International Electronic Journal of Elementary Education, 2012, 4(3), 473-487.

Student Academic Performance Outcomes of a Classroom Physical Activity Intervention: A Pilot Study

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Received: June, 2012 / Revised: June, 2012 / Accepted: July, 2012

Abstract

A Physical activity is beneficial to children's health, yet academic pressures limit opportunities for students throughout the school day. The purpose of this study was to determine the effect of a classroom PA intervention on student academic performance outcomes. Intervention participants (n=15) received daily PA breaks. Reading and mathematics fluency, PA, grades, and standardized test scores were collected. Effects of the intervention were examined using mixed-design ANOVAs. Intervention students had significantly higher reading fluency and mathematics scores post-intervention and higher means for standardized reading and mathematics scores as well as grades. Short bouts of PA are important for improving CBM math and reading fluency scores. Classroom teachers should be encouraged to devote time during academic learning to incorporate PA.

Keywords: Curricular Intervention, Academic Achievement, Child Health, Curriculum-Based Measurement

Introduction

Throughout the last three decades, children have become increasingly more sedentary given the changes in our modernized environment (Centers for Disease Control and Prevention [CDC], 2009; Stevens, To, Stevenson & Lochbaum, 2008). Schools have been identified as locations in which physical activity (PA) promotion should occur (Pate, Davis, Robinson, Stone, McKenzie & Young, 2006). *No Child Left Behind* legislation has led to budget cuts and increased pressure for schools to increase standardized test scores, thereby leaving schools

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ISSN:1307-9298

www.iejee.com

to reduce or even eliminate programs that could enhance PA in children (Chomitz, Slining, McGowan, Mitchell, Dawson & Hacker, 2009; Coe, Pivarnik, Womack, Reeves & Malina, 2006; Sibley & Etnier, 2003). During school hours, the decrease of PA through limited time spent in physical education class or recess breaks contributes to the significant increase of sedentary behaviors in children. Fewer children walk or ride their bicycles to school, and PA is increasingly being replaced with television watching, time spent on the Internet, and the ubiquitous playing of video games (CDC, 2009; Stevens et al., 2008; World Health Organization [WHO], 2009). Experts recommend that children engage in 60 minutes or more of moderate to vigorous PA per day (Strong, Malina, Blimkie, Daniels, Dishman, Gutin…Trudeau, 2005), yet studies have found that only 42% of children ages 6-11 years obtain this goal (Troiano, Berrigan, Dodd, Masse, Tilert & McDowell, 2008).

When addressing health outcomes, typically the physical benefits are discussed; however, participating in physical activities has also shown a significant and positive effect on children's cognitive functioning (Fedewa & Ahn, 2011; Trudeau & Shephard, 2010) and academic outcomes, with no detrimental effects to learning when time is taken away from instruction (Sibley & Etnier, 2003). Researchers theorize that children receive cognitive benefits from participating in PA through a number of mediating processes (Basch, 2010; Trudeau & Shephard, 2010). In a review of the literature, Trudeau and Shephard (2010) identified physiological influences such as greater arousal and enhanced levels of neurotrophins that stimulate neural connections in the hippocampus or learning center of children's brains. Further, additional psychosocial influences were also found in the literature, including an increased level of self-esteem and connectedness in schools, likely enhancing children's ability to learn (Trudeau & Shephard, 2010). Research attempting to identify the mediating relationships between children's levels of PA and cognitive outcomes are limited by methodology employed in most of the studies (see Fedewa & Ahn, 2011), and thus the specific causal pathways between PA and children's cognitions have yet to be identified.

To date, most of the research examining the academic and cognitive effects of children's PA has been measured through traditional, standardized tests or grades. Although helpful in assessing the long-term effects of PA interventions on children's cognitive outcomes, these traditional measures are not useful in assessing short-term gains or improvement as a result of the intervention (Bricker, Yovanoff, Capt & Allen, 2003; Pretti-Frontczak, 2002). Given that PA interventions are not typically implemented over long durations of time (i.e., greater than one academic year), it is likely that effects of these interventions may be missed due to the measurements used to assess academic or cognitive gains (see Macy, Bricker & Squires, 2005).

Curriculum-Based Measurements (CBMs)

One way of assessing academic gains over short periods of time is through the use of CBMs. CBMs are research-based assessments used in schools to ascertain student achievement on basic skills such as reading, math, writing, or spelling. In response to the limitations of traditional, standardized tests, CBMs were developed in the 1970s as a means of monitoring children's response to an intervention (see Reschly, Busch, Betts, Deno & Long, 2009). These measures are well known and utilized by many teachers, school psychologists and other school personnel, as they are sensitive to small growth over time, are inexpensive, and translate into targeted goals for student achievement (Macy et al., 2005; Reschly et al., 2009). In a recent meta-analysis, Reschly and colleagues (2009) were able to demonstrate the strong predictive validity ($r = .67$) of a particular type of CBM — oral reading fluency measures — on children's future reading achievement and high-stakes standardized assessments. The cumulative evidence over the past three decades has been remarkable for these measures given the relatively minimal resources in terms of cost and administration time.

As pressures for high stakes testing increase and the time children spend engaged in PA decreases, considerable evidence is needed to demonstrate the effectiveness of classroom-based interventions that promote PA during the school day. Yet despite this need, there is a dearth of research assessing the effectiveness of classroom-based PA interventions on children's learning outcomes. These types of interventions have, however, been shown to significantly increase student PA levels and intensity in the classroom (Cardon, De Clercq, De Bourdeaudhuij & Breithecker, 2004; Erwin, Abel, Beighle & Beets, 2009; Erwin, Beighle, Morgan & Noland, 2011; Gibson, Smith, DuBose, Greene, Bailey, Williams…Donnelly, 2008; Liu, Hu, Ma, Cui, Pan, Chang, et al., 2007; Mahar, Murphy, Rowe, Golden, Shields & Raedeke, 2006; Stewart, Dennison, Kohl & Doyle, 2004), as well as result in enhanced health outcomes such as improved BMI (Liu et al., 2007), decreased back/neck pain (Cardon et al., 2004), increased bone strength (Macdonald, Kontulainen, Khan & McKay, 2007; Macdonald, Kontulainen, Beck, Khan & McKay, 2008), and noise reduction in the classroom. All of these positive outcomes result in an increased ability to concentrate (Norlander, Moas & Archer, 2005).

In the handful of studies assessing the impact of classroom-based PA on children's academic performance, a number of benefits have been found. In particular, students have improved their behaviors (Maeda & Randall, 2003; Mahar et al., 2006), concentration (Lowden, Powney, Davidson & James, 2001; Norlander et al., 2005), recognition and memory (Della Valle, Dunn, Dunn, Geisert, Sinatra & Zenhausern, 1986), and reading and mathematical skills (Fredericks, Kokot & Krog, 2006; Uhrich & Swalm, 2007) from physical activities performed in the classroom setting.

Embedded within the need to establish effective PA classroom interventions are measures that are sensitive to incremental changes in students' academic growth. CBMs will not only allow for progress monitoring but also assesses students on content in which they are being exposed through their instruction. By using measures that detect small changes in academic growth, it may be possible to more accurately detect whether PA is exerting a positive effect on children's rate of learning or ability to retain material. Thus, the purpose of the current pilot study was twofold. First, the study aimed to evaluate whether implementing curricular PA positively influenced children's reading and mathematics achievement. Second, the relationship of CBMs with other standardized measures and grades used in assessing children's reading and mathematics achievement will be measured in order to examine its potential for further use as an academic assessment tool in monitoring the effectiveness of PA interventions. Because CBMs have not been used before as a tool for measuring the impact of curricular PA on children's academic outcomes, the present study serves as a pilot in investigating these questions.

Methods

Participants

Participants included 29 3rd grade students (M_{age} = 8.87, *SD* = .54) from one Southeastern elementary school (two classrooms). Students were assigned to intervention (*N* = 16) and control (*N* = 13) conditions via a quasi-experimental design (by homeroom class) over a 20-week intervention period. One classroom served as the treatment, while another classroom served as the control. Procedures were approved by the lead author's Institutional Review Board, and all parents/guardians signed an informed consent form, while all child participants completed an assent form to participate.

Instrument

Measurements of reading fluency, mathematics aptitude, grades, standardized test scores, classroom behavior, and school day PA were collected for all participants.

Two CBMs.Reading and mathematics fluency. Specifically, curriculum-based reading fluency and mathematics measures are short progress measures designed to assess children's reading and mathematical fluency (Stecker & Lembke, 2005). Criterion validity coefficients for curriculum-based measurements are .80-.90 for reading and .between .60-.80 for mathematics (Foegen, Jiban & Deno, 2007; Jitendra, Sczesniak & Deatline-Buchman, 2005). The oral reading fluency measures consisted of three reading passages wherein the child would read aloud for one minute, with the examiner recording the number of words correctly read for each passage. The median score out of the three reading passages was used for the child's oral reading fluency score at each of the three time points. For mathematical fluency, grade-appropriate mathematical problems consisting of addition, subtraction, and basic multiplication were given on a classwide level to the students every two weeks. The students were given one minute to complete as many problems as they could with the number of correct responses used as their mathematical fluency score for each of the three time points. The psychometric properties of these instruments are described in the results section.

Grades. Each classroom teacher also provided student grades for reading and mathematics at each of the three designated time points throughout the school year (December 2009, March 2010, May 2010). These were recorded as percentages (out of 100).

Standardized test scores. A number of different standardized tests were administered at different points throughout the school year. At the beginning and end of the school year, students took the Test of Primary Reading Outcomes (T-PRO), which assesses phonics, vocabulary, comprehension, and research skills, as well as Standardized Testing and Reporting (STAR) Reading tests (r=0.93; http://www.cde.ca.gov/ta/tg/sr/technicalrpts.asp), which coincide with the Accelerated Reader program. At three time points (August 2009, December 2009, and March 2010), the students completed the Discovery Education Assessment which assesses reading/language arts and mathematics. The outputs rate the students at levels, which are determined by the number of correct responses. These levels were recorded as: novice = 1, apprentice = 2, proficient = 3, and distinguished = 4.

Physical activity. To measure school day PA, participants wore a pedometer (Walk4Life, LS 2500, Plainfield, IL) for five consecutive school days, which is consistent with recommendations of monitoring periods for this age of children (Vincent & Pangrazi, 2002). This pedometer brand and model has been found to produce reliable and valid scores when used with children (Beets, Patton & Edwards, 2005).

Procedures

Curriculum-based reading and mathematics fluency. During the baseline week (September, 2010), trained researchers administered the reading fluency probes and each classroom teacher administered the mathematics assessments for all students. The same procedures were followed once every two weeks using different forms (alternate passages and worksheets validated for the purposes of alternate use) of the reading and math standardized assessments designed to measure small progress over time (Stecker & Lembke, 2005).

Physical activity. To prevent reactivity with the pedometers, participants were given the opportunity to handle the pedometer, open it, and practice applying and removing it from their waistband prior to data collection. On the first day of data collection, each participant was assigned a pedometer to be used for the duration of the study. Upon entering the classroom first thing in the morning, students were instructed to wear the pedometer on their waistband for the entire school day. Immediately prior to dismissal, students returned their pedometer to the assigned bin. Their data were recorded on a data sheet and reset for use the next day. This occurred during five days of baseline and one random day per week during the intervention.

The classroom teacher of the intervention group led PA breaks for 20+ minutes per day. She maintained a log of all PA breaks she provided including the name and nature of the PA break as well as the duration and time period. Each integrated PA break related to the math and reading content that was currently being taught. She participated in a 30-minute classroom PA training provided by an expert in classroom-based PA. The training took place prior to baseline data collection. During the training, the definition of PA, the importance of PA in the classroom, and the connection between PA and academic performance were presented. Additionally, managing children in PA settings and instructional means for presenting activity breaks to the students were emphasized. The intervention teacher was provided with *Promoting Physical Activity and Health in the Classroom* activity break cards (Pangrazi, Beighle & Pangrazi, 2009) and other web resources for classroom physical activities (i.e., Energizers, PE Central). In addition to the training and resources, the year prior to implementation of the intervention, the intervention classroom teacher took two graduate courses related to PA promotion with youth and teaching effectiveness in PA settings. The courses each addressed classroom PA breaks.

The classroom teacher of the control group did not provide these PA breaks to her students. In lieu of the PA breaks, students in the control group continued with traditional, in-seat learning of the content. This included teacher-directed instruction, individual student seatwork, and partner or group work at desks. All students had the same amount of time allotted for physical education (two 30-minute classes per week) and recess (one 30-minute session per day).

Data Analysis

The validity of curriculum-based measurement (research question 1) was addressed by examining the extent to which a particular test (i.e., CBM) correlates with previously validated measures (i.e., standardized test scores and teacher-reported grades). Therefore, scores from CBM's, standardized test scores, and teacher reported grades were correlated and compared separately for reading and mathematics achievement. Of nine repeated CBM measures, only scores at baseline, time 5, and time 8—which were collected at the same time points as standardized test scores and teacher grades of mathematics and reading—were correlated with the other two measures such that differences in the number of repeated measures were controlled and further students' performance on different measures were compared concurrently.

Next, the intervention effects of PA on mathematical and reading performances (research question 2) were examined, using a series of mixed-design ANOVAs. To control for differences in the number of repeated scores, the authors chose three CBM scores at baseline, time 5, and time 8. Therefore, for reading and mathematics achievement, two sets of mixed-design ANOVA—using time and measures as within-subject factors and the type of intervention as a between-subject factor—were performed.

Results

Validity of Curriculum-Based Measurement

The concurrent validity of the curriculum-based measurement was evaluated based on inter-correlations among all three measures (i.e., CBM, standardized test scores, and teacher ratings of students' grades) on reading and mathematics, separately. Table 1 and Table 2 show correlations among scores from CBM, standardized test scores, and teachers' reported grades for the control group in the upper diagonal of the matrix and for the treatment group in the lower diagonal of the correlation matrix for mathematics and reading, respectively.

As shown in the shaded areas of Table 1, mathematics scores from CBM had small to large correlations with standardized test scores on mathematics for both control and intervention groups. However, the correlations between CBM scores and grades were small and insignificant. As shown in the shaded areas of Table 2, reading scores from CBM, standardized scores, and grades were correlated with a small to large magnitude. Patterns of correlations among three measures on reading were similar between intervention and control groups, showing lower correlations between CBM scores and grades, yet higher correlations between CBM scores and standardized test scores.

Intervention Effect on Mathematics Achievement

A preliminary analysis was first performed to determine whether any preexisting differences on mathematics scores existed between control and intervention groups. Results from three sets of independent t-tests showed that the intervention group was not statistically different from the control group on CBM scores ($t(27) = -.87$, $p = .39$), standardized test scores ($t(25) = -.24$, $p = .81$), or teacher's reporting of students' grades ($t(25)=-2.52$, $p = .05$), indicating no statistically significant pre-existing differences at the baseline measures of mathematics between the two groups.

Mauchly's tests indicated that the assumption of sphericity was violated for the main effects of measure, $\chi^2(2) = 10.94$, $p = .004$, and interaction effect between measure and time, $\chi^2(9) = 23.58$, $p = .005$, but not for the main effect of time ($\chi^2(2) = 2.43$, $p = .30$). Therefore, degrees of freedom were corrected using the Huynh-Feldt estimates of sphericity (Gamst, Myers & Guarino, 2008) for measure ($\varepsilon = .78$) and interaction between measure and time ($\varepsilon = .77$). As shown in Table 3, a mixed-design ANOVA showed that the main effects of time ($F(2, 44) =15.52$, $p < .01$, partial $\eta^2 = .41$), measures ($F(1.56, 34.36) = 2716.32$, $p < .01$, partial $\eta^2 =.99$), and intervention ($F(1, 22) = 7.49$, $p = .01$, partial $\eta^2 =.25$) were statistically significant. Further, two-way interactions between time and measure ($F(3.08, 67.84) = 8.67$, $p < .01$, partial $\eta^2 = .28$) and three-way interactions among time, measure, and intervention ($F(3.08, 67.84) = 6.49$, $p < .01$, partial $\eta^2 = .23$) were statistically significant.

Because a higher-order interaction supersedes lower-order effects (Gamst, Myers & Guarino, 2008), follow-up tests were performed to further investigate the three-way interaction among time, measure, and intervention in detail. Tests of simple effects showed a significant two-way interaction effect between time and intervention for CBM scores ($F(2,26) = 10.31$, $p <.01$), but not for standardized test scores ($F(2,21) = 2.63$, $p = .10$) or teachers' reported grades ($F(2,23) = 1.59$, $p = .23$) . As shown in Figure 1, the intervention group ($M = 24.56$, $SD = 2.21$) scored significantly higher on CBM scores than the control group ($M = 13.69$, $SD = 2.45$) at time 3 ($M_{\text{diff}} = 10.87$, $p = .003$), but not time 1 ($M_{\text{diff}} = 2.75$, $p = .39$) or time 2 ($M_{\text{diff}} = 2.16$, $p = .49$).

Table 1. *Correlations among CBM, Standardized Test Scores, and Grades on Mathematics*

Time3	Time2	Time1	Test: Time3	Test: Time2	Test: Time1	CBM: Time3	CBM: Time2	CBM: Time1	
.445	.386	.370	.741**	.646*	.544	.883**	.895**	1	CBM Time1
.235	.422	.306	.842**	.685*	.464	.753**	1	.359	CBM Time2
.379	.273	.130	.722**	.690*	.579*	1	.424	.843**	CBM Time3
.697**	.661*	.516	.561	.686*	1	.483	.311	.423	Test Time1
.488	.708**	.219	.851**	1	.782**	.548*	.526	.585*	Test Time2
.336	.498	.327	1	.402	.352	.280	.165	.581*	Test Time3
.647*	.508	1	-.277	.463	.002	.505	.019	.420	Grades Time1
.408	1	.070	.337	-.013	.582*	.107	-.254	.216	Grades Time2
1	.011	.670**	.067	.632*	.394	.666**	.167	.544*	Grades Time3

Note. $^{**}p < .01$; $^{*}p < .05$

Table 2. *Correlations among CBM, Standardized Test Scores, and Grades on Reading*

Grades: Time3	Grades: Time2	Grades: Time1	Test: Time3	Test: Time2	Test: Time1	CBM: Time3	CBM: Time2	CBM: Time1	**0**
.445	.386	.370	.741**	.646*	.544	.883**	.895**	1	CBM Time1
.235	.422	.306	.842**	.685*	.464	.753**	1	.359	CBM Time2
.379	.273	.130	.722**	.690*	.579*	1	.424	.843**	CBM Time3
.697**	.661*	.516	.561	.686*	1	.483	.311	.423	Test Time1
.488	.708**	.219	.851**	1	.782**	.548*	.526	.585*	Test Time2
.336	.498	.327	1	.402	.352	.280	.165	.581*	Test Time3
.647*	.508	1	-.277	.463	.002	.505	.019	.420	Grades Time1
.408	1	.070	.337	-.013	.582*	.107	-.254	.216	Grades Time2
1	.011	.670**	.067	.632*	.394	.666**	.167	.544*	Grades Time3

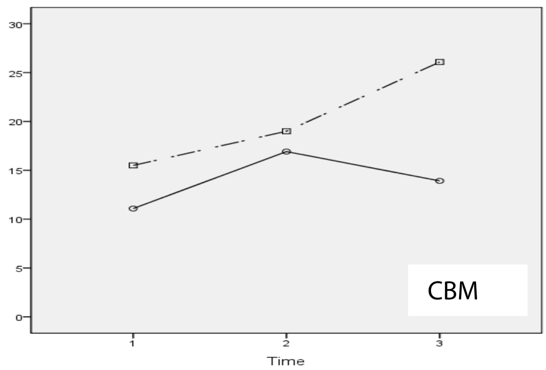
Note. ** $p < .01$; * $p < .05$

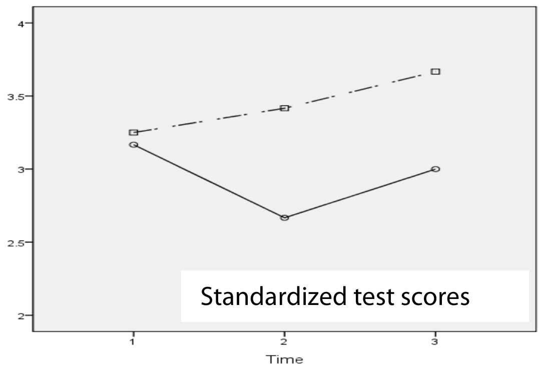
Table 3. *Results from Mixed-design ANOVA on Mathematics*

Source	*SS*	*df*	*MS*	*F*	*p*	Partial η^2
Time	563.18	2	281.59	15.52	<.01	.41
Time * Intervention	76.95	2	38.48	2.12	.13	.09
Error (Time)	798.31	44	18.14			

Table 3 (Continue). *Results from Mixed-design ANOVA on Mathematics*

Source	*SS*	*df*	*MS*	*F*	*p*	Partial η^2
Measure	330133.93	1.56	211367.38	2716.32	<.01	.99
Measure * Intervention	341.37	1.56	218.56	2.81	.09	.11
Error (Measure)	2673.81	34.36	77.81			
Time * Measure	432.63	3.08	140.30	8.67	<.01	.28
Time * Measure * Intervention	323.74	3.08	104.99	6.49	.<.01	.23
Error (Time * Measure)	1097.19	67.84	16.17			
Intervention	872.02	1	872.02	7.49	.01	0.25
Error	2562.85	22	116.49			





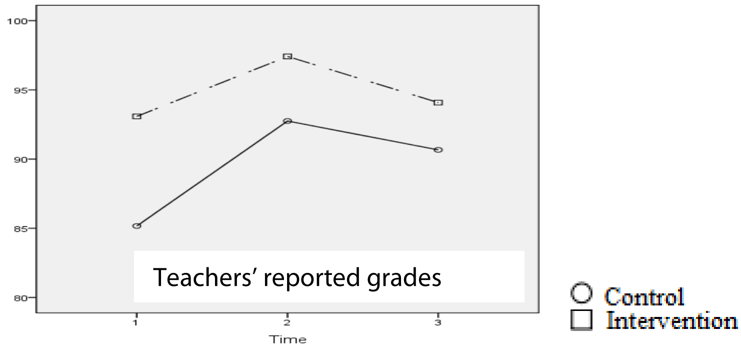


Figure 1. Mathematics across Time by Intervention Groups

Intervention Effect on Reading Achievement

Results from three sets of an independent t-test indicated no pre-existing differences between control and intervention groups on all three measures of reading achievement, $t(27) = -1.48$, $p = .15$ for the CBM scores, $t(26) = -.97$, $p = .34$ for standardized test scores, or $t(25) = -1.39$, $p = .18$ teacher's rating of students' grades.

Mauchly's tests indicated that the assumption of sphericity had been violated for the main effects of measure, $\chi^2(2) = 80.06$, $p < .01$, and interaction effect between measure and time, $\chi^2(9) = 48.35$, $p < .01$, but not for the main effect of time ($\chi^2(2) = .22$, $p = .90$). Therefore, degrees of freedom were corrected using the Huynh-Feldt estimates of sphericity (Gamst, Myers & Guarino, 2008) for both measure ($\varepsilon = .53$) and interaction between measure and time ($\varepsilon = .67$). A mixed-design ANOVA showed statistically significant main effects of time ($F(2, 40) = 14.39$, $p < .01$, partial $\eta^2 = .42$), intervention ($F(1, 22) = 353.51$, $p < .01$, partial $\eta^2 = .95$) and measures ($F(1.06, 21.23) = 95.27$, $p < .01$, partial $\eta^2 =.83$) as well as two-way interactions between time and measure, $F(2.67, 53.29) = 7.66$, $p < .01$, partial $\eta^2 =.28$.

The significant two-way interaction between time and measure was examined by testing the simple effects of measures at each time point. Pairwise comparisons using a Bonferroni adjustment indicated that the CBM scores were statistically higher than standardized test scores for all three time points ($M_{diff} = 79.46$, $p <.01$ for time 1; $M_{diff} = 87.41$, $p <.01$ for time 2; $M_{diff} = 92.46$, $p <.01$ for time 3). Similarly, students scored higher on standardized test scores than teachers' reported grades for all three time points ($M_{diff} = 88.50$, $p <.01$ for time 1; $M_{diff} = 90.73$, $p <.01$ for time 2; $M_{diff} = 91.91$, $p <.01$ for time 3). However, no differences were found between CBM scores and teachers' reported grades for any of the three time points.

Table 4. *Results from Mixed-design ANOVA on Reading*

Source	*SS*	*df*	*MS*	*F*	*p*	Partial η^2
Time	1015.12	2	507.56	14.39	<.01	.42
Time * Intervention	11.40	2	5.70	0.16	.85	.01
Error (Time)	1410.59	40	35.26			
Measure	344423.48	1.06	324414.61	95.27	.<.01	.83

Measure * Intervention	7829.28	1.06	7374.45	2.17	.16	.10
Error (Measure)	72308.34	21.23	3405.38			
Time * Measure	1015.48	2.66	381.11	7.66	<.01	.28
Time * Measure * Intervention	11.02	2.66	4.14	0.08	.96	.00
Error (Time * Measure)	2649.72	53.29	49.72			
Intervention	757396.55	1.00	757396.55	353.51	<.01	0.95
Error	5912.75	1.00	5912.75	2.76	.11	0.12

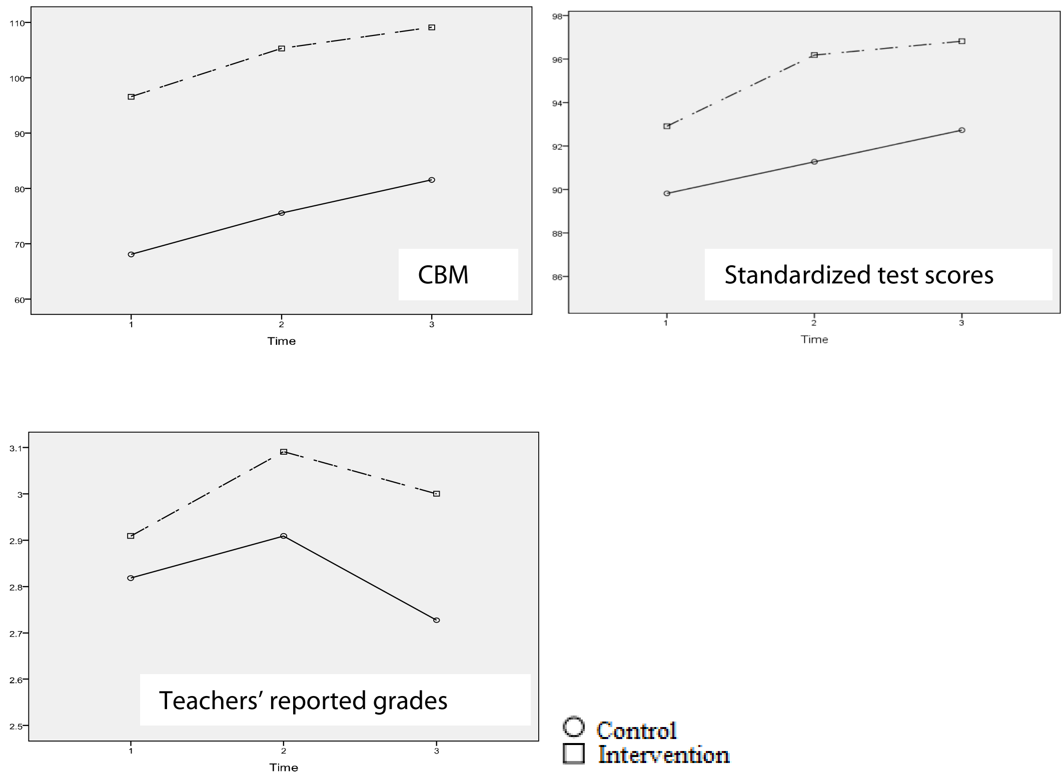


Figure 2. Reading across Time by Intervention Groups

Discussion

The present study sought to evaluate the potential effectiveness of implementing curricular PA on children's reading and mathematics achievement. Second, the authors examined the validity of curriculum-based measures with other standardized measures and grades in assessing children's reading and mathematics achievement. Each of these questions will be discussed with respect to the findings of the current study as well as implications for classroom teachers.

The results of the current study suggest that curricular PA had a significantly positive effect on children's CBM reading and mathematics scores. Given the short increments of time in which these measures were administered, it is likely that CBMs were better able to pick up small increments of growth in children's achievement than were standardized test scores. The results of the additional PA on children's reading and mathematics scores that was implemented in the treatment group confirm the general body of research in this area, suggesting that PA may enhance children's cognitive outcomes (Fedewa & Ahn, 2011; Sibley & Etnier, 2003; Trudeau & Shephard, 2010).

When examining mathematics scores, in particular, CBM scores for the control group peaked at Time 2 and dropped at Time 3, whereas the intervention group continued to improve upon their outcomes. With regard to standardized test scores, both groups scored similarly at Time 1; the control group dropped at Time 2, and both groups improved at Time 3. Again, the intervention group showed a consistent trend of improvement. Teachers' reported grades showed a jump at Time 2 and a slight drop at Time 3 for both groups. These trends suggest that PA enhanced learning for those students in the intervention group.

For reading, students in both groups showed improvement from Time 1 to Time 3 on CBM scores and teachers' reported grades. Standardized test scores for reading peaked at Time 2 and dropped for both groups at Time 3; however, the control group demonstrated a greater drop in scores than the intervention group. Thus, the PA intervention appeared to be more beneficial for mathematics. One possible explanation is that the PA breaks may have been more geared towards mathematics content thus leading to greater improvements in that area.

The last hypothesis examined whether CBMs are valid measures of assessing students' achievement over time in comparison to standardized test scores and teacher grades. As mentioned earlier, although standardized test scores may be helpful in assessing the long-term effects of PA interventions on children's cognitive outcomes, these traditional measures are not useful in assessing short-term gains or improvement as a result of the intervention (Bricker et al., 2003; Pretti-Frontczak, 2002). In the vast majority of PA intervention research, durations of curricular interventions are not typically implemented for longer than one academic year, thus necessitating a measure that can capture small increments of achievement growth.

In the present study, it was hypothesized that CBMs would provide a more accurate indicator of student academic progress than standardized test scores given the short 20 week duration of the study. It was discovered that students in the treatment group had significantly higher scores in reading and mathematics when assessed by CBMs, but that this difference did not reach significance when compared by standardized test scores or teacher grades. Further, the reading and mathematics CBMs were moderately to largely correlated with the standardized test scores while teacher grades were not correlated with either CBM or standardized test scores. These are very promising findings, as the inclusion of CBM assessments in measuring the effects of curricular PA interventions should be strongly considered. CBM assessments are short, accurate, and reliable measures that have been used to assess student academic progress for over four decades (Reschly et al., 2009). Perhaps by using standardized test scores or teacher grades as indicators of student academic progress, the beneficial effects of PA interventions have been missed in the literature. The current study provides preliminary evidence for the benefits of using CBMs in measuring students' academic growth as a result of curricular PA interventions.

In conclusion, allotting 20+ minutes per day to provide curricular-based PA breaks to students does not appear to detract from student performance outcomes, behavior or PA levels. In fact, reading and math scores (as measured by CBMs) significantly improved, while PA levels showed a trend of increasing due to this type of intervention. Elementary teachers should be encouraged to incorporate PA during their lessons in the classroom setting due to the multiple positive student outcomes.

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Acknowledgements

The authors would like to thank Lydia Childress and her students for participating in this research project. We enjoyed her passion for doing physical activity with her students.

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