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# Active Learning Increases Children's Physical Activity across Demographic Subgroups

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## Abstract

**Purpose—**Given the need to find more opportunities for physical activity within the elementary school day, this study was designed to asses the impact of I-CAN!, active lessons on: 1) student physical activity (PA) outcomes via accelerometry; and 2) socioeconomic status (SES), race, sex, body mass index (BMI), or fitness as moderators of this impact.

**Methods—**Participants were 2,493 fourth grade students (45.9% male, 45.8% white, 21.7% low SES) from 28 central Texas elementary schools randomly assigned to intervention (n=19) or control (n=9). Multilevel regression models evaluated the effect of I-CAN! on PA and effect sizes were calculated. The moderating effects of SES, race, sex, BMI, and fitness were examined in separate models.

**Results—**Students in treatment schools took significantly more steps than those in control schools (β = 125.267, SE = 41.327, p = .002, d = .44). I-CAN! had a significant effect on MVPA with treatment schools realizing 80% (β = 0.796, SE =0.251, p = .001; d = .38) more MVPA than the control schools. There were no significant school-level differences on sedentary behavior (β = −0.177, SE = 0.824, p = .83). SES, race, sex, BMI, and fitness level did not moderate the impact of active learning on step count and MVPA.

**Conclusion—**Active learning increases PA within elementary students, and does so consistently across demographic sub-groups. This is important as these sub-groups represent harder to reach

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**Contributors' Statement**
John B. Bartholomew: Dr. Bartholomew conceptualized and designed the study, drafted the initial manuscript, and approved the final manuscript as submitted.
Esbelle M. Jowers: Dr. Jowers contributed to the conceptualization and design of the study, reviewed and revised the manuscript, and approved the final manuscript as submitted.
Gregory Roberts, Anna-Mària Fall: Drs. Roberts and Fall carried out analyses, drafted the results, reviewed and revised the manuscript, and approved the final manuscript as submitted.
Vanessa L. Errisuriz: Dr. Errisuriz coordinated and participated in data collection at all sites, reviewed and revised the initial manuscript, and approved the final manuscript as submitted.
Sharon Vaughn: Dr. Vaughn carried out analyses, reviewed and revised the manuscript, and approved the final manuscript as submitted

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populations for PA interventions. While these lessons may not be enough to help children reach daily recommendations of PA, they can supplement other opportunities for PA. This speaks to the potential of schools to adopt policy change to require active learning.

**Keywords**

children; active learning; elementary school; physical activity

## Introduction

Strong evidence exists for the benefit of regular physical activity (PA) on a host of health outcomes, from prevention of cardiovascular disease (CVD) (1) to several cancers, including colon (2), breast (3), and endometrial (4). The importance of a physically active lifestyle begins in childhood. Although it is recommended that children obtain at least 60 minutes of moderate-to-vigorous intensity physical activity (MVPA) each day (5,6), it is estimated that fewer than half of U.S. children are meeting these recommendations. This is particularly problematic for children who are overweight. Estimates show that only 18.6% of overweight and 15.4% of obese children meet the recommendation for PA (7). While PA has been shown to reduce cardiovascular risk in children (8), particularly in those who maintain activity into young adulthood (9), for most children the level of PA declines from childhood to adolescence (10). It is, therefore, important to intervene in the elementary years.

Given that children spend up to 30 hours at school - 73% of that time spent wholly sedentary (11) - it is important to consider interventions to create opportunities for increased PA in this context. However, increasing pressure for academic success has negatively impacted the school PA environment and reduced opportunities - such as recess and physical education (PE) - for children to be active in school (12). To address the reduction of in-school PA opportunities, innovative approaches, such as the implementation of physically active learning, have been developed. Active learning is built around teacher-implemented academic lessons that are designed to incorporate 10–15 minutes of PA as a part of the lesson. Several programs have been developed recently that combine moderate-to-vigorous movement with the teaching or review of academic content across the United States and globally, including Energizers (13), Take 10! (14), Physical Activity Across the Curriculum (15,16), Texas Initiatives for Children's Activity and Nutrition (I-CAN!) (17), Active Classrooms (18), Fit & Vaardig op School (F&V) (19), and Encouraging Activity to Stimulate Young (EASY) Minds (20).

While previous research has indicated that active learning lessons are successful in increasing the amount, duration, and intensity of PA, these studies are limited by their assessment of PA. PA has been assessed in a variety of ways across interventions, such as pedometers (17,21), the SOFIT observation system (15,22), and accelerometry (17,18,20,23). Accelerometry has become the standard method for measuring PA in free-living children (24). However, those that have used this method have only done so among a random sample of participants ranging from n=20 (18) to n=200 (17). Further, it is unclear how representative the randomly sampled participants are of the larger sample. Therefore, it

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is necessary to assess PA with accelerometers during these types of interventions on a much larger scale to gain a better understanding of how physically active lessons impact PA.

In addition, because the previous research has been with relatively small samples, it has been insufficiently powered to examine whether active learning differentially impacts children's activity based on demographic characteristics, such as sex, race, BMI, or fitness level. There are a limited number of studies that have investigated whether the impact of active learning on PA outcomes differed by demographic characteristics. Of these, one study only found improvement in PA levels among those girls that were least active at baseline (25). Another study compared PA between BMI groups (normal versus at-risk/overweight children) and found that normal-weight children exhibited significantly more steps throughout the school day relative to at-risk or overweight children, but no difference during the intervention (26). Martin and Murtagh (18) examined the differences in amount of MVPA obtained during active lessons between girls and boys. Results indicated that girls accumulated slightly more MVPA than boys, but this difference was nonsignificant. Thus, the limited data to date indicate a relatively similar change across sub-groups. It is, however, important to confirm whether this intervention strategy consistently impacts subgroups of children, particularly those groups that have been historically been hard to reach (i.e. minorities, low-SES children). If active learning can consistently promote and engage numerous children in PA during the school day, it greatly increases the justification for policy that supports the inclusion of these interventions throughout the school day. Finally, as these lessons are completed in the regular education classroom by their classroom teacher, they are nested within classrooms and schools. The small samples to date do not allow for the appropriate, hierarchical statistical model to account for the nested nature of these data.

Therefore, the purpose of this study was to: 1) examine the impact of Texas I-CAN!, active lessons on student PA outcomes relative to control schools; to 2) determine whether SES, race, sex, BMI, or fitness moderate this impact; and to (3) do so within the appropriate hierarchical analysis.

## Methods

### Study Design

District approval for the Texas Initiatives for Children's Activity and Nutrition (I-CAN!) project was sought and obtained from four, central Texas school districts. Once district approval was obtained, research staff approached elementary schools within each district for participation. Fourth grade teachers and students were targeted for recruitment within each school. Teachers in schools were recruited as a team, and consent from each teacher was obtained for inclusion in the program. Consent was obtained from teams of teachers from twenty-eight elementary schools across three academic years (2012–2013, 2013–2014, 2014–2015). Schools were stratified by size and randomly assigned to condition (n=19 intervention and n=9 control) via computer generated random number. The difference in numbers is a result of the underlying 3 arm RCT, which included two experimental arms (math, spelling) and one control arm. Consequently, there were twice as many experimental as control schools. Despite this, the control condition included 743 students, from 50 classrooms in 9 schools, which is more than three times the number of students assessed

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with accelerometers in any study of active learning to date (n=200) (17). The control group therefore provides a sufficient comparison to the math (868 students, from 49 classrooms in 9 schools) and spelling (882 students, from 49 classrooms in 10 schools) experimental conditions. All fourth-grade students were eligible for inclusion in this study. Both parental consent and student assent were obtained for each student. All study protocols were approved by the university's Institutional Review Board.

## Sample Size Determination

Based on effect sizes found in previous research (15), a power analysis was conducted to determine the number of students needed to detect an effect of .40 at $p < .05$ for a three-level, hierarchical model (students nested within classrooms nested within schools). The power analysis resulted in a total sample of 15 students per class (total of 2,160 students) across 24 schools. Given the number of schools, we limited our study to a single grade. We selected $4^{th}$ grade as it serves as the mid-point of the upper, elementary grades that experience the most precipitous reductions in physical activity (10).

## Intervention

Once schools and teachers consented to be a part of the study, they were told of their assigned condition: 1) active math lessons, 2) active language arts lessons, or 3) traditional academic lessons. Students in schools assigned to active math or active language arts conditions received academic lessons in a specific content area (i.e. either math or language arts) injected with 10–15 minutes of PA, for instance math or spelling freeze tag. In this case, two students are designated as taggers and two as questioners. The rest are free to run within a set area. If tagged, the child stops running, performs an exercise skill such as hopping in place, and raises their hand. They are then approached by a questioner with content from class as selected by the teacher (e.g. vocabulary words, math facts). Once answered correctly, the child is free to run again and the questioner moves to the next tagged student. Other games (e.g. spelling or math relay) are completed in the classroom. Students in schools assigned to the control condition learned math and language arts content through traditional, sedentary academic lessons.

Intervention teachers underwent 1 day of training where they were taught how to implement lessons in their classrooms and received materials to assist them in implementing academic lessons (i.e. game equipment, ready-made lessons). Blinding to group assignment, was therefore, not possible.

## Attrition

Attrition and attrition-related bias in cluster randomized-control trials depends on attrition at both the cluster and the case levels. In the current sample, there was no school-level attrition (See Figure 1). At the student level, overall attrition for the three outcomes (step count, MVPA, sedentary) was 8.2%, which represents low student-level attrition. Differential attrition was 0.6%, suggesting a minimal threat to the study's internal validity (i.e., very low bias due to differential attrition) based on guidelines provided by the What Works Clearinghouse (27). Common reasons for attrition from the study included students' absence

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from schools on assessment days or moving to attend another school. Thus, the final sample included 2,493 fourth-grade students.

## Participants

Participant demographic information (i.e. sex, age, race/ethnicity, eligibility for free/reduced lunch, BMI) was obtained through school records. Schools were, on average, 31.99% Hispanic, 9.51% Black, and 46.26% White. About 21% of students were eligible for free or reduced-priced lunch, and 28.5% classified as overweight/obese. Thus, the sample was sufficiently diverse to adequately test these demographic variables as moderators of the impact of active learning on PA. To establish baseline equivalence across conditions, we compared students in the treatment and control groups on the characteristics presented in Table 1. No statistically significant differences were found ($p$-values ranged from .09 to .51). Moreover, there were no statistically significant demographic differences at the school level ($p$-values ranged from .74 to .98), suggesting that randomization produced two demographically comparable groups of schools at baseline. Table 1 presents demographic information for schools and students participating in the study.

## BMI and Aerobic Fitness

Both BMI and Aerobic Fitness were collected from school FITNESSGRAM® data (28). FITNESSGRAM® is completed each year by the PE teachers. While multiple components of fitness are assessed, this study centered on aerobic fitness as assessed through use of the Progressive Aerobic Cardiovascular Endurance Run (PACER) test.

## Physical Activity

PA data were collected over the course of one school week (five days). Schools were randomly assigned to have their students' data collected during the Fall or Spring semester of the academic year. During data collection week, students wore an Actigraph GT3X+ monitor in a belt around their waist, positioned on their right hip. The Actigraph GTX3X+ is widely considered the most valid and reliable accelerometer (29). The devices were initialized to collect data at a frequency of 30 Hz. Raw accelerometer data were then downloaded and integrated in 5 second epochs using ActiLife software, to best capture the variability in children's activity. Research staff were present at the beginning of each school day to properly affix the accelerometer around the students' waists. Research staff also instructed students to not take off the accelerometer at any point during the school day. At the end of each school day, research staff returned to ensure that students took off their accelerometers and returned them to staff until the following school day. Student PA outside of school (e.g. leisure-time, at home) was not collected for this study.

School start and end times were collected for each school, and filters were created within the ActiLife program to analyze the amount of PA students engaged in from when students arrived at the school until they left school. Research staff kept track of students who were absent or left early on each school day. Students who were absent or left early on more than one school day were excluded from analyses. Additionally, teachers were randomly observed on one day during data collection week. Research staff tracked start and end time of the I-CAN! or control lesson for that day. Filters were then created within the ActiLife

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program to analyze the amount of PA students engaged in during I-CAN! or control lessons. Students who were absent that day were excluded from analyses. PA data were analyzed with ActiLife software that applied Evenson (30) cut points to determine percent time in sedentary and MVPA.

### Data Analytic Strategy

We used multilevel regression models to evaluate the effect of the I-CAN! treatment on school day PA and PA during I-CAN! lessons. Multilevel modeling corrects for the statistical dependence that characterizes nested data, yielding correct standard errors and, ultimately, permitting unbiased significance tests (31). We nested students within classes and classes within schools and estimated the effect of treatment at Level 3 (the school-level). We also controlled for differences between districts by entering them as covariates (three dummy variables) at the school level. Effect sizes were calculated as a ratio, with the coefficient for the relevant model parameter in the numerator and the pooled standard deviation at posttest in the denominator (32). We evaluated the moderating effects of SES, race/ethnicity, sex, BMI, and fitness in separate multilevel regression models by including cross-level interactions (the product of student-level values for the potential moderators and school-level assignment to treatment) as well as a between-school Level 3 interaction terms (the product of school means on the potential moderators and assignment to treatment) to control for contextual effects (33). All analyses were conducted using Mplus 7.31 (34).

## Results

### Preliminary Analyses

Table 2 presents means and standard deviations across the two treatment groups for the outcome variables. We examined skewness and kurtosis values, residual plots, and histograms to assess normality, linearity, homoscedasticity, and outliers and the statistical assumptions underlying our models were reasonable, including assumptions related to the MVPA data which is scaled as a proportion (i.e., the distribution was not censored or otherwise non-normal). Variance for the step count variable was larger than the maximum allowed by M*plus* (1,000,000). For purposes of analysis, we divided school day step count by 100 and step count during the I-CAN! lesson by 10, which represents a linear transformation. Because the fixed part of a multilevel model is invariant for linear transformation (35), changing a variable’s scale changes its model-predicted coefficients and standard errors by the same factor (100 and 10 in this case, respectively). *P*-values are unaffected, and unstandardized coefficients for fixed model components can be back transformed, in this case by multiplying the model-derived value by 100 and 10, respectively (36).

To evaluate the clustering in the data, we fit the unconditional (i.e., no predictors) three-level model, which partitions total variance into its student-level, class-level, and school-level components. Among the general PA outcomes measures 43% of the variance in step count was across students, 27% was across classes, and 30% was across schools (Table 3). For MVPA and sedentary behavior, variance clustered at the student level (79% of MVPA, and 80% for sedentary behavior). Interclass correlations presented in Table 4 indicated that 50%

to 61% of the variance in PA measures during I-CAN! lessons occurred at the school level. The remaining variance lay between classrooms (13% – 17%) and between students (22% −34%).

## Main effect analysis

**School day physical activity—**The results of the main effect analysis are summarized in Table 3. Students in treatment schools took significantly more steps (an average of about 2,645 more weekly) than their counterparts in control schools ($\beta = 125.267$, $SE = 41.327$, $p = .002$), with a moderate effect, effect size = .44. The I-CAN! treatment also had a statistically significant effect on percent time in MVPA ($\beta = 0.796$, $SE = 0.251$, $p = .001$; effect size = .38). There were no statistically significant school-level differences on sedentary behavior ($\beta = -0.177$, $SE = 0.824$, $p = .83$).

**Physical activity during ICAN lessons—**The results indicated that the intervention had a significant impact on PA and participation in sedentary behaviors during I-CAN! lessons. More specifically, students in the treatment schools took significantly more steps ($\beta = 54.79$, $SE = 7.90$, $p = .00$; effect size = 1.49) during I-CAN! lessons and engaged in more MVPA ($\beta = 19.23$, $SE = 1.48$, $p = .00$; effect size = 1.80) during I-CAN lessons! than those in control schools. Students in treatment schools spent significantly less time sedentary ($\beta = -33.25$, $SE = 2.46$, $p = .00$; effect size = −2.03).

## Moderation analysis

To test the differential impact of treatment on school day PA and PA during I-CAN! lessons we performed multilevel moderation analysis. Results indicated no statistically significant differences in the impact of I-CAN! on step count and MVPA by race, sex, SES, BMI, or PACER-indicated fitness level (see Tables 3 & 4, Supplemental Content 1, which shows the non-significant moderation analyses).

# Discussion

This study was designed to assess the impact of a physically active learning intervention on PA in 4$^{th}$ grade students and to do so with an objective measure of activity across a large number of schools and a range of sub-groups. Results indicated that children in interventions schools took more steps (d=.44) and engaged in greater percent time in MVPA (d=.38) over the school week than did students in the control schools. This is equivalent to an additional 530 steps per day and about 3 minutes more MVPA per day (or 2,650 steps and 14.3 minutes more MVPA per week). Previous research has recommended a target number of 15,000 steps/day for boys and 12,000 steps/day for girls (37). Findings from the present study indicate that the magnitude of the effect of Texas I-CAN! on children's step counts is in-line with the moderate effects demonstrated in previous studies, ranging from $d = .46$ to $d = .54$ (13,25,38). The effect of I-CAN! on minutes of MVPA per week ($d = .41$) was also comparable to other research (15).

The difference in PA outcomes over the school week between intervention and control participants can primarily be explained by the active lessons. During active lessons, students,



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took 686 steps relative to 137 steps taken by students during traditional, sedentary lessons (*d* = 1.49). This is a difference of 549 steps, which is in line with the discrepancy seen in steps per day across the school week. Additionally, students in intervention conditions spent greater percent time in MVPA (22.47%) and less time sedentary (41.70%) compared to those in the control condition (3.32% MVPA, and 73.97% spent sedentary). These findings indicate that the active lessons were effective in promoting MVPA (*d* = 1.80) and reducing time spent sedentary (*d* = 2.03) relative to traditional lessons. In fact, these data demonstrate that students engaged in approximately 3.5 minutes of MVPA, 6 min sedentary, and 5.5 minutes in light activity during the I-CAN! lesson. In contrast, students participating in traditional academic lessons spent less than 30 seconds in MVPA, 11 minutes sedentary, and approximately 3.5 minutes in light activity. Thus, it appears that brief periods of active learning – be it Texas I-CAN! or other programs - provide a reliable means to provide meaningful amounts of PA for elementary grade students. These are, of course, mean data across all children within a condition, which can obscure the variability in response within any individual classroom. Specifically, examining the average time spent in MVPA across classrooms shows that classes within the intervention group ranged from 4.16% to 48.81% time spent in MVPA. This variation does not undermine the effectiveness of the intervention, as control classrooms averaged between 0.1% and 14.7% time in MVPA, and the overall impact of active learning on PA is clear. Instead, this variation speaks to the need to better understand how these lessons are implemented and the means to increase teacher fidelity. Texas I-CAN! is a teacher-implemented intervention with minimal training. While this enhanced the ability to generalize these data, it also likely led to high variation in accumulated PA in response to the intervention – an outcome that likely applies to other teacher-implemented, active learning interventions. Enhancing intervention fidelity is a critical area for future research.

This was the first RCT with intervention assigned at the school level with a sufficient sample size (approximately 2,500 children) to provide a well-powered test of demographic variables as potential moderators. Results indicated that the observed increase in PA was not moderated by SES, race/ethnicity, sex, BMI or fitness. Therefore, it appears that the benefits of active learning on PA is robust across most student sub-groups. This is a critical finding, as these sub-groups represent some of the harder to reach populations for PA interventions, i.e. minority children, females, and those with higher BMI. The consistency of results is likely due to the authoritarian role of the teacher. That is, when PA is a part of the standard, full-class academic lesson, there is less opportunity for students to choose inactivity. While this benefit has been argued to occur (17,39), this is the first study to directly test this possibility. This, then, supports wider efforts to disseminate physically active learning. The intervention integrated PA with academic content and was teacher-implemented with minimal training. As such, it is an easy to disseminate intervention that can result in approximately 10 minutes of additional PA across most children in a class and is highly palatability to schools. The present study is especially relevant as it supports the power of this approach to achieve a similar increase in PA across students.

One of the attractions of active learning is that it provides brief opportunities for physical activity that allow teachers to simultaneously provide academic content. In fact, these attributes are precisely why we expect teachers to implement these lessons. There is, of

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course, a downside. While our data indicate that these lessons will achieve significant increases in PA, the brief nature of the intervention resulted in an increase of only 530 steps and 3 minutes of MVPA at each implementation – a value that is not expected to have clinical significance in isolation. If we are going to realize the full translational goal of sufficient school-based PA to maintain and improve health, future research must consider how to support multiple implementations of active lessons and to integrate active lessons with other school-based, PA interventions. One area of interest would be the inclusion of qualitative data to provide insight to the way that children experience these lessons and how that experience might differ by subgroup. Future research should be designed to address this issue. In addition, while the schools were drawn from three school districts and varied greatly in SES and other demographics, they were all in suburban settings. It has long been recognized that schools in suburban settings tend to have more resources than do rural and urban schools (40). Therefore, these data should be replicated before they can be generalized to rural or urban locations. Finally, data were limited to the 4$^{th}$ grade and should not be generalized to earlier elementary or to middle school settings. However, the magnitude of these results was similar to those found among students aged 8 to 12 years old (13,15,25,38).

## Conclusion

The present study is the largest RCT to date to assess the impact of active learning on PA and to do so with objective measures of PA. As such, it overcomes several limitations of previous research. The resulting data clearly demonstrate that active learning interventions are sufficient to provide a similar increase in steps and MVPA for most students. While insufficient to provide a majority of daily recommended PA, these lessons do provide up to 20% of the recommended level of daily PA and are a viable intervention to supplement other opportunities for PA in children. These data, therefore, speak to the potential of schools to adopt policy change to require active learning as a means of increasing PA across all students.

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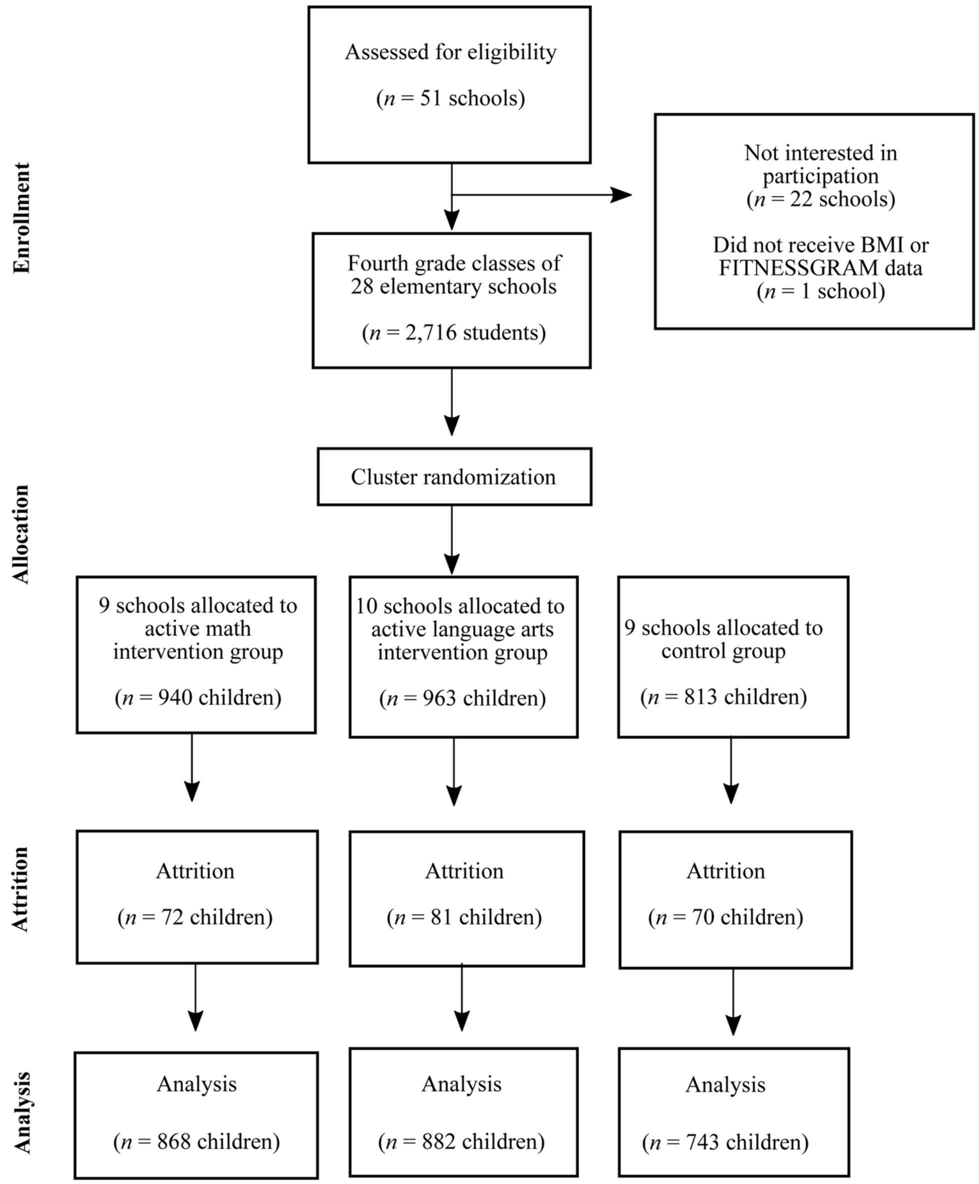


**Figure 1.**
Diagram showing flow of participants from enrollment, allocation, attrition, and analysis.

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## Table 1

Demographic Characteristics of Schools and Students

| School characteristics (%) | Overall ($j$ = 28) | Treatment ($j$ = 19) | Control |
|---|---|---|---|
| Mean % low SES | 34.31 | 35.43 | 31.69 |
| Mean % race/ethnicity | | | |
| 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 |
| BMI | | | |
| Underweight | 4.6 | 4.2 | 6.1 |
| Normal weight | 66.9 | 66.7 | 69.4 |
| Overweight/Obese | 28.5 | 29.1 | 24.5 |
| Race/ethnicity | | | |
| 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 |

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**Table 2**

Means and Standard Deviations for Physical Activity Outcomes

| | **Condition** | ***n*** | ***M*** | ***SD*** |
|---|---|---|---|---|
| School day physical activity averaged across the week | | | | |
| Step count | Control | 743 | 19091.11 | 5314.19 |
| | ICAN | 1750 | 21735.85 | 5830.02 |
| % in MVPA | Control | 743 | 6.01 | 1.99 |
| | ICAN | 1750 | 6.69 | 2.14 |
| % in Sedentary | Control | 743 | 68.33 | 7.61 |
| | ICAN | 1750 | 69.03 | 7.26 |
| Physical activity during active ICAN lessons | | | | |
| Step count | Control | 686 | 137.17 | 218.30 |
| | ICAN | 1670 | 686.31 | 413.33 |
| % in MVPA | Control | 686 | 3.32 | 5.89 |
| | ICAN | 1668 | 22.47 | 12.11 |
| % in Sedentary | Control | 686 | 73.97 | 15.64 |
| | ICAN | 1670 | 41.70 | 16.71 |

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## Table 3

Fixed and Random Effects for School Day Physical Activity Outcomes

| | | Unconditional model | | | Conditional model | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Fixed effects | | | | |
| **Measures** | **Predictor** | **Estimate** | **SE** | **p-value** | **Estimate** | **SE** | **p-value** | **Effect size** |
| Step count | | | | | | | | |
| | Intercept | 207.03 | 5.58 | 0.000 | 197.82 | 8.26 | .000 | |
| | Treatment | | | | 25.05 | 8.26 | .002 | .44 |
| | District 2 | | | | −19.56 | 10.72 | .068 | |
| | District 3 | | | | −13.21 | 13.57 | .330 | |
| | District 4 | | | | −10.78 | 11.69 | .356 | |
| MVPA | | | | | | | | |
| | Intercept | 6.43 | 0.16 | 0.000 | 5.79 | 0.23 | .000 | |
| | Treatment | | | | 0.80 | 0.25 | .001 | .38 |
| | District 2 | | | | 0.15 | 0.31 | .638 | |
| | District 3 | | | | −0.25 | 0.43 | .564 | |
| | District 4 | | | | 0.52 | 0.34 | .126 | |
| Sedentary | | | | | | | | |
| | Intercept | 69.24 | 0.48 | .000 | 70.16 | 0.68 | .000 | |
| | Treatment | | | | −0.18 | 0.82 | .830 | .02 |
| | District 2 | | | | −2.40 | 1.23 | .051 | |
| | District 3 | | | | −0.11 | 1.27 | .929 | |
| | District 4 | | | | −1.59 | 0.95 | .094 | |
| | | | | | Random Effect | | | |
| | | **Estimate** | **p-value** | **ICC** | **Estimate** | **p-value** | **ICC** | |
| Step count | | | | | | | | |
| | Level 1 | 11614.77 | .000 | .43 | 11711.21 | .000 | .71 | |
| | Level 2 | 7120.71 | .000 | .27 | 2040.47 | .024 | .12 | |
| | Level 3 | 8104.86 | .000 | .30 | 2824.99 | .041 | .17 | |
| MVPA | | | | | | | | |

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| | | Unconditional model | | | Conditional model | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Fixed effects | | | | |
| Measures | Predictor | Estimate | SE | p-value | Estimate | SE | p-value | Effect size |
| | Level 1 | 3.62 | .000 | .79 | 3.62 | .000 | .82 | |
| | Level 2 | 0.30 | .000 | .07 | .30 | .000 | .07 | |
| | Level 3 | 0.65 | .023 | .14 | .47 | .067 | .11 | |
| Sedentary | | | | | | | | |
| | Level 1 | 41.67 | .000 | .80 | 41.66 | 2.417 | .82 | |
| | Level 2 | 5.79 | .000 | .11 | 5.84 | 1.620 | .11 | |
| | Level 3 | 4.50 | .000 | .09 | 3.45 | 1.308 | .07 | |

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## Table 4

Fixed and Random Effects for Physical Activity during Active Lessons Outcomes

| | | Unconditional model | | | Conditional model | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Fixed effects | | | |
| Measures | Predictor | Estimate | SE | p-value | Estimate | SE | p-value | Effect size |
| Step count | | | | | | | | |
| | Intercept | 53.20 | 7.33 | 0.00 | 24.79 | 7.65 | .00 | |
| | Treatment | | | | 54.79 | 7.90 | 0.00 | 1.49 |
| | District 2 | | | | −14.39 | 10.27 | 0.16 | |
| | District 3 | | | | −4.60 | 11.84 | 0.70 | |
| | District 4 | | | | −26.62 | 11.94 | 0.03 | |
| MVPA | | | | | | | | |
| | Intercept | 16.43 | 1.94 | 0.00 | 3.02 | 1.45 | 0.04 | |
| | Treatment | | | | 19.23 | 1.48 | 0.00 | 1.80 |
| | District 2 | | | | 2.60 | 2.48 | 0.30 | |
| | District 3 | | | | 1.28 | 2.26 | 0.57 | |
| | District 4 | | | | −1.78 | 2.25 | 0.43 | |
| Sedentary | | | | | | | | |
| | Intercept | 51.72 | 3.22 | 0.00 | 75.35 | 2.75 | 0.00 | |
| | Treatment | | | | −33.25 | 2.46 | 0.00 | 2.03 |
| | District 2 | | | | −4.16 | 3.02 | 0.17 | |
| | District 3 | | | | 0.36 | 3.43 | 0.92 | |
| | District 4 | | | | −0.58 | 3.05 | 0.85 | |
| | | | | | Random Effect | | | |
| | | Estimate | p-value | ICC | Estimate | p-value | ICC | |
| Step count | | | | | | | | |
| | Level 1 | 499.55 | 0.00 | 0.22 | 499.46 | 0.00 | 0.34 | |
| | Level 2 | 377.91 | 0.00 | 0.17 | 383.45 | 0.00 | 0.26 | |
| | Level 3 | 1388.51 | 0.03 | 0.61 | 570.21 | 0.18 | 0.39 | |
| MVPA | | | | | | | | |

| | | Unconditional model | | | Conditional model | | | |
|---|---|---|---|---|---|---|---|---|
| | | Fixed effects | | | | | | |
| Measures | Predictor | Estimate | SE | p-value | Estimate | SE | p-value | Effect size |
| | Level 1 | 69.06 | 0.00 | 0.35 | 69.06 | 0.00 | 0.61 | |
| | Level 2 | 29.24 | 0.00 | 0.15 | 29.41 | 0.00 | 0.26 | |
| | Level 3 | 97.24 | 0.00 | 0.50 | 14.20 | 0.03 | 0.13 | |
| Sedentary | | | | | | | | |
| | Level 1 | 176.57 | 0.00 | 0.34 | 176.58 | 0.00 | 0.66 | |
| | Level 2 | 64.53 | 0.00 | 0.13 | 65.19 | 0.00 | 0.24 | |
| | Level 3 | 272.70 | 0.00 | 0.53 | 26.80 | 0.07 | 0.10 | |



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