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Use of Outdoor Education to Increase Physical Activity and Science Learning among Low-Income Children from Urban Schools

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ABSTRACT

Background: Outdoor education may positively impact the educational, physical, and emotional development of youth, but studies are sparse among urban children.

Purpose: To investigate 1) physical activity (PA) levels in outdoor versus indoor education environments, 2) science learning gains during outdoor education, and 3) programmatic acceptability among children from an urban, low-income school district attending an outdoor education program.

Methods: N = 69 were randomly chosen from 571 4th graders participating in an outdoor education program. PA levels were measured using accelerometers; science knowledge was measured using a pre-post assessment; acceptability was assessed using a questionnaire.

Results: Students took part in over an hour more of moderate to vigorous physical activity (MVPA) ($p < .05$) and increased the proportion of time spent in MVPA by 25% ($p < .05$) on outdoor education days compared to indoor school days. Science knowledge improved significantly pre- to post participation ($p < .01$). Students reported high levels of enjoyment and science learning engagement. Teachers reported the experience increased students' PA levels and improved students' science knowledge.

Discussion: School districts may be able to leverage outdoor programs with community partners to promote PA and simultaneously improve science learning.

Translation to Health Education Practice: Community partnerships can help urban youth from under-resourced schools meet PA recommendations and improve academic performance through outdoor education programming.

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Background

Childhood obesity is a serious health concern in the United States, elevating lifetime chronic disease risk.[1,2] Currently, the prevalence of obesity among school-aged children is 18.4% in the United States.[3] Low levels of physical activity (PA) and high levels of sedentary behavior are one of the major contributing factors to the rise of childhood obesity and its associated risk factors.[4,5] The increase in sedentary behavior and obesity rates among youth is strongly associated with increases in screen time activities such as watching television, playing video games, or exploring on a computer or tablet.[6] This is highly problematic given adequate PA has been shown to positively affect physical health, cognitive function, and behavioral development in youth.[7]

Meeting or exceeding the recommended daily 60 minutes of PA for school-aged children, most of which should be moderate to vigorous physical activity (MVPA), has been shown to improve fitness levels, support bone and metabolic health, cognition, and reducing the risks of depression.[4,6,8,9] Importantly, developing healthy physical activity behaviors in childhood is associated with less risk of chronic diseases such as obesity and type 2 diabetes across the life course, conditions which disproportionately affect low-income and minority populations.[10] Currently, however, school-aged children achieve an average of 30 MVPA minutes daily, and urban youth are at higher risk of inadequate MVPA.[11] In school, physical education (PE) and recess are two areas children can increase levels of PA and MVPA. However, prior research has shown PE and recess alone are typically not sufficient for the majority of children to achieve the recommended PA/MVPA guidelines.[3,9]

Urban public schools attempting to improve PA and MVPA levels often face unique challenges related to limited resources in the school environment, including funding, facilities, equipment, and personnel that often lead to infrequent and under-resourced

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PE classes.[12] Thus, providing youth attending urban public schools with additional opportunities to achieve PA guidelines during the school day may help decrease obesity rates and improve academic performance.[12,13]

The outdoor environment can provide a great opportunity for school-aged children to freely participate and improve PA levels, thus complementing the traditional in school environment.[13–15] Unfortunately, opportunities for children to experience outdoor play in their home environments, schools, and local communities are diminishing.[16–20] The rapid development of technology and increase in screen time, combined with the lack of outdoor play space, availability, and transport to greenspaces, and safety concerns have resulted in decreased rates of outdoor exploration among children, particularly those in urban areas, which can have negative effects on children's health and well-being.[14,21] Evidence suggests that children who are physically active outdoors have a lower risk of developing a chronic illness and better mental health.[7]

In addition to providing PA opportunities, outdoor learning activities can also serve as an opportunity for children to expand their science knowledge and skills beyond skills learned in a traditional classroom.[13,14] In particular, outdoor education, defined as the instructional use of natural and built areas to meet student learning objectives in a variety of subject-matter disciplines through direct experience,[22] is most often conducted in greenspaces, and so it lends itself to inquiry about nature, which provides children with unique opportunities to gather, interpret, analyze, and predict scientific data in meaningful contexts.[15,23] Evidence has shown that outdoor experiences with nature may positively impact a child's environmental awareness, science learning, environmental attitudes, and outdoor comfort and fears.[14,20]

Given the positive benefits that outdoor education can have on youth development, school districts, and local communities should consider integrating outdoor education opportunities to promote PA and learning among school-aged children in low-income areas. Recognizing the financial and logistical barriers to outdoor education in urban public schools, one approach utilized in some cities is collaborating with community-based partnerships like local YMCA's, Boys, and Girls Clubs, and other organizations that serve as partners to provide access and opportunities to outdoor education. These opportunities can include mentoring, tutoring, academic enrichment, as well as provide PE equipment, supplies, and services to students and school systems.[24]

Purpose

The outdoor education collaboration between the YMCA and the Lawrence Public Schools sought to address two societal challenges that affect many children in low-income urban public schools: low PA levels and poor science achievement. The purpose of the current study was to evaluate the effects of this program on PA and science-inquiry learning outcomes in children attending low-income urban elementary schools, as well as perceptions of acceptability among students and teachers. The specific aims were: (a) to determine if children were more physically active when learning in an outdoor setting compared to the traditional in school setting, (b) to identify if science activities conducted in an outdoor education program improve science learning outcomes, and (c) to explore students' and teachers' perceptions of the acceptability of the outdoor education programming.

Methods

The Merrimack Valley YMCA has partnered with Lawrence, Massachusetts Elementary Schools to integrate inquiry-based experiences that combine science learning and physical activities in an outdoor education setting. The current study was embedded as a pragmatic evaluation of ongoing programming. All study methods and procedures were reviewed and approved by both the Merrimack College and Lawrence Public Schools Institutional Review Boards.

Research context and participants

A total of 571 4th grade students from five elementary schools in Lawrence, Massachusetts attended the outdoor education program. No other grades currently attend the programming. One class was randomly selected from each of the three largest participating schools, resulting in n = 69 students (48% female; ages 9–10 years). In order to better understand experiences across all schools and participating classes, all participating teachers and paraprofessionals (n = 29) completed acceptability surveys. While race/ethnicity data were not collected because of parental reporting burden, the school district is 93.4% Hispanic, 1.2% Asian, 1.3% African American, and 3.7% Caucasian.[25]

Children participated in a two, three, or four consecutive-day, five-hour per day outdoor education program that took place at a local outdoor camp owned by the YMCA. The duration of the program for each school was different based on school resources and funding

provided by the local YMCA, thus the average duration for intervention across the three levels was 15 hours.

The outdoor education program utilized the camp's facilities and natural systems to provide the children with unique learning activities and hands-on experimentation related to environmental education, science, and mathematics. Through these engaging activities and the use of the outdoor environment, students were encouraged to explore their interests and abilities in a safe, nurturing, and fun environment.

(1) *Environmental Education*. Students engaged in hands-on experiments focusing on different ways to protect the environment (e.g. oil spills, natural disasters, recycling). Students also took nature hikes to explore and learn about the different ecosystems at the camp (e.g. woods, freshwater lake, and open fields).
(2) *Science and Mathematics*. Students engaged in a variety of activities to learn math and science skills. Some of these included:
    a. Physical Science – The students engaged in hands-on experiments focusing on density, matter, gravity, and physical reactions.
    b. Boating/Canoeing – While participating in boating/canoeing, the goal was for students to learn about propulsion, angles, resistance and friction, wind and currents.
    c. Ropes Courses – While participating in ropes course activities, the focus was for students to learn about belaying, heights, building trust, problem-solving, and team building.
    d. Active Science® – While participating in a variety of physical activities, students wore a simple digital accelerometer on their hip (EKHO, Dallas, TX) to measure steps, distance, total activity time, and MVPA, which they entered into the Active Science learning application. These accelerometers were worn in addition to the research-grade accelerometers students wore around their waist for the entire duration of the day. Participants used the readout from these devices to enter their data in the Active Science® mobile tablet application, analyze the data, answer questions, and draw scientific conclusion about the data. The Active Science curriculum is described elsewhere,[15] the goal of Active Science® is to use MVPA to prime students for science learning, and leverage PA data collection to increase PA levels.

Evaluation design

Physical activity assessment

To measure PA outcomes (average daily MVPA, steps per minute, and percentage time spent in MVPA), participants wore a research-grade accelerometer buckled around their waist and positioned on their right hip (Actigraph (wGT3X-BT), Pensacola, FL) for approximately 5 hours each day. The same children wore the accelerometers during two typical school days to measure baseline PA levels. Accelerometers were placed on the participants immediately at the beginning of the day to ensure the devices were worn correctly. At the end of the day, participants removed the devices. Accelerometer data were downloaded weekly; Freedson (youth) cutoffs were used to determine time spent in MVPA.[26]

Science-inquiry learning

To assess science content knowledge and science-inquiry learning in the outdoor setting, a pre- and post-assessment developed by the researchers was administered at the beginning and end of each environmental and physical science lesson which included oil spills, recycling, density, matter, gravity, and physical reactions. The pre- and post-assessments included 5–8 multiple choice objective questions with four response options on the lessons' subject matter. During each lesson, participants responded to a variety of questions that focused on scientific-inquiry skills, such as generating a hypothesis, data interpretation, and the ability to draw conclusions. At the end of each lesson, participants completed the post-assessment. Due to time constraints and a high volume of participants, a pre and post-assessment was not administered during the boating/canoeing and ropes course experience.

Perceptions

Researchers used written surveys to determine students' and teachers' perceptions of the acceptability of the outdoor education program. Researchers developed a questionnaire designed (a) to determine students' perceptions about incorporating outdoor education to improve science learning, (b) to determine students' experiences about learning in an outdoor setting compared to a traditional classroom setting and, (c) to determine students' perceptions regarding their overall PA in the outdoors compared to in school. The first four items assessed students' perceptions of their knowledge of physical and environmental science content prior to and after participating in outdoor education. The final two items asked students how comfortable they were

Table 1a. Student perception of outdoor education questionnaire.[a]

Responses range 0–10.
(1) How much do you think you knew about physical science (i.e. gravity, density, or matter) **before coming** to outdoor education?
(2) How much do you think you know about physical science (i.e. gravity, density, matter.) **after** coming to outdoor education?
(3) How much do you think you knew about environmental science (i.e. oil spills, nature) **before coming** to outdoor education?
(4) How much do you think you know about environmental science (i.e. oil spills, nature) **after** coming to outdoor education?
(5) Are you more comfortable learning science in a classroom or in the outdoors?
(6) Do you think you learn more science in the classroom or in the outdoors?
Open-Ended Questions
(7) Explain how learning science in the outdoors different from learning in the classroom.
(8) Explain how physical activity in the outdoors differs than physical activity in school.

[a]Questions 1–6, student responses range from 0–10. Questions 1–4, response choice of 0 = I didn't know anything, 5 = I knew some information, 10 = I knew a lot; question 5, response choice of 0 = in the classroom, 5 = in the classroom and outdoors, 10 = in the outdoors; question 6, response choice of 0 = in the classroom, 5 = in the classroom and the outdoors, 10 = entirely the outdoors. Students provided written responses to questions 7 and 8.

Table 1b. Teachers' perceptions of outdoor education questionnaire.[a]

(1) In general, what kinds of experiences in and about nature/outdoor education can effectively support children's development and learning? (be specific)
(2) How can/do experiences in and about nature (ropes, boating, environmental, physical, and active science) support children's development and learning?
(3) Describe an activity/ies or lesson/s your students experienced in outdoor education (ropes, boating, environmental, physical, and active science) that you perceived as a positive and effective student experience. Please explain why.
(4) What conceptual knowledge did students demonstrate during outdoor education? (be specific).
(5) What emotions and/or behaviors did students express during outdoor education? How were these emotions and/or behaviors similar or different compared to the emotions and/or behaviors express in the classroom?

[a]Sample questions from the teacher' perceptions of outdoor education questionnaire. The questions were adapted and modified from the *Teachers Perceptions of Nature in Early Childhood Education*.[16] Teachers provided written responses.

learning science in the outdoors and whether they thought they learned more science in-school in the classroom or in the outdoors. Multiple items across the survey were reverse coded; the range representation is included in Table 1a. Students also responded to two open-ended questions about their perceptions of learning science in the classroom versus outdoors and PA in the outdoors compared to in school (Table 1a).

The researchers also developed and administered a nine-question questionnaire to assess teachers' and paraprofessionals' perceptions and attitudes of (a) implementing outdoor education into a typical school week, and (b) outdoor education relative to students' development and learning. The questions were adapted and modified from the *Teachers Perceptions of Nature in Early Childhood Education*.[21] The students, teachers, and paraprofessionals completed the acceptability questionnaires during the final day of the program. Table 1b displays selected questions from the teachers' questionnaire.

Data analysis

All quantitative analyses were performed using STATA 13. Descriptive statistics were used to describe baseline demographic data. Because of imbalanced number of days per student in each condition, as well as potential cluster effects of school, multilevel mixed-effects models were used to assess associations between PA outcomes (average daily MVPA, steps per minute, and percentage time spent in MVPA) and indoor versus outdoor programming, controlling for fixed effects of gender, and nested random effects of school and individual. Comparisons of percent correct on pre- and post-science learning assessments were assessed using paired t-tests. Cohen's *d* was used to calculate effects size for all primary outcomes. Paired t-tests and descriptive statistics were used to analyze the Likert scale questions from the students' perceptions questionnaire. Modified Grounded Theory was used to develop a codebook from student and teacher qualitative responses. Multiple reviewers coded data and analyzed for emergent themes. Reviewer coding conflicts were reviewed and resolved by the primary investigator.

Results

Physical activity outcomes

Crude analyses showed that all PA metric averages were higher on outdoor education days, as compared to indoor days (Table 2). Multi-level mixed-effects models

Table 2. Results of the crude analysis for all physical activity metrics[a].

Outcome	Indoor Day		Outdoor Day	
	M	SD	M	SD
MVPA minutes	60.77	27.21	124.64*	23.27
% Time Spent in MVPA	23.14	10.29	47.57*	8.75
Steps per Minute	9.03	3.26	23.568	5.82

[a]MVPA = moderate to vigorous physical activity. *All physical activity metric averages were higher on outdoor education days, as compared to indoor days ($p < .05$).

Table 3. Associations between exposure type and physical activity outcomes[a].

Outcome	Indoor Day	Outdoor Day
	Coeff (95% CI)	Coeff (95% CI)
MVPA minutes	−2.42	63.85
% Time Spent in MVPA	0.01	0.24
Steps per Minute	0.89	14.52

[a]MVPA = moderate to vigorous physical activity.

confirmed a significant, positive association between outdoor education participation and MVPA (Table 3), accounting for individual variation and school clustering effects; power to detect effects for the smallest outcome effect size was (1-β) = 0.89. Students took part in over an hour more of MVPA ($p < .05$, $d = 2.55$), achieved an average of 14.5 more steps per minute ($p < .05$, $d = 3.12$), and increased the proportion of their time spent in MVPA by nearly 25% ($p < .05$, $d = 2.53$) on outdoor education days compared to indoor education days. Gender was not a significant predictor of physical activity outcomes.

Science-inquiry learning outcomes

Students' response rate for the pre- and posttest was 100%. Students improved significantly from pre-science knowledge assessments where they averaged 55% correct answers, to post-assessments where they averaged 61% correct answers ($p < .01$, $d = 0.42$). Again, this association persisted across all three schools and did not change when analyses were stratified by gender.

Student perceptions

Students' perceptions of their physical and environmental science knowledge were significantly higher at the completion of the outdoor education program compared to prior ($p < .01$; Table 4). The mean score for students' perceptions of physical science content knowledge (gravity, density, matter) prior to outdoor education was 6.26 on a 10-point scale, and 5.77 on a 10-point scale for environmental science (oil spills, recycling, nature). At the completion of the program, the mean score for students' perceptions of physical science and environmental science was 7.12 and 7.18, respectively. When students were asked if they felt more comfortable learning science outdoors compared to indoors in addition to whether they felt they learned more science outdoors compared to indoors, the mean response was above 7 on a 10-point scale, indicating that students felt more comfortable learning science and felt they learned more science outdoors than in-school. Student open responses were positively oriented; they reported feeling that the outdoors provided more time and space to engage in PA. Many participants in the current study do not have access to a gymnasium in school, so physical education takes place in a classroom setting; thus, the outdoor education program provided students the opportunity to engage in physical activities in a spacious and safe outdoor environment. Relative to science learning, students felt the outdoors exposed them to new experiences to perform science experiments as well as to learn about nature and the world around them.

Table 4. Student responses to outdoor education questionnaire.

	M	SD
1. How much do you think you knew about physical science (i.e. gravity, density, or matter) **before coming** to outdoor education?	6.26	2.61
2. How much do you think you know about physical science (i.e. gravity, density, matter.) **after** coming to outdoor education?	7.12	2.62
3. How much do you think you knew about environmental science (i.e. oil spills, nature) **before coming** to outdoor education?)	5.77	2.79
4. How much do you think you know about environmental science (i.e. oil spills, nature) **after** coming to outdoor education?	7.18	2.64
5. Are you more comfortable learning science in a classroom or in the outdoors?	7.56	3.23
6. Do you think you learn more science in the classroom or in the outdoors?	7.01	3.30

[a]Student responses range from 0–10. Questions 1–4, response choice of 0 = I didn't know anything, 5 = I knew some information, 10 = I knew a lot; question 5, response choice of 0 = in the classroom, 5 = in the classroom and outdoors, 10 = in the outdoors; question 6, response choice of 0 = in the classroom, 5 = in the classroom and the outdoors, 10 = entirely the outdoors.

Teacher perceptions

When asked to rate the importance/value of the outdoor education programming, 25 of 29 participating teachers/paraprofessionals rated the program as a 5 on a 5-point scale, where 5 indicated "very important and valuable to students learning and development". Teachers' responses to open-ended questions were organized into four main themes: 1) interaction with nature, 2) hands-on learning, 3) self-awareness, confidence, and overcoming fears, and 4) exposure to PA. Quotes include a non-identifiable participant code to allow for source differentiation.

Theme 1: Interaction with nature

Teachers identified that the outdoor education program provided students with an opportunity to interact with nature – an experience many students do not have access to.

> "Outdoor education is important and teaches students to connect to the world around them. I think students learning about a topic and then interacting with it in its natural environment is how students learn." [P6]

> "A better connection to how humans impact and effect nature. An example is how certain materials may harm nature when disposed improperly." [P23]

> "All outdoor activities involving the interaction with nature are crucial to our students who have very little outdoor time." [P14]

"Experiences that allow children to relate and make connections to their own lives helped children be natural persistent and curious. If a child were to see how animals were to interact, they are able to learn how they interact." [P7]

Theme 2: Hands-on learning

The teachers felt that the program's curriculum was more hands-on than a typical classroom environment. As a result, teachers emphasized that children were more engaged in the learning process.

"When students are actively involved in the gathering of knowledge, learning occurs. Therefore, hands-on experiences involving scientific experiments are valuable. My English Language Learners understand more clearly when participating in activities." [P2]

"Children learn best from being hands-on and exploring. Outdoor education is the best way for students to get excited and explore. Kids love learning about nature and will gain problem-solving skills." [21]

"Outdoor education is more hands-on than the classroom education. Kids have the opportunity to see, touch, and feel the subject matter. Kids are more apt to want to participate in learning. There are also many more teachable moments in this type of environment." [P27]

"The experiences are hands-on and show children there are more ways to learn than being in a classroom." [P13]

"The hands-on experience is invaluable to developing knowledge of topics and concepts. Rather than just reading about density of objects they experienced it. It is much more meaningful." [P24]

Theme 3: Self-awareness and confidence

The teachers felt the children's engagement and interaction with nature resulted in enhanced self-awareness and confidence. Specifically, the teachers felt students were more aware of their behaviors impacting the environment, physical health, and overcoming fear and obstacles.

"Boating-many students thought they could never do it. They were so worried and felt incapable. After going out the first day, they gained confidence. They also developed their understanding of how to cooperate to row the boat where they wanted it to go. Confidence soared after they accomplished the tasks! Very different from what they usually get to do." [P23]

"Outdoor experiences help a lot of under privileged children get a better understanding of their surroundings." [P11]

"Students are aware of their behaviors affecting the earth, physical health, mental health, and overcoming fear and obstacles." [P18]

Theme 4: Exposure to PA

The teachers felt that the experiences in nature expanded opportunities for children to engage in PA by providing them with outdoor space and resources.

"Being active and interacting in the outdoors are experiences that these students do not typically have access to, such as being active and getting outside." [P16]

"The physical experiences like ropes and boating helped students get active and move their bodies in different ways." [P6]

"Experiences in nature can support kids in being active and getting outside." [P16].

"Being in nature can be very therapeutic for students who are often surrounded by chaos. They can actively move much more, boat and experience many aspects of nature … not sit still." [P17]

Discussion

Children in urban school districts are less likely to meet current PA guidelines of at least 60 minutes of MVPA per day, less inclined to engage in PA outside of the traditional school day, and underperform on standardizing testing relative to peers in higher-income school districts.[3,6,8] However, the present study shows that community partnerships can be leveraged to implement an effective outdoor education and physical activity program during the traditional school day, resulting in improved PA levels and science learning in school children attending urban public schools.

Results of this study showed that during the outdoor education program, students completed over an hour more of MVPA than when they were in school, which was consistent with previous studies.[15,27] This is critical given that increased physical movement and exercise has been positively linked to children's cognitive, physical, and social-emotional development.[13,28] Importantly, we found that gender was not a significant predictor of any PA outcomes, perhaps as a result of the intervention and the equal opportunities for all children to freely participate and learn in a safe outdoor environment. This is important given that boys typically achieve more PA per day than girls at various age and grade levels among inner-city minority children.[28] Evidence has shown that girls perform on average 17% less total PA daily[29]; girls have been show to participate in less organized sport, may receive less social support to engage in PA, and may perceive less enjoyment when taking part in PE.[30] Therefore, developing strategies and opportunities aiming to potentially modify these factors to

decrease this gender-based disparity among youth is critical among this population.

Our study findings regarding science learning were also consistent with existing literature showing that outdoor learning and enhanced PA can result in improved academic outcomes.[15] Outdoor exploration and play, particularly in natural settings and greenspaces, are limited for most children in the urban community of Lawrence, Massachusetts; thus, developing safe opportunities for children to experience these settings as part of their education is important. In addition to the programmatic effects on increasing PA levels, outdoor education programming also includes other positive learning benefits. Outdoor learning experiences in the current setting can build on and serve to extend traditional indoor learning by allowing children to connect with nature and the world around them to understand a specific concept.[31] The significant improvements in science-knowledge observed in this study support the idea that informal science through experience, inquiry, and hands-on activity can increase science literacy and enable students to learn from their natural environment.[13,31]

Well-designed outdoor programs can also increase children's positive attitudes toward nature, interest in environmental learning, and knowledge.[32] In this study, students reported they had more space to engage in movement-related activities in the outdoors compared to the indoors. Most participants expressed they felt comfortable in the outdoors and that the opportunity provided them more space compared to a traditional day in-school. Students also perceived that they learned more about physical and environmental science after completing the outdoor education program.

Importantly, teachers and paraprofessionals reported the program as beneficial to student learning as well and expressed support for continuation. Interaction with nature, hands-on learning, self-awareness, and confidence, and exposure to physical activity were among the main benefits observed by the participating teachers. When asked what kinds of experiences in and about nature can effectively support children's development and learning, one teacher said "I think students learning about a topic and then interacting with it in its natural environment is how students learn. Getting to do hands-on activities and observations helps students learn and connect to the world around you." This sentiment aligns with previous studies showing that children show more interest in science learning when they collect and analyze their own data.[33]

The results of this study support incorporation of outdoor education in natural settings into traditional curriculum to get students excited about learning and being active through fun, hands-on, team-based activities. Providing children in urban public school systems with these experiences can help students develop more positive attitudes about physical activity and may get them more interested in incorporating physical activity beyond the traditional school day.[31] Likewise, literature supports the value of the outdoor education in promoting interactive, hands-on learning for children in under-resourced school districts.[13,33] Given these positive benefits on vulnerable children's PA and learning outcomes, community partnerships are crucial to enabling under-resourced urban school districts to offer such opportunities to their students. In this case, the Lawrence Public School system has partnered with the Merrimack Valley YMCA to create a sustainable program offered during the school day, leveraging existing busing and professional staff to create effective learning and physical activity programming.

Limitations

The collection of objectively measured physical activity was a strength of this study, as was the ability to test science knowledge before and after outdoor education participation. Often researchers cannot gain access to such settings or use more cost-effective subjective PA reporting measures. However, the study was limited by the lack of a control group. Also, the pre- and post-science assessments were developed to reflect the curricula, but were not previously validated for use with this age group and setting. Findings from this study are limited to 4th graders from the selected Lawrence Public Schools, potentially impacting generalizability to other grades and settings. Researchers could not attribute physical activity or cognitive outcomes to any one programmatic component, and therefore report only non-causal associations. Lastly, the generalizability of the results is limited by the sampling frame; therefore, additional research is recommended to determine the best strategies to scale similar programs in geographically and culturally diverse economically disadvantaged urban school systems.

Translation to Health Education Practice

Active, experiential learning in the natural outdoor settings has been identified as providing potential motivation for children's physical activity and science learning by allowing them to observe, explore, test hypotheses, reflect, and develop knowledge and awareness of the world around them. The current study exemplifies Area IV (Conduct Evaluation and Research Related to Health Education/Promotion) of the CHES NCHEC

Responsibilities, Competencies and Sub-competencies. Specifically, the study aimed to evaluate an ongoing outdoor education program's impact on science learning and physical activity among children attending under-resourced, urban public schools, meeting competencies 4.2–4.7 (develop a research plan for health education/promotion; select, adapt, and/or create instruments to collect data; collect and manage data; analyze data; interpret results; apply findings). Recognizing the importance of movement and learning in natural outdoor settings to children's growth and development, educators, parents, and caregivers are challenged to create innovative ways to encourage children to get back into the natural environment; community health educators are needed to play vital roles in the development, implementation, and ongoing evaluation of such programming. Despite limited resources, urban public schools may be able to capitalize on local partnerships, such as YMCA's, scout camps, Boys, and Girls Club, etc., to provide children and adolescents with positive opportunities to integrate PA and science learning in an enjoyable and innovative way. Further evidence is needed to evaluate the scalability of this approach; however, the outdoor education program described in the current study expands the research based supporting the role of outdoor education in improving both physical activity and academic achievement.

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Disclosure statement

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