Preventive Medicine 111 (2018) 49–54

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Active learning improves on-task behaviors in 4th grade children

J.B. Bartholomew[a,*], N.M. Golaszewski[a], E. Jowers[a], E. Korinek[a], G. Roberts[b], A. Fall[b], S. Vaughn[b]

[a] The University of Texas at Austin, Austin, TX, United States
[b] The Meadows Center for Preventing Educational Risk, The University of Texas at Austin, United States

ARTICLE INFO

Keywords:
Physically active academic lessons
Elementary school
Academic engagement
Children

ABSTRACT

While increased opportunities for physical activity (PA) are a critical, public health need for children, school-based interventions often place teachers in the position to choose between PA and time spent on academic lessons. Active learning is designed to overcome this by combining PA with academic material. Moreover, teachers are likely to be more responsive to change in academic-related outcomes than in PA. This study utilizes a large, cluster randomized control trial in which student attention, or time on task (TOT) and accelerometer-based PA is assessed in conjunction with active learning. Participants were 2716 children (46% male, 46% white) from 28 elementary schools in Central Texas that were assigned to either: 1) active learning (math $n = 10$; spelling $n = 9$); or 2) traditional, sedentary academic lessons (n = 9). PA was measured with accelerometers. TOT was measured through a momentary time sampling protocol. A series of three-level (student, classroom, school) regression models estimated the effect of the intervention. The intervention lead to significantly increased TOT. Moreover, the dose of PA (steps) during the intervention was positively associated with the increase in TOT. In contrast, a greater dose of PA was associated with reduced TOT for students in control schools. Race, gender, and SES did not moderate these effects. Planned PA - as a part of an active, academic lesson - positively impacted TOT. In contrast, a traditional, sedentary lesson was associated with lower TOT. This differential impact offers intriguing possibilities to better understand the relationship between PA and academic performance.

1. Introduction

Given the paucity of children who meet recommendations for daily physical activity (PA) (United States Report Card on Physical Activity for Children and Youth, 2014), and the decline in PA that occurs during the elementary years (Trost et al., 2002), there has been a concerted effort to increase opportunities for PA during the elementary school day. Schools are natural target for intervention. During the week, children spend the majority of their waking time in school and the majority of that time – up to 73% - is spent sedentary (Carson et al., 2014). In response, there are a number of interventions that seek to increase opportunities for PA in school. While these have successfully been applied to PE (Lonsdale et al., 2013) and recess (Ickes et al., 2013), the impact of these interventions are undermined by the fact that they target time when many children are already active. In contrast, PA interventions will be maximized to the extent that they can substitute PA for what would traditionally be seated time. While this may be a natural and acceptable trade-off for a public health specialist, it is far from obvious for teachers and school administrators who are unlikely to sacrifice time for academic pursuits to increase child PA. The health and academic missions of schools (Harold et al., 2013) can come into conflict as administrators seek additional academic time – especially given the growing emphasis on standardized test performance. For example, schools across the country have chosen to reduce time in recess and PE to expand time spent on academic lessons (Harold et al., 2013). It is imperative that public health researchers seek to counter this trend and to do so with outcomes that are relevant to the academic mission of schools.

Fortunately, there is strong evidence that PA can enhance academic outcomes in children. While the impact of fitness and PA on overall academic performance is well known (Donnelly et al., 2016), there is also support for the impact of acute bouts of PA, especially for student focus. Students have been shown to respond to brief periods of PA with enhanced attention and impulse control (Grieco et al., 2016; Grieco et al., 2009; Mahar et al., 2006). PA during recess has been shown to improve classroom focus on teacher assigned tasks and reduce the amount of disruptive, verbal interaction between students (Pellegrini and Smith, 1993). Likewise, students aged 9–11 years who engaged in

* Corresponding author at: Department of Kinesiology and Health Education, The University of Texas at Austin, 2109 San Jacinto Blvd, Mail Stop D3700, Austin, TX 78712-1204, United States.
E-mail address: jbart@austin.utexas.edu (J.B. Bartholomew).

https://doi.org/10.1016/j.ypmed.2018.02.023
Received 26 October 2017; Received in revised form 7 February 2018; Accepted 19 February 2018
Available online 21 February 2018
0091-7435/

even four minutes of MVPA improved standardized assessment of attention and concentration, (Ma et al., 2015) which, in turn, predict academic achievement (Brickenkamp and Zillmer, 1998; Stallings, 1980). The attention data are in line with research that demonstrates the benefits of acute bouts of PA for executive functioning (Best, 2010; Tomporowski et al., 2011), concentration (Taras, 2005), and academic performance (Mullender-Wijnsma et al., 2015; Mullender-Wijnsma et al., 2016). Moreover, these acute responses may be particularly impactful when advocating for change. Teachers are sensitive to challenges with children's attention control (Abikoff et al., 1993) and PA interventions that can be shown to modify this outcome may be attractive to schools.

The challenge is to develop and test PA interventions that would occur during the normally, sedentary class times without sacrificing academic time. Physically active academic lessons, or active learning, are designed to do just this. They integrate acute bouts of PA with academic material as a means to increase MVPA throughout the school day without sacrificing academic time (Institute of Medicine, 2013). Active learning interventions are often brief, 5–15 min lessons that range from teacher-designed and implemented lessons to video-based systems and have been associated with improved academic performance. Mullender-Wijnsma et al. (2016) conducted a two-year intervention in which math and language lessons were taught through acute 10–15 min physically active lessons (Mullender-Wijnsma et al., 2015). Results indicated significant improvement in both mathematics and spelling (Mullender-Wijnsma et al., 2016). In addition, while each bout of active learning is of a relatively short duration, they consistently result in acute improvement in attention and impulse control as assessed by direct observation of time focused on teacher-assigned tasks (TOT). Mahar et al. (2006) found that implementing acute 10-min bouts of active learning improved TOT by > 10% for students aged 8–11 years old (Mahar et al., 2006). Grieco et al. (2009) showed similar results in teacher-implemented active learning in 3rd - 5th grade children (Grieco et al., 2009). It may be that the long-term improvement in academic performance was due, in part, to the accumulated benefit of daily, acute improvement in attention and impulse control following each active lesson.

Recently, Szabo-Reed et al. (2017) showed an improvement in TOT that was correlated with the dose of activity (Szabo-Reed et al., 2017). They assessed MVPA through observation via SOFIT (System for Observing Fitness Instruction Time) and found that the acute change in TOT was correlated with the level of MVPA during the lesson. These stand in contrast to the only experimentally-manipulated assessment of the dose response. Grieco et al. (2016) compared low and moderate intensity active lessons with a traditional sedentary lesson and an enjoyable, though sedentary game (Grieco et al., 2016). Results indicated that TOT only increased following both physically active lessons, but with no difference between low and high intensity versions (Grieco et al., 2016). In addition to the differences in design (experimental vs correlational) there are a number of other differences between these studies. The correlational study (Szabo-Reed et al., 2017) failed to include a control condition and examined children in groups of 5 across multiple days to achieve the full class assessment over time rather than a single assessment/class. Moreover, their assessment of PA intensity was based on observation rather than accelerometer-based assessment. To address these limitations, the present study recruited 28 elementary schools, with 149 teachers to implement the lessons, and 2716 4th grade students as participants. This is a sample that provides the power to conduct the appropriate hierarchical model for data nested within classrooms and to test for potential moderating effects for demographic sub-group. Research staff conducted TOT observations for all participants in full class sessions in conjunction with active or traditional sedentary control lessons. PA was assessed with GT3X+ accelerometers to accurately assess intensity. As a result, this is the first study to provide the power and appropriate design to conduct a hierarchical analysis of the moderating role of both PA intensity and demographic subgroups on the impact of active learning on TOT.

2. Methods

2.1. Participants

Students and parents were recruited from 28 schools (n = 19 intervention; n = 9 control) with 149 teachers (n = 99 intervention; n = 50 control) to participate in the parent study, Texas Initiatives for Children's Activity and Nutrition (I-CAN!) program over the years 2012–2015. The I-CAN! program focuses on implementing active lessons in the classroom for 10–15 min for 5 days during the school week (Bartholomew et al., 2017). Schools were recruited for study participation and agreed to be randomly assigned to one of 3 possible conditions: control, intervention language arts, or intervention math. Once schools were recruited for the next year of the study, they were then grouped into sets of 3 based on similar demographics and size. Once the sets of 3 were created, the 3 schools within each set were then randomly assigned to conditions. All students in the 4th grade from these schools were recruited to participate in I-CAN!. For more details on the design see Bartholomew et al. (2017). Both parents and students provided informed consent prior to the start of the study. The institutional review boards for each of the four school districts as well as The University of Texas at Austin approved this study.

I-CAN! active lessons include a series of general games (e.g. freeze tag, relay races) focused on either math or language arts academic material. These active lessons are designed to engage students in moderate-intensity aerobic PA, but the resulting level of activity is dependent upon the specific lesson chosen and implemented by the teacher. Results for the impact of I-CAN! on child PA can be found in Bartholomew et al. (2018). The current study examined the impact of a single, acute bout of PA during the active lesson and its impact on TOT compared to a traditional academic lesson. A traditional academic lesson consists of students seated at their desks and listening to the teacher present the material or students are seated completing a teacher assigned task.

Student demographic information (i.e. sex, age, race/ethnicity, eligibility for free/reduced lunch) was obtained through school records. Table 1 presents the demographic information for schools and students participating in the study. Schools were 9.5% Black, and 46.3% White, with 32.0% Hispanic. In each school, an average of 21.0% of students were eligible for free or reduced-priced lunch. To establish baseline equivalence, students were compared in the treatment and control conditions on the characteristics presented in Table 1. There were no statistically significant differences (p-values ranged from 0.09 to 0.51).

Table 1
Demographic characteristics of schools and students.

	Overall	Treatment	Control
School characteristics	j = 28	j = 19	j = 9
Mean % economically disadvantaged	34.31	35.43	31.69
Mean race			
% Hispanic	31.99	33.06	29.51
% African American	9.51	9.73	8.97
% White	46.26	46.54	45.60
Student characteristics	n = 2716	n = 1903	n = 813
Male	45.90	49.00	43.90
Free/reduced priced lunch	21.70	23.60	19.70
Race			
Hispanic	22.9	24	22.9
American Indian/Alaska native	1.1	1.4	0.5
Asian	6.3	4.4	11.4
African American	7.7	8.3	7.1
Native Hawaiian	0.1	0.1	0.2
White	45.8	49.2	42.7
Multi	4.7	4.8	4.9
Missing	11.5	7.9	10.2