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PEDAGOGY

# Impact of Physical Best Warm-Up Activities on Elementary Students' Physical Activity Levels and Knowledge

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## Abstract

*Daily physical activity (PA) benefits children's and adolescents' overall health while reducing the likelihood of obesity. Elementary school physical education (PE) classes provide opportunities for children and adolescents not only to participate in PA but also to build the knowledge and skills needed to be physically active across their lifetime. Physical Best (PB) is one program physical educators might use to develop students' physical literacy and skills. The purpose of this study was to determine the effect of PB program inclusion on elementary PE students' PA levels and health-related fitness knowledge (HRFK). Three activity games were paired once with a PB fitness concept-based warm-up activity and once with a traditional warm-up activity for six lessons. PA levels of elementary school students (n = 75, 30 males, 45 females) were recorded with both movement tracking bracelets and heart monitors during these six PE lessons. Means were calculated for movements and time in and above target heart rate zone (TZ) by warm-up type (PB vs. traditional), sex, and grade level. An HRFK assessment given to students pre- and postintervention assessed*

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*changes in fitness knowledge. Repeated-measures analysis of variances were utilized in the comparison of sex and grade level differences in relation to movements, TZ minutes, and HRFK assessment scores. Overall, children had significantly more movements in the PB lessons compared with traditional lessons ($p < .05$), while there was no difference in TZ minutes. HRFK assessment scores increased from pre- to postintervention ($p < .05$). Children accrued more movements in PB warm-up lessons than in traditional warm-up lessons but exhibited no difference in PA intensity. Children also increased HRFK from pre- to post-PB experience.*

Approximately 13.7 million children and adolescents are affected by obesity in America (Centers for Disease Control and Prevention [CDC], 2018b). Obesity among children is clinically defined as greater than 90th percentile for weight and height, or greater than or equal to the 95th percentile body mass index for age and sex (Kendall et al., 2019). A body mass index (BMI) of about 22.5 is considered to be in the 95th percentile for 10-year-old boys and girls, for example. Thus, a 5-ft tall boy weighing 103 lb (BMI = 22.9 kg/m$^2$) would be considered obese (CDC, 2018a). The percentage of children and adolescents affected by obesity in the United States has tripled since the 1970s (CDC, 2018c). As the prevalence of obesity continues to rise, public health efforts must be made to reverse the trend.

According to the *Physical Activity Guidelines for Americans* (U.S. Department of Health and Human Services, 2018), children and adolescents aged 6 to 17 years old should achieve 60 or more minutes of moderate to vigorous intensity physical activity (PA) each day. Daily PA benefits children's and adolescents' overall health while reducing the likelihood of obesity. Despite substantial evidence documenting these benefits and established national guidelines, PA is a major public health concern in the United States and several other countries (Zhu et al., 2019). For example, a longitudinal study of 6,473 adolescents reported that obese boys and girls engaged in more sedentary time and lower amounts of moderate to vigorous intensity PA than their nonobese counterparts (Jago et al., 2019). It is critical to address this lack of PA by engaging youth in enjoyable PA experiences that help them to develop lifelong PA habits at an early age.

Elementary school physical education (PE) classes provide opportunities for children and adolescents not only to participate in PA

but also to build the knowledge and skills needed to be physically active across their lifetime. Physical educators must present and engage students with the tools needed to make healthy personal choices. Physical Best (PB) is one program physical educators might use to develop students' physical literacy and skills. The PB program was established in 1987 by the American Alliance for Health, Physical Education, Recreation, and Dance (now known as the Society of Health and Physical Educators, or SHAPE America), with a mission of fostering a healthier youth by providing quality resources and professional education for physical educators (SHAPE America, 2020). PB is designed to promote student understanding of the body's response to PA and skills for lifelong PA participation while emphasizing individualization and enjoyment. PB inclusion requires PE teachers to implement the five components of health-related fitness (aerobic fitness, muscular strength, muscular endurance, flexibility, and body composition) into lesson plans of existing curricula. This may require slightly more sedentary time than traditional movement-based lessons for adequate incorporation of conceptual fitness knowledge. While PB inclusion may require more daily instructional time, students' overall PA minutes may increase as a result of enhanced health-fitness understanding (Prichard & Deutsch, 2013).

Deutsch et al. (2019) studied PB program inclusion in relation to PA levels of third-, fourth-, and fifth-grade students during PE classes at one elementary school. Participants were separated into groups that participated in six PE lessons containing either PB or traditional warm-up activities. Children of both groups wore movement counters and heart rate monitors to track and record PA levels during the class periods. The researchers concluded that at every grade and sex (except third-grade girls), significantly lower PA levels (measured by total movements) and time in or above the target heart rate zone (TZ) were achieved by the PB group. The study was not without limitations, however. The traditional activities included in the study were familiar to the students and therefore required less sedentary instructional time than a typical lesson that introduces a new activity. Additionally, the impact of the health and fitness emphasis within the PB lessons was not measured in terms of children's knowledge pre- and postintervention.

The purpose of this study was to build upon the methods used by Deutsch et al. (2019) to further determine the effect of PB program inclusion on elementary PE students' PA levels. We also sought to minimize the previous study's limitations by including traditional activities that are unfamiliar to students and evaluating students' health-related fitness knowledge (HRFK) both pre- and post-intervention.

# Method

## Participants

Participants were second- ($n$ = 23), third- ($n$ = 21), and fourth- ($n$ = 31) grade students ($M_{age}$ = 8.97 ± .97) from one elementary school in the Midwestern United States ($n$ = 75, 30 boys, 45 girls). Participants engaged in lessons with both PB and traditional warm-ups and were asked to not change any PA or performance behaviors during the study. All lessons were taught by the participants' regular PE teacher, who had 8 years of prior teaching experience. The PE teacher was trained by Joe Deutsch, who is PB certified, in the implementation of each PB warm-up activity. Informed consent was obtained from both parents/guardians and students. All students returning consent and assent forms received a glow-in-the-dark necklace despite the level of participation selected. All research procedures were approved by the university's Institutional Review Board.

## Instrumentation

Movement trackers or step counters have been identified as an economical tool in the assessment of student movement (Brazendale et al., 2019; Kim & Lochbaum, 2018; Pavlicek & Deutsch, 2016). A Minnesota SHAPE America grant provided 23 SODIAL Smart Wrist Band Sports Fitness Activity Tracker Pedometer Bracelet Watches (pedometer watches) to track the number of student movements during a class period. For the purpose of this study, a "movement" is any movement sensed and recorded by a 3-axis accelerometer in all directions (Nield, 2017). These watches were used for data collection at the elementary school and then retained by the school for daily PE use after the study concluded. Students also wore Adidas Zone Interactive Health Technologies (IHT) Spirit wrist heart rate

monitors, which indicated the total number of minutes spent in or above the student's target heart rate zone (TZ; 60% of maximum heart rate [MHR] or higher) during each lesson. Zones use Philips optical biometric sensing and algorithms to determine heart rate and have comparable accuracy and latency to chest-strap (ECG) systems (IHT, 2017). The Karvonen formula (Machado & Denadai, 2011; Mahon et al., 2010), MHR = 208 – (.7 × age), was used in the calculation of MHR in the determination of heart rate zones.

An HRFK assessment (six true/false questions in pencil-and-paper format) was given to students pre- and postintervention for measurement of changes in fitness knowledge. The HRFK assessment included questions from the original PE Metrics Standards 3 & 4, Grade 2 Performance Descriptors & Sample Questions bank. These questions have been found to have acceptable reliability and validity (SHAPE America, 2010). The total number of questions answered correctly served as the measure for the assessment.

## Procedures

Participants took the HRFK assessment prior to participating in six 30-min PE lessons over 4 weeks. Three activity games were each used twice across the six lessons. Students had previous experience playing each of the activity games in their PE class and were familiar with the rules. Activity games were each paired once with a 15-min PB fitness concept-based warm-up activity and once with a 15-min traditional warm-up activity. Students did not have prior experience with the six warm-ups (PB or traditional) in PE class. PB warm-ups included an explanation or demonstration of the activity (2 min or less), time for students to participate in the activity, and time dedicated for teaching and reinforcing one fitness concept. Traditional warm-up activities included an explanation or demonstration of the activity (2 min or less) and time to engage in the activity. Participants had the opportunity to engage in vigorous PA throughout the activity time for each warm-up (i.e., minimized wait times). See Table 1 for a description of each warm-up activity. The order of the warm-up pairings was alternated to limit effects of the order of warm-up type (Table 2).

**Table 1**
*Warm-Up Activity Categorization and Descriptions*

| Warm-up activity | Warm-up type | Description |
|---|---|---|
| Jumping Frenzy | PB | Set up stations with instruction cards for various jump rope activities and stretches. Provide the "Am I giving my heart a workout?" chart at each rest station for children to self-assess what activities were most intense and beneficial to physical health. |
| Moana Tag | Traditional | Students move around the gym in a variety of movement patterns. After being tagged by a tagger, students must "row their boats" (Russian Twists) 10 times prior to returning to the tag game. |
| Artery Avengers | PB | Students try to fill an opponent's Hula-Hoop (arteries) with yarn balls (fat from food) while keeping their Hula-Hoop empty. Keeping hoops empty involves increased running and throwing, just as being more active keeps fat from the arteries to improve health. |
| Tic-Tac-Toe | Traditional | Teams of 2–3 students play against each other and each starts with three beanbags. Teammates alternate running down to a large tic-tac-toe board and placing a beanbag on the board before running back. Play continues in this fashion as players attempt to get three in a row before their opponents. If a team is unsuccessful in the first three beanbag placements, the game continues with teammates running down and moving one of their team's beanbags to a new spot on the board. The game is over when one team achieves three in a row, and a new round starts immediately. |
| Clean the Beach | PB | Students "clean the beach" by collecting beanbags (trash) and placing them in Hula-Hoops (trash can) using various locomotor movements (walking on all fours, tip toes, hopping on one foot). To demonstrate knowledge of specificity, after the activity is over, students identify which body parts' muscular strength was developed by each locomotor movement. |
| Quidditch | Traditional | Students throw a reaction ball across the gym. A thrown ball must hit the opposite wall and is then collected by the student who threw it and returned to the starting spot. The game involves high intensity activity and hand–eye coordination because the reaction ball's design results in unpredictable return patterns. |

*Note.* PB warm-up activity descriptions from *Physical Best Teacher's Guide* (3rd ed.), by the American Alliance for Health, Physical Education, Recreation, and Dance, 2011, Human Kinetics.

**Table 2**
*Lesson Schedule*

| Day | PB warm-up | Traditional warm-up | Game activity |
|---|---|---|---|
| 1 | | Moana Tag | Treasure Hunter |
| 2 | Jumping Frenzy | | Cardio Kickball |
| 3 | | Quidditch | Ultimate Football |
| 4 | Artery Avenger | | Treasure Hunter |
| 5 | | Tic-Tac-Toe | Cardio Kickball |
| 6 | Clean the Beach | | Ultimate Football |

Participants wore both pedometer watches and heart rate monitors for the entire lesson. At the end of each class, students' number of movements and total minutes in TZ were recorded. Participants' daily PA data were only included in the analysis if an individual participant remained in PE class for the entire class period. Participants took the HRFK assessment a second time after completing all six lessons.

## Analysis

Data were first cleaned through the removal of participants' PA data (movements and TZ minutes) for each day they did not complete all 30 min of the PE lesson. PA data from 434 sessions across the sample were used in the final analysis. Movements and TZ minutes from six class sessions for each grade (second to fourth) were analyzed. Pre- and post-HRFK results were also analyzed for differences. Means for movements and TZ minutes were calculated by warm-up type (PB vs. traditional), sex, and grade level. The number of correct answers on the HRFK assessment at baseline and following the sixth lesson was averaged by sex and grade level. Repeated-measures analyses of variance were utilized in the comparison of sex and grade differences in relation to movements, TZ minutes, and HRFK assessment scores. Partial eta-squared values determined effect size. Levene's test for homogeneity of variance checked for violations of homogeneity assumptions. The assessment of within-subject effects meant assumptions of sphericity tests were not violated. Statistical analyses were performed using SPSS version 24.0. Statistical significance was defined at $p < 0.05$.

## Results

Results are reported for both PA and knowledge. PA results are organized by data collection type (movements and TZ minutes). For all repeated-measures analyses of variance, Levene's tests for homogeneity of variance were nonsignificant (assumptions were not violated) and equal variances could be assumed.

### Movements

Means and standard deviations for movements by warm-up type (PB vs. traditional), sex, and grade level were calculated (Table 3). PB lessons resulted in more mean movements overall compared with traditional warm-up lessons. All groups by grade and sex (except second-grade girls) had higher movement means for PB lessons as well. Overall, children had significantly more movements in PB warm-up lessons compared with traditional warm-up lessons, $F(1, 69)= 5.795$, $p = .019$, with a small effect (.077). However, there were no significant differences between participants' movements across grade levels. There were also no significant differences in movements between boys and girls, across grade levels. These findings indicate that the number of movements students accrued during a class period was greater when participating in a PB warm-up activity lesson compared with a traditional warm-up activity lesson. When ignoring whether students experienced PB or traditional warm-up lessons, the study found significant main effects of grade level and sex. Movements were significantly different across grade level, $F(2, 69) = 4.093$, $p = .02$, with a small effect (.106), and between the sexes, $F(1, 69) = 7.531$, $p = .008$, with a small effect (.098; Figure 1). Movement counts increased with grade level (post hoc comparisons revealed fourth graders trending toward significantly more steps than second graders, $p = .051$), and boys recorded more movements than girls. When ignoring warm-up content, the study found no significant differences for movements of boys and girls within the same class however.

### TZ Minutes

Means and standard deviations for TZ minutes by warm-up type (PB vs. traditional), sex, and grade level were calculated (Table 4). For all participants, mean measures of TZ were higher

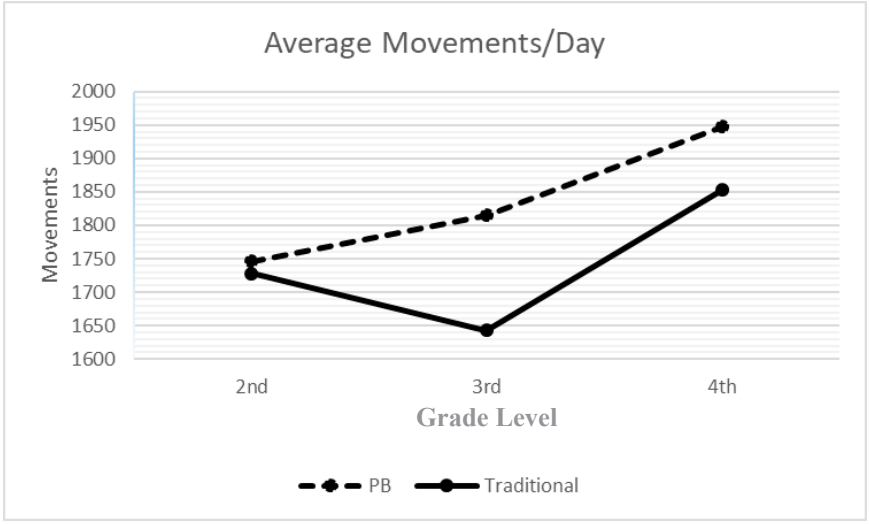
**Table 3**
*Mean Movements/Day*

| Grade | PB | Traditional |
|---|---|---|
| All grades | | |
| All participants | 1836 ± 38.1 | 1741.1 ± 32.9 |
| Boys | 1933.8 ± 60 | 1805.8 ± 51.8 |
| Girls | 1738.2 ± 47 | 1676.4 ± 40.6 |
| Fourth grade | | |
| All | 1947.3 ± 56.6 | 1852.6 ± 48.8 |
| Boys | 2024.4 ± 86.2 | 1926.1 ± 74.5 |
| Girls | 1870.1 ± 73.3 | 1779.2 ± 63.3 |
| Third grade | | |
| All | 1815 ± 75.1 | 1642.7 ± 64.9 |
| Boys | 1928.2 ± 126.9 | 1739.1 ± 109.7 |
| Girls | 1701.8 ± 80.2 | 1546.3 ± 69.3 |
| Second grade | | |
| All | 1745.7 ± 64.9 | 1727.8 ± 56.1 |
| Boys | 1848.8 ± 93.7 | 1752.1 ± 81 |
| Girls | 1642.2 ± 89.7 | 1703.5 ± 77.5 |

*Note.* Means are displayed with standard errors. PB is the experimental condition and traditional is the control condition. Decimals are rounded to the nearest tenth.

during participation in traditional warm-up lessons. However, student measures of TZ minutes were not significantly different between PB warm-up lessons and traditional warm-up lessons. There were also no significant differences in TZ minutes between grade levels or between boys and girls across grade levels. When ignoring whether children partook in PB or traditional warm-ups, the study found that TZ minutes were not significantly different between boys and girls (regardless of grade level) or between second-, third-, and fourth-grade classes. These findings indicate that PB warm-up lessons and traditional warm-up lessons had similar effects on students' heart rates during class.

**Figure 1**
*Average Movements/Day*




*Note.* This figure illustrates the differences in average movements between grade levels when experiencing the two different conditions.

## Knowledge

HRFK assessment scores increased from pre- to postintervention, $F(1, 65) = 5.714$, $p = .02$, with a small effect (.081). Mean HRFK assessment scores improved from pre- (boys, 4.6; girls, 3.9) to postintervention (boys, 4.9; girls, 4.4; Figure 2). Boys scored higher at both pre- and posttest. For the entire sample, students' scores increased by 6%. There were no significant differences between grade levels or between boys and girls across grade level. Main effects of sex were significant, $F(1, 65) = 9.35$, $p = .003$, with a small effect (.126). However, no significant differences existed for scores between classes or between boys and girls of the same class.

## Discussion

The results of this study indicate that students accumulated more movements in class when lessons included a PB warm-up activity compared with a traditional warm-up activity. However, the average TZ minutes were not significantly different between the two conditions. This indicates that participants moved more during the PB lessons, but these movements may have been at a lower intensity rate

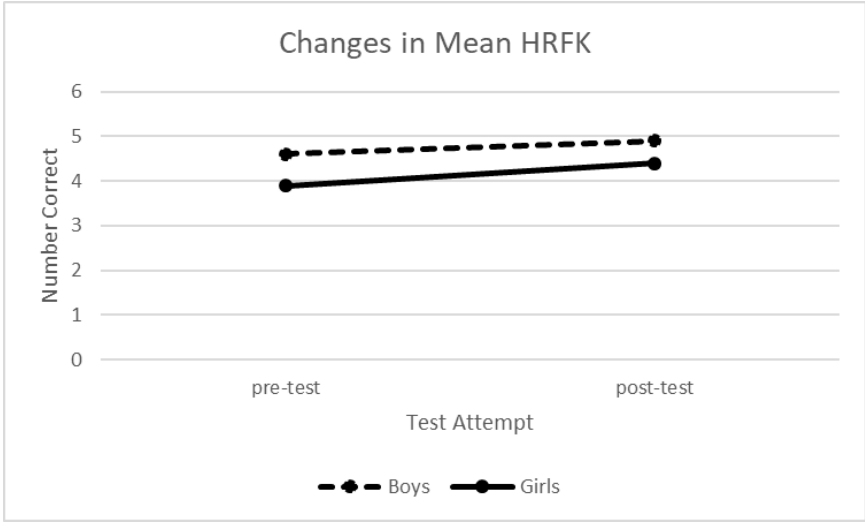
**Table 4**
*Mean TZ Minutes/Day*

| Grade | PB | Traditional |
|---|---|---|
| All grades | | |
| All participants | 7.3 ± .38 | 8.04 ± .35 |
| Boys | 7.87 ± .59 | 8.39 ± .55 |
| Girls | 6.73 ± .47 | 7.68 ± 40.6 |
| Fourth grade | | |
| All | 7.73 ± .56 | 8.58 ± .52 |
| Boys | 7.6 ± .85 | 8.82 ± .8 |
| Girls | 7.87 ± .73 | 8.33 ± .68 |
| Third grade | | |
| All | 7.42 ± .74 | 7.29 ± .69 |
| Boys | 8.56 ± 1.26 | 8.83 ± 1.17 |
| Girls | 6.28 ± .8 | 5.74 ± .74 |
| Second grade | | |
| All | 6.75 ± .643 | 8.24 ± .6 |
| Boys | 7.47 ± .93 | 7.52 ± .87 |
| Girls | 6.02 ± .89 | 8.97 ± .83 |

*Note.* Means are displayed with standard errors. PB is the experimental condition and traditional is the control condition. Decimals are rounded to the nearest tenth.

than the TZ. These results differ from those in Deutsch et. al (2019), who found no differences in total movements or minutes in TZ across grade and sex (except third-grade girls). This difference may be due to our attempts to minimize the novelty effect that likely occurred in the original study. Boys also accumulated more overall movements than girls did. This finding parallels results of other studies indicating greater PA levels among elementary boys (Weaver et al., 2018; Wilk et al., 2018). Finally, movement of children increased with grade level, similar to results reported in a meta-analysis investigation of research including children in third, fourth, and fifth grades (Fairclough & Stratton, 2006).

**Figure 2**
*Changes in Mean Health-Related Fitness Knowledge*




*Note.* This figure illustrates the differences between health-related fitness knowledge assessment scores at baseline and postlesson exposure for boys and girls.

Increased movements in PB warm-up lessons may be a result of students' increased motivation during PB activities or a lack of motivation during traditional activities. The PB warm-up activities included more equipment, fitness content, and objectives (Table 1). Researchers have found lack of equipment as a reported barrier to student PE participation (Mehmeti, 2015) and PE equipment introduction programs to be effective in promoting PA levels of students (McCrady-Spitzer et al., 2015). Also, positive associations have been found between children's PA at recess and equipment availability (Delidou et al., 2016; Verstraete et al., 2006). Finally, this concept has been demonstrated in a study in which activities with a variety of equipment may have been more stimulating and encouraged more movement when compared with those with less equipment (Tanaka et al., 2018).

HRFK results indicated a moderately high level of fitness knowledge preintervention and may have been due to prior non-PB fitness instruction conducted by the PE teacher. While HRFK scores

significantly increased from pre- to postexperiment, caution must be exercised in the interpretation due to the relatively low number of questions on the HRFK assessment and the nature of these questions (true/false). Given the limited time in PE class, a comprehensive number of items with variations in question structure were not included.

Pre- to posttest increases in HRFK scores may be a result of the conceptual fitness instruction that took place during the PB warm-up lessons. Thus, PB inclusion may bolster efforts by physical educators to promote physical fitness knowledge and and, in turn, motivate children to be physically active at a young age, as well as in the future. Kulinna et al. (2018) surveyed adults who had participated as high school students in a PA fitness initiative program 24 years prior and found that the majority met national guidelines for PA at rates higher than national averages, the majority reported very low amounts of physical inactivity, and a moderate amount even remembered class content. This lends support for programs such as PB for the promotion of lifelong PA.

## Limitations

Due to the authenticity of the setting, fidelity of implementation may have been impacted. For example, while efforts were made for standardization of the time spent on warm-up activities and activity games, time spent on whole-class behavior prompts and interventions were not tracked and accounted for within the analysis. We, however, did not note extensive time spent on classwide reactive behavior management. However, differences in equipment and PA requirements were not specifically controlled and may be associated with the differences among the number of movements. Despite the limitations of the study, the authenticity of the study's setting demonstrates the feasibility of implementing PB activities for students' benefits during short-duration PE classes.

## Conclusion and Future Research

This study's results support integration of the PB program into existing PE curriculum. Participants accumulated significantly more movements in lessons containing PB warm-up activities compared with those containing traditional warm-ups. PB warm-up lessons, however, had similar effects on heart rate intensities when compared

with traditional warm-up lessons. Improved HRFK assessment scores also support PB's intent to improve conceptual fitness knowledge. PB lessons can be used by PE teachers to promote students' PA participation, develop their fitness knowledge, and ultimately improve their overall physical literacy.

Future research on the impact of PB activities on PA should try to determine why movement differences occur. First, comparing PB activities alone with traditional activities alone (as opposed to in combination with other lesson activities) would isolate the true differences between the activities. Second, a similar study could better control for differences in equipment and games involved with each lesson. Participants' perceptions of enjoyment and motivation while partaking in different lesson types could also be incorporated, allowing for a better understanding of differences in PA. Recording the amount of time spent sedentary during times of conceptual fitness knowledge instruction would allow for an analysis of return (PA) on investment (time spent sedentary).

Other PB components, such as goal setting, should be incorporated in future studies that examine PA during PE lessons, as well as overall daily PA, for better evaluation of the impact of PB inclusion on children's overall PA levels. Chase et al. (2018) found that use of goal setting by third and fourth graders resulted in a greater number of steps taken during PE lessons. Burns et al. (2016) also found that goal setting significantly increased the number of PACER laps and daily step counts achieved by sixth graders. Inclusion of goal setting would better depict the value of PA gained.

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