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Ten Years of TAKE 10!®: Integrating physical activity with academic concepts in elementary school classrooms

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ABSTRACT

Objective. Current literature supports the link between physical activity (PA) or fitness and a child's ability to achieve academically; however, little structured activity time is incorporated into elementary school classrooms. This paper explores the impact of a classroom-based PA program, TAKE 10!, and health–academic integration through existing state and federal policy and programming.

Methods. Evidence from journal articles, published abstracts, and reports were examined to summarize the impact of TAKE 10! on student health and other outcomes. This paper reviews 10 years of TAKE 10! studies and makes recommendations for future research.

Results. Teachers are willing and able to implement classroom-based PA integrated with grade-specific lessons (4.2 days/wk). Children participating in the TAKE 10! program experience higher PA levels (13%>), reduced time-off-task (20.5%), and improved reading, math, spelling and composite scores ($p<0.01$). Furthermore, students achieved moderate energy expenditure levels (6.16 to 6.42 METs) and studies suggest that BMI may be positively impacted (decreases in BMI z score over 2 years [$P<0.01$]).

Conclusion. TAKE 10! demonstrates that integrating movement with academics in elementary school classrooms is feasible, helps students focus on learning, and enables them to realize improved PA levels while also helping schools achieve wellness policies.

Introduction

According to the Centers for Disease Control and Prevention (CDC), approximately 4% of 6- to 11-year-olds in the United States were obese in the early 1970s. The most recent CDC data (2007–2008) indicate that 19.6% of children aged 6 to 11 years are obese (Ogden and Carroll, 2010). Today's children are also spending record amounts of time sitting or sedentary, particularly related to school activities (Sturm, 2005). Although at least 60 min per day of moderate-to-vigorous physical activity (MVPA) is recommended, few children are achieving this recommendation (Nader et al., 2008). This fact is demonstrated by the 2009 Youth Risk Behavior Survey data, which indicate that only 18.4% of 9th to 12th graders were physically active for at least 60 min per day on all 7 days of the prior week (CDC, 2010a). Butte et al. (2007) notes that this decreased physical activity (PA) may play an important role in the increase in childhood obesity as a sedentary lifestyle upsets the energy balance—the balance between calories eaten and calories expended—that substantially determines body weight.

The elementary school setting provides an ideal environment to improve the PA levels of children. Schools can reach a large volume of children with offerings that include unstructured recess, physical education (PE), and PA in the classroom as well as before and after school. The current literature supports the link between PA or fitness that enhances a child's ability to achieve academically; however, little structured activity time is incorporated into elementary school classrooms. Historically, experiential learning was noted by Confucius around 450 BC in the now famous quote "Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand." In recent history, Dr. David Kolb's work detailed the existence of different learning styles and notes those learners who are doers favor active experimentation and participation in learning (Kolb, 1984).

A recent review of PA and academic achievement reported that "eight of the nine studies found positive associations between classroom-based physical activity and indicators of cognitive skills and attitudes, academic behavior, and academic achievement; none of the studies found negative associations" (CDC, 2010a, p. 6). Results from the

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2006 CDC School Health Policies and Programs Study, conducted every six years, showed that no more than 16% of school districts required regular physical activity breaks, excluding recess and PE, during the elementary school day, and these statistics decrease as students progress through the upper grades. However, 76% of states now have PA guidelines based on the National Standards for Physical Education (Kann et al., 2007). Belansky et al. (2009) studied how the development and implementation of a local wellness policy, required by the Child Nutrition Act of 2004, impacted the health of rural elementary school students in Colorado. The study showed that schools did not increase time for PA after policy implementation. Interviews conducted with school principals and district personnel confirmed that schools that were focused on academic achievement standards mandated by the No Child Left Behind Act, were not well informed of the local wellness policy, and lacked resources for implementation and accountability (Hackett et al., unpublished data, 2010).

At present, schools seem to be placing greater emphasis on nutrition policies, rather than PA programs and policies, to address the obesity issue. For example, University of Minnesota researchers found a statistically significant correlation between states adopting food service and nutrition policies when childhood obesity rates are high, but no such correlation for physical activity and education and weight assessment policies. These results emphasize that states are lagging in implementing PA and body mass index (BMI) control programs (Nanney et al., 2010). Hooker and Buchner (2009) argue that more attention must be focused on academic programs that train public health researchers and practitioners to develop models that effectively promote PA and "strategically implement evidence-based intervention strategies at the informational, behavioral and social, and environmental and policy levels" (p. 295). Although the availability of evidence-based programs for use in the classroom is noted in the literature, research is lacking on if and how states have thus far effectively implemented PA policies and what factors may predict successful implementation at the state level.

Since 1996, the Physical Activity and Nutrition (PAN) Program of the International Life Sciences Institute (ILSI) Research Foundation, a nonprofit organization, has been working on practical solutions to promote PA and impact obesity-related behaviors in children. One of PAN's priorities is to partner with schools and universities to conduct "system-fit" obesity prevention interventions that can be sustained in various settings. The TAKE 10!® program is one such system-fit intervention that PAN has worked to implement, evaluate, and refine since 1999 (Peregrin, 2001). TAKE 10! (www.take10.net) is designed to reduce sedentary behavior during the elementary school day and to increase structured minutes of PA in the classroom. This curriculum tool is designed to get students moving without sacrificing time dedicated to academic learning. TAKE 10! engages students in PA while reinforcing specific learning objectives in math, reading, language arts, science, social studies, and general health.

The idea for the program was generated in May 1999, at a conference titled Childhood Obesity: Partnerships for Research and Prevention (Trowbridge and Kibbe, 2002). A school expert panel—consisting of experts in health and PE, curriculum design, recess and PA, and school nutrition—noted that short bouts of PA have health benefits (U.S. Department of Health and Human Services, 1996). Thus, it was agreed by conference participants that, due to the decline in the quality and quantity of PE time, a research priority was an intervention that integrated PA with academics in the classroom. Working with education and health experts, the first version of TAKE 10! was created in fall 1999 to promote structured, 10-minute activities in the elementary classroom. With continual feedback from experts, TAKE 10! has been revised and disseminated in the United States and around the globe since 2002.

Methods

Three electronic databases (ScienceDirect, Medline®, EBSCO) were searched between March and September 2010 to identify literature published about TAKE 10!. In addition to the program name, search terms included: physical activity, movement, exercise, classroom, elementary, school, or children (aged 5–11 years). The search revealed 19 journal articles, published abstracts, final reports, and unpublished studies that included the TAKE 10! program or variations on TAKE 10!. From 2000 to 2007, a variety of studies were identified that explored specific issues related to TAKE 10! format, content, implementation, and impact. Between 2007 and 2010, several larger projects were conducted by universities that incorporated TAKE 10!. This article provides an overview of the various studies over 10 years of TAKE 10! programming and evaluation, as well as summarizing policy and program implications. An overview of the studies presented in this TAKE 10! summary is provided in Table 1.

Results

TAKE 10! materials

Imagine third-grade students learning multiplication tables by doing Invisible Jump Rope. Picture a classroom of second graders doing Contraction Action—singing and performing two-part muscle contraction movements to better understand how two words become a contracted word. These examples hint at what happens in a TAKE 10! classroom when movement and learning are integrated. The first version of the program consisted of colorful activity cards, worksheets, and stickers presented in two grade ranges: from kindergarten to second grade, and from third to fifth grade. The OrganWise Guys (The OrganWise Guys Inc., Duluth, GA), a group of fun and colorful characters based on organs of the body (Lombardo, 2008), were featured on the materials. Teachers quickly indicated that this version was not viable due, in part, to academic standards that should be addressed in each grade (Kohl et al., 2001). The materials were thus revised into grade-specific content for kindergarten through fifth-grade classrooms. The second version presented the materials in a seasonal theme: spring, winter, and fall. Teacher advisers and a teacher focus group commenting on this format revealed that teachers preferred materials be divided by academic content area: language arts, math, science, social studies, and general health. Furthermore, methods for tracking activities were brainstormed and teachers suggested colorful posters on which stickers could be attached to document TAKE 10! use.

In 2006, TAKE 10! program research expanded to China (Liu et al., 2007, 2008). The OrganWise Guys characters and their alliterative names did not translate well into Chinese and were not culturally relevant to students. At that point, the PAN program surveyed third- and fourth-grade children and teachers in two U.S. states to obtain input on the design of and names for a new set of characters. This feedback resulted in the development of the TAKE 10! Crew, a group of five diverse children (Jordan, Junji, Minda, Raven, and Reina) who are now featured in the materials. Each kit contains approximately 35 activity cards with clearly defined physical activities and learning objectives, 50 worksheets designed to reinforce learning objectives presented in the activity cards, three tracking posters, stickers to track activities and reward students, teacher resources to enhance implementation, student health knowledge assessments to measure knowledge mastery (topics: general health, PA, and nutrition), and a teacher implementation questionnaire. New materials on energy balance and nutrition, as well as a subset of Spanish-language materials, will be completed in 2010 and evaluated in the 2011–2012 school year. It is clear that engaging teachers in the provision of feedback on format, content, ease of use, and classroom applicability of this type of resource can result in a product that will be attractive, user-friendly, and sustainable.

Teacher acceptance and implementation

Early concerns related to the acceptance and ease of implementation of TAKE 10! by classroom teachers. One small quasi-experimental study of 22 teachers reported use of TAKE 10! 4.3 ±

Table 1
Summary of TAKE 10! studies.

Study	Number of classrooms or students	Outcomes	Randomization	Age range	Results
Mahar, M. et al., 2003. Med. Sci. Sports Exerc. 35, S135.	342 students, 22 classrooms	Implementation Student knowledge—no change) Attraction to PA (4th and 5th graders only)—no change	Yes	5–11 years (K thru 5th grades)	Implementation 4.3 ± 1.2 days/week Average # of steps per TAKE 10! class—142 more steps/day
Barry, M.J., et al., 2002. Med. Sci. Sports Exerc. 34, S300. Barry, M.J., et al., 2003. Med. Sci. Sports Exerc. 35, S134.	269 students, 24 classrooms	Students–Children's Attraction to Physical Activity (CAPA) Questionnaire: ANOVA–CAPA score with 4 factors: grade, sex, school, pre–post assessment Classroom environment survey: environment improved and less disciplinary action	Yes	7–11 years, 2nd thru 5th grades	PA attraction scores increased in intervention by 1.95 ± 0.59 (p = 0.001) Intervention impact on CAPA vs. control, pre–post not-significant (p = 0.06)
Stewart, J.A., et al., 2004. J School Health. 74, 397–400.	3 classrooms, 71 students	Energy expenditure (CSA) and step counts (Walk4Life)	No	≈6, 8, 10 years; 1st, 3 rd and 5th grades	MET values across grades (adjusted for body weight) = 6.16 to 6.42 METs 25 to 37 kcal per 10-minute session
Metzler and Williams, unpublished data, 2004	38 classrooms	Classroom observation of student behavior	No	Kindergarten thru 5th grade	Significant reduction in fidgeting (20.51%) from pre- to post-TAKE 10! session. Student off-task behavior reduction of 21.4% (non-significant).
Lloyd, L.K., et. al., 2005. TAHPERD J. Spring, 8–11.	8 classrooms, 200 students	Weekly implementation Compatibility with classroom curriculum	No	5 to 8 years, Kindergarten thru 2nd grade	4 classes did 1–2 activities/week; 3 classes did 3–4 activities/week
Moore, D.S., et al., 2007. Med. Sci. Sports Exerc. 39, S490.	36 students (boys n = 16, girls n = 20)	Activity levels (average activity count/min) over a continuous 7-day period. Test for differences in activity levels during TAKE 10!, PE, recess, lunch, and after-school/ weekend activities.	No	9 to 12 years	Significant main effect for activity ($F = 9.01$, $p < .01$) Pairwise follow-up analyses: higher PA levels in TAKE 10! compared to PE, lunch and after school/weekend.
Tsai, P.Y., et al., 2009. J. Sch. Nurs. 25, 163–172.	840 students (92% Hispanic), 29 teachers	Knowledge change Teacher opinions	No	Kindergarten thru 6th grade	Significant increases in PA knowledge for most learning objectives; no change for nutrition knowledge. Teachers implemented 30–50 min per week; reported increased student concentration
Hollar, D., et al., 2010a. J. Am. Diet. Assoc. 110, 261–267. Hollar, D., et al., 2010b. Am. J. Public Health. 100, 646–653.	45888 students	Anthropometrics, Blood pressure, Florida Comprehensive Achievement Test (FCAT) Scores	No	6–13 years	Intervention girls realized significant decreases in diastolic blood pressure (P<0.05), BMI z score (P<0.01) and weight z score (P<0.05) over 2 years; Intervention students had significantly higher FCAT math scores vs. control children in both years (P<.001)
PASS & CATCH (modified TAKE 10!) Murray, N.G. et al., 2008a,c.	933 students, 8 elementary schools	Student Stanford 10 scores: reading comprehension and math problem solving (baseline, interim, follow-up) Behavioral Assessment System for Children (BASC-2): assessed psychosocial variables, including adaptive skills	No	8–11 years, 3rd and 4th grades (mean age = 9.27 years)	Math scores (not reading) improved significantly more over time in intervention group; Poorly adapting students in intervention group improved their reading and math scores at a significantly greater rate compared to the controls.
PAAC (modified TAKE 10!) Donnelly, J.E., et al., 2009. Prev. Med. 49, 336–341.; Gibson, C.A., et al., 2008. Int. J. Behav. Nutr. Phys. Act. 5, 36.	4905 students, 24 schools	Physical activity Body mass index Academic achievement	Yes	2nd thru 5th grade	Significantly greater PA levels (p<0.0001) in PAAC students. No significant difference for BMI; schools with ≥75 min of PAAC realized significantly less BMI increase Math, reading, spelling scores and a composite score: all between group differences were significant (p b0.01).
Happy 10 (TAKE 10! China) Liu, A.L., et al., 2007. Biomed. Environ. Sci. 20, 19–23. Liu, A., et al., 2008. Obes. Rev. 9(Suppl 1), 130–134.	753 students (357 boys, 396 girls), 26 classes	Daily PA duration Energy expenditure Body mass index	No	6–12 years	Intervention students realized significant increases in the average daily PA energy expenditure and duration; change in girls' BMI; no significant difference in the change in prevalence of student overweight and obesity between the intervention and the control schools

1.2 days per week, and 75% of teachers reported that they would continue to use the program (Mahar et al., 2003). Another intervention revealed that 62.5% of the teachers implemented one to two activities per week, and 37.5% of the teachers implemented three to four TAKE 10! activities per week (Lloyd et al., 2005). Furthermore, 62.5% of teachers agreed or strongly agreed that the activities were compatible with classroom curriculum objectives a majority of the time, and 86% of teachers agreed or strongly agreed that the activity breaks helped students refocus during long academic blocks (Lloyd et al., 2005). Another small intervention (Hunnell, unpublished data, 2008) asked 28 teachers about implementation patterns. The overall implementation average was 4.29 times per week, with first-grade teachers implementing the program the most at a rate of 5 times per week. Second-grade teachers had the lowest average, with 3.33 times per week. Teachers also responded that the morning time and times varied were considered the strongest for implementation.

Collaboration with the OrganWise Guys on the Delta H.O.P.E. (Healthy Options for People through Extension) Tri-State Initiative examined TAKE 10! use by a large number of teachers (Lombardo, 2008). This project was conducted from 2003 to 2007 in partnership with the Mississippi Alliance for Self-Sufficiency and university cooperative extension programs in Arkansas, Louisiana, and Mississippi. The weekly self-reported implementation patterns of the 10-minute physical activities for individual teachers are reported in Table 2. The first year of the intervention resulted in 51% of the participating teachers integrating the TAKE 10! activities in their classrooms 3 times or more per week. The percentage of teachers integrating 3 or more activities per week increased over time, with 68% of the teachers in 2004–2005 and 63% in 2005–2006. In the final year, teacher implementation fell below the half-way mark with 45% of the 1000+ teachers integrating at least 30 min of PA in their classrooms on a weekly basis (Williams et al., 2008). It is unclear as to the reason for the decline in the third year, but possible explanations may include fewer extension agents were employed to collect data, teachers were not incentivized to respond, and the period of data collection in the final year of the project occurred in advance of standardized testing.

A cluster-randomized, controlled, 3-year, elementary school-based trial called Physical Activity Across the Curriculum (PAAC) also utilized TAKE 10! resources (Gibson et al., 2008). PAAC explored teacher implementation with specific academic subjects. PAAC teachers reported incorporating PA into language arts (73%) and math (22%). Although teachers are willing to and do implement TAKE 10! activities in their elementary classrooms, the characteristics of teachers who embrace the program to a greater extent are not yet clear. A study that explores teacher self-efficacy in PA, personal PA behavior, and TAKE 10! implementation patterns is warranted, along with a long-term study exploring patterns of use.

Physical activity and energy expenditure

As the TAKE 10! concept began to gain popularity, the question of "how do you know it works?" was raised by health experts, educators, and curriculum specialists. The ILSI Research Foundation and other organizations embarked on a series of studies examining its impact.

Physical activity levels

Delta H.O.P.E. proved to be an award-winning program (2006 Department of Health and Human Services Innovation in Prevention Award; 2006 Cooper Institute Gold Award), and impacted 1485 classrooms (approximately 26,730 students). During the 2006–2007 intervention year, encompassing 36 weeks, teachers documented an average of 26.8 min per week of PA (Williams et al., 2008). Although the Delta H.O.P.E. program model was successful, the project had two clear shortcomings relative to PA impact: the lack of a control group and reliance on teacher self-reporting.

An investigation of children's PA levels during TAKE 10! as compared with activity levels in PE, recess, lunch, and after-school/weekend activities was undertaken in 36 children randomly selected from two elementary schools in Louisiana (Moore et al., 2007). ActiCal activity monitors (Mini-Mitter Co., Inc., Bend, OR) were used to measure activity levels (average activity count/min) over a continuous seven-day period. A 2 (gender) × 5 (activity) ANOVA with repeated measures on the second factor was used to test for differences in activity levels. The results indicate that activity levels during TAKE 10! ($\bar{x} = 2775.0$ counts/min, $P < .05$) were higher than those realized during PE ($\bar{x} = 1813.7$ counts/min, $P < .05$), lunch ($\bar{x} = 1371.5$ counts/min, $P < .01$), and after school/weekend activities ($\bar{x} = 1480.4$ counts/min, $P < .01$). TAKE 10! activity levels compared to those in recess time ($\bar{x} = 2169.7$ counts/min, $P = .14$) were not significantly different.

The Happy 10 program, piloted in two primary schools (one intervention, one control) in a district in Beijing, China, was conducted at least once per day. Increases in PA duration (2.8 h vs. 3.3 h) was experienced among Chinese students in the intervention school ($N = 328$), whereas duration decreased in the control school ($N = 425$) (Liu et al., 2008). Using the System for Observing Fitness Instruction Time (SOFIT), results from the PAAC project demonstrated that students in the intervention schools exhibited significantly greater levels of PA in the classroom than students in the control groups (Gibson et al., 2008). Observations were performed on a total of 4515 students (3465 intervention students and 1050 control students) and higher SOFIT scores indicated higher activity intensity levels. Intervention students' scores were 3.40 ± 0.02, compared with 2.17 ± 0.03 for control students ($P < .0001$). Also of interest was the fact that modeling of an active lesson by PAAC teachers resulted in student activity levels being increased significantly ($P < .0001$).

Energy expenditure

The effectiveness of the TAKE 10! program in providing MVPA was first assessed by Stewart et al. (2004). A convenience sample of first-, third-, and fifth-grade classrooms was observed implementing the TAKE 10! program while being monitored by either accelerometers or digital pedometers. Pedometer step counts and accelerometer data were recorded for each student and activity. The average caloric expenditure (kcal) per 10-minute session was 25.6–27.8 (first grade), 27.6–33.9 (third grade), and 29.7–42.9 (fifth grade). Average

Table 2
Number of participating Delta H.O.P.E. teachers and weekly implementation of TAKE 10! activities (by school year).

School year	n	1 time (x)/week (% of n)	2x/week (% of n)	3x/week (% of n)	4x/week (% of n)	5x/week (% of n)	6 + x/week (% of n)
2003–2004	185	35 (19)	56 (30)	72 (39)	13 (7)	6 (3)	5 (3)
2004–2005	764	91 (12)	153 (20)	344 (45)	92 (12)	53 (7)	31 (4)
2005–2006	969	213 (22)	242 (25)	349 (36)	100 (10)	40 (4)	30 (3)
2006–2007	2415	845 (35)	459 (19)	338 (14)	266 (11)	266 (11)	217 (9)

metabolic equivalent (MET) levels during the activities were 5.72–7.05 (first grade), 5.51–6.77 (third grade), and 4.98–7.19 (fifth grade), and levels were not different between grades ($P>.05$). To better understand the METs impact of TAKE 10!, consider results of one study in third- and fourth-grade children exploring leisure time activities that reported the average metabolic equivalent level of 4.2 for girls and 4.8 for boys (Harrell et al., 1997). TAKE 10! sessions for all three grades produced exercise levels in the moderate intensity range throughout the full duration of the session. Other researchers have published similar results. First, results from the Happy 10 project in China (discussed above) showed that the average energy expenditure (EE) per 10-minute session ranged from 25.0–35.1 kcal, in first through fifth grades (Liu et al., 2007). Next, Honas et al. (2008) reported EE results from a subset of students participating in the PAAC intervention, which involved two 10-minute physically active academic lessons per day. PAAC activities proved to be of moderate intensity and, as measured by indirect calorimetry, resulted in students expending $3.1 \pm 1.0\ \text{kcal} \times \text{min}^{-1}$ ($P<.05$). Given these results, it is possible that TAKE 10! activities will decrease students' risk for obesity.

Knowledge change

Each TAKE 10! binder contains questionnaires intended to assess mastery of nutrition, physical activity and general health knowledge based on learning standards in these areas for each grade. No significant knowledge change was noted in the study by Mahar et al. (2003). Tsai et al. (2009) reports significant physical activity knowledge change among students but no impact on nutrition knowledge.

Other areas of impact

Body mass index

Results from Donnelly et al. (2009) suggest that BMI levels were positively impacted over the multi-year PAAC study. However, the researchers noted that this result was influenced by exposure levels whereby students in intervention schools with ≥75 min of PA/week showed significantly fewer increases in BMI levels at 3 years compared with schools that had <75 min. Another study, Healthier Options for Public Schoolchildren (HOPS), assessed BMI in 4588 students in five Florida elementary schools (non-randomized, four intervention and one control) (Hollar et al., 2010a). OrganWise Guys and TAKE 10! materials were incorporated over two school years (2004–2005 and 2005–2006) in the predominantly Hispanic student population. The researchers reported that girls in the intervention group realized significant decreases in overall BMI z scores and weight z scores ($P<.05$ and $P<.01$, respectively) and more intervention students than control students stayed within normal BMI percentile ranges both years ($P=.02$).

In comparing the Happy 10 intervention and control students, there was no significant difference in the change in height; however, the change in weight (2.4 kg intervention vs. 4.6 kg control) among girls was significant. Girls in the Happy 10 intervention group also had a significant difference in change of BMI as compared with girls in the control group ($0.47\ \text{kg/m}^2$ vs. $0.66\ \text{kg/m}^2$). The prevalence of overweight and obesity in the intervention group decreased by 0.4%–5.6%, as compared with an increase of 0.6%–4.5% in the control group.

Academic achievement

Three investigators have examined the impact of classroom-based movement on academic achievement as part of larger, longer-term trials: 1) the PAAC research study by Donnelly et al. (2009); 2) the PASS & CATCH project by Murray et al. (2008a,b); and 3) the HOPS initiative by Hollar et al. (2010b). Variations on TAKE 10! were implemented in each study, and the investigators reported improvement in different measures of academic performance. The HOPS project examined the results of 1197 students who took the Florida Comprehensive Achievement Test (FCAT). The FCAT is administered to public school children beginning in the third grade. Intervention children had significantly higher FCAT math scores than did control students in the 2004–2005 and 2005–2006 school years ($P<.001$). Although all ethnic groups showed a significant improvement in FCAT math scores, of particular interest is the fact that Hispanic children in the intervention schools showed a 20-point gain in FCAT math scores. The PASS & CATCH study combined the CATCH (Coordinated Approach To Child Health) coordinated health program with classroom-based TAKE 10! activities. The investigators examined the association between increased PA during the school day and academic achievement among 932 third and fourth graders from eight elementary schools in Texas. Stanford 10 tests assessed abbreviated reading comprehension and math problem-solving and were administered in September/October 2005, May 2006, and December 2006. Using the Behavioral Assessment System for Children (BASC-2), students were also evaluated on psychosocial variables, including adaptive skills such as student adaptability, social skills, leadership, study skills, and functional communication. Students who were not adapting well to the school environment had poorer scores on reading and math tests at baseline compared with students without adaptive challenges. Among students in the PASS & CATCH intervention, math scores improved significantly more over time in intervention students than compared with controls ($ß_1 = 6.58$ vs. 4.93, $P=.02$). Reading scores increased in both the control and intervention groups at similar rates. Students who were part of the PASS & CATCH schools and considered poor adapters significantly improved their reading ($ß_1 = -1.12$ vs. 3.30, $P<.01$) and math scores ($ß_1 = 7.40$ vs. 2.46, $P<.01$). Finally, the PAAC study assessed academic achievement for reading, writing, mathematics, and oral language skills using the Wechsler Individual Achievement Test-2nd Edition (WIAT-II-A; The Psychological Corporation, 2001). Detailed results are reported elsewhere in this supplement (see Donnelly and Lambourne, this issue), but a summary paper indicates that students in PAAC classrooms realized significant improvements in academic achievement from baseline to 3 years for reading, math, and spelling scores (Donnelly et al., 2009).

Attraction to physical activity

The Children's Attraction to Physical Activity (CAPA) scale was designed to assess children's interest and attitude toward PA (Brustad, 1993, 1996). Attraction to PA was explored in four schools participating in a 10-week TAKE 10! intervention (Barry et al., 2002). Two classes each from third, fourth, and fifth grades were randomly chosen and selected to function as the control and intervention classes at each grade level. Children ($N=269$) were administered the CAPA questionnaire at baseline and completion. Overall CAPA scores were significantly ($P=.0003$) higher for boys (48.1) than for girls (45.8), indicating a lower interest and enjoyment of PA in girls. Overall CAPA scores (boys and girls combined) tended to decrease in control classes and increase in classes that used the TAKE 10! program. The pre–post difference between control and intervention schools was nearly significant ($P=.06$). The majority of teachers reported that TAKE 10! improved the classroom environment and that classes required less disciplinary intervention. These data suggest that participation in TAKE 10! may improve attraction to PA among children in third to fifth grades.

Classroom behavior

Teacher anecdotal feedback on improved classroom behavior resulted in a study that explored this issue (Metzler and Williams, unpublished data, 2004). Thirty-eight classes in the Atlanta metro area were observed in a variety of school settings and elementary grade levels (K–5). A systematic observation instrument was developed and field tested, with observers trained for inter-observer

reliability. The system uses duration (time) recording at four levels: 1) Content; 2) Leader; 3) Structure; and 4) Engagement. The Content level indicates the specific focus at the moment: academic; management/general (transitional time between subjects; outside interruptions); and TAKE 10!. The leader level indicates who is assuming the lead role for instruction at a given moment: teacher or student. The Structure level indicates how students are grouped for instruction: class; assigned groups; individual. The Engagement level describes how each student is engaged at the moment of observation: listening; working; waiting; transition; resting; off task; stretching (pre- or post-TAKE 10! stretching or cool-down); checking heart rate; and low vs. moderate vs. vigorous level of exercise. (Data were analyzed using the Noldus Observer ™ software.) Mean duration of 25.13 min was observed in the classroom before TAKE 10! lessons and a mean of 23.01 min observed after them. The observers used a rule of thumb to collect post-TAKE 10! data for approximately the same amount of time as pre-, allowing for better pre–post comparisons. The mean time for TAKE 10! lessons in this study was 9.26 min (SD = 3.91). With the class sizes and length of the pre- and post-TAKE 10! segments, all children were observed for at least one 2-minute interval in every observation. Sampling intervals during TAKE 10! segments were 15 s long, to allow all students to be observed, and to reflect the faster pace of those segments. Subjects alternated between males and females, and across areas in the classroom. Comparisons were made of students' behavior before, during, and after the activity segments. The results indicated a reduction of over 20% in off-task and other inattentive behaviors following the activity segment, suggesting that the activity segment had a positive effect on students' behavior. Another study conducted in predominantly Hispanic school children (N = 840) over one school year reported that both teachers and students indicated that participating students were more able to concentrate on coursework after a TAKE 10! session (Tsai et al., 2009).

Discussion

The current evidence regarding the efficacy of school-based interventions to promote healthy weight is limited (Katz, 2009). One barrier to health promotion programming success during school hours is the ability of the systems to implement programs with fidelity and to sustain them for maximum impact. The findings reviewed in the 10 years of the TAKE 10! intervention suggest that classroom-based physical activity is feasible for elementary classroom teachers and has positive impacts on student health. The programming and policy impact of this model are discussed in the following paragraphs.

Programming implications

Energy balance

Despite the challenges of time and academic focus, more than 40% of teachers participating in various projects reported TAKE 10! implementation three or more times per week. TAKE 10! is also effective in increasing PA levels among students and a modest number of kilocalories are burned during a 10-minute session. Reports from Butte et al. (2007) and others (Hill et al., 2003; Wang et al., 2006) regarding the energy imbalance contributing to excess weight gain over time varies widely in children—from 100 to 263 kcal/day. The various studies cited here (Harrell et al., 1997; Honas et al., 2008; Liu et al., 2007; Stewart et al., 2004) suggest incremental expenditure realized via TAKE 10! activities ranges from 24 to 43 kcal per 10-minute session. Thus one bout each day may address one-fourth to one-half of the positive energy balance experienced by TAKE 10! students in first through fifth grades. This idea is also supported by the longer-term studies reported here, which suggest that BMI maintenance is achieved in intervention students when exposure is sustained. Given that the majority of children in the United States attend school; classroom-based PA in 10-minute increments delivered daily on a national scale could help to slow the gradual increase in childhood overweight prevalence at the population level.

International replication

Despite differences in school structure (longer school days or years) and a focus on academic performance or education content in core learning areas, studies outside of the United States have also explored classroom-based PA (Liu et al., 2007, 2008; Ahamed et al., 2007; Verstraete et al., 2007). The first international study using TAKE 10! was conducted in Beijing, China (Happy 10) beginning in 2004 and a multi-centered, randomized, controlled trial is now under way (Li et al., 2010). Additional projects in Brazil (TIRE 10!; pronounced "cheer-ay 10") and England (TAKE 10! UK) are now under way. This international expansion of TAKE 10! through collaboration with the ILSI branches and university partners in those countries suggests that the model is replicable in other school system structures around the globe. This replication may allow investigators to collect and contrast outcome data across school structures, cultures, and student populations.

Pre-service teacher training

Over the years, the ILSI Research Foundation has received requests for TAKE 10! from universities who train pre-service teachers. The materials are used to provide future teachers with ideas for integrating health, PA, and nutrition content into learning concepts. The various impacts of the program described in this review and other similar studies (Mahar et al., 2006; Parks et al., 2007) suggest that teachers are willing to integrate movement into their classrooms. Promoting health and PA integration into core content during university training may be effective in improving teacher self-efficacy related to movement and health and more activity may thus be incorporated into classroom lessons.

Academic achievement

Another important consideration for school administrators is the impact of PE and PA programs on academic achievement (Langille and Rodgers, 2010). Recent reviews (Carlson et al., 2008; Trudeau and Shephard, 2008; CDC, 2010b) indicate that schools with more minutes of PE and PA have higher levels of academic performance. Although schools in the United States have developed wellness policies with PE/PA goals, it is challenging to achieve those policies. A "system-fit" program that integrates age-appropriate movement and grade-specific learning objectives is an opportunity to help those children who are kinesthetic learners and, according to one report (Murray et al., 2008a,b,c), those children who are not adapting well to the school setting.

Program research needs

There are many questions that still need to be explored relative to TAKE 10! and its impact. Tsai et al. (2009) note that improvement in and validation of knowledge assessment tools in the materials is required. Outcomes realized in PAAC and PASS & CATCH suggest that a longer-term, large study focusing on academic achievement is needed. Other research topics to be explored include program sustainability and the characteristics of schools and teachers that are "sustained users," impact on teacher PA behavior and PA self-efficacy, and BMI-for-age impact among students in kindergarten through second grades.

Policy implications

Several states have passed or debated coordinated school health and/or PE/PA policy mandating a specific number of minutes each week in the school setting. A recent policy analysis examined 17 states that have taken legislative action to promote PA/PE, and analyzed legislative, regulatory, and policy environments to determine facilitators for successfully implementing classroom-based PA as an

evidence-based intervention (Hackett et al., unpublished data, 2010). There is a lack of research on which states have thus far effectively implemented PA/PE policies and which factors may predict successful implementation at the state level.

One policy achievement success story is found in the adoption of the TAKE 10! program in Tennessee. A mandate was passed in 2006 with Tennessee state law requiring 90 min of PA per week for elementary and secondary students. The law also includes explicit language directing local districts to include PA in "the instructional day" (Healthy Students Healthy Schools Act). Tennessee's statutory language provides a prime opportunity for programs such as TAKE 10! that rely on curricula-based initiatives to incorporate PA. Tennessee also makes a clear distinction between PA and PE within the law. Tennessee's adoption of Coordinated School Health (CSH) and the successful implementation of TAKE 10! within the state from 2007 to 2010 demonstrate the importance of state leadership to provide guidance to local districts on how to implement a state law. This success is further documented in the recent Tennessee CSH report, which notes that "over 8000 fewer children were classified as overweight and obese in 2008–2009 compared to the previous year. The prevalence of overweight and obesity among the state's children dropped from 40.9% to 39.0%" (Tennessee Department of Education, 2010, p. 6). Nemours health system in Delaware has also utilized TAKE 10! to achieve policy and practice changes (Chang, et al, 2010, p. 48). Schools are striving to achieve 150 min of structured PE or PA each week with TAKE 10!, CATCH or other evidence-based programming. Highlighting policy attainment and its impact within states, using a substantial data collection and evaluation process, may generate strong political support at the state and federal levels. This process is critical to ensure these laws are successfully implemented and simply not "unfunded mandates."

The Let's Move initiative announced by The White House in early 2010 is an opportunity for states with existing policy mandates to link to federal action and strengthen the policy base for both coordinated school health and classroom-based nutrition and PA initiatives (The White House, 2010). Let's Move recommendations are to "build physical activity into classroom lessons" (Let's Move website, 2010) and to integrate nutrition and PE into the curriculum (The White House Task Force on Childhood Obesity, 2010). Obesity prevention efforts and related funding from federal agencies are primarily focused on policy and environmental change. Through concerted action by state departments of education to integrate nutrition and PE into core academics through evidence-based programs such as TAKE 10!, we can ensure achievement of certain school wellness policies and share success stories with federal officials that can lead to change in other states where policy action is needed to address obesity and PA in children.

Conclusions

As of August 2010, TAKE 10! has been disseminated to more than 40,000 elementary classrooms in the United States. It is clear from the TAKE 10! body of work between 1999 and 2010 that a classroom-based PA program that integrates academic and health concepts can be implemented with success in elementary classrooms impacting both teachers and students in a positive and fun way. Certain results suggest that students experiencing 15 min of daily TAKE 10! may realize BMI maintenance over time. It is also clear that such a program can be used by schools to achieve state or district PA/PE policy mandates as demonstrated by Tennessee and Delaware. Continuing to explore characteristics of those adopting and sustaining the TAKE 10! program, the impact on teacher behavior and self-efficacy, international opportunities, and the impact on academic achievement are key priorities for TAKE 10! research in the future.

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