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Integrating Movement and Science to Promote Physical Activity and Academic Performance in Middle School Children

Kevin E. Finn
Merrimack College, finnk@merrimack.edu

Kyle McInnis
Merrimack College, mcinnisk@merrimack.edu

PROJECT REPORT

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Kevin E. Finn
Merrimack College

Kyle J. McInnis
Merrimack College

Abstract

Background:

Recommendations from leading U.S. health agencies concerned with reducing childhood obesity call for increased physical activity during school and afterschool environments.

Methods:

We developed the Active Science curriculum, which is a variety of activity-based lessons (e.g., nature hike, dance class, walk at local park, treadmill at local YMCA) and incorporated them into traditional science classes and after school programs for middle school children in a low-income, ethnically diverse community. Following the activity experiments, students and teachers uploaded data from devices to an interactive website that provided inquiry-based exploratory learning of science content. Results: Physical activity results showed that the activity portion of the program were consistent with national recommendations for accumulating physical activity. Significant increases in science inquiry test scores from pre- to post were observed.

Conclusions:

The findings from this study suggest incorporating movement into traditional science curriculum helps to promote physical activity and academic performance in underprivileged middle school-age students

Introduction

Children throughout the US and globally are facing an unprecedented epidemic of obesity. As childhood obesity rates have been rising over the past thirty years, two significant changes have been occurring in American culture. Children's unhealthy eating habits have increased, and the amount of time they spend in physical activity has decreased. Individuals, on average, consume about 200 more calories per day than they did thirty years ago (USDA, 2012). In addition, more American families

consume more fast food and sugary beverages and eat out more often than they have in the past (Farooqi and O'Rahilly, 2008). And finally, children are less physically active (White House Task Force on Childhood Obesity, 2010). All of these factors have contributed to the childhood obesity epidemic.

Lack of physical activity is a problem seen both at home and in schools. A substantial challenge facing schools and afterschool educational programs is to develop practical strategies to effectively increase physical activity within the time constraints of their existing curricula. For schools, lack of adequate funding, failing test scores, discipline issues, student/teacher ratio, and reduction or elimination of athletic and/or recreational programs are commonly identified as challenges to the creation of healthy learning environments (Belansky et al., 2009). Even community-based youth centers and school-age childcare settings are often characterized as places where kids are not sufficiently active (CDC, 2007). Thus, innovative approaches during school and out-of-school time that support wellness standards for physical activity are urgently needed.

Multiple strategies for addressing the problem have emerged at various levels of intervention, and in May 2010, the White House Task Force on Childhood Obesity (2010) created a report to the President that sought to develop a set of strategic recommendations. These recommendations endorsed the incorporation of movement and activity into diverse school and afterschool curricular activities, thus offering physical activity as part of academic lessons on subjects such as science, math, and the language arts. The literature suggests that physical activity may impact academic performance through cognitive, emotional, and physiological aspects of learning (Sibley and Etnier, 2003). While such recommendations hold promise for addressing youth obesity, there is a continued need for practical resources that help schools and youth-serving community organizations to implement these strategies (Stewart et al., 2004).

In response to the need for innovative strategies, the researchers developed the Active Science curriculum, which tested innovative approaches that introduce physical activity into traditional school and afterschool childcare programs. This program is intended to leverage kids' interest and engagement in technology to enhance physical activity and promote science inquiry skills. This approach follows national recommendations on Active Education that incorporates activity into the academic learning experience (Active Living Research, 2009). The purpose of this paper is to summarize the Active Science project and present the results from the school-based Active Science intervention.

Methods

Active Science Approach

At Merrimack College, we have gathered an existing foundation of research that demonstrates that the integration of movement with learning helps to promote physical activity and supports academic performance in school-age children (Finn et al., 2011). Our work is based upon a growing body of research focused on the close connection between physical activity and academic performance among children. In particular, our Active Science research initiative demonstrated that incorporating movement into science lessons helps to promote both physical activity and academic performance in underprivileged middle school-age children (Finn et al., 2011; Finn and McInnis, 2010). Two studies have been performed using the Active Science approach, one in a classroom environment and the other in an afterschool setting. The design and methodology used in the two settings were similar, but only the data from the classroom-based project will be presented in this paper.

Science Education and Civic Engagement

The Active Science initiative has been a research project targeting the improvements in physical activity levels and science academic achievement in middle-school-aged children in a low-income community. With the Active Science program, the researchers are trying to address two significant societal issues facing many children in the United States: childhood obesity and poor science academic performance. In addition, undergraduate students in the Health Sciences Department at Merrimack College have participated as research assistants in all phases of the project. They have been instrumental in the data collection, analysis, and presentation of the findings and have assisted the researchers in taking on this major societal issue of childhood obesity. The Health

Sciences Department has made civic engagement and social responsibility the cornerstone of our program, uniting all facets of a major educational experience that is meaningful and relevant for our students. Our goal is to produce graduates who are professionally competent, who are aware of the complex public issues in health and human performance, and who will continue to seek out opportunities to serve their community. The undergraduate students have been able to experience cutting-edge community-based research while helping to address the major societal issue of childhood obesity.

Procedures

The Active Science curriculum was an integration of exercise activities and science lessons to promote classroom-based physical activity within a school's existing science curriculum. Active Science was developed utilizing seven lessons of exercise activities and seven lessons of science content. The ideas for the lessons were adapted from frameworks of the existing Science of Energy Balance and We Can! curricula developed by the National Institutes of Health (NIH) and National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). The lessons introduced concepts of healthy lifestyles through regular physical activity and nutrition, while simultaneously teaching important scientific principles. Collaborating with the science teachers ensured that each lesson supported the particular learning objectives and goals of the school. The Active Science lessons reinforced topics included as part of national and state science standards such as structure and function in living systems, personal health, nutrition, and scientific investigation.

Students and teachers accessed each of the lesson plans and schedule of activities by logging onto an interactive website created by experts in instructional media and web design. The website was used to provide students with an introduction to each weekly topic, describe the goals of each unit, give clear instructions, provide a system for entering activity data, track student and class progress, provide an interactive class forum for discussions, and describe tasks or homework assignments. Moreover, the website was designed to provide the teacher with a convenient mechanism for organizing and delivering each lesson plan in a time-efficient manner.

Participants

A convenience sample of four science classes was selected at a tuition-free, independent middle school in Massachusetts during the spring of 2010 and 2011. Class enrollment included Hispanic female students with ninety-one percent of the student body qualifying for free/reduced lunch. The four science classes were taught by three teachers and were comprised of fifth- and sixth-grade students (n=47). The school and classes were selected based on teacher and administrator willingness to participate in data collection.

Instruments

During each lesson, students experienced hands-on data collection by wearing computerized exercise monitoring devices, heart rate monitors, and pedometers, which captured a variety of physical activity data. The pedometer measured distance, estimated calories, and step count data. The heart rate monitor assessed estimated calories, average heart rate, maximum heart rate, and time spent above, below, or within a prescribed target heart rate range. The Polar E40 heart rate monitor and Digiwalker SW-701 pedometer were utilized for physical activity data collection.

To assess science academic gains, the students were given a science pre-test at the start of the curriculum and a post-test at the end of the unit. The researchers and science teachers created the science inquiry skills and content knowledge test which focused on the science content of the Active Science curriculum (scientific method, data interpretation, nutrition, fitness). The purpose of this test was to determine whether students had learned the science inquiry skills and content knowledge at the completion of the curriculum. The science test was distributed by the classroom teacher and was graded by the researcher. The results of the test were anonymous and did not affect the students' overall academic grade in science class.

Results

Science Learning and Physical Activity

As a powerful example of our evidence, data from our studies showed children's mean heart rates (146 +/- 9

bpm), maximal heart rates (196 +/- 10.6 bpm), steps (3050 +/- 402.7), calories (99 +/- 8.4kcal), and distance traveled (1.1 +/- 0.2 miles) per lesson, while performing the Active Science curricular activities met national recommendations for youth physical activity. Significant improvements in performance on science content and skills tests were observed (43.9% to 66.3%; $p<0.001$) from pre- to post-curriculum, while qualitative and quantitative data supported program enjoyment and engagement.

Discussion

The Active Science curriculum was developed to provide a framework for integrating physical activity into academic class time. Results from this study reveal that students participating in the Active Science curriculum were able to achieve physical activity levels that were equivalent to or above the adolescent physical activity recommendations from national health organizations such as the Centers for Disease Control, National Association for Sport and Physical Activity, and the US Department of Health and Human Services. Our comparison of the Active Science curriculum and the traditional (baseline) science lessons revealed that the students in the Active Science classrooms accumulated increased amounts of physical activity during the lessons that were statistically significant. These findings indicate that the implementation of the Active Science curriculum not only successfully increased students' physical activity levels during academic classroom time, which was a primary objective for the curriculum, but also that it helped students to reach or almost reach daily recommended amounts of physical activity. This is a very important finding, because this school is located in a severely deprived and under-resourced urban community in Massachusetts, where 47% of children and adolescents are overweight or obese (the highest level in the State); 70% of residents are Latino, and 86% of families live below the poverty level (Massachusetts Department of Public Health, 2010).

Data revealed statistically significant increases in science inquiry skills and content knowledge test scores from pre- to post-test in all four sections of science classes. Differences in performance on the science inquiry skills and content tests were observed with a 22.4% increase (43.9% to 66.3%; $p<0.001$) from pre- to post-test. Many schools have significantly downsized physical activity programs due to budgetary constraints and increasing pressure to improve standardized test scores. Proponents of school-based physical activity programs have argued that physical activity improves academic performance and that regular exercise improves students' concentration and cognitive functioning (Castelli et al., 2007). The Active Science data support these findings by suggesting that including physical activity as a part of academic lessons can facilitate student learning and that the inclusion of physical activity by no means adversely impacts academic performance in classes. This classroom-based physical activity approach is one way to get students physically active while still promoting learning in the classroom. The positive results from this study examining the Active Science curriculum, which is an example of a program designed to incorporate physical activity into an academic subject area, are important, because they provide insight into an alternative method of teaching science that incorporates physical activity and facilitates learning of science inquiry skills and content.

Conclusions

Our findings from these initial studies were consistent with an accumulating and impressive body of scientific evidence demonstrating that the integration of movement with learning helps to promote physical activity and supports academic achievement in school-age children. The children who participated in this project increased their physical activity in school, while simultaneously improving science achievement skills. The results of this study are well aligned with the recommendations from First Lady Michelle Obama's Let's Move campaign and the White House Task Force for Solving the Problem of Obesity within a Generation (2010), which endorse innovative strategies to incorporate movement and activity into diverse school and afterschool curricular activities. We hope that through the many positive experiences of the Active Science program, the children will continue to participate in daily physical activity and make healthy nutritional choices.

Future Directions

The future plan involves the enhancement of the Active Science initiative, to further develop scalable frameworks and successful policies that help school and afterschool programs across the region and nationwide to incorporate movement concepts into diverse activities, thereby promoting improved health and academic success of school-age children.

About the Authors

Kevin E. Finn, EdD, ATC, CSCS (finnk@merrimack.edu) is an Associate Professor of Health Sciences at Merrimack College in North Andover, MA. His area of expertise is curriculum and teaching in the health professions with a focus around increasing physical activity in children. Kevin is a licensed athletic trainer in Massachusetts and a certified strength and conditioning specialist.

Kyle J. McInnis, Sc.D., FACSM is the chair and Professor of Health Sciences at Merrimack College. He is a leading researcher in the United States on fitness, wellness, and chronic disease prevention. He has published many scholarly articles and edited two books including the American College of Sports Medicine's Health/Fitness Facilities Standards and Guidelines, 3rd Edition and Lifestyle Obesity Management.

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