacher report tools.[28,30] One study also used subjective semi-structured interviews with school staff to assess the fidelity of intervention implementation.[33]

Overall results. The results of the included studies were mixed. The three classroom-based interventions, the school garden intervention and the pedometer-based goal setting intervention had significant positive findings while most of the playground-

based interventions had significant negative findings. A few studies had non-significant findings. For example, the IPLAY intervention had no effect on the PA levels of any of the intervention groups as compared to the control.[34] In the *Playworks* intervention, the results were equivocal. Researchers found that *Playworks* had a significant impact on teacher-reported levels of student PA during recess ($p = .01$), with a higher percentage of teachers in intervention schools reporting that their students engaged in intense PA during recess. However, there was no significant impact on student reports about their own PA during recess ($p = .92$). There were marginally significant differences between intervention and control groups for the mean number of accelerometer intensity counts recorded per minute during recess ($p = .10$) and the mean percentage of time spent in vigorous PA during recess ($p = .07$).[30]

The results of the *Ready for Recess* intervention were similarly varied. The combination of staff training and new recreational equipment had a significantly positive impact on boys, increasing their MVPA by 14.1% ($p < .05$) and decreasing their time spent in sedentary behavior by 15.3% ($p < .05$) as compared to the control condition. But staff training alone had a significant detrimental effect on children's PA ($p < .05$). In boys, staff training alone significantly decreased MVPA by 13.5% ($p < .05$) and increased their time spent in sedentary behavior by 20.8% ($p < .05$) compared with the control group. Girls in the staff training group significantly decreased their MVPA by 11.4% ($p < .05$) and increased their time spent in sedentary behavior by 20.6% ($p < .05$) compared to the control condition. Neither boys nor girls in the equipment alone group significantly increased their time spent in MVPA or decreased their time spent in sedentary behavior as compared to boys and girls in the control group.[32]

The *Energy Balance 4 Kids with Play* intervention had differential effects by grade. Overall, students did not increase their MVPA over the two school years in which they participated in the intervention. However, the intervention had a significant effect on fourth-grade students' school sedentary time, which decreased by 15 minutes ($p = .024$) compared to the control group. There was no significant change for fifth graders. There was also no significant change in mile run time between intervention and control students.[31]

The Mayfield et al. playground-based PA study also had disparate results. The first intervention school did not have statistically significant changes in MVPA or sedentary behavior from baseline to follow up. The second intervention school, on the other hand, had statistically significant increases in the percentage of boys ($\Delta = 20.5\%$; 95% CI: 9.5, 31.4; $p \leq .05$) and girls ($\Delta = 15.5\%$; 95% CI: 6.3, 24.8; $p \leq .05$) engaged in MVPA. It is noteworthy that the first intervention school that did not have significant changes in MVPA or sedentary behavior began with a much higher percentage of girls who engaged in MVPA (12.5%) than the second intervention school (1.9%). These baseline differences between the intervention schools did not carry over to boys' MVPA or to sedentary behavior for both sexes. Girls in the second intervention school also decreased their sedentary behaviors ($\Delta = -10.9\%$; 95% CI: −21.7, −0.1; $p \leq .05$); no statistically significant change in the percentage of boys' sedentary behavior was observed. One control school also had a statistically significant increase in the percentage of boys engaged in MVPA ($\Delta = 11.5\%$; 95% CI: 6.3, 24.8; $p \leq .05$) and a decrease in the percentage of boys observed in sedentary behavior ($\Delta = 11.3\%$; 95% CI: −18.4, −4.3; $p \leq$

.05), but no statistically significant changes in girls observed in MVPA or sedentary behaviors.[33]

For the school garden intervention, the results indicated mostly positive and significant findings. According to results from the self-report measure, children in the intervention group showed a greater decrease in usual sedentary activity from baseline to post-intervention follow-up as compared to children in the control group ($p = .001$). The accelerometry data demonstrated that children in the intervention group showed a greater increase in percentage of time spent in moderate PA ($p = .010$) and MVPA ($p = .044$) from baseline to follow up as compared to children in the control group. There were no significant differences for changes in percentage of time spent in sedentary behavior ($p = .144$), light PA ($p = .492$) or vigorous PA ($p = .213$). According to the findings from direct observation, children spent more time in vigorous PA during outdoor gardening lessons compared to indoor lessons ($p < .0001$), more time standing ($p < .0001$), more time walking ($p < .0001$) and less time sitting ($p < .0001$).[35]

Among the classroom-based PA interventions, the results were primarily positive. In the *Instant Recess* study, students in intervention classrooms had statistically significant increases in light PA (51%; $p = .038$) and moderate PA (16%; $p = .038$), as well as increases in time spent in on-task behavior (11%; $p = .038$).[27]

The Erwin et al. classroom-based study similarly had significant, positive results. At immediate follow-up, the intervention compliance group had a mean of approximately 1100 (33%) more steps per day compared to the control group ($p < .001$). At 3-month delayed follow-up, the intervention compliance group still had significantly more mean steps per day (~1350; 32%) than the control groups ($p < .001$).[28]

The final classroom-based study which evaluated the effect of active math or language arts lessons compared to sedentary lessons found that students in intervention schools took significantly more steps than students in control schools (p = .002), with a moderate effect (effect size = 0.44). The I-CAN! active lessons also had a statistically significant effect on time spent in MVPA (p = .001; effect size = 0.38).[29]

The pedometer-based goal setting intervention also had a significant, positive impact on student PA. Both experimental groups had significantly higher PA as measured by steps per PE class compared to the control group (p < .001) at follow-up (large effect sizes ranging from 1.3 = d = 1.8).[36]

Discussion

There were several elements characterizing the effective PA interventions that emerged from our systematic review. The expansion of opportunities for PA during the school day outside of typical PE classes, particularly in the form of class-based active breaks, may be a promising way to increase PA levels among school children. As noted above, classroom-based active breaks provide an expanded opportunity for minority and underserved youth to be active during the school day, which was the focus of this review. However, it is apparent that interventions promoting PA in diverse population must be well-planned and implemented with fidelity to achieve sustainable results. In accordance with systematic review methodology guidance, our review addressed a clearly stated, focused question. Although a comprehensive search was conducted, only a limited number of studies met the inclusion criteria for this review, indicating a critical need for more high-quality research in this area. By focusing exclusively on RCTs, this review

may have missed interventions that relied on less substantive evidence but may have provided additional data in this arena. Overall, teacher-led classroom-based activity breaks hold the most promise for effecting change. These types of interventions tend to be low-cost and relatively easy to implement, though they require the support and training of both the school administration and classroom teachers and may be difficult to sustain over the long term due to competing priorities and challenges with meeting intervention fidelity. Further research on best practices for sustaining these types of interventions is warranted.

School gardens may be another way to promote increased activity among children. Overall, the intervention was beneficial at the group level, though Wells et al. noted that the intervention was not uniformly implemented from classroom to classroom. There were also significant differences in ethnicity and age between the intervention and control groups, which may limit the findings.[35]

Additionally, the pedometer-based goal-setting intervention demonstrated that incorporating pedometers as a motivation tool may be an affordable way to increase PA through step counts.[36] However, the short, 8-week duration of the study of the intervention limits the generalizability of the findings. Moreover, restricting the use of pedometers to PE class reduces opportunities to expand PA throughout the school day.

In comparison to these more successful interventions, staff changes to recess and to the playground setting to promote PA among students should be undertaken with caution as some of these interventions can impact student PA negatively. Although the combination of adding specially trained coaches that were not previously part of the school faculty and new recreational equipment for recess had a statistically significant,

positive impact on boys in the *Ready for Recess* for intervention, the addition of the new, trained coaches alone without new equipment had a significant detrimental effect on children's PA ($p < .05$). It is notable that the combination of the coach-led and new equipment intervention only resulted in a positive increase in PA in boys when boys are already more active than girls. PA interventions should target less active populations like girls. The addition of new equipment without staff training did not significantly impact children's PA, either.[32] Despite the challenges in implementation that the authors note in their paper, the overall findings of the *Ready for Recess* intervention suggest that incorporating new, specially trained coaching staff to organize games during recess may actually hinder children's ability to play freely during recess. Additionally, the novelty effect of new playground equipment may motivate children to engage with it, but only if they are instructed how to do so. Recess-based interventions should focus on training staff members, preferably those who are already part of the school faculty, to help engage all children in active play during recess and incorporate new play equipment for expanded recreational opportunities. Trained staff should be able to support recess-based PA using a more flexible approach. Children crave the unstructured nature of recess and may resist too much rigid instruction during this period. Finally, instead of a "one size fits all" approach, a recess curriculum should be tailored to and integrated with the specific playground environment.

Limitations

When taking the above recommendations into consideration, it should be noted that only ten studies met the inclusion criteria. In addition to the underlying issues with some of the interventions, there were limitations because of some of the measurement

methods. The classroom-based *Instant Recess* study, for example, used a direct observation tool that was not validated for classroom use. The SOFIT tool was validated for use in PE classes with normally distributed data, but the classroom-based PA data in the *Instant Recess* study were not normally distributed, limiting the validity of the findings.[27] Additionally, studies that used more subjective data collection tools like questionnaires should not be evaluated in the same way as studies that used device-based measurements like accelerometry. Most questionnaires have not been calibrated and are therefore not directly comparable to device-based measures. Future studies should identify the appropriate dose of PA, as well.

The lack of uniformity and fidelity in implementation across interventions limits the ability to apply the findings. Since many of the interventions had significant results, some variability in the application of the various interventions is still effective, but it is not possible to determine the minimum required dose of intervention. Also, significant differences in accelerometer wear time criteria, the definition of a valid day and wear time compliance across the studies limit our ability to compare findings. These decision points have an important effect on the way that researchers analyze missing data and, subsequently, on whether study findings are positive and/or significant.

This review provides an update on the effectiveness of school-based PA interventions targeting elementary-school age children, with a particular focus on minority and underprivileged study populations. Our findings are consistent with previous reviews that suggest that the results of these interventions are mixed. Classroom-based, teacher-led PA breaks seem to be more effective than recess-based interventions. A key strength of this review is that it focused on the effectiveness of PA

interventions in improving the PA levels of U.S. elementary school children by only including RCTs, the studies with the strongest level of evidence. Additionally, the emphasis on studies that included minority and low SES study populations was unique as previous systematic reviews did not focus specifically on these populations with inequitable access to PA opportunities.

Limitations of this review include the significant heterogeneity in accelerometry protocol between studies and some missing data on study characteristics, which make interpretation of some of the results difficult. Although most study authors were contacted for clarification, two authors did not want to disclose the specific details of certain study characteristics like study location(s), the study sample's race/ethnicity, or SES data in order to protect the privacy of their study population. Even though a z-test to compare the study sample to the surrounding population could not be calculated for either of these studies, one study author reported that they only included schools in which at least half the student population was eligible for free- or reduced-price lunch. Additionally, the demographic data reported for part of the study sample indicated that the study participants represented an ethnically and racially diverse sample. In this case, even though data on the surrounding population was missing, there was enough information to conclude that the study population fit our inclusion criteria. The other study author referenced an earlier publication, noting that the two study populations were similar. The previous publication listed appropriate study characteristics to conclude that the sample matched our inclusion criteria. In two other cases, two studies were excluded based on research into the surrounding counties, even though the authors did not have specific details on their study populations.

Conclusions

Increasing opportunities for PA among children is a significant priority of the Healthy People 2020 (HP 2020) objectives. The HP 2020 objectives call for daily physical education for all students (PA-4) and an increase in regularly scheduled elementary school recess (PA-6). However, a large proportion of low-income, racially/ethnically diverse children do not meet a majority of the HP 2020 objectives.[37] Public health officials, education administrators and researchers must work together to address these disparities when developing future HP 2030 objectives. Given that most of the HP 2020 objectives have not been achieved in the area of PA, interdisciplinary teams from various sectors must work together to identify barriers to implementing the objectives and to address these barriers in future policies. Additionally, public health officials and educators should develop strong joint policies for school health including the promotion of PA.

This systematic review demonstrated that classroom-based interventions may have the greatest impact on improving the PA level of elementary-school age children, while recess-based interventions lead to equivocal results. With the increasing research on opportunities for PA during the school day outside of traditional PE class and recess time, the HP 2030 objectives should include guidance on increasing PA in the classroom setting. Guidelines should be directed toward school district administrators' supporting PA in classrooms by providing teacher training for no- or low-cost resources to promote PA in the classroom. Additionally, school-research partnerships should be developed to help identify the most effective approaches. As policymakers develop future health

objectives, the dose and long-term effectiveness of classroom-based interventions must be studied by researchers to gain further insight into how to increase the fidelity and sustainability of these interventions.

While PA-6 of the HP 2020 objectives calls for an increase in the number of states and school districts that require regularly scheduled recess, recess-based interventions should be reevaluated to assess both the positive and negative aspects. As noted above in the systematic review, some recess-based interventions had a detrimental effect on student PA outcomes; a blanket recommendation to increase recess may not lead to optimal results. Rather, researchers must help identify the best ways to increase PA during recess in order to optimize this objective in the future. Furthermore, it is beneficial to have a variety of recommendations since schools with diverse populations may have varied needs and equipment for recess.

Additionally, more robust studies with standardized accelerometry wear time criteria should be conducted to assess the overall effectiveness of school-based PA interventions. One of the primary challenges with comparing children's PA levels across studies is a lack of uniformity in wear time algorithms.[38] Researchers should also implement studies that use multiple data collection methods for PA including device-based measurements, direct observation, proxy report and self-report to collect a more complete assessment of current PA trends. Finally, more studies that focus on ethnically diverse and underserved populations should be undertaken as these populations are in critical need of successful PA-promoting interventions in order to achieve the goals of HP 2020.

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Table 1. Studies Examining the Effect of School-Based Interventions on Student PA

Ref	**N**	**# schools or class-rooms**	**Grades**	**Race/ ethnicity and SES** **(intervention % / control %)**	**Intervention**	**Duration**	**Delivery/ intervention type**	**PA measure**	**Results**	**Sig. results?**
27	NA	8 schools	3rd-5th	White: 32.6% Black: 31.4% Hispanic: 29.5% SES not reported.	10-minute PA breaks in classrooms. The breaks consist of a series of basic aerobic dance, calisthenics, and sports movements and are available on CD or DVD.	One semester	Teacher led	SOFIT obser-vation tool	Students in intervention classrooms had statistically significant increases in LPA (51%; p = .038) and moderate-intensity (16%; p = .038) PA and increases in time spent in on-task behavior (11%; p = .038).	Sig. +
28	106	2 schools	3rd-5th	White: 91 / 78 Black: 4 / 8 Hispanic: 1 / 3 Asian/Pacific-Islander: 2 / 8 26.1% free/reduced-price lunch	Activity break cards were provided to intervention classroom teachers. The cards included 5-10-minute movement activities that could be completed in a small space. Intervention teachers were encouraged to include at least one 5-10-minute classroom PA break each day.	One school year	Teacher led	1) Pedo-meters 2) Inter-vention fidelity -teacher self-report	At follow-up, the compliance group (only 5 of the 9 intervention teachers implemented at least 1 break/day) averaged ~1100 (33%) more school steps/day compared to the control group (p < .001). At delayed follow-up, (3 months after immediate follow-up), the intervention compliance group continued to average significantly more school steps/day (~1350; 32%) than the control groups (p < .001).	Sig. +

29	2493	28 schools	4th	White: 45.8% Black: 7.7% Hispanic: 22.9% Asian: 6.3 % ~21% free/reduced-price lunch	The 3-arm RCT included 2 intervention conditions: active math and active language arts lessons. Students in these groups received either math or language arts lessons along with 10–15 min of PA, for instance, math or spelling freeze tag. In these games, 2 students were assigned to be "taggers" and 2 as "questioners." The other students would run around. When tagged, the student would stop running, perform an exercise such as jumping jacks, and raise his/her hand. The questioner would then ask a question based on content from class as selected by the teacher (eg, vocabulary words, math facts). If the child answered correctly, he/she would be able to run again. Students in control schools learned math and language arts content through traditional, sedentary academic lessons.	5 days	Teacher-led	Accele-rometers	Students in treatment schools took significantly more steps (an average of approximately 2645 more weekly) than did their counterparts in control schools ($\beta = 125.267$, SE = 41.327, $p = .002$), with a moderate effect, effect size = 0.44. Students in treatment schools also spent significant more time in MVPA ($\beta = 0.796$, SE = 0.251, $p = .001$; effect size = 0.38). There were no statistically significant school-level differences on sedentary behavior ($\beta = -0.177$, SE = 0.824, $p = .83$). SES, race, sex, BMI, and fitness level did not moderate the effect of active learning on step count and MVPA.	Sig. +

30	1537	27 schools	4th - 5th	White: 26.3 / 21.9 Black: 30.9 /29.5 Hispanic: 35.7 / 47.0 Asian/Pacific-Islander: 24.0 / 14.8 American Indian or Alaskan Native: 8.4 / 5.8 All schools had ≥50% free/reduced-price lunch	Coach-led intervention to increase organized games and PA time during school recess	One school year	Coach-led	1) Accele-rometers 2) Student self-report tool 3) Teacher report tool	A significantly higher percentage of teachers in treatment schools reported that their students engaged in an intense physical activity during recess ($p = .01$). Students in treatment schools had marginally higher mean accelerometer intensity counts recorded per minute during recess ($p = .10$) and a larger mean percentage of time spent in VPA during recess ($p = .07$) than students in control schools. No significant differences were found for student reports about their PA during recess ($p = .92$). Overall, Playworks had a significant impact on teacher-reported levels of student PA during recess, but not on student reports about their own PA during recess.	Mixed. Playworks had a significant impact on teacher-reported levels of student PA during recess, but not on student reports about their own PA during recess

31	879	6 schools	3rd-5th	Intervention / Control % for accelerometer data: White: 5.6 / 7.5 Black: 5.3 / 10.2 Hispanic: 51.5 / 44.9 Asian: 7.6 / 14.3 Multiracial: 15.8 / 12.9 Other: 14.2 / 10.2 Intervention / Control % for fitness data: White: 5.1 / 8.0 Black: 5.8 / 10.7 Hispanic: 53.1 / 46.7 Asian: 7.4 / 16.0 Multiracial: 15.8 / 10.7 Other: 12.9 / 8.0 All low-income	Each intervention school received one part-time RD coach and one full-time Playworks coach for 2 school years. Each year, the RD coach delivered a 12-week nutrition and energy balance education curriculum that included food tastings, PA games to reinforce nutrition messages, and strategies to help students meet their nutrition and PA goals. The Playworks coach structured recess activities before and during school hours to encourage active participation from all students. The Playworks coach also led a PA session with individual classes every other week. Classroom teachers were trained to implement Playworks games and classroom management strategies in their physical education (PE) sessions with students (classroom teachers were responsible for leading PE in this district).	2 school years	Out-side staff and staff train-ing	1) Accele-rometers 2) Cardio-respiratory fitness – 1-mile run	Overall, students did not increase their MVPA over 2 school years of exposure to EB4K with Play. Compared to control students, fourth-grade intervention students reduced school-day sedentary time by 15 minutes (p = .024). There was no significant change for 5th graders. There was no significant change in mile run time between intervention and control school students in overall or stratified models.	Sig. + for 4th grade. No change for 5th grade.

32	667	12 schools	3rd-6th	Demographic data for first 4 schools reported in 13[17] as: White: 40% Black: 28% Hispanic: 29% Asian/Pacific-Islander: 2% Other: 1% 91% free/reduced-price lunch Author confirmed by email on 3/7/2018 that the subsequent 8 schools had similar demographics.	School recess intervention that targets staff training (ST) or provides recreational equipment (EQ) either separately, or together (EQ+ST), to improve PA.	One school year	Staff train-ing, recrea-tional equip-ment	1) Acceler o-meters 2) SOPLAY observation tool	Boys in EQ+ST significantly increased their MVPA by 14.1% over the control condition ($p < .05$) and decreased their time spent in sedentary behavior by -15.3% ($p < .05$). ST significantly decreased the boys' MVPA by –13.5% ($p < .05$) and increased their time spent in sedentary behavior by 20.8% ($p < .05$) compared with the control group. Girls in ST significantly decreased their MVPA by –11.4% ($p < .05$) and increased their time spent in sedentary behavior by 20.6% compared to the control condition ($p < .05$). Neither boys nor girls in EQ significantly increased their time spent in MVPA or decreased their time spent in sedentary behavior as compared to boys and girls in the control group.	Mixed EQ+ ST sig. + PA in boys. But ST had a sig. -effect on PA overall

33	NA	4 schools	3rd - 5th	Student population: White: 71% Black: 15% Hispanic: 7% Other: 7% 41% free/reduced-price lunch	Environmental changes (e.g. marked surfaces, equipment) and staff training.	One school year	Environ-mental changes and student education	1) SOPLAY direct observation tool 2) Intervention fidelity – semi-structured interviews	School 1 (intervention) showed no statistically significant changes in boys or girls MVPA or sedentary behaviors from baseline to follow up. School 2 (intervention) had large and statistically significant increases in the percent of boys ($\Delta = 20.5\%$; 95% CI: 9.5, 31.4; $p \leq .05$) and girls ($\Delta = 15.5\%$; 95% CI: 6.3, 24.8; $p \leq .05$) engaged in MVPA. School 2 also had a reduction in the percent of girls observed in sedentary behaviors ($\Delta = -10.9\%$; 95% CI: −21.7, −0.1; $p \leq .05$), but no statistically significant change in the percent of boys' sedentary behavior was observed. School 3 (control) unexpectedly saw an increase ($\Delta = 11.5\%$; 95% CI: 6.3, 24.8; $p \leq .05$) in the percent of boys engaged in MVPA and a decrease ($\Delta = 11.3\%$; 95% CI: −18.4, −4.3; $p \leq .05$) in the percent of boys sedentary but no statistically significant changes in girls observed in MVPA or sedentary behaviors.	Mixed results. Sig. (+) for 1 intervention school. Not sig. for the other intervention school. Sig (+) for one control school for boys.

34	11670	24 schools	1st - 5th	Hispanic: 58.9% White: 31.3% 63.6% free- or reduced-price lunch	Playground renovations and a curriculum intervention, which combined the Sports, Play, and Recreation for Kids (SPARK), Active Recreation (AR), and Balance First curricula. The curriculum was delivered for 8 weeks each fall and spring semester for 2 years.	2 school years	Recre-ational equip-ment & recess curri-culum	Direct observation, self-report and accelerometers	No effect	

35	408	12 schools	4th-5th	% of students who were ethnic minority varied across the 12 schools from 4% to 99%, with an average of 58% ethnic minority. Overall numbers: White: 67 / 35.7 Black: 21.7 / 38.4 Hispanic: 8.7 /8.9 Asian/Pacific-Islander: 2.6 / 17 All schools had >50% free/reduced-price lunch, with an average of 69% of children participating in FRPM (range: 51% to 97%).	The intervention had 4 components: 1) a 4' x8' garden for each classroom, 2) a 20-lesson curriculum for grades 4-6, 3) resources for the school related to food safety in the garden, and 4) a garden implementation guide about starting and sustaining the garden	One year (Spring to spring)	Class-room equip-ment (gar-den) and curri-culum	1) Acceler ometers 2) PARA-GON observa tion tool 3) self-report tool	According to the self-report measure, children in the intervention group showed a greater decrease in usual sedentary activity from baseline to post intervention follow ups than did children in the control group ($p = .001$). According to accelerometry data, children in the intervention group showed a greater increase in percentage of time spent in moderate PA ($p = .010$) and MVPA ($p = .044$) from baseline to follow up as compared to children in the control group. No significant differences were found for changes in percentage of time spent in sedentary ($p = .144$); LPA ($p = .492$); or VPA ($p = .213$). According to findings from direct observation, children spent more time in VPA during outdoor gardening lessons vs. indoor lessons ($p < .0001$), more time standing ($p < .0001$), more time walking ($p < .0001$) and less time sitting ($p < .0001$).	Sig. +

36	273	3 schools	4th - 5th	Student population: White: 64.1% Black: 13.6% Hispanic: 12.1% Other: 10.2% 37% free/reduced-price lunch	Classes in each school were randomly assigned to one of three experimental groups: 1) intervention group with a individualized pedometer weekly target for step count in PE class; 2) intervention group with a general pedometer target range for step count in PE class; 3) control group	8 weeks	PE class pedometer-based goal-setting	1) Pedo-meters	The two experimental groups had significantly higher PA ($p < .001$) as measured by average steps/PE class compared to the control group. There was no difference in school PA (steps/day) between individual-based and group-based goal conditions.	Sig. +

Abbreviations: EE, energy expenditure; LPA, light physical activity; LMPA, light-to-moderate physical activity; MVPA, moderate-to-vigorous physical activity; PA, physical activity; SES, socioeconomic status; sig., significant; VPA, vigorous physical activity; PE, physical education; +, positive; -, negative.

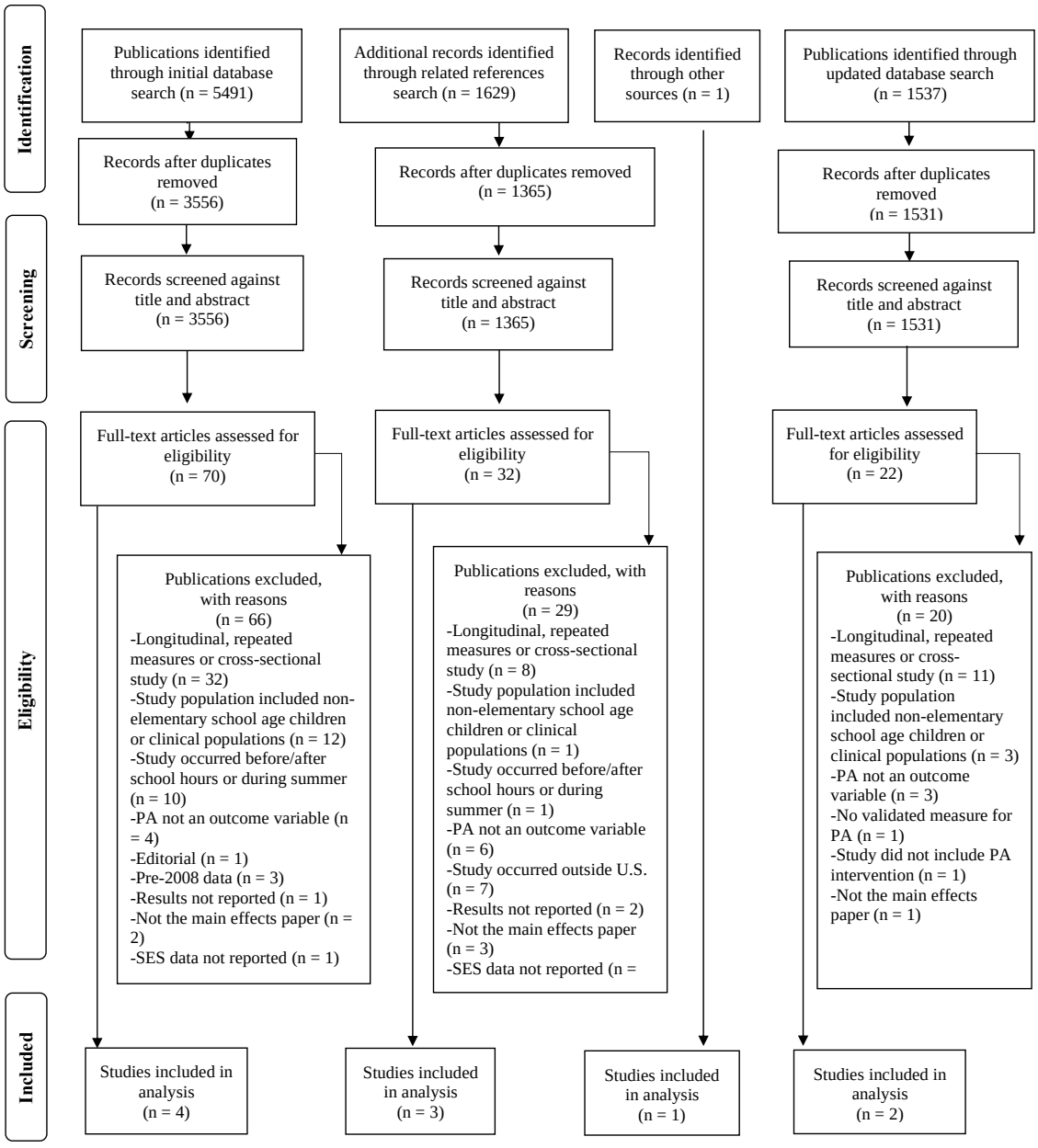

Figure 1. PRISMA Flowchart

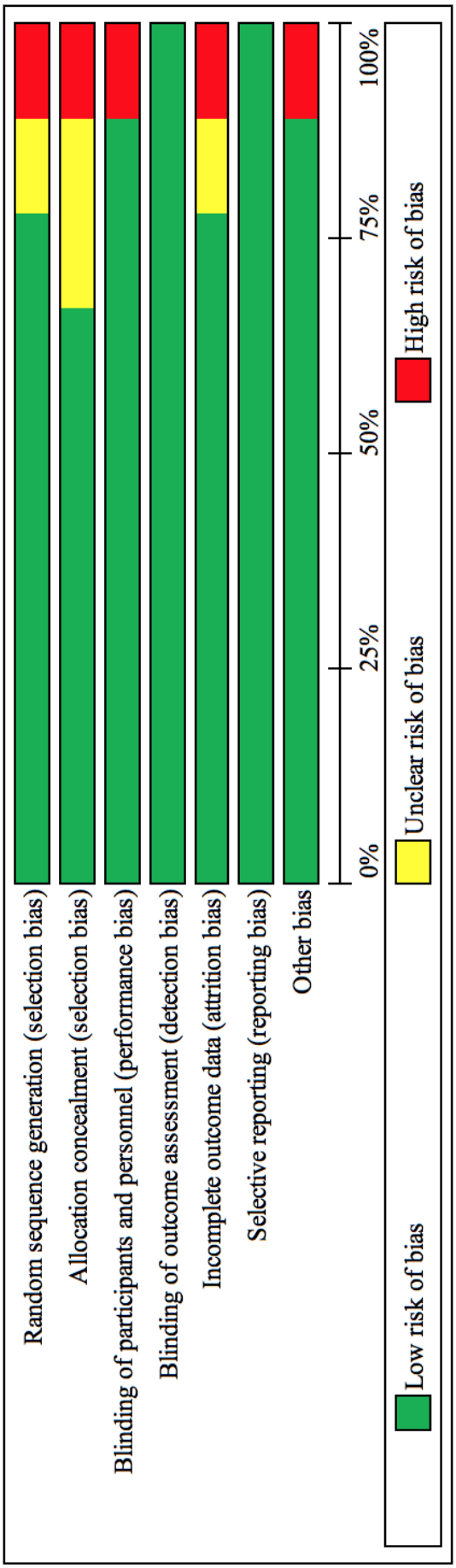

Figure 2. Risk of Bias Assessment

Chapter III

PILOT STUDY TO EVALUATE A CLASSROOM-BASED ACTIVE BREAK PROGRAM IN A DIVERSE URBAN SETTING: HYPE BREAK

Abstract

Introduction

Children in urban schools have limited opportunities for physical activity (PA). We pilot tested a 10-minute music video workout ["Healthy You with Physical Education (HYPE) Break"] to evaluate its feasibility as a classroom PA break in a diverse urban setting.

Methods

Baseline interviews were conducted with three elementary school teachers in Bronx, NY. One teacher and her 3rd grade students in Queens, NY screened HYPE 3 times daily for 4 weeks. Baseline and follow-up interviews were conducted to measure acceptability. Students (n = 14) wore accelerometers for 7 days at baseline and at week 2 to assess changes in step count.

Results

The Bronx teachers reacted favorably to the HYPE program concept, though they preferred incorporating academics into breaks. The Queens teacher and class welcomed the daily break, and students were more focused after HYPE. It was challenging to fit 3 HYPE breaks into the school day, and the classroom space was too small for some exercises. Children's median step count/day increased from baseline to week 2 (effect size: $r = 0.17$; $p = .363$), demonstrating HYPE's potential to increase children's PA.

Conclusion

The HYPE program was feasible and well-received, although time and space were challenges. PA breaks should be developed with attention to space limitations of underprivileged schools, including chair-based exercises. Increased step count during the school day demonstrated HYPE's potential to increase children's PA levels.

Introduction

Childhood obesity affects 17.4% of children aged 6-11 years old.[1] The high prevalence of childhood obesity, along with the lifetime cumulative negative health, societal, and economic costs of the disease, mark this epidemic as one of the top health problems in the U.S.[2] A major contributor to childhood obesity is insufficient participation in physical activity.[3] Insufficiently active children have higher levels of obesity, more adverse lipid profiles, and higher systolic blood pressure as compared to more active children,[4] and they may also have decreased cognitive function and academic achievement.[5]

According to results from the 2005-06 National Health and Nutritional Examination Survey, only 42.5% of children aged 6-11 years met the recommended 60 minutes of daily physical activity (PA), while merely 7.5% of adolescents aged 12-19 years met the recommended target.[6] Despite data demonstrating higher levels of PA among non-Hispanic Black youth and Mexican American youth, as compared to non-Hispanic White youth, White youth had a lower prevalence of obesity.[7] Because of this discrepancy, innovative programs that target improving the health of minority youth are essential.

Since children spend a significant amount of time in school during the week, schools can provide an ideal setting for PA-based behavioral interventions.[8] Most of the time spent in school is sedentary, including time attending class and school-based media use. Children aged 6-11 years spent an average of 6 hours per day in sedentary behavior, both in and out of school. Among 12-15-year-olds, this number increased to 7.5 hours per day.[9] Further compounding the problem, daily physical education (PE) is provided in only 4% of elementary schools. Only 15% of elementary schools require students to take PE classes on at least 3 days per week.[6] In New York City (NYC), the lack of PE affects Black students in nearly all geographic areas disproportionately, with only 19% of Black students in grades K–5 receiving the mandated amount of PE, compared to 30% of White students in grades K–5 (Figure 3).[10] This issue is also more pronounced in schools located in low resourced neighborhoods. In a cross-sectional study in two U.S. regions, researchers found that schools in low resourced areas were less likely to have a PE teacher and also had fewer affordances for PE than did schools in more affluent areas ($p < .05$).[11]

For these reasons, researchers and public health officials have proposed integrating additional opportunities for daily PA during the school day, such as short bouts of classroom-based PA.[12] These opportunities are intended to support the aims of school PE as the primary academic subject that instructs students in PA and health, and not to supplant the crucial role of PE in schools. To this end, we created a 10-minute music video workout called, “Healthy You with Physical Education (HYPE) Break” for children in 3rd to 5th grades. The workout contains simple, high-impact exercises that a child can do in a constrained space, such as a school classroom, led by a classroom

teacher. The purpose of this pilot study was to evaluate the overall feasibility of the program in a diverse urban school setting, including both teacher and student acceptability of including PA breaks in the classroom. In anticipation of the potential logistical complications of the intervention, it was ideal to pilot test the program on a small scale before expanding to full-scale implementation. A secondary aim was to study the impact of the activity breaks on students' PA levels.

Methods

Study Sample

Three 4th and 5th grade classroom teachers in a public school in Bronx, NY and 21 3rd grade children in a single classroom (12 girls, 9 boys, mean age: 9 years) in a public school in Queens, New York, selected by convenience sampling, participated in this pilot study, conducted in May-June 2016. Both schools had participated in previous health research programs and the teachers volunteered to participate. School level data from 2015-16 for the Bronx school indicated that 57.3% of students identified as non-Hispanic Black, 39.8% as Hispanic, 1.6% as White and 1.3% as other. For the Queens school, school level data from the same year indicated that 13.9% of student identified as non-Hispanic Black, 24.1% as Hispanic, 17.2% as White, 43.0% as Asian and 1.8% as other. All children attending the Bronx school received free or reduced price lunch, while nearly half the student population of the Queens school received free or reduced lunch.[13] Written parental consent, classroom teacher consent, and student assent to participate in the study were obtained prior to the baseline measurement. The study was conducted in accordance with the policies and procedures of the Institutional Review Boards of Teachers College,

Columbia University, Columbia University Medical Center and the New York City Department of Education.

Intervention

A University of Texas at San Antonio exercise physiologist and an Ailey School (the official school of Alvin Ailey American Dance Theater) choreographer developed the exercises in the HYPE Break video, and children were consulted on the overall design of the program. The video features the choreographer and ten of his students demonstrating the exercises, along with a cameo appearance by Iman Shumpert, a professional basketball player. The video also includes an original hip-hop song called "Let's Move" performed by Doug E. Fresh and Artie Green. The workout begins with a light warm-up consisting of marching in place and then transitions to a lateral movement exercise that simulates speed skating. Subsequent exercises include the "bear boogie," which involves a cross-body pattern of walking on hands and feet, the Burpee exercise, and mountain climbers. The video concludes with a dance circle in which each student is given the opportunity to demonstrate a unique dance exercise. The choreographer introduces a basic way to complete each exercise, as well as a "hyped" version, which includes more complex, higher intensity movements. Viewers are also introduced to the traffic light method of perceived level of exertion. Students are taught to exert enough effort to exercise at the appropriate intensity in the green "go" zone. The yellow "slow" zone means that one is not exercising hard enough, while the red "whoa" zone means that one is exercising too hard.

During the intervention period, the classroom teacher was asked to screen the video three times daily for five days per week over the course of four weeks. The teacher

was trained on how to screen the video on the classroom Smart Board and provided with strategies for fitting the active breaks into the school day. The research team was in constant contact with the teacher to ensure adherence to the program and to address any challenges that arose.

Measurement Protocol

The three classroom teachers from the Bronx participated in a structured group interview with open-ended questions related to the feasibility of the intervention. Baseline and follow-up interviews consisting of open-ended questions were also conducted with the classroom teacher whose class participated in the intervention to assess acceptability of the program. The teachers were given a nominal gift of a messenger bag with the HYPE Break logo for participating.

The student participants wore an ActiGraph wGT3X-BT or GT9X accelerometer (ActiGraph, Pensacola, FL) over the course of seven consecutive days at baseline, seven consecutive days during the second week of the intervention and seven consecutive days immediately after the intervention for a total of 21 days.[14,15] Participants were instructed to wear the accelerometer on the iliac crest at the anterior axillary line on the right side of the body during all waking hours and to remove the device for water-based activities. Participants were told to continue usual daily activities. Previous studies have demonstrated that accelerometers provide a valid, objective way to study the PA behaviors of large groups of individuals, including children.[16,17]

Hourly, daily and weekly step count totals were collected on the accelerometers. We used step counts because they are easily translatable to daily life by the participants. Step output from accelerometers is a reasonable translation of the public health guideline

for 60 minutes of daily moderate-to-vigorous PA (MVPA). According to Tudor-Locke et al., 60 minutes of MVPA in elementary school children can be translated to 13,000 to 15,000 steps/day in boys and 11,000 to 12,000 steps/day in girls.[18] Previous studies have demonstrated that the ActiGraph accelerometer provides valid step estimates using waist placement in children.[19,20]

It was hypothesized that mean step count would increase significantly from baseline to mid-intervention and decrease slightly at post-intervention. In addition to step count, participants' age and gender were collected through self-report measures. Children were given nominal gifts such as reusable water bottles and pencils with the HYPE Break logo for participating.

Data Reduction

The accelerometry data were preprocessed as accelerometer data files (AGD files) using ActiLife software (ActiLife v6.13.2; Pensacola, FL, 2016) and then converted to CSV files with 60-second epochs. This epoch length was selected based on a previous validation study for this age group.[21] To capture the most data given the overall low wear time compliance, a minimum of two weekdays of at least five hours of wear time per day (approximately 85% of the school day) was selected in accordance with a previous study.[15] Participants with less than two weekdays of five hours per day of wear time were excluded from the results. Based on the results of earlier studies with children in this age group, 60 minutes of consecutive zero counts were classified as non-wear time.[22,23] Non-wear time was excluded from calculations for each individual child.

Statistical Analysis

Statistical analyses of accelerometry data were conducted using SPSS Version 24.0 software (IBM SPSS Statistics for Windows, 2016). Because the distribution of step counts did not follow a normal curve, non-parametric statistical tests were used. Friedman tests and Wilcoxon Signed Rank tests were utilized to examine differences in mean step count at baseline, during implementation of activity breaks (mid-intervention period) and after implementation of activity breaks (post-intervention).

Results

Teacher Feedback

The primary aim of this research pertained to the feasibility and acceptability of the program in relation to both teachers and students. The 4th and 5th grade public school teachers from the Bronx reacted favorably to the idea of a classroom-based PA program. The classroom teacher whose class participated in the intervention also reacted positively to the program at post-study.

One of the main skills that the Bronx teachers practiced with students leading up to the standardized exams was sitting still for 50 minutes, which was very difficult for young students. The teachers felt that a short in-class activity break would help students utilize extra energy and regain focus. They remarked that later in the day, when the children have lost their focus and are tired, would be an ideal time for the breaks. The Queens teacher noted post-study that “the students were a lot more focused after doing the exercises. They were also quieter when they worked.”

The Bronx teachers also suggested creating activity breaks that incorporated academics to maximize learning time. For instance, an activity break might incorporate some math skills. In comparison, the Queens teacher reported that she and her students welcomed the daily break from academics.

The Bronx teachers shared that while they were under pressure to get through the assigned curriculum in a timely manner before annual standardized exams in the spring, classroom time allocation on a day-to-day basis was determined by each individual teacher. The Queens teacher echoed this sentiment in the baseline interview when we discussed ideal times for the breaks. However, during the intervention, she experienced difficulty trying to find time to fit three active breaks into the school day. From a research standpoint, it was difficult to find time for data collection as the classroom schedule became more erratic toward the end of the schoolyear.

The Bronx teachers emphasized the importance of including activities that could be done in a constrained space. At post-study, the Queens teacher reported that space proved to be a significant challenge during the intervention. She felt that with 30 students, her classroom space was too small to allow everyone to participate in the exercises. The classroom had an open space for gathering at the front of the room in which the teacher tried to have everyone complete the workout. While 30 children could fit in that space by sitting cross-legged, there was not sufficient space for them to complete a workout in that space. When the students attempted to complete mountain climbers, which require the individual to start in a plank position and then to alternate raising each knee up to the chest quickly, they often ended up kicking each other because

there was not enough space for all the participants. Understandably, the teacher did not want the students moving their desks and chairs out of the way three times a day.

As an alternative, the teacher attempted to complete the HYPE workout in the morning and then go for a walk in the afternoon for the four weeks of the intervention, but time was not always found to do so. She also reported that many students forgot their accelerometers at home or did not adhere to wear time guidelines. The teacher also inquired about the possibility of using wrist-worn accelerometers instead of waist-worn accelerometers to increase the ease of use of the devices. She reported that getting the students to wear the accelerometers consistently posed a significant challenge.

The Queens classroom teacher also recommended the inclusion of a rewards program for the students based on the number of breaks completed to incentivize participation. She noted that her students who participated in an after-school running program accrued points for each session in which they participated. These accumulated points could then be converted into nominal gifts. Overall, despite the challenges, the teacher was satisfied with the program and would continue the program year-round with more support.

Accelerometry Results

The exploratory research question analyzed whether there was a significant change in PA as measured by mean step count. Out of a class of 30 students, 21 received parental consent to participate in the study (9 males, 12 females, mean age = 9 years). Of these, 2 participants returned non-working accelerometers after the baseline measurement week. A third participant lost their accelerometer in the middle of the intervention period. Seven participants met valid wear time criteria for all 3 time points, and 14 met valid

wear time criteria for the baseline and mid-intervention time points. We focused primarily on the change in step count between baseline (T1) and mid-intervention (T2) because of the large drop-off after the middle of the intervention due to end of school year activities. For the 14 cases that met valid wear criteria for baseline and mid-intervention, the median score on mean step count per valid day increased from 6631.1 at baseline to 7420.5 at week 2 of the intervention (z = -.910, p = .363, with a small effect size of r = 0.17). These differences were not statistically significant due to high variability of activity counts and the small number of participants. Median step count per valid hour increased significantly from 664.3 at baseline to 716.1 at week 2 of the intervention (z = -2.291, p < .05, with a medium effect size of r = 0.43) (Figure 4 and Table 2).

While the students expressed excitement about participating in the program and wearing the accelerometers, adherence to wear time recommendations among the students throughout the intervention was extremely low. Many participants forgot their devices at home and thereby would miss out on a full day of data collection. In one instance, a student mentioned anecdotally that they attached their device to their dog for a few hours. The students complained that the devices were uncomfortable around their waists and continually inquired about why they could not wear a FitBit, a popular wrist-worn activity monitor, instead of the waist-worn ActiGraph.

Discussion

Classroom-based activity breaks may provide additional opportunities for students to be active and may help to reduce periods of sedentary activity during the school day,

especially among high-risk, minority populations. We assessed the acceptability of activity breaks among 4th-5th grade classroom teachers and conducted a pilot study of an activity break in a 3rd grade classroom in two diverse urban schools. We found that the program was feasible and well-received by students and teachers, although there were challenges in implementing the program as designed. Despite the challenges, the preliminary data suggest that this approach could be a viable addition to the classroom routine. Moreover, the lessons learned from this pilot study can help shape a future iteration of the intervention. Overall, the teacher whose class participated in the four-week intervention felt that the program had a positive impact on the students, as she reported improved attention and focus.

The Institute of Medicine (IOM) recommends that at least 50% of the recommended 60 minutes of daily PA for children be achieved during the school day. To translate this recommendation to step count, children would have to achieve 5500 to 7500 steps/day. During this intervention, step count/day increased from 6631.1 at baseline to 7420.5 at week 2 of the intervention, indicating that all participants met the high end of the IOM's recommended target for school PA.[24] Furthermore, a statistically significant increase in mean step count per hour from baseline to intervention with a medium effect size was observed, highlighting the potential efficacy of HYPE breaks for improving PA.

Lessons Learned

The logistical challenges faced in this pilot study allow for a unique learning opportunity when designing a future version of the HYPE Break activity program. For instance, while the constrained nature of classrooms was considered during the theoretical design of HYPE Break as a key issue raised by the Bronx classroom teachers,

this remained a challenge in the pilot classroom. Space constraints present a particular challenge in a major urban center such as NYC, where there is wide variability across schools with respect to the size of classrooms and the availability of gymnasiums, utility rooms and outdoor areas that can be used for PA. Co-located schools, or schools that share a building with another school, present a unique challenge for finding space for PA in NYC. 76 out of 706 elementary schools in NYC do not have any space allocated for PE.[10] Another similar study conducted in Santiago, Chile also reported that space was the primary complaint of teachers.[25] Taking all of this into account, the HYPE Break video should be revised with attention to the space limitations of underprivileged schools, including chair-based exercises.

The Bronx teachers also suggested creating activity breaks that incorporate academics to maximize learning time. While the teacher whose classroom participated in the pilot study welcomed the break from academics, perhaps the inclusion of a math or English lesson would make activity breaks more appealing to a wider audience, particularly one that is concerned with sacrificing instruction time for PA.

In a follow-up interview, the classroom teacher who participated noted that more in-depth training would have been helpful. Training should include strategies for incorporating the activity breaks during the day, regardless of time or space constraints, as this was the most challenging part of the program for her. After this pilot study was conducted, the 2018 Physical Activity Guidelines Advisory Committee determined that bouts of any length count toward total volume of PA. Previous research suggested that PA had to be done in 10-minutelong increments. In light of this new finding, shorter activity breaks should be created to alleviate the time constraint issue.

The teacher also recommended the establishment of a point person on the research team for questions and troubleshooting specifically with regard to the use of accelerometers. While a member of the research team was in contact with the teacher via email during the intervention, a researcher was only on site during the first and last day of data collection for each time period. Additionally, the teacher did not have the time to reach out to the research team via email in the middle of the school day if an immediate issue arose. Since there were several other assistant teachers in the classroom, perhaps the task of immediate troubleshooting should have been delegated to an assistant.

Additionally, identifying an appropriate school site and scheduling time with the classroom teacher for data collection proved to be challenging. Even though the teacher was eager to participate in the program, it was still challenging for the research team to schedule time for data collection due to competing demands such as field trips.

Limitations

There were several limitations to this pilot study. The teachers who participated noted that they were biased toward incorporating more opportunities for PA into their classrooms. Other teachers might not be as open to including activity breaks in their classrooms. Additionally, opportunities to engage directly with PE teachers to avoid the dangers of "outsourcing" PE and minimizing the role of PE in school should have been explored.

As noted above, student adherence to the recommended accelerometer wear time was extremely low. The low overall wear time, as well as incidents like the student attaching their accelerometer to their dog, highlight the unique research challenges of working with a pediatric population. The students were instructed on how and when to

wear the device during a one-day training at the beginning of each data collection period, but perhaps the research team could have provided more support for the teacher to ensure that devices were worn correctly each day during data collection. Additionally, more frequent distribution of incentives to encourage adherence to device wear time may have improved wear time outcomes. In a future iteration of this study, the teacher should collect the participants' devices at the end of the school day to decrease the chance of the participants' forgetting their devices at home and to improve wear time during the school day. While many researchers have succeeded in using accelerometers in studies with children, future researchers should be cognizant of the difficulty involved in conducting this type of research with young children. Using accelerometry measurements with pediatric populations presents many challenges and is only worthwhile if the research team can provide the requisite, proper oversight.

Because of the participants' low wear time of the accelerometers, a lower minimum for wear time was selected. Previous studies have shown that a minimum of two days of at least eight hours of wear time per day is needed for reliable estimates of physical activity in children.[26,27] However, only four participants met these criteria at baseline and during the intervention; only one participant met these criteria for all three time points. Because of low participation rates, the lower minimum of two weekdays with only five hours of wear time per day (approximately 85% of the school day) was selected in accordance with a previous study.[15] The selection of a low minimum wear time may limit the reliability of this pilot study. Additionally, caution needs to be taken when interpreting differences in step counts between baseline and mid-intervention, as well as the effect size, as the study was underpowered. However, it should be noted that

the purpose of this study was to examine feasibility and not effectiveness of the HYPE break program.

Moreover, post-intervention measurements may have been artificially low because the final data collection week was too close to the end of the school year. This time of year was selected to avoid interference with standardized exams in April, but it was probably too late in the school year to ensure quality data collection. Because of the warmer weather and fewer academic requirements, there were more field trips and on-site field days (schooldays spent outside the classroom) during this time period than during earlier time points in the school year. Also, many children left before the official end of the school year, and so they either did not wear an accelerometer at all for the post-intervention period or returned their device before the end of the seven-day data collection period.

As a possible alternative to waist-worn accelerometers to increase compliance rates, researchers have studied the validity and reliability of wrist-worn accelerometers. In one study of 9- to 10-year-old children, researchers found greater compliance with wrist-worn devices than with waist-worn. The children in the study reported that they did not like that the waist-worn accelerometer was so visible and slightly uncomfortable.[28] However, while changing the attachment site might improve adherence to wear time recommendations, previous studies have shown that the attachment site significantly affects the counts per minute estimate of accelerometers.[29] When measured against visually counted steps, waist-worn accelerometers provided a more accurate assessment of steps per minute when compared to wrist-worn accelerometers.[30] Therefore, the attachment site should only be changed to the wrist site if the researchers can demonstrate

a clear benefit for doing so, such as increased adherence to wear time. Based on the preliminary results of this pilot study, changing the attachment site of the accelerometer from the waist to the wrist might increase adherence to wear time recommendations in this population. However, researchers must be aware that step counts may be elevated with wrist-worn attachment.

In response to the Queens teacher's recommendation to include a rewards program, a classroom log chart could detail who participated in each break, since participation is voluntary. After a full week of breaks, a student might receive a pencil; after a full month, a student might receive a t-shirt. The onus of monitoring who participated would be on the teacher, though. The long-term sustainability and impact of providing incentives throughout the intervention needs to be addressed in a future study.

Conclusions

The many challenges faced in the implementation of this pilot study can be translated into lessons learned that can be addressed in future studies. The primary challenges of finding time during the busy school day and physical space for the workouts should be addressed first. A revised, shorter workout video that includes exercises that can be completed in a cramped classroom would help the teacher as extra time would not have to be allotted to moving classroom furniture out of the way. Additionally, a more comprehensive training program for teachers could help ensure greater adherence to the recommendation of three workouts per day. More oversight by the research team during data collection periods would also ensure greater fidelity to the intervention on the part of both the teacher and the students. However, the increase in

physical activity as measured by mean step count per valid day from baseline to mid-intervention demonstrates the potential of classroom-based activity breaks to increase children's physical activity levels during the school day. The lessons learned from this pilot study should be incorporated into future classroom-based physical activity interventions.

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Table 2. Quartile Values for Mean Step Count per Valid Day and per Valid Hour for Baseline (T1) and Mid-Intervention (T2) for Participants who met Valid Wear Time Criteria at those Timepoints

Timepoint	N	Percentiles - per valid day			Percentiles - per valid hour		
		25th	50th**	75th	25th	50th**	75th
T1	14	5087.125	6631.1	8111.0786	574.7254	664.2993	754.2564
T2	14	5525.5	7420.4583	8525.625	683.6607	716.0677*	835.4377

Note. *Mean step count at T2 differs from mean step count at T1 by $p < .05$.

**50th percentile is the median.

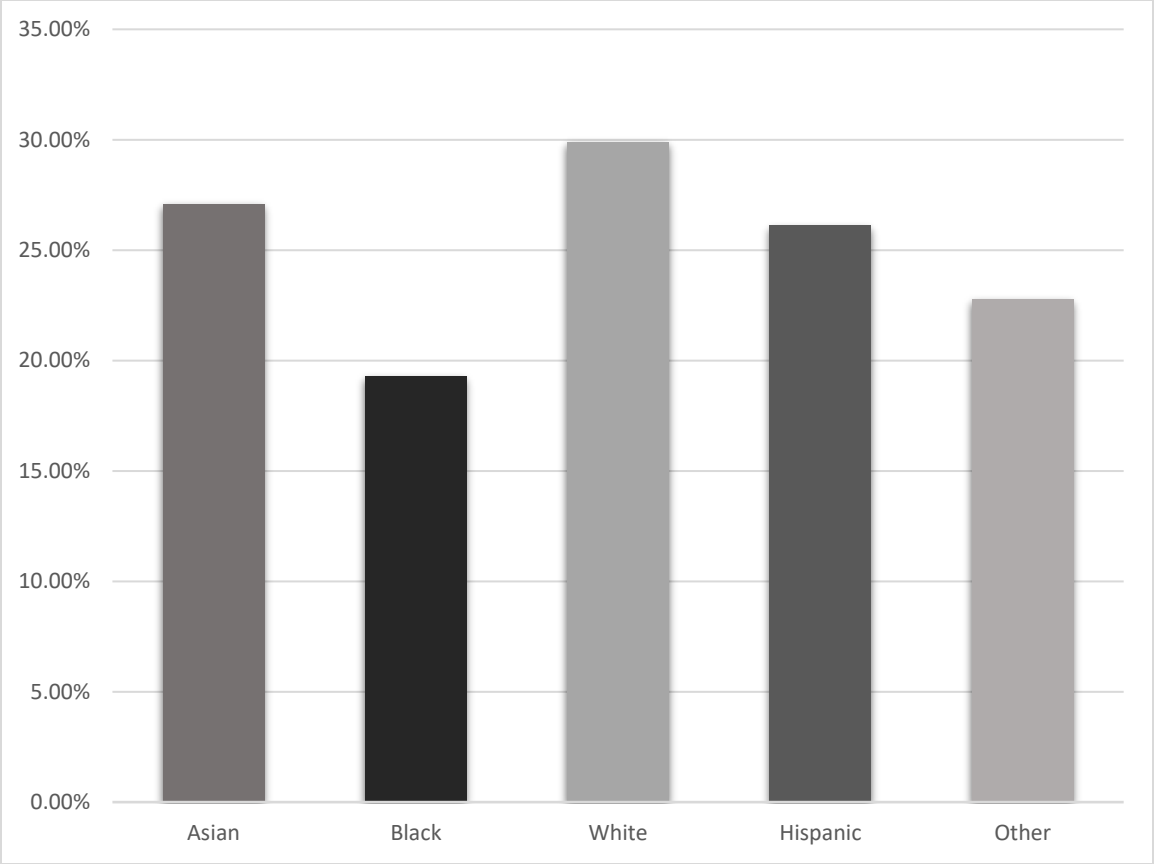

Figure 3. Overall Percentage of Students in Grades K–5 in NYC who Receive the Mandated Amount of PE by Race/Ethnicity

Source: New York Lawyers for the Public Interest, 2017

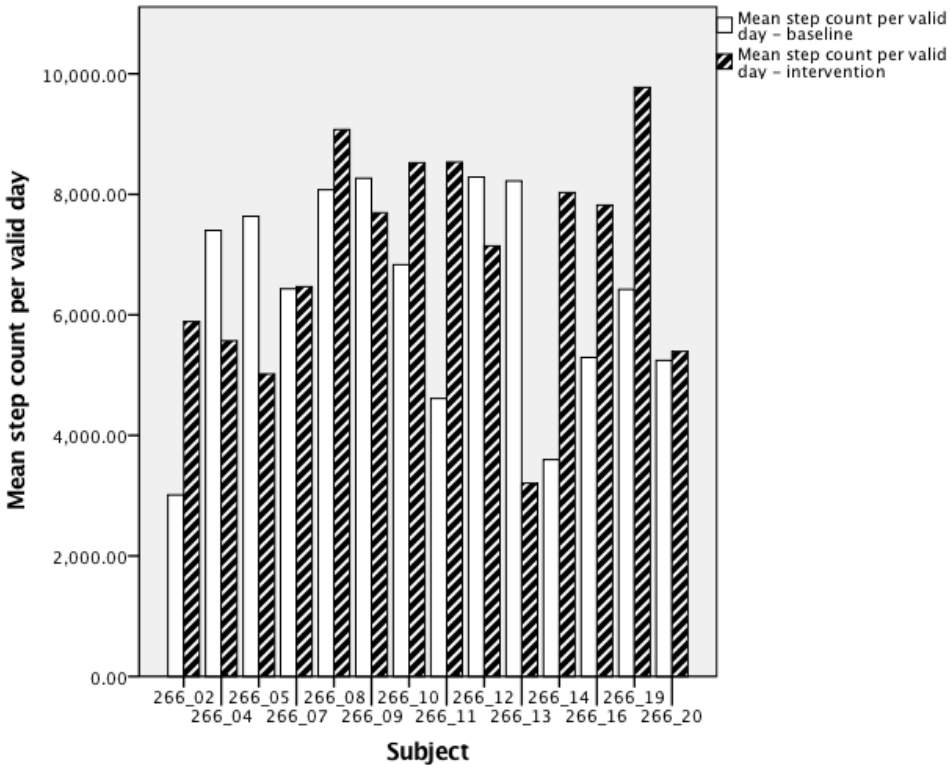

Figure 4: Mean Step Count per Day at Baseline vs. Mid-Intervention for Participants Who Met Valid Wear Time Criteria at those Timepoints

Chapter IV

STUDY OF THE EFFECTIVENESS OF THE POWER PROGRAM IN IMPROVING PHYSICAL ACTIVITY AND EXECUTIVE FUNCTION IN FIFTH GRADE STUDENTS

Abstract

Introduction

High volumes of sedentary instructional time during the school day contradict research supporting the role of physical activity (PA) in enhancing students' attention, academic achievement and executive function (EF). This study evaluated the effectiveness of a multimodal classroom program called "Prioritize, Organize, Work, Exercise and Regulate" (POWER) in improving the PA-related health outcomes and EF of fifth grade children. We also investigated whether POWER could assist teachers with classroom behavioral management.

Methods

The study population included a convenience sample of six fifth grade classes (3 = intervention [POW]; 3 = waitlist control [CONT]) and their teachers (n = 6) located in two socioeconomically and racially/ethnically diverse elementary schools in one community in New Jersey. A subset of students wore wrist-worn accelerometers for a full school week at three timepoints for 15 days in total [week 1 (T1), week 6 (T2) and week 12 (T3)] to assess changes in total PA. EF was assessed at T1 and T3 by three NIH Toolbox (NIHTB) tests. Academic performance was assessed via the standardized STAR Math tests at T1 and T3. Teachers completed the validated Early Childhood Longitudinal

Study Survey at T1 and T3 to report on classroom behavioral management. Follow-up interviews were conducted with the POW principal, teachers and a group of students to assess acceptability and collect feedback on POWER. Quantitative data are reported as mean (standard deviation). Group comparisons were made by multivariate repeated measures ANOVA and multivariate linear regression.

Results

Total PA (mean vector magnitude [VM] count) decreased from T1 to T2 and then increased slightly at T3 for both groups (n = 33, POW; n = 25, CONT; $p < 0.001$). There was a significant main effect for time on VM counts. There was also a significant main effect for group on VM counts ($F(1,56) = 19.926$, $p < 0.001$). POW also had significantly higher PA during class-time at T3 than CONT ($p = 0.001$). POW's NIHTB mean standardized national score increased by 6.01 percentiles (14.62), while CONT's mean increased by only 3.08 (17.78) (n = 48, POW; n = 35, CONT). There were significant differences between classes for the NIHTB test of cognitive flexibility associated with teacher implementation fidelity. Student scores for the STAR math test increased significantly for both schools from T1 to T3, but there was no significant main effect for group. POW teachers' score of classroom behavior improved over time while CONT teachers' score worsened, but there were no significant differences between groups. Feedback from the POW group was very positive, with the POW principal reporting fewer disciplinary visits from students, POW teachers conveying positive growth in themselves and their students, and POW students noting their reduced anxiety from stressors due to the program.

Conclusions

POW's significant increase in class-time PA at T3 highlights the increase in classroom-based activity breaks, even while overall school-based PA decreased. Differential cognitive outcomes by class were correlated to teacher fidelity and underscore the important role of teachers in successful implementation. The lack of significant improvements to EF by group may be due to the short duration and insufficient power of the study. The improvement in POW teachers' classroom behavioral management score also emphasizes the potential of POWER to assist teachers with this crucial task. Moreover, POW students', teachers' and principal's overwhelmingly positive reception of the POWER program demonstrates the potential of this program to improve children's emotional, social and mental wellbeing, as well as their overall physical health.

Introduction

The benefits of physical activity (PA) for elementary school-age children are well-researched and extend to the realms of physical health, mental health, cognitive health and academic achievement.[1] Nonetheless, only 42.5% of U.S. children aged 6-11 years meet the recommended target of 60 minutes of daily PA.[2] Given the large amount of time that children spend in school, schools can provide an ideal setting for a PA intervention.[3] However, with school administrators' preoccupation with complying with the educational standards of the Every Student Succeeds Act of 2015 and Common Core State Standards Initiatives, PA time has been reduced in favor of increased sedentary instructional time.[4,5] This practice contradicts research supporting the role of PA in

enhancing students' time-on-task,[6-13] attention,[14,15] concentration,[16] academic achievement,[4,5,16,17] mental health[18,19] and executive function.[4,5,14-16,20,21]

Executive function (EF) refers to the set of cognitive skills related to the planning and management of mental processes that enable the control and organization of goal-directed behavior.[22,23] The three primary domains of EF are inhibition, working memory and cognitive flexibility.[22] Research has demonstrated that an array of activities can improve children's EF, with the strongest evidence existing for computer-based training and select school-based curricula.[24] A multifaceted program that incorporates both PA and the teaching of EF skills may have a significant effect on the PA-related health outcomes and EF of elementary school children.

POWER is an established, school-based, multimodal program designed to teach students the necessary skills to succeed academically, emotionally and socially. It has been implemented successfully in a variety of in-school and out-of-school settings. The primary skills that students learn in the program are related to the multiple cognitive skills encompassed within EF. The core components of the program, as represented by each letter in the word POWER, include prioritizing, organizing, working, exercising and regulating. PA activities are embedded throughout POWER, and children use the POWER framework to plan their own PA using provided affordances.

Previous school-based interventions that have sought to improve EF in children through PA have either focused on the afterschool setting[20] or have relied on the use of devices (e.g. heart rate monitors) to help children learn to recognize an impending emotional/behavioral issue.[25] The POWER program is unique in its implementation by classroom teachers, and complete integration of both social and emotional learning (SEL)

and PA skills. Additionally, the knowledge and skills that students learn in POWER are intended to extend beyond the classroom. The evidence-based RULER approach to teaching emotional intelligence (EI) also employs a classroom-based approach for integrating SEL across a school or district, but it lacks the additional components of mindfulness and PA.[26] The multimodal approach of POWER presents a new, comprehensive method for teaching both EF and PA, with each component reinforcing the other in a synergistic way.

This study seeks to evaluate the effectiveness of the POWER program in improving PA and EF. The study population included a convenience sample of six fifth grade classes (n = 133 students total) located in two socioeconomically and racially/ethnically diverse elementary schools in New Jersey. The implementation of POWER in three classrooms in a single school began in September 2019 and allowed for the evaluation of POWER in the three intervention classes and comparison with three classes in the second school who were not participating in the POWER program until January 2020 (waitlist controls).

Methods

Overview and Study Design

Three classrooms that comprised the entire fifth grade in one school receiving POWER (POW) were selected by convenience sample to participate in the study and three additional classrooms that comprised the entire fifth grade in a second school not receiving POWER until a later date were selected as waitlist control classrooms (CONT). The study evaluated POWER over 12 weeks, with quantitative measurements and process evaluation obtained before the start of POWER and at several time points throughout the

12 weeks in all participating classes. The Teachers College Institutional Review Board and the schools' Board of Education both approved the study.

Participants and Recruitment

POW teachers were trained to deliver POWER during a 6-hour in-service session in September 2019 conducted by the child psychologist who developed POWER. Initial teacher training was followed by individual support meetings for teachers with research staff throughout the intervention, as well as opportunities to model lessons and receive feedback from research staff. Teachers also received a guide to POWER with lesson plans, access to web-based resources and a list of required classroom materials. They were also asked to log every time they completed a POWER lesson to assess implementation fidelity.

At the start of the school year, parents received a letter that outlined the assessment procedures, as well as a consent form for their child's participation. We waited one week for students to return signed consent forms, with a midweek reminder. Research staff also presented the research study to parents at back to school night. Parents had the opportunity to ask questions and learn more about the study. Those students whose parents returned a signed consent form also signed an assent form to participate.

Program Overview

The POWER program engages both students and teachers in developing their EI and executive functioning through the school day. The program was developed by a child psychologist to help teachers and students adapt to an increasingly challenging school

environment in which students are expected to succeed academically, behaviorally, socially and emotionally. Additionally, overstimulation from digital screens, electronics and technology interferes with children's ability to self-regulate and focus on their responsibilities.[27] With the advent of "overparenting," many children are unable to manage themselves and function autonomously.[28] POWER is designed to give children the confidence to be aware of their actions and feelings and to notice the impact of these on their lives with a metacognitive approach.[29] Metacognition refers to the ability to monitor and reflect on cognitive processes. Children must learn how to develop metacognition in order to be able to inhibit or control impulses and successfully engage in the higher-order thinking of EF.[29]

The POWER program is grounded in Social Cognitive Theory.[30] One of the primary constructs of this theory is self-regulation, which is defined as the ability to control oneself through self-monitoring, goal-setting, feedback and the enlistment of social support. Together, these behaviors increase the individual's self-efficacy.[30] POWER also employs the theoretical construct of responsive pedagogy. The goal of responsive pedagogy is to educate students to be self-confident, creative problem solvers through feedback and assessment. Students learn to master social-emotional skills such as academic self-efficacy and the management of psychological distress. Research supports the idea that acquiring skills, such as self-regulation, will help prepare students for future challenges.[31]

As part of the program, children learn a new language to help them develop a structure around each of the core skills within POWER: prioritize, organize, work, exercise and regulate. There are many skills encompassed within the five core skills of

POWER, each with a specific label. Because exercise and regulation are key to developing the primary skills of POWER—the "POW" of POWER—these are integrated throughout the program. Children also learn how to identify, categorize, retrieve and organize information in a useful way. Learning the language of POWER helps children remember and develop their new skillset. Each classroom features a word wall with the POWER vocabulary words to help students develop fluency. Throughout the day, students move vocabulary words from the word wall to the "applied" column as they utilize the various words.

Similarly, naming and labeling emotions using a granular feeling vocabulary allows children to retrieve these new words and apply them in everyday life. Research demonstrates that the ability to differentiate between emotions using a complex vocabulary (emotion differentiation) is associated with positive emotional well-being in adolescents.[32,33] Helping children develop EI through the acquisition of distinct emotional words enables them to process and regulate their emotions through high-level thinking instead of acting out, which is much more beneficial both in the short- and long-term.[32] Children who learn EI by identifying and discerning their own feelings, as well as others' feelings, will then be able to self-regulate and form interpersonal relationships more successfully.[34,35] As part of POWER, students learn a wide spectrum of granular feeling words and are encouraged to apply these during the day through various exercises.

Moreover, the nurturing and development of a "growth mindset" is key to POWER. A growth mindset refers to one's belief in their capacity to grow through "hard work, good strategies, and instruction" as opposed to fixed traits or characteristics.[36] Research demonstrates that children who have a growth mindset perform better

academically, especially those students who face challenges. Teachers play an important role in promoting a growth mindset by helping children focus on the learning process. In the POWER program, students are encouraged to take a learning-oriented approach as opposed to an outcome-oriented approach.

PA is a core component of POWER, as it is both a mechanism for teaching all of the POWER skills and an end in itself. Children "learn to engage in exercise to help them regulate their emotions, attention and fatigue."[37] In the first exercise/regulate ("ER") lesson, children learn how to distinguish between feelings and actions. Children are instructed to stand up when they hear a feeling word and sit down when they hear an action word. They have an opportunity to move their bodies and to practice impulse control as they expand their EI. Learning to distinguish between feelings and actions is a crucial life skill for children. Fred Rogers, the famed creator of *Mister Rogers' Neighborhood*, agreed: "'Everyone has lots of ways of feeling. And all of those feelings are fine. It's what we do with our feelings that matter in this life.'"[38]

In another ER lesson titled, "Rock, Pebble, Sand," children use planned exercise to memorize a pattern and learn to notice the impact of exercise on their bodies and minds. They learn the skills of sequencing and prioritizing through PA. In subsequent ER lessons like chair-based yoga and "Shake and Settle," children learn to become more aware of their bodies through movement and to regain focus. They are instructed to "check in" with themselves before and after the activity breaks to increase self-awareness and self-regulation.

Each morning begins with a "morning mindfulness" session, where students are led through a guided meditation in deep breathing and mental awareness. After

participating in these sessions for a few weeks, students are encouraged to create and lead their own activity and mindfulness breaks in their classroom. This empowers students to take a leadership role in the classroom and to understand that they can teach their fellow classmates and their teacher. Students can also advocate for themselves and choose not to lead a break if they prefer.

Quantitative Measurements

Students' unidentified aggregated demographic characteristics including age, sex, race/ethnicity and free-/reduced-price lunch status were collected from school data sources at the start of the intervention period. Data collection staff members were distinct from POWER development staff to ensure separation of measurement to reduce bias.

PA: accelerometry. For the primary outcome measure of PA, a subset of participants (n = 37, POW; n = 34, CONT) wore an ActiGraph (Pensacola, FL, USA) accelerometer for a full school week (five days) at T1, five days at T2 and five days at T3 (15 days total). During data collection weeks, students wore an ActiGraph GT3X+ monitor on a wrist strap on their non-dominant wrist, which is an accepted placement with this population.[39] The monitors were distributed at the start and collected at the end of each school day during the data collection periods.

Many researchers consider the ActiGraph GT3X+ to be the most valid and reliable accelerometer.[40] The devices were initialized to collect data at a sampling rate of 30 Hz, as per the most common protocol for sampling rate.[41] Research staff assisted students with properly wearing the devices on the first morning of data collection weeks. Students were instructed not to remove the accelerometer during the school day. At the end of each school day, teachers ensured that students removed their devices and left

them in school until the following school day. Student PA outside of school (e.g. after-school PA) was not collected for this study.

Following data collection, raw accelerometer data were downloaded in 5-second epochs using ActiLife software. This epoch length was selected based on previous studies that have also focused on the high variability in children's PA patterns.[7] Non-wear time was defined as 30 minutes of continuous zeroes, as per the recommendations of previous studies of PA in children.[42] The cut-points developed by Chandler et al. (2016)[43] were used to differentiate between time spent in sedentary behavior (SB), light PA (LPA), moderate PA (MPA), vigorous PA (VPA), and moderate-to-vigorous PA (MVPA). The main outcome variable was the total counts of PA for each weeklong measurement period, as calculated using vector magnitude (VM: the square root of the sum of squares of each of the three axes measured by the ActiGraph) count.[43] Following guidelines for this age group, at least three days of wear time with at least six hours of wear time on each day were set as the minimum criteria for valid wear time.[44] While a minimum of two days with 10 hours of wear time on each day is generally needed to consider the data to be a valid assessment of children's PA,[45] the school day is only six hours long. As such, we extrapolated the 20-hour total minimum to at least three days lasting at least six hours, or approximately 18 hours total.

PA: Youth Activity Profile. Children's PA was also assessed three times during the study via the Youth Activity Profile (YAP), a 15-item self-report tool which was completed online during class-time (Appendix E). The YAP has been calibrated to provide estimates of moderate-to-vigorous PA (MVPA) that closely match output from device-based measures.[46] At the end of the survey, children received a customized report.

The tool is both an assessment and education tool and was used as part of the feedback loop central to POWER.

EF: NIH Toolbox. Another primary outcome of the study was EF, assessed by three tests from the NIH Toolbox (NIHTB) at T1 and T3. These iPad-delivered tests were the Flanker Inhibitory Control and Attention Test, the List Sorting Working Memory Test, and the Dimensional Change Card Sort Test (DCCS), which took approximately 14 minutes total to complete. These tools assess the primary domains of EF,[22] with the Flanker Test measuring inhibitory control, the List Sorting Test assessing working memory and the DCCS evaluating cognitive flexibility.

The Flanker Test includes a series of 20 trials which require the participant to focus on a central stimulus while tuning out the distraction of the flanking stimuli. For each trial, the participant sees a screen with a central arrow flanked by two additional arrows. The participant is instructed to select one of two buttons on the screen that matches the direction in which the central arrow is pointing. The trials include both congruent (i.e., all the arrows point in the same direction) and incongruent trials (i.e., flanking arrows point in opposite direction of middle arrow). The trials are scored for both accuracy and reaction time, and a "home base" button is used to ensure that all participants rest their index finger in the same location between trials.

In the List Sorting Working Memory Test, the participant is asked to remember and arrange a series of various pictures in size order from smallest to largest. The participant views a series of images of different foods and animals on the iPad, which also lists the written name of the object and plays an audio recording of each object's name. After all the items have been displayed one at a time on the screen, the participant

is asked to recall and sequence the items for the evaluator. For instance, in the first trial with two objects, the participant would see the images and hear the names for a pig and a mouse. The participant would then have to recite back to the evaluator, "mouse" and "pig." With each correct response, the participant advances to the next level with a new set of images and an additional item. After passing the two-object trial successfully, the participant would then proceed to the three-object trial.

Additionally, the test includes two conditions: a one-list condition, in which the participant only sequences related images (i.e., food or animals), and a two-list condition, in which the participant is required to list the food items first in ascending size order followed by the animal items in ascending size order.

Finally, the DCCS requires participants to match a series of pictures (30 trials total after several practice trials for each dimension) along two dimensions, namely shape and color. For instance, the participant is shown a blue truck and asked to match that item to either a yellow truck (shape) or a blue ball (color). A cue word that both flashes on the screen and is played by audio recording reminds the participant which dimension is relevant for each trial. The participant must be able to pay attention and demonstrate cognitive flexibility by switching back and forth quickly between matching by shape or color. Like the Flanker Test, the trials are scored for both accuracy and reaction time. Similarly, a "home base" button is used to ensure that all participants rest their index finger in the same location between trials.[47]

Participants received age-corrected scores for each of the three tests. This score compares the score of the test-taker to those in the NIHTB nationally representative normative sample at the same age. These scores were then transformed to a national

percentile rank, where the national age-corrected average is 100. A composite score of EF was calculated from the mean of the national percentile rank score for all three tests.

Academic performance: STAR math tests. As an additional outcome, academic performance was assessed via the validated and reliable STAR Math test, a computer-adaptive test that takes approximately 20 minutes to complete.[48] The test is designed to assess students' current achievement level and monitor academic progress over time. The test was administered in both schools at T1 and T3. Students receive a scaled score from 0 to 1400 "based on the difficulty of the items administered, and the pattern of right and wrong answers." A single scale is used to measure math achievement in students from first through twelfth grade.[49]

Classroom behavioral management: ECLS. The validated Early Childhood Longitudinal Study Survey (ECLS) was used to assess the secondary outcome of teacher-reported classroom behavioral management at T1 and T3. The valid and reliable ECLS Survey is a self-report tool for teachers to reflect on their classroom behavioral management. The survey consists of a total of 13 items related to school climate and school environment rated on a 5-point Likert scale from strongly disagree to strongly agree, as well as items related to the teacher's background (Appendix E).[50] Teacher report of group classroom behavior was extrapolated from responses to the item, "The level of child misbehavior (for example, noise, horseplay, or fighting in the halls or cafeteria) in this school interferes with my teaching." A lower score is a more positive reflection of child behavior. These surveys were collected and managed via REDCap electronic data capture tools hosted at Teachers College, Columbia University.[51,52]

Feedback Assessments

Structured interviews and focus groups. Structured interviews and focus groups were also conducted with the POW principal, all POW classroom teachers and a group of POW students selected by their teachers to assess acceptability and collect feedback on POWER at T3.

Data Analysis

Demographic data is summarized descriptively, using means and standard deviations for continuous data and frequencies and percentages for categorical data. The primary outcomes assessed were changes in overall PA as measured by VM count and indices of EF. Secondary outcomes were changes in math test scores and teacher report of classroom behavioral management. Quantitative results are presented as mean (standard deviation).

Statistical analyses for PA, EF, math scores and teacher data were conducted using SPSS V26 software. Analyses were conducted by multivariate repeated measures analysis of variance (ANOVA) with additional variables nested within the primary analytical procedure based on the outcome. For the accelerometry data, the change in VM count was analyzed to test whether children's PA levels during the school day improved over the course of the three timepoints of the study using a 2 (group: POW, CONT) x 3 (time: T1, T2, T3) multivariate repeated measures ANOVA (Aim 1). Change in EF composite score was analyzed to assess whether children's EF improved over time using a 2 (group: POW, CONT) × 2 (time: T1, T3) multivariate repeated measures ANOVA (Aim 2). Change in students' math test scores was studied for improvements from T1 to T3 using a 2 (group: POW, CONT) × 2 (time: T1, T3) multivariate repeated measures

ANOVA (sub-aim of Aim 2). Change in teacher report of classroom behavioral management from T1 to T3 was also evaluated (Aim 3). A multivariate linear regression analysis for PA, classroom (independent variable) and sex (independent) were also conducted to explore the relationship between these variables and possible mediation.

Feedback assessments were analyzed thematically in Microsoft Word and are presented with both direct quotes and analysis by theme (changes to EF, changes inside and outside the classroom, etc.) and group (student, teacher, principal).

Results

Overall, 86 students (n = 49, POW; n = 37, CONT; mean age = 10.48 [0.33] years; n = 43 girls) returned signed parental consent forms. All 86 students completed the YAP survey and the NIHTB cognitive tests at T1. A subset of 75 students (n = 38, POW; n = 37, CONT) wore accelerometers at T1. Of these, 72 (n = 37, POW, n = 35, CONT) met minimum wear time criteria at T1. Math test results for 80 students were collected at T1 (n = 45, POW; n = 35, CONT). Baseline demographics appear in Table 3.

Baseline Results

At baseline, POW had a mean VM count of 7,377,334.11 (1,449,091.94), while CONT had a mean VM count of 5,825,742.19 (1,319,937.16). There was a statistically significant difference between VM counts for POW and CONT at T1 ($p < 0.001$). According to the YAP, the average activity score at school was 3.46/5 for POW and 3.18/5 for CONT. The mean national percentile age-corrected composite score for the NIHTB tests was 37.36 (21.12) for POW and 43.38 (18.23) for CONT at T1. Students' mean score for the STAR math assessment was 730.84 for POW and 730.54 for CONT,

respectively (approximately 70th percentile). There were no significant differences between POW and CONT for the YAP, NIHTB or STAR math tests at baseline.

Quantitative Results

PA: accelerometers. At T2, POW's (n = 35) mean VM count decreased to 4,980,492.67 (1,046,193.61), while CONT's (n = 25) mean VM count decreased to 3,462,360.80 (672,247.67). Thirty-three POW students and 25 CONT students met valid wear-time criteria for all three timepoints. VM counts for this subgroup are displayed in Table 4. Both POW's and CONT's mean VM counts at T3 increased slightly from T2 values. There was a significant main effect of time on VM counts. There was a significant main effect for group on VM counts, $F(1,56) = 19.926$, $p < 0.001$; $\eta^2 = 26.2\%$. While VM count in both schools decreased over time, it dropped less precipitously in POW (Figure 5). School explains 26.2% of the total variability in VM count over time.

The PA component of POWER was comprised of short classroom-based activity breaks. As such, we analyzed a single day of wear at T1, T2 and T3 for each class, filtering out physical education class-time, lunch and recess using ActiLife software. Since the assumptions of normal distributions for a repeated measures ANOVA were not met, a non-parametric Mann-Whitney U test was conducted. At T3, POW had statistically significantly higher mean VM counts during class time than CONT ($U = 271$, $p = 0.001$) (Figure 6).

A multiple linear regression was also calculated to predict VM counts at T3 based on participants' classroom and sex. A significant regression equation was found ($F(2, 63) = 9.540$, $p < 0.001$) with an R^2 of 23.2%. Participants' predicted VM count at T3 is equal to 5971384.888 - 661829.273(sex) - 261858.175 (classroom), where sex is coded as 0 =

male, 1 = female and classroom is coded as 1 to 6 (POW classes = 1 to 3, CONT classes = 4 to 6). Mean VM count at T3 increased by 661829.273 counts for males as compared to females and increased by 261858.175 counts for POW classes (with higher fidelity classes, coded as 1 and 2, having higher increases). Both sex ($p = 0.017$) and classroom ($p = 0.001$) were significant predictors of VM counts at T3. The findings of the regression model corroborate earlier research that boys tend to be more active than girls in this age group[53] and that those classes with higher fidelity to POWER had improved outcomes.

PA: Youth Activity Profile. According to results from the student-report YAP, average school-based activity scores decreased for both schools over time. POW students started with a higher mean and ended with a higher mean than CONT, but differences between the schools over time was not significant ($F(1, 75) = 2.581$, $p = 0.112$; $\eta^2 =$ 3.3%). Average MVPA on weekdays during school time in minutes decreased over time in both schools, though for POW the decrease was not as steep. Differences between the schools over time was not significant ($F(1, 75) = .713$, $p = 0.401$; $\eta^2 = 0.9\%$) (Table 5 and Figure 7). Similarly, total MVPA at school for the week in minutes decreased in both schools over time, but POW's decrease was not as pronounced. Differences between the schools over time was not significant ($p = 0.401$).

NIH Toolbox. Eighty-three students (POW n = 48; CONT n = 35) completed the NIHTB at T3. POW's mean national percentile rank score increased by 6.01 (14.62) percentiles to 43.72 (21.35) percentiles while CONT's mean increased by 3.08 (17.78) percentiles to 46.50 (19.07) percentiles. While overall mean composite scores for NIHTB

increased significantly from T1 to T3 ($p < 0.001$), the change by group over time was not significant ($F(1, 81) = 1.048$, $p = .309$; $\eta^2 = 1.3\%$) (Figure 8).

Since POWER implementation across the three POW classes varied widely, a nonparametric Kruskal-Wallis *H* test was conducted to assess differences between classes for NIHTB score. While there were no significant differences between classes for NIHTB mean composite score ($p = .274$), there were significant differences between classes for the third NIHTB test, the Dimensional Change Card Sort Test (DCCS), an assessment of cognitive flexibility ($H(5) = 12.424$, $p = 0.029$). The POW class with the highest fidelity to the program had the highest mean rank score among POW classes, and the class with the lowest fidelity had the lowest mean rank score (Figure 9 and Table 6).

Math scores. Student scores for the STAR math test also increased significantly for both schools from T1 to T3, with a change score of 32.93 (38.42) for POW (n = 43) and 35.20 (46.69) for CONT ($p < .001$) (Figure 10). However, time did not have a significant effect by group ($F(1,76) = .157$, $p = .693$; $\eta^2 = 0.2\%$).

Teacher report data. Six teachers participated in the study, with three in each group (mean age = 47.00 [8.62], n = 4 female). For the secondary hypothesis of improvements to POW teachers' self-report of classroom behavioral management, POW teachers' (n = 3) score improved over time while CONT teachers' (n = 3) score worsened. These changes were not significant ($p = 0.346$). Five of the six teachers had 18 or more years of teaching experience (range: 9 to 32 years). Four completed master's degrees while two held bachelor's degrees.

Feedback Assessments

Focus groups and interviews. At T3, POW students, teachers and principal responded highly favorably to POWER overall in interviews and focus groups. Students reported that POWER helped them manage anxiety related to schoolwork and life at home and helped them become more organized in both settings. Intervention teachers noticed growth in both themselves and their students and agreed that POWER was beneficial to them and their students. The principal noted fewer disciplinary visits to his office from fifth grade students since the implementation of POWER. As he remarked:

> From a principal's standpoint, we've seen less behavioral issues, less behavioral referrals since the beginning of the year. Fewer kids are coming to me with concerns.

He also shared that it was easier to address behavioral issues since the advent of POWER.

Many students shared how POWER helped them cope with daily anxiety and stress. One student noted, "Sometimes in life, things can be very stressful, and I have a lot of anxiety. POWER helps me calm down with my anxiety and focus on my work." Another echoed this sentiment, "POWER helps me focus more when it's a test. If I ever think I can't do it, I just breathe and have a growth mindset." Many also attributed their calmer demeanor to the morning mindfulness sessions. One student reported that the morning mindfulness sessions helped them become more energized, while another reported that they felt calm after meditation. The student noted:

> The morning mindfulness…really helps me. I have to hand things in, there's a due date and stuff, and so the morning mindfulness helps me focus and calm myself down for the rest of the day.

The students' comments also highlighted how many of them became more empowered both in and out of school through the program. One student shared, "POWER

taught me…there are choices to be made in life and you can be the boss of yourself." Another noted:

> POWER has helped me in school and out of school…Yesterday, I had to get up in front of the class and like read my morning mindfulness sheet and that made me really nervous. So, then I was breathing…and that helped me, like, stay focused on what I was supposed to read.

Another student noted, "Sometimes I'm very forgetful, so the checklist and fixed location helps me manage where all my stuff is. It's really helpful. I use it at home and at school." Another student summarized, "POWER is amazing. I love POWER. It helps me in life. It reminds me of the song, 'I've got the power!'…Improvement happens every day."

Positive changes in PA behaviors was another recurring theme of the student focus groups. One student mentioned that they found the exercise breaks to be particularly helpful. "The exercise part really helps me out," the student noted, "(be)cause, like, sitting in a desk all day and doing work, that helps me get up and stretch and get all my energy out." Another shared, "[After an exercise break] I feel more calm, I feel more relaxed, I feel more focused." The positive behavioral changes also extended beyond the school setting. One student commented, "Instead of using my iPad, I try to go outside now after school."

Additionally, the integrated approach of the program was apparent in the students' feedback. Students applied skills that they learned in one part of POWER to another unrelated part of their life. For instance, one student shared:

> POWER is everywhere! At soccer during recess, I said maybe I shouldn't be the goalie because I'm not very good at it. My classmate turned to me and said, 'That's a fixed mindset!'

The students learned to empower themselves and their peers through the program.

Since the students felt so positively about POWER, they expressed a strong interest in continuing POWER, particularly through middle and high school as life becomes more challenging. Several students shared stories about family members or friends who struggled with anxiety and depression in middle or high school. These students all agreed that POWER might have helped these students face academic and social stressors more successfully. One student remarked:

> We're learning about meditating, using soft, kind inner voices. We're learning about expressing emotions. Some kids are never introduced to this and never express their emotions. So, all this builds up in their minds and they could eventually get, like, depression or something.

As one student contemplated the end of the formal POWER program in their classroom, they started to choke up with emotion. This student tearfully shared that POWER had transformed their life for the good and they did not want to face the day without the daily lessons. The teacher assured the student that POWER would remain a part of the classroom, even as the formal study came to a close.

The teachers shared stories about their students' emotional growth, particularly in relation to the development of a granular feeling vocabulary. One teacher observed, "They really like talking about their feelings, and I think this is new to them…now they're very aware of them and they just want to talk about them." Another observed that the program helped them support their students' SEL. They noted, "POWER has given me more of a full lens on my students and how to tap into not just their academics, but their social, emotional and physical behaviors." The principal echoed this statement about the students' expanded vocabulary when he remarked:

> The vocabulary I hear students using is a complete change. There are words that I hear students using today…that I have never heard fifth graders use before. The

> self-regulation, the soft inner voice. A lot of the terminology is being used in daily language.

Additionally, the teachers shared how POWER helped them become more confident in their task as educators and helped them empower their students. One teacher commented:

> I'm always looking for opportunities to empower myself so I can empower my students. I really feel that the POWER program has given me language to do so. I've seen the active involvement and implementation of the POWER program to my classroom since September and how it's benefiting both myself and the students.

Another felt that POWER synthesized the social, emotional and mental wellbeing of students in one program effectively.

One teacher shared a story about the transformation of one of their students over the course of participation in the POWER program. Previously, this student was extremely introverted and barely participated in class. As students began to write the script for and lead the class in morning mindfulness sessions, the teacher asked this particular student if they would like to volunteer for this task. The student mulled over the request and initially decided only to write a script for the session. Eventually, the student agreed to lead the class in the session, too. The teacher reported that the student bravely stood up in front of the class on their appointed morning and read the script to their classmates, instructing the students to close their eyes and visualize a place that brought them a sense of calmness. The students sat quietly and respectfully with their eyes closed for ten minutes, following the instructions of their classmate. After completing the session, the student who had written and led the session reported feeling accomplished and empowered, and the teacher exuded a sense of pride in their student's achievement.

One teacher, who had been resistant to implementing POWER from the start because of their own insecurities, reported that they were trying to be open-minded about the program and that they saw some benefits in their students' growth. Initially, the teacher felt intimidated by the size of the program binder and felt that they would not be able to fit POWER into their day. As the teacher described:

> When Dr. Kahane came in I said, 'I can't do this, this is not a priority for me.' But I do it, I'm getting better at it, I'm having a growth mindset, but it takes me a little longer to get into the groove of it…When I see that they're [the students] growing and I get positive feedback, I think 'Okay, I must be doing something right.'…I think it [POWER] can help the kids in the classroom, when they're older, in the workforce, with their families…I definitely see a change in myself…I hope the other teachers who do this won't have a fixed mindset and will grow with it.

In relation to the in-class activity breaks, the teachers had mixed feelings. One teacher felt that the active breaks were sometimes disruptive and caused the students to act "silly." This teacher expanded, "The mindfulness is a lot calmer, versus having them do chair yoga. They get kind of silly sometimes with that." Another teacher reported more positively:

> In my class we complete at least two ERs [exercise and regulation breaks] a day. It's a balance of getting them out of their seats, to be a little more active, and allow them to regulate their feelings and emotions throughout the day. My students unanimously will always choose the POWER ball as their favorite. That's part of why their granular feelings vocabulary is one of their strengths.

Another teacher enjoyed the mindful nature of the activity breaks. The teacher noted that encouraging the students to check in with their bodies before and after exercise allowed students to understand how the PA helped them.

The principal shared his broader perspective on POWER, as well. In relation to changes in EF, he noted:

> We are seeing positive changes in executive function…I wouldn't expect to see giant leaps yet. But even the smaller leaps that we haven't seen in the past in this timespan have been nicer. I've also seen bigger strides in certain students who really needed it.

He shared that when he volunteered his school to participate in the POWER program, he had certain students with behavioral challenges like ADHD in mind. He elaborated:

> When I heard about the program, they were the first pictures in my mind…one student is a…diagnosed textbook ADHD student. He takes the things like the mindfulness and is able to internalize them. He tries to self-regulate. It's difficult for him…He's trying his best in school and he does try to incorporate these pieces into his day-to-day functioning in school to be able to be successful in school.

He felt that these were the students who made the biggest improvements over time as a direct result of participation in POWER. He summarized, "From what I see so far, it's a very strong program. So far, positive."

Discussion

A multimodal classroom-based program to improve PA and EF had a positive impact on measures of PA, EF and classroom behavior and was received favorably by students, teachers and administrators. Total PA in both schools decreased over time, probably with the change of seasons (fall to winter) and the accompanying loss of outdoor recess time, but POW's decrease in PA at T3 was significantly less precipitous than CONT's ($p < 0.001$). Intervention group explains 26.2% of the total variability in VM count over time, which is a very large effect size. Additionally, POW's significant increase in class-time PA at T3 highlights the increase in classroom-based activity breaks as part of the POWER program, even while overall school-based PA decreased.

While we hypothesized that student VM count would increase over time as a result of participation in POWER, PA dropped in both schools during the week of

midpoint data collection much more than anticipated. It rained every day during the data collection week and students did not have their usual 20 minutes of outdoor recess. Instead, their lunch period was extended, and they were given unstructured free time in the lunchroom. VM count then increased slightly for both groups at T3. Students were given the option to play outdoors during recess in the final data collection period, but many elected not to due to the cold weather.

Results from the self-report data from the YAP also did not differ significantly between the schools, though POW's mean scores were slightly higher at all three timepoints.

Both NIHTB and math test scores improved significantly over time, though there were no statistically significant differences by group. At T3, POW's mean NIHTB national percentile rank score increased by 6.01 percentiles (14.62), as compared to CONT's increase of only 3.08 percentiles (17.78). The variability for NIHTB scores in both groups was very large, which may have limited the statistical power of any analyses.

We also analyzed class-level differences in NIHTB scores over time because of variations in teacher implementation of POWER. There were statistically significant differences between classes for the DCCS, an assessment of cognitive flexibility (p = 0.029). The class with the highest fidelity to POWER had the highest mean rank score for this test, while the class with the lowest fidelity to POWER had the lowest mean rank score. This emphasizes the key role that teachers play as gatekeepers in the successful implementation of a classroom-based intervention like POWER.

There were also no statistically significant differences between schools at T3 for STAR math scores. Surprisingly, CONT had a greater change score for STAR math

scores, but there was no significant main effect for group. The lack of statistically significant findings between groups for both NIHTB composite score and STAR math scores corroborates findings from previous PA interventions that have not had a significant impact on measures of academic achievement and cognitive function.[4,5,10,21] Many of these studies also failed to find statistically significant changes as a result of participating in a PA-based intervention, though academic scores and measures of cognitive function improved over time. These results are consistent with earlier studies' findings that classroom-based PA interventions do not affect students' academic outcomes negatively and may improve their achievement levels over time. Those studies that have documented significant improvements in EF as a result of PA focused on the acute effect of PA, as opposed to the chronic effect of PA.[54] The lack of significant effect could also be related to the short duration of the intervention.

POW teachers' reports of classroom behavioral management became more favorable over time, while CONT teachers' reports worsened over time. While these differences were not statistically significant because of the low power of the analysis, the improvement in POW teachers' data reflects positively on the POWER program and the potential of POWER to assist teachers with the crucial task of classroom management. As noted in the teacher interviews, even the teacher who was most resistant to implementing POWER observed positive changes in their students. This teacher had the most negative attitude toward their students at the outset but was still able to note improvements in their students' behavior over time.

The POW principal's, teachers' and students' overwhelmingly positive reception of the program highlights the potential of POWER to impact children, teachers and the

larger school community in a constructive way. The POW principal felt that the program was efficacious overall and reported fewer disciplinary visits from fifth graders, which is a noteworthy finding. POW teachers commented on the overall growth of their students in terms of enhanced emotional intelligence, increased attention span, improved classroom behavior and reduced anxiety. POW students were excited to share their love for the program and their desire to continue participating through high school to help prevent mental health crises as the stress in their lives might increase. They noted myriad positive changes in their behavior in terms of increasing PA, being aware of their emotional state and using the POWER skills to reduce anxiety before a test or when dealing with a stressful situation at home. The positive feedback overall establishes the efficacy of POWER in improving the physical health, mental health and emotional wellbeing of elementary school children, as well as classroom behavioral management.

Limitations

At baseline, POW's PA as measured by accelerometer was significantly higher than CONT's PA. Immediately after the teacher training, before baseline measures had been collected, POW teachers began implementing some portions of POWER mistakenly. Once research staff learned that POW teachers had begun implementing the exercise breaks before baseline data collection, teachers were asked to stop immediately, but this likely resulted in higher PA counts among intervention students at T1.

Dramatic decreases in school-based PA that seemed to be a result of the change in seasons was an unanticipated result of the study. The limited dose of PA in the POWER program was not able to compensate for the overall decrease in PA due to seasonality. Previous interventions that found statistically significant improvements in students'

cognitive outcomes relied on a much larger dose of PA. For instance, the FITKids initiative included at least 70 minutes of MVPA after school for approximately 90% of school days during the academic year.[55] Moreover, the small study population limited the power of this study.

Additionally, some aspects of the study design, including the relatively small sample size; the convenience sampled, non-randomized individual classrooms; the lack of blinding to intervention condition for both research staff and participants; the short 12-week duration; and the lack of rigor related to the collection of feedback from participants may have impacted the outcomes. Many studies on the effectiveness of PA interventions on EF and academic outcomes have used much larger sample sizes and more robust study designs. Most have also collected data for a full academic year or more.[5,21] But even one two yearlong study of the impact of physically active academic lessons on EF failed to find significant differences between the control and intervention groups,[21] potentially also due to the low dose of PA as compared to the FITKids study. De Greeff et al. (2016) hypothesized that the low dose and intensity of PA in their intervention did not elicit the necessary improvement in cardiovascular fitness that is thought "to lead to physiological changes in the brain structural network."[21] This may have been the case in our study, as well.

Moreover, PE teachers should have been recruited to participate in the study, in addition to general classroom teachers, since PE is the lone academic subject that instructs student in PA. Researchers in the field of PE have noted the potential risk of school PE being "outsourced" to teachers who are not professionally trained to teach PE.

While the POWER program is only intended to supplement existing PE classes, the exclusion of PE teachers is a limitation of this study.

Some seminal studies on the academic benefits of certain characteristics like smaller class sizes and teacher quality have used a longitudinal approach that can span eight years. For instance, the five-year Project Student-Teacher Achievement Ratio (STAR) study followed students from kindergarten through fourth grade and continued to study the impact of small class sizes on academic achievement through eighth grade. Researchers found a statistically significant positive impact of small class size on standardized test scores through eighth grade.[56] Another research group that studied the connection between the Project STAR data and administrative records from tax returns noted a high correlation between kindergarten test scores and college attendance and earnings at age 27.[57] Chetty et al. (2011) found that Project STAR kindergarteners who were randomly assigned to more experienced teachers with at least 10 years of experience had significantly higher earnings—an extra $1,093 (6.9% of mean income) on average—over two decades later in comparison to their counterparts who had less experienced teachers.[57]

Additionally, fidelity to implementation guidelines varied widely between POW teachers. One teacher reported implementing POWER lessons 64 times over the course of the 12-week study while another reported implementing only 30 lessons. The POW class with the teacher with the highest fidelity to POWER had the highest mean rank scores for VM count change score, NIHTB composite change score, NIHTB Flanker Test change score and NIHTB DCCS change score, while the POW class with the teacher with the lowest fidelity to POWER had the lowest mean rank scores for these assessments.

The limitations of the NIHTB as a measure of EF may have impacted the study results, as well. One study that documented an improvement in student cognitive function as a result of PA utilized real-time, electrophysiological indices of cognitive flexibility through the use of an EEG.[20] Many studies have relied on direct observation of time-on-task as a measure of improved cognitive function.[8-10] We sought to incorporate a more robust measure of cognitive function than direct observation, but perhaps the NIHTB was too rigid a choice for such a short study duration with a small study population.

Finally, all students were eligible for participation in this study, including children with special educational services due to cognitive or attentional disorders and/or children with physical disabilities. We wanted our study population to be as inclusive as possible and to reflect the composition of a typical U.S. public school. The POW principal noted that the potential positive impact of POWER on students with special educational needs such as ADHD was a particular draw of participation in the program. Previous studies have limited the study population to children without individualized educational plans due to physical or cognitive limitations.[20] Our study's more expansive inclusion criteria may have impacted the NIHTB test results and limited the findings of the study. However, the data could have been controlled for students with individualized educational plans.

Conclusions

Overall, the positive improvements in the POW group demonstrate the effectiveness of a multimodal program to enhance children's PA, EF and classroom behavior. Moreover, POW students', teachers' and principal's overwhelmingly positive

reception of POWER reflects the potential of this program to improve children's emotional, social and mental wellbeing, as well as their overall physical health. Additionally, POW's significant increase in class-time PA at T3 reflects the increase in classroom-based PA as part of the POWER program. The differential cognitive outcomes by class highlight the impact of teacher fidelity on the overall success of POWER.

The limited statistically significant cognitive and academic findings of the study may be due to a variety of factors, including the small sample size, the short duration of the study, the study sample composition and the limited dose and intensity of PA. Additionally, many of the positive attributes of POWER are difficult to measure with behavioral and brain function indices of performance. However, the positive feedback from the intervention principal, teachers and students related to cognitive, emotional and behavioral outcomes should be highlighted as central to the positive analysis of this study. In future testing of the effectiveness of POWER, the sample size should be increased; the PA dose and intensity should be expanded; more sensitive cognitive assessments should be added; teacher fidelity should be monitored closely by research staff; and a more robust qualitative research design should be included. The research design of a future study should also be updated to a randomized control design.

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Table 3. Baseline Characteristics of 5th Grade Student Participants in the POWER Study

	Group					
	POW		CONT		TOTAL	
	Mean (SD)	*N* (%)	Mean (SD)	*N* (%)	Mean (SD)	*N* (%)
Age	10.49 (.32)	48	10.47 (.35)	35	10.48 (.33)	83
Sex						
male		26		17		43
female		23		20		43
Race						
White		5 (10.2)		5 (13.5)		10 (11.6)
Black		2 (4.1)		0 (0)		2 (2.3)
Native Hawaiian or other Pacific Islander		1 (2.0)		1 (2.7)		2 (2.3)
Asian		13 (26.5)		6 (16.2)		19 (22.1)
American Indian or Alaska Native		1 (2.0)		1 (2.7)		2 (2.3)
2 or more races		1 (2.0)		1 (2.7)		2 (2.4)
Other		15 (30.6)		22 (59.5)		37 (43.0)
Not provided		11 (22.4)		1 (2.7)		12 (14.0)
Ethnicity						
Not provided		9 (18.4)		0 (0)		9 (10.5)
Not Hispanic or Latino		20 (40.8)		14 (37.8)		34 (39.5)
Hispanic or Latino		20 (40.8)		23 (62.2)		43 (50.0)
Free or reduced-price lunch status		11 (22.9)		9 (24.3)		20 (24.1)

Table 4. Mean Vector Magnitude (VM) Counts for Intervention Participants (POW) and Control Participants (CONT) at Week 1 (T1), Week 6 (T2) and Week 12 (T3)

	School	Mean (SD)	N
VM counts - T1	POW	7219384.72 (1486320.90)	33
	CONT	6064392.08 (1333577.74)	25
	Total	6721543.07 (1523789.24)	58
VM counts - T2	POW	4955300.19 (1000202.94)	33
	CONT	3226809.120 (924199.20)	25
	Total	4210260.93 (1291059.96)	58
VM counts - T3	POW	5234582.45 (1228429.77)	33
	CONT	4381645.39 (968942.77)	25
	Total	4866937.16 (1193327.62)	58

Abbreviations: VM, vector magnitude; POW, POWER intervention participants; CONT, waitlist control participants; T1, time 1, week 1; T2, time 2, week 6; T3, time 3, week 12.

Table 5. Average Daily Moderate-To-Vigorous Physical Activity (MVPA) During School Time in Minutes at Week 1 (T1), Week 6 (T2) and Week 12 (T3) for Intervention Participants (POW) and Control Participants (CONT) from Youth Activity Profile (YAP) Survey Data

	School	Mean (SD)	*N*
Average daily MVPA during school time (minutes), T1	POW	23.23 (6.26)	49
	CONT	22.18 (6.70)	28
	Total	22.85 (6.40)	77
Average daily MVPA during school time (minutes), T2	POW	22.74 (6.05)	49
	CONT	22.20 (7.27)	28
	Total	22.54 (6.48)	77
Average daily MVPA during school time (minutes), T3	POW	21.17 (6.70)	49
	CONT	19.15 (8.08)	28
	Total	20.44 (7.24)	77

Abbreviations: MVPA, moderate-to-vigorous physical activity; T1, time 1, week 1; T2, time 2, week 6; T3, time 3, week 12; POW, POWER intervention participants; CONT, waitlist control participants; YAP, Youth Activity Profile Survey.

Table 6. Mean NIH Toolbox (NIHTB) Dimensional Change Card Sort Test Change Score and Mean Rank from Week 1 (T1) to Week 12 (T3) by Class for Intervention Participants (POW) and Control Participants (CONT)

School	Class	Mean (SD)	N	Mean Rank
POW	1 (moderately high fidelity)	10.8000 (24.07)	20	46.13
	2 (high fidelity)	13.5882 (22.27)	17	48.09
	3 (low fidelity)	8.2727 (16.22)	11	39.77
	Total	11.2083 (21.52)	48	
CONT	4	18.3846 (21.52)	13	53.04
	5	-.7500 (32.63)	12	31.71
	6	-10.3000 (26.63)	10	23.85
	Total	3.6286 (29.03)	35	

Abbreviations: NIHTB, NIH Toolbox; T1, time 1, week 1; T3, time 3, week 12; POW, POWER intervention participants; CONT, waitlist control participants.

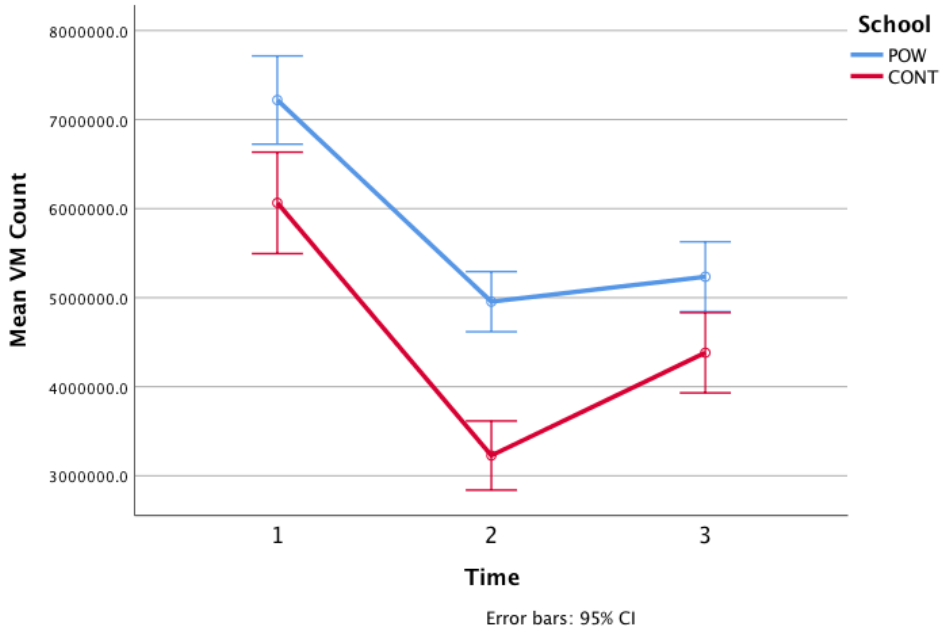


Figure 5. Mean Vector Magnitude (VM) Counts at Week 1 (T1), Week 6 (T2) and Week 12 (T3) for Intervention Participants (POW) and Control Participants (CONT)

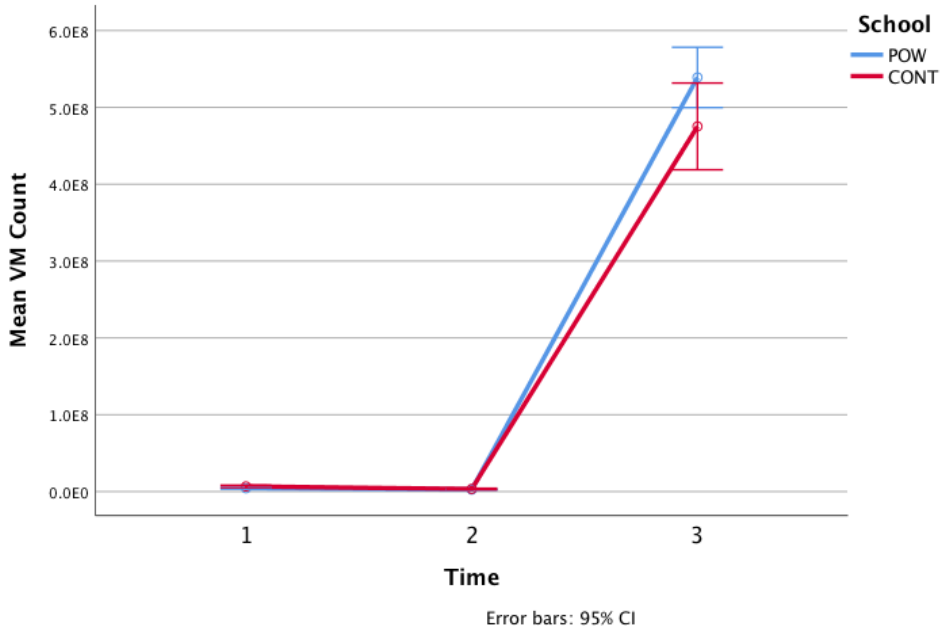


Figure 6. Class-time Physical Activity at Week 1 (T1), Week 6 (T2) and Week 12 (T3) for Intervention Participants (POW) and Control Participants (CONT)

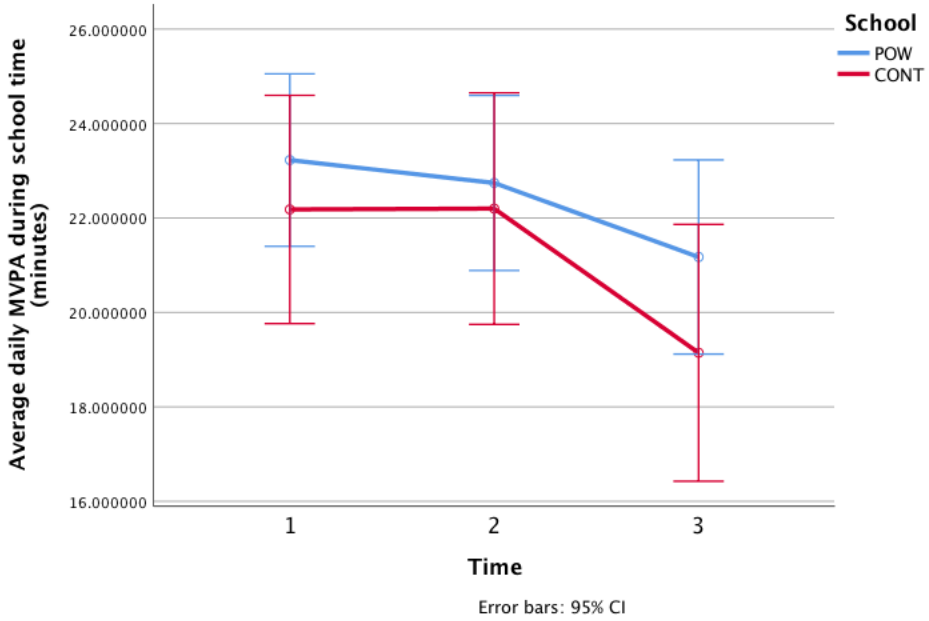


Figure 7. Average Daily Moderate-to-Vigorous Physical Activity (MVPA) During School Time in Minutes for Intervention Participants (POW) and Waitlist Control Participants (CONT) at Week 1 (T1), Week 6 (T2) and Week 12 (T3) from Youth Activity Profile (YAP) Survey Data.

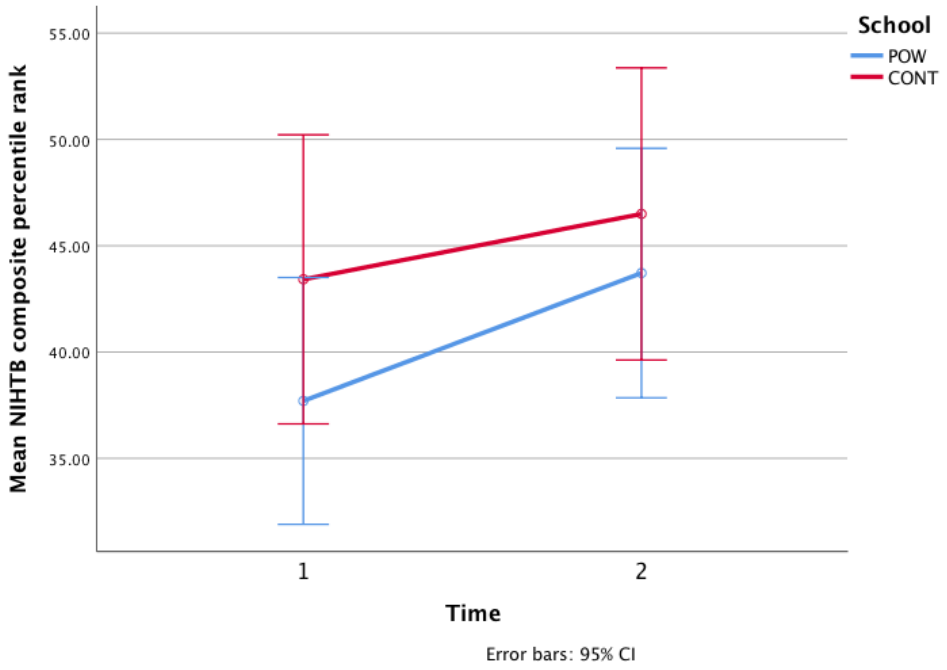


Figure 8. Mean NIH Toolbox (NIHTB) Composite Percentile Rank Score at Week 1 (T1) and Week 12 (T3) for Intervention Participants (POW) and Waitlist Control Participants (CONT)

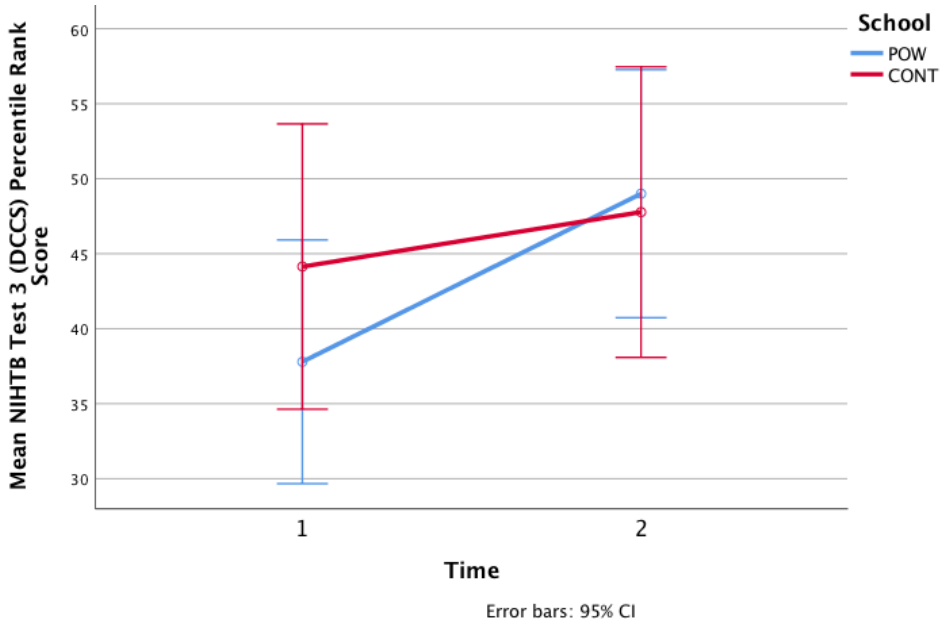


Figure 9. Mean NIH Toolbox (NIHTB) Percentile Rank for Test 3 Dimensional Change Card Sort Test (DCCS) at Week 1 (T1) and Week 12 (T3) for Intervention Participants (POW) and Waitlist Control Participants (CONT)

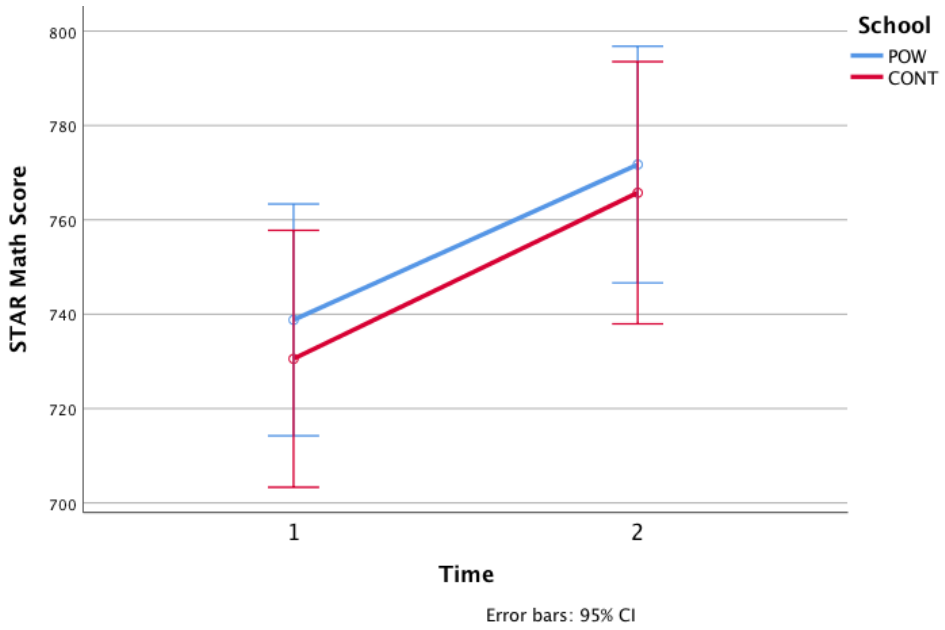


Figure 10. Mean STAR Math Scores at Week 1 (T1) and Week 12 (T3) for Intervention Participants (POW) and Waitlist Control Participants (CONT)

Appendix A

Definitions and Abbreviations

Definitions

1. Physical activity: any bodily movement produced by the operation of muscle that leads to an elevation in energy expenditure.
2. Exercise: physical activity that is intentional, planned, structured and repetitive.
3. Sedentary behavior: any behavior during waking hours that reaches an energy expenditure ≤1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture.
4. Academic achievement: the degree to which a student reaches certain goals set in an instructional setting like school, usually measured by tests or exams.
5. Low Income: characterized by possessing limited resources, defined by the U.S. Department of Housing and Urban Development as 80 percent of the median family income for the area. In this dissertation, low income is defined as at least 25% of study sample eligible for free or reduced-price lunch status, a proxy for low-income level, which includes individuals that identify as any race/ethnicity.
6. Minority: a population that is at least 50% nonwhite, including heterogenous populations that identify as non-Hispanic Black, Hispanic, and/or Asian/Pacific Islander) and low-income individuals.
7. Diverse, underserved: terms that are used interchangeably with both low income and minority.

8. Classroom-based active breaks, activity breaks: a short, purposeful exercise activity interval completed in the classroom, led by a teacher, student, or video/music.
9. Overweight: In children, defined by the CDC as a BMI at or above the 85th percentile and below the 95th percentile for children and teens of the same age and sex.
10. Obesity: In children, defined by the CDC as a BMI at or above the 95th percentile for children and teens of the same age and sex.
11. U.S. Department of Health and Human Services' (HSS) *Physical Activity Guidelines for Americans*: Federal evidence-based physical activity recommendations for different populations published initially in 2008, with a second edition published in 2018. For children aged 6-17 years, the recommended target is 60 minutes of daily moderate-to-vigorous physical activity.
12. Light physical activity: activity that is classified as < 3 METS. Examples include walking slowly, light housework.
13. Moderate physical activity: activity that is classified as 3 to 5.9 METs. Examples include brisk walking, yard work.
14. Vigorous physical activity: activity that is classified as $\geq$ 6 METs. Examples include jogging, active sports, carrying heavy loads.
15. ActiGraph accelerometer: a device that measures bodily movement and activity in three axes. The raw acceleration data can be converted to various exercise intensities (i.e. light PA, moderate PA, vigorous PA).

16. Vector magnitude count: the square root of the sum of squares of each of the three axes measured by the ActiGraph accelerometer.
17. Executive function: refers to the set of cognitive skills related to the planning and management of mental processes that enable the control and organization of goal-directed behavior. The three primary domains of executive function are inhibition, working memory and cognitive flexibility.
18. Youth Activity Profile (YAP): a 15-item self-report tool for children's in-school and out-of-school physical activity that has been calibrated to provide estimates of moderate-to-vigorous PA (MVPA) that closely match output from device-based measures.
19. Early Childhood Longitudinal Study Survey (ECLS): a validated survey for teachers used to assess classroom behavioral management. The survey consists of a total of 13 items related to school climate and school environment rated on a 5-point Likert scale from strongly disagree to strongly agree, as well as items related to the teacher's background.
20. NIH Toolbox: a set of neuro-behavioral measurements used to assess cognitive, emotional, sensory, and motor functions.
21. STAR Math Test: a valid and reliable computer-adaptive test designed to assess students' current achievement level and monitor academic progress over time. Students receive a scaled score from 0 to 1400.

Abbreviations

1. PA: physical activity
2. HHS: The U.S. Department of Health and Human Services
3. HP 2020: Healthy People 2020
4. MVPA: moderate-to-vigorous PA
5. PE class: physical education class
6. SES: socioeconomic status
7. RCT: randomized controlled trial
8. PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
9. SOFIT: System for Observing Instructional Fitness Time
10. SOPLAY: System of Observing Play and Leisure Activity in Youth
11. PARAGON: Physical Activity Research & Assessment Tool for Garden Observation
12. GEMS: Girls health Enrichment Multi-site Studies Activity Questionnaire
13. HYPE Break: Healthy You with Physical Education Break
14. NYC: New York City
15. T1: time 1, baseline
16. T2: time 2, midpoint
17. T3: time 3, post-study in Chapter III; week 12 in Chapter IV
18. POW: POWER intervention participants
19. CONT: waitlist control participants
20. EF: executive function
21. POWER: prioritize, organize, work, exercise, regulate

22. NIHTB: NIH Toolbox

23. SEL: social and emotional learning

24. EI: emotional intelligence

Appendix B

Search Strategies

All databases were searched on November 16, 2016 and again on June 4, 2019.

Ovid MEDLINE
1946 to November Week 2 2016 and 2016 to June 03, 2019

1. exp Exercise/
2. exp "Physical Education and Training"/
3. Motor Activity/
4. "Play and Playthings"/
5. (exercis$ or play$).tw.
6. (physic$ adj (activ$ or fit$ or educat$)).tw.
7. or/1-6
8. exp Child/
9. Infant/
10. (child$ or schoolchild$ or kindergarten$ or pre-k or pre-school$ or nurser$ or infant$ or grade$ or primary or elementary).tw.
11. (boy$ or girl$ or kid or kids or toddler$).tw.
12. or/8-11
13. schools/ or schools, nursery/
14. (school$ or class$ or recess$ or break$ or program$ or club$).tw.
15. 13 or 14
16. exp United States/
17. (united states or us or usa or america$).tw.
18. 16 or 17
19. and/7,12,15,18
20. limit 19 to yr="2008 -Current"
21. exp Monitoring, Physiologic/
22. exp "Surveys and Questionnaires"/
23. Program Evaluation/
24. (measur$ or assess$ or monitor$ or evaluat$).tw.
25. or/21-24
26. 20 and 25

Ovid PsycINFO
1806 to November Week 1 2016 and 2016 to May Week 4 2019

1. exp EXERCISE/
2. exp physical activity/
3. exp recreation/
4. (exercis$ or play$).tw.
5. (physic$ adj (activ$ or fit$ or educat$)).tw.
6. or/1-5
7. primary school students/
8. (child$ or schoolchild$ or kindergarten$ or pre-k or pre-school$ or nurser$ or infant$ or grade$ or primary or elementary).tw.
9. (boy$ or girl$ or kid or kids or toddler$).tw.
10. or/7-9
11. schools/ or elementary schools/ or kindergartens/ or nursery schools/
12. (school$ or class$ or recess$ or break$ or program$ or club$).tw.
13. 11 or 12
14. (united states or us or usa or america$).tw.
15. and/6,10,13-14
16. limit 15 to yr="2008 -Current"
17. exp measurement/
18. exp program evaluation/
19. (measur$ or assess$ or monitor$ or evaluat$).tw
20. or/17-19
21. 16 and 20

CENTRAL

Searched 11/17/2016 and 6/4/2019

#1 MeSH descriptor: [Exercise] explode all trees
#2 MeSH descriptor: [Physical Education and Training] explode all trees
#3 MeSH descriptor: [Motor Activity] this term only
#4 MeSH descriptor: [Play and Playthings] explode all trees
#5 (exercis* or play*):ti,ab
#6 (physic* next (activ* or fit* or educat*)):ti,ab
#7 #1 or #2 or #3 or #4 or #5 or #6
#8 MeSH descriptor: [Child] explode all trees
#9 MeSH descriptor: [Infant] this term only
#10 (child* or schoolchild* or kindergarten* or pre-k or pre-school* or nurser* or infant* or grade* or primary or elementary):ti,ab
#11 (boy* or girl* or kid or kids or toddler*):ti,ab
#12 #8 or #9 or #10 or #11
#13 MeSH descriptor: [Schools] this term only
#14 MeSH descriptor: [Schools, Nursery] this term only

#15 (school* or class* or recess* or break* or program* or club*):ti,ab
#16 #13 OR #14 OR #15
#17 MeSH descriptor: [United States] explode all trees
#18 ("united states" or us or usa or america*):ti,ab
#19 #16 or #17
#20 MeSH descriptor: [Monitoring, Physiologic] explode all trees
#21 MeSH descriptor: [Surveys and Questionnaires] explode all trees
#22 MeSH descriptor: [Program Evaluation] this term only
#23 (measur* or assess* or monitor* or evaluat*):ti,ab
#24 #20 or #21 or #22 or #23
#25 #7 and #12 and #16 and #19 and #24

ERIC (EBSCOHost)
1966 to November 17, 2016 and 2016 to June 4, 2019
S1 DE "Physical Activities" OR DE "Athletics" OR DE "Dance" OR DE "Exercise"
S2 DE "Play" OR DE "Play Therapy" OR DE "Playground Activities" OR DE "Recess Breaks"
S3 TI (exercis* or play*) OR AB (exercis* or play*)
S4 TI physic* N2 activ* OR TI physic* N2 fit* OR TI physic* N2 educ* OR AB physic* N2 activ* OR AB physic* N2 fit* OR AB physic* N2 educ*
S5 S1 OR S2 OR S3 OR S4
S6 DE "Young Children" OR DE "Infants" OR DE "Preschool Children" OR DE "Toddlers"
S7 TI (child* OR schoolchild* OR kindergarten* OR pre-k OR pre-school* OR nurser* OR infant* OR grade* OR primary OR elementary) OR AB (child* OR schoolchild* OR kindergarten* OR pre-k OR pre-school* OR nurser* OR infant* OR grade* OR primary OR elementary)
S8 TI (boy* OR girl* OR kid OR kids OR toddler*) OR AB (boy* OR girl* OR kid OR kids OR toddler*)
S9 S6 OR S7 OR S8
S10 DE "Elementary Schools" OR DE "Nursery Schools"
S11 TI (school* OR class* OR recess* OR break* OR program* OR club*) OR AB (school* OR class* OR recess* OR break* OR program* OR club*)
S12 S10 OR S11
S13 TI ("united states" OR US OR USA OR america*) OR AB ("united states" OR US OR USA OR america*)
S14 DE "Measures (Individuals)" OR DE "Affective Measures" OR DE "Attitude Measures" OR DE "Biographical Inventories" OR DE "Interest Inventories" OR DE "Personality Measures" OR DE "Projective Measures" OR DE "Questionnaires" OR DE "Rating Scales" OR DE "Tests"
S15 DE "Evaluation Methods" OR DE "Audience Analysis" OR DE "Benchmarking" OR DE "Case Studies" OR DE "Comparative Analysis" OR DE "Componential Analysis" OR DE "Content Analysis" OR DE "Cost Effectiveness" OR DE "Data Analysis" OR DE "Drug Use Testing" OR DE "Focus Groups" OR DE "Functional Behavioral Assessment" OR DE "Hypothesis Testing" OR DE "Input Output Analysis" OR DE "Inspection" OR DE "Interviews" OR DE "Job Analysis" OR DE "Life Cycle Costing" OR DE "Need

Analysis (Student Financial Aid)" OR DE "Phonetic Analysis" OR DE "Policy Analysis" OR DE "Pretesting" OR DE "Quality Control" OR DE "Readability Formulas" OR DE "Replication (Evaluation)" OR DE "Scoring Rubrics" OR DE "Site Analysis" OR DE "Skill Analysis" OR DE "Structural Analysis (Linguistics)" OR DE "Structural Analysis (Science)" OR DE "Surveys" OR DE "Synthesis" OR DE "Task Analysis"
S16 TI (measur* OR assess* OR monitor* OR evaluat*) OR AB (measur* OR assess* OR monitor* OR evaluat*)
S17 S14 OR S15 OR S16
S18 S5 AND S9 AND S12 AND S13 AND S17

Appendix C

Study Ia Approved Teachers College Materials

TEACHERS COLLEGE
COLUMBIA UNIVERSITY

Teachers College *IRB* — *Approval Notification*

To: Mindy Hecht
From: Karen Froud, IRB Chair
Subject: IRB Approval: 15-096 Protocol
Date: 04/02/2015

Dear Mindy,

Please be informed that as of the date of this letter, the Institutional Review Board for the Protection of Human Subjects at Teachers College, Columbia University has given full approval to your study, entitled "*HYPE Break Pilot Study Feasibility Assessment*," after a **Full Board Review**.

The approval is effective until **03/31/2016**.

The IRB Committee must be contacted if there are any changes to the protocol during this period. **Please note:** If you are planning to continue your study, a Continuing Review report must be submitted to either close the protocol or request permission to continue for another year. Please submit your report by **03/03/2016** so that the IRB has time to review and approve your report if you wish to continue your study. The IRB number assigned to your protocol is **15-096**. Feel free to contact the IRB Office (212-678-4105 or hersch@tc.edu) if you have any questions.

Please note that your Consent form bears an official IRB authorization stamp. Copies of this form with the IRB stamp must be used for your research work. Further, all research recruitment materials must include the study's IRB-approved protocol number. You can retrieve a PDF copy of this approval letter from the Mentor site.

Best wishes for your research work.

Sincerely,

Karen Froud, Ph.D.
Associate Professor of Neuroscience & Education
IRB Chair

Attachments:
- HYPE pilot teacher consent-STAMPED.pdf

Appendix D

Study Ib Approved Teachers College Materials

TEACHERS COLLEGE
COLUMBIA UNIVERSITY

Teachers College IRB — *Approval Notification*

To: Mindy Hecht
From: Karen Froud, IRB Chair
Subject: IRB Approval: 15-161 Protocol
Date: 06/22/2015

Please be informed that as of the date of this letter, the Institutional Review Board for the Protection of Human Subjects at Teachers College, Columbia University has given full approval to your study, entitled "*HYPE Break Pilot Study*," after a **Full Board Review**.

The approval is effective until **06/18/2016**.

The IRB Committee must be contacted if there are any changes to the protocol during this period. **Please note:** If you are planning to continue your study, a Continuing Review report must be submitted to either close the protocol or request permission to continue for another year. Please submit your report by **05/21/2016** so that the IRB has time to review and approve your report if you wish to continue your study. The IRB number assigned to your protocol is **15-161**. Feel free to contact the IRB Office (212-678-4105 or **IRB@tc.columbia.edu**) if you have any questions.

You do not need a TC stamp on your informed consent forms since they are stamped by the IRB at CUMC.

Best wishes for your research work**.**

Sincerely,

Karen Froud, Ph.D.
Associate Professor of Neuroscience & Education
IRB Chair

Appendix E

Study II Approved Teachers College Materials

TEACHERS COLLEGE
COLUMBIA UNIVERSITY

Teachers College IRB *Expedited Approval Notification*

To: Mindy Hecht
From: Myra Luna Lucero Research Compliance Manager
Subject: IRB Approval: 19-154 Protocol
Date: 06/07/2019

Please be informed that as of the date of this letter, the Institutional Review Board for the Protection of Human Subjects at Teachers College, Columbia University has given full approval to your study, entitled "*Feasibility of the POWER Program to Enhance Physical Activity and Executive Function in the Classroom*," under **Expedited Review** on 06/07/2019: Category (4) Collection of data through noninvasive procedures
(6) Collection of data from voice, video, digital, or image recordings made for research purposes.
(7) Research on individual or group characteristics or behavior

The IRB Committee must be contacted if there are any changes to the protocol during this period. Under the new IRB regulations, continuing review for this study is not required. If you encounter any problems or issues, please contact the IRB office to discuss. When you have completed the study, please terminate using the "Terminate Protocol" button at the top of the view protocol page in Mentor IRB. The IRB number assigned to your protocol is **19-154**. Feel free to contact the IRB Office (212-678-4105 or irb@tc.edu) if you have any questions.

Please note that your Consent form bears an official IRB authorization stamp and is attached to this email. Copies of this form with the IRB stamp must be used for your research work. Further, all research recruitment materials must include the study's IRB-approved protocol number.

As the PI of record for this protocol, you are required to:

- Use current, up-to-date IRB approved documents
- Ensure all study staff and their CITI certifications are on record with the IRB
- Notify the IRB of any changes or modifications to your study procedures
- Alert the IRB of any adverse events

You are also required to respond if the IRB communicates with you directly about any aspect of your protocol. Failure to adhere to your responsibilities as a study PI can result in action by the IRB up to and including suspension of your approval and cessation of your research.

You can retrieve a PDF copy of this approval letter from Mentor IRB.

When your study ends, please visit the IRB Mentor site. Go to the view protocol page and click on the "Terminate Protocol" button at the top.

Best wishes for your research work.

Sincerely,
Dr. Myra Luna Lucero
Research Compliance Manager
IRB@tc.edu

Attachments:
- FINAL Child_Assent POWER.pdf
- Final Informed Consent Form_POWER_teachers_2019.pdf
- Final Parental Permission Form_POWER_2019.pdf

Appendix F

Included Surveys and Tools: ECLS

Confidential

ECLS Teacher Questionnaire

Please complete the survey below about school climate and your teaching experience.

Thank you!

VIEWS ON SCHOOL CLIMATE AND SCHOOL ENVIRONMENT 1
MARK ONE RESPONSE ON EACH ROW.

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1)	The level of child misbehavior (for example, noise, horseplay, or fighting in the halls or cafeteria) in this school interferes with my teaching.	○	○	○	○	○
2)	Many of the children I teach are not capable of learning the material I am supposed to teach them.	○	○	○	○	○
3)	Parents are supportive of school staff.	○	○	○	○	○
4)	There is a great deal of cooperative effort among the staff members.	○	○	○	○	○
5)	There is a consensus among administrators and teachers on goals and expectations.	○	○	○	○	○
6)	The academic standards at this school are too low.	○	○	○	○	○
7)	The school administrator sets priorities, makes plans, and sees that they are carried out.	○	○	○	○	○
8)	The school administration's behavior toward the staff is supportive and encouraging.	○	○	○	○	○

VIEWS ON SCHOOL CLIMATE AND SCHOOL ENVIRONMENT 2
MARK ONE RESPONSE ON EACH ROW.

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
9)						

Confidential

	The attitudes and habits students bring to my class(es) greatly reduce their chances for academic success.	○	○	○	○	○
10)	My success or failure in teaching is due primarily to factors beyond my control rather than to my own effort or ability.	○	○	○	○	○
11)	The amount a student can learn is primarily related to family background.	○	○	○	○	○
12)	I really enjoy my present teaching job.	○	○	○	○	○
13)	If I could start over, I would choose teaching again as my career.	○	○	○	○	○

14) What is your gender?

○ Male
○ Female
○ Non-conforming
○ Prefer not to answer
(MARK ONE RESPONSE.)

15) In what year were you born?

_____
(WRITE IN YEAR BELOW.)

16) Are you of Hispanic, Latino, or of Spanish origin?

○ Yes
○ No
(Select one)

17) Which best describes your race?

☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or Other Pacific Islander
☐ White
(MARK ONE OR MORE RESPONSES TO INDICATE WHAT YOU CONSIDER YOURSELF TO BE.)

18) Counting this school year, how many total years have you been a schoolteacher, including years in which you taught part time?

_____
(WRITE THE NUMBER OF YEARS TO THE NEAREST FULL SCHOOL YEAR. IF THIS IS YOUR FIRST YEAR, WRITE "1.")

19) Is this school year the first year you have taught in this school?

○ Yes
○ No
(MARK ONE RESPONSE.)

20) What is the highest level of education you have completed?

○ Did not complete high school
○ High school diploma or equivalent/GED
○ Some college or technical or vocational school
○ Associate's degree
○ Bachelor's degree
○ Master's degree
○ An advanced professional degree beyond a master's degree (for example, Ph.D., MD, Ed.D.)
(MARK ONE RESPONSE.)

21) Which of the following describes the teaching certificate you currently hold in THIS state?

- ◯ Regular or standard state certificate or advanced professional certificate
- ◯ Certificate issued after satisfying all requirements except the completion of a probationary period
- ◯ Certificate that requires some additional coursework, student teaching, or passage of a test before regular certification can be obtained
- ◯ Certificate issued to persons who must complete a certification program in order to continue teaching
- ◯ I do not hold any of the above certifications in THIS state.

(MARK ONE RESPONSE.)

Included Surveys and Tools: YAP

Youth Activity Profile (YAP)

The Youth Activity Profile will assess your physical activity and sedentary behavior habits. **Please answer all of the questions as carefully as possible** to get accurate information. Descriptions of physical activity and sedentary behavior habits are below:

Physical activity habits are those activities that involve walking, running, or moving around. It includes biking and dancing, and sports or outdoor play that involves a lot of moving around.

Sedentary behavior habits are those activities that do not involve much moving around. These are activities like watching TV, playing video games, computer games, or handheld games that you do in your free time. It does NOT include the time you spend sitting while eating or while doing your homework.

Most questions will ask you only to think about the last 7 days, but a few questions will ask about what you usually do (during a normal week). There are no right or wrong answers, so please answer as honestly as possible.

Begin Survey

School

Activity Levels at School

Tell us about the activity you do at school. Answer the questions based on the last 7 days.

Continue

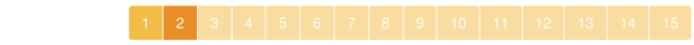
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

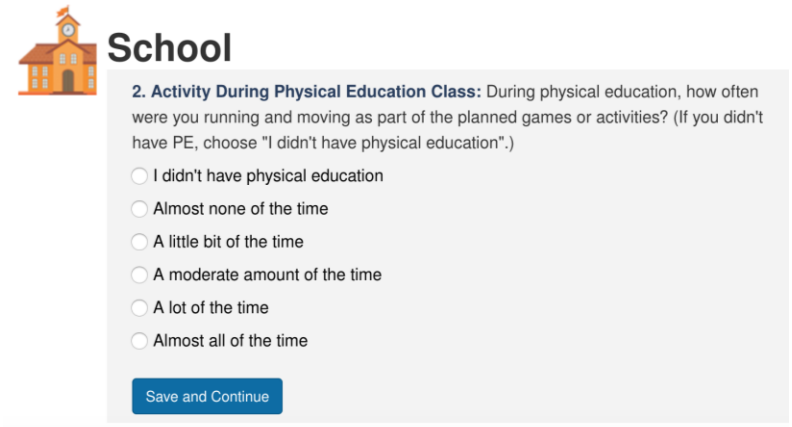
School

1. Activity to School: How many days did you walk or bike to school? (If you can't remember, try to estimate.)

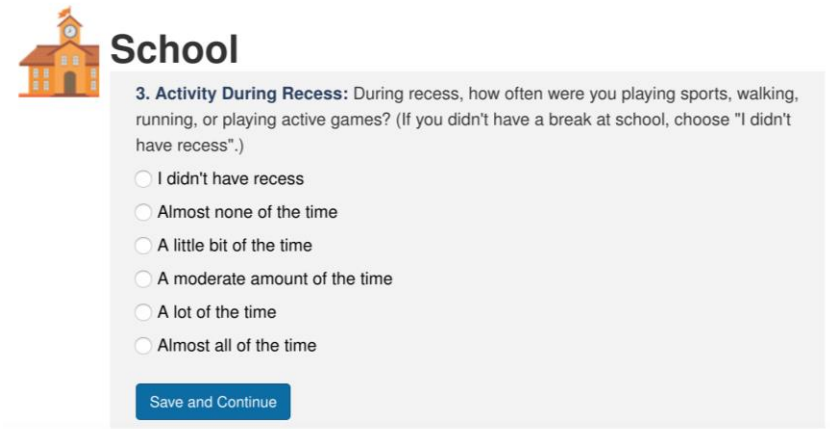
- 0 days (never)
- 1 day
- 2 days
- 3 days
- 4-5 days (almost every day)

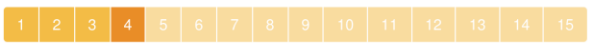
Save and Continue


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


School
2. Activity During Physical Education Class: During physical education, how often were you running and moving as part of the planned games or activities? (If you didn't have PE, choose "I didn't have physical education".)
I didn't have physical education
Almost none of the time
A little bit of the time
A moderate amount of the time
A lot of the time
Almost all of the time
Save and Continue


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


School
3. Activity During Recess: During recess, how often were you playing sports, walking, running, or playing active games? (If you didn't have a break at school, choose "I didn't have recess".)
I didn't have recess
Almost none of the time
A little bit of the time
A moderate amount of the time
A lot of the time
Almost all of the time
Save and Continue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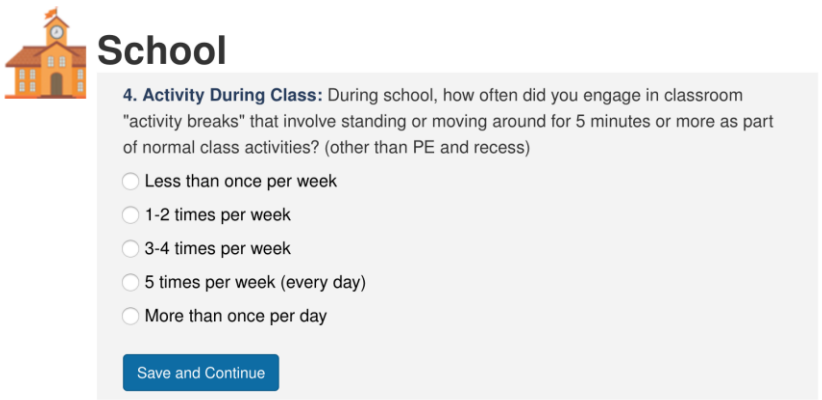
School
4. Activity During Class: During school, how often did you engage in classroom "activity breaks" that involve standing or moving around for 5 minutes or more as part of normal class activities? (other than PE and recess)
Less than once per week
1-2 times per week
3-4 times per week
5 times per week (every day)
More than once per day
Save and Continue

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

School

5. Activity From School: How many days did you walk or bike from school? (If you can't remember, try to estimate.)

- 0 days (never)
- 1 day
- 2 days
- 3 days
- 4-5 days (almost every day)

Save and Continue

Outside of School

Activity Levels Outside of School

Tell us about your activity when you are not at school. Answer the questions based on the last 7 days.

Continue

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Outside of School

6. Activity Before School: How many days before school (6:00 - 8:00 am) did you do some form of physical activity for at least 10 minutes? (This includes activity at home NOT walking or biking to school.)

- 0 days
- 1 day
- 2 days
- 3 days
- 4-5 days

Save and Continue

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Outside of School

7. Activity After School: How many days after school (between 3:00 - 6:00 pm) did you do some form of physical activity for at least 10 minutes? (This can include playing with your friends/family, team practices or classes involving physical activity but NOT walking or biking home from school.)

- 0 days
- 1 day
- 2 days
- 3 days
- 4-5 days

Save and Continue

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Outside of School

8. Activity on Weeknights: How many school evenings (6:00 - 10:00 pm) did you do some form of physical activity for at least 10 minutes? (This can include playing with your friends/family, team practices or classes involving physical activity but NOT walking or biking home from school.)

- 0 days
- 1 day
- 2 days
- 3 days
- 4-5 days

Save and Continue

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Outside of School

9. Activity on Saturday: How much physical activity did you do last Saturday? (This could be for exercise, work/chores, family outings, sports, dance, or play. If you don't remember, try to estimate.)

- No activity (0 minutes)
- Small amount of activity (1 to 30 minutes)
- Small to Moderate amount of activity (31 to 60 minutes)
- Moderate to Large amount of activity (1 to 2 hours)
- Large amount of activity (more than 2 hours)

Save and Continue

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Outside of School

10. Activity on Sunday: How much physical activity did you do last Sunday? (This could be for exercise, work/chores, family outings, sports, dance, or play. If you don't remember, try to estimate.)

- ○ No activity (0 minutes)
- ○ Small amount of activity (1 to 30 minutes)
- ○ Small to Moderate amount of activity (31 to 60 minutes)
- ○ Moderate to Large amount of activity (1 to 2 hours)
- ○ Large amount of activity (more than 2 hours)

Save and Continue

Sedentary

Sedentary Behavior

Tell us about the time you spend sitting and watching TV or playing games. Answer the questions based on the last 7 days.

Continue

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Sedentary

11. TV Time: How much time did you spend watching TV outside of school time? (This includes time spent watching movies or sports but NOT time spent playing video games.)

- ○ I didn't really watch TV at all
- ○ I watched less than 1 hour per day
- ○ I watched 1 to 2 hours per day
- ○ I watched 2 to 3 hours per day
- ○ I watched more than 3 hours per day

Save and Continue


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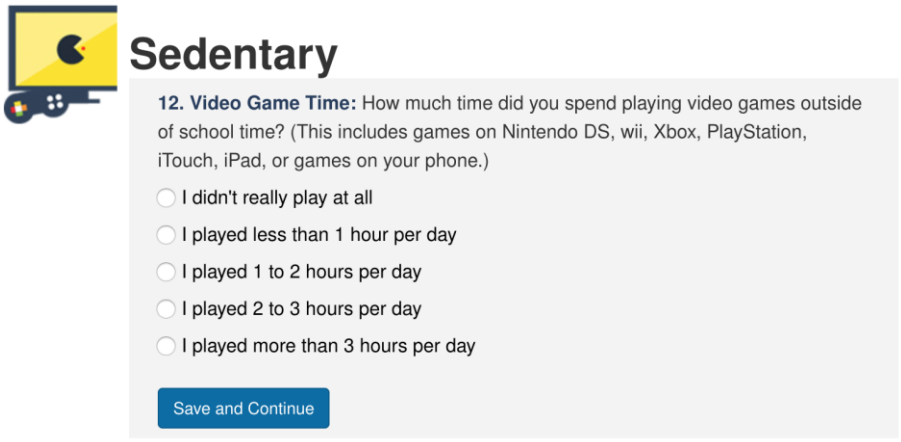
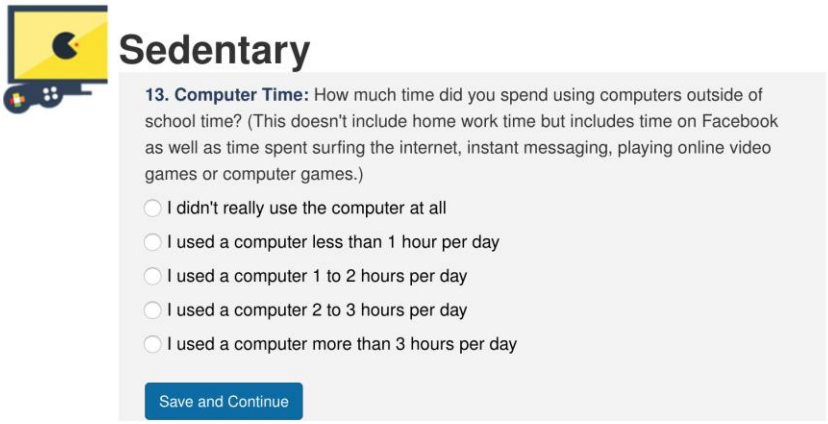
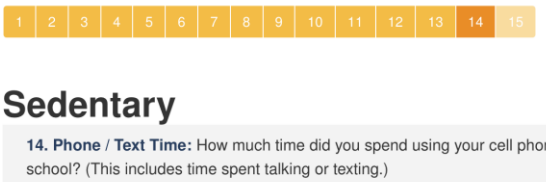
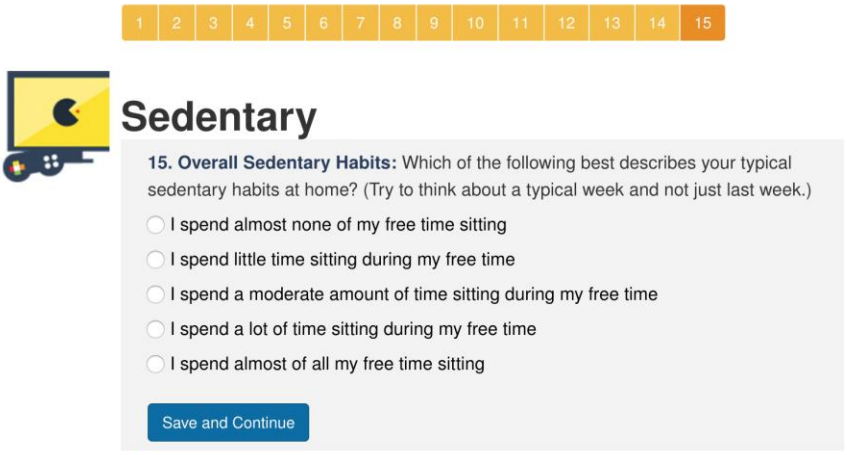
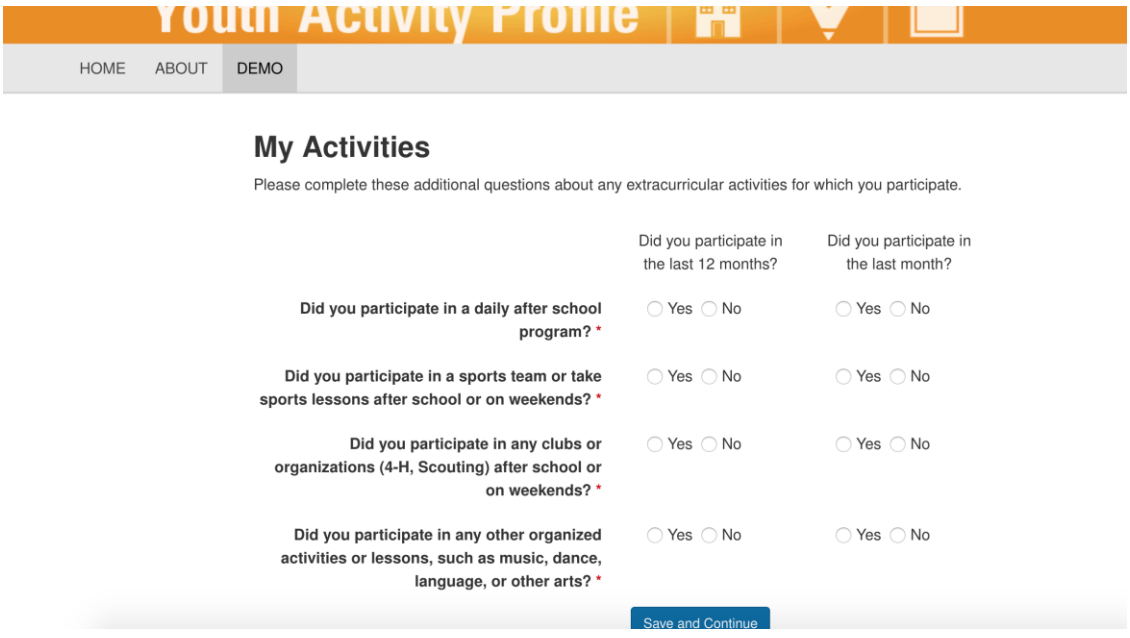

Sedentary
12. Video Game Time: How much time did you spend playing video games outside of school time? (This includes games on Nintendo DS, wii, Xbox, PlayStation, iTouch, iPad, or games on your phone.)
I didn't really play at all
I played less than 1 hour per day
I played 1 to 2 hours per day
I played 2 to 3 hours per day
I played more than 3 hours per day
Save and Continue


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


Sedentary
13. Computer Time: How much time did you spend using computers outside of school time? (This doesn't include home work time but includes time on Facebook as well as time spent surfing the internet, instant messaging, playing online video games or computer games.)
I didn't really use the computer at all
I used a computer less than 1 hour per day
I used a computer 1 to 2 hours per day
I used a computer 2 to 3 hours per day
I used a computer more than 3 hours per day
Save and Continue


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Sedentary
14. Phone / Text Time: How much time did you spend using your cell phone after school? (This includes time spent talking or texting.)
I didn't really use a cell phone at all
I used a phone less than 1 hour per day
I used a phone 1 to 2 hours per day
I used a phone 2 to 3 hours per day
I used a phone more than 3 hours per day
Save and Continue


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Sedentary
15. Overall Sedentary Habits: Which of the following best describes your typical sedentary habits at home? (Try to think about a typical week and not just last week.)
I spend almost none of my free time sitting
I spend little time sitting during my free time
I spend a moderate amount of time sitting during my free time
I spend a lot of time sitting during my free time
I spend almost of all my free time sitting
Save and Continue


Youth Activity Profile
HOME
ABOUT
DEMO
My Activities
Please complete these additional questions about any extracurricular activities for which you participate.
Did you participate in the last 12 months?
Did you participate in the last month?
Did you participate in a daily after school program? *
Did you participate in a sports team or take sports lessons after school or on weekends? *
Did you participate in any clubs or organizations (4-H, Scouting) after school or on weekends? *
Did you participate in any other organized activities or lessons, such as music, dance, language, or other arts? *
Yes No
Save and Continue