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How can schools help youth increase physical activity? An economic analysis comparing school-based programs

Susan H. Babey [a], Shinyi Wu [b,c,*], Deborah Cohen [c]

[a] UCLA Center for Health Policy Research, Department of Health Policy and Management, Fielding School of Public Health, University of California, Los Angeles, CA, USA
[b] School of Social Work, Epstein Department of Industrial and Systems Engineering, University of Southern California, Los Angeles, CA, USA
[c] RAND Corporation, Santa Monica, CA, USA

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ABSTRACT

Objective. For optimal health, physical activity should be an integral and routine part of daily life. Youth spend a significant amount of time at school yet rarely achieve the recommended 60 min of moderate and vigorous physical activity in physical education (PE) classes or recess. This study assessed the following types of school-based opportunities to improve physical activity for youth: after-school programs, before-school programs, PE classes, extended-day PE, and short physical activity breaks during the school day.

Method. An economic analysis conducted in 2013 compared school-based approaches to increasing physical activity. Analysis factors included costs, reach, effects on physical activity gains, cost-effectiveness, and other potentially augmenting benefits.

Results. Two programs were significantly superior in terms of reach and cost per student: (1) extending the school day with mandatory PE participation and (2) offering short (10-minute) physical activity breaks during regular classroom hours. After-school program costs per student are high and the programs have a smaller reach, but they offer benefits (such as childcare) that may justify their higher costs. Before-school programs did not appear feasible.

Conclusion. Incorporating short physical activity breaks into the existing school day would be a cost-effective way to increase school-based activity. This type of program is inexpensive and has broad reach. Inserting activity breaks throughout the day is appropriate, especially when youth are otherwise largely sedentary.

Introduction

The Institute of Medicine (IOM) recommends that everyone make physical activity a routine part of life in order to reduce obesity, promote health and fitness, and reduce the risk for chronic health conditions (IOM, 2012). The *Physical Activity Guidelines for Americans* recommends that youth engage in at least 60 min of daily physical activity (U.S. Department of Health and Human Services, 2008). In addition to the well-documented health benefits of physical activity, research also suggests that school-based physical activity is positively associated with academic benefits including better academic achievement, better performance in math, reading and English, and improved attention and concentration (Centers for Disease Control and Prevention, 2010; Nelson and Gordon-Larsen, 2006; Castelli et al., 2007; Chomitz et al., 2009). Importantly, no studies have reported evidence that time spent in school-based physical activity adversely impacted academic performance (Centers for Disease Control and Prevention, 2010; Active Living Research, 2009). Regular physical activity in childhood also influences health outcomes in adulthood. Physically active youth are more likely to become physically active adults (Telama et al., 2005) and have reduced risk for various chronic illnesses, such as obesity, diabetes, high blood pressure, high cholesterol, asthma, arthritis, and poor health status (IOM, 2005).

Despite these benefits, few youth meet physical activity recommendations. According to the 2006 National Health and Nutrition Examination Survey (NHANES), which measured physical activity with accelerometers, fewer than 9% of adolescents and 42% of children met physical activity guidelines (Troiano et al., 2008). Many other studies have also documented low rates of moderate and vigorous physical activity (MVPA) among youth, and the rates tend to decline as youth mature (Brownson et al., 2005; Kimm et al., 2000). Youth spend a significant amount of time at school, making schools a good venue for opportunities to increase physical activity. Research suggests that school-based physical activity programs can increase physical activity among youth (Kriemler et al., 2011). Information about the cost-effectiveness of different options for school-based physical activity can guide decisions about utilization of limited school resources.

We reviewed four types of school-based approaches to increasing youth physical activity and estimated their costs and cost-effectiveness:

* Corresponding author at: School of Social Work, Epstein Department of Industrial and Systems Engineering, University of Southern California, University Park Campus, ATT 1412, Mail Code 1400, Los Angeles, CA 90089-1400, USA.
E-mail address: shinyiwu@usc.edu (S. Wu).

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after-school programs, before-school programs, extending the school day to provide 60 min of PE, and short (10-minute) in-class physical activity breaks. These four broad types of programs were selected to represent the general types of school-based programs that are commonly found in schools and have been examined previously in intervention research. In addition, we included before school programs because of a planned intervention on this topic (Tompkins et al., 2012).

School-based approaches to increasing physical activity

After-school programs

After-school programs traditionally have provided a means to supervise youth who might otherwise not have age-appropriate adult supervision (Beets, 2012; Tebes et al., 2007; Vandell and Corasaniti, 1988; Posner and Vandell, 1994). They can include a variety of activities that vary with the age of participants including arts and crafts, recreational opportunities, field trips, computer labs, homework assistance, informal sports, interscholastic sports, and clubs. After-school programs have been found to contribute to modest amounts of physical activity. One study found that out of 102 min of after-school time, students participated in, on average, 40.8 min of light, 13.4 min of moderate, and 6.9 min of vigorous physical activity, yielding a total of 20.3 min of MVPA (Trost et al., 2008). This is one third of the recommended children's daily physical activity level. Given that after-school programs typically last 3 h per day, they offer a significant opportunity to increase children's physical activity.

Before-school programs

Theoretically, physical activity among youth could be increased by providing opportunities for exercise before school begins each day, similar to after-school programs that incorporate recreation and informal sports. We have found no published research that examines before-school physical activity programs, but there is one planned study (Tompkins et al., 2012).

PE classes and extended-day PE

PE classes offer another opportunity for youth to engage in physical activity. Approximately 75% of the states require that schools teach PE in elementary through high school, and the majority of states require schools or districts to follow guidelines based on the National Standards for Physical Education (Lee et al., 2007). However, many students accumulate only a few, if any, minutes of MVPA during PE. For each hour of PE class, standardized curricula typically include only half an hour of MVPA; and research suggests that most classes seldom achieve even this 50% benchmark (Levin et al., 2001). Extending the school day to offer additional PE time using evidence-based PE curricula that optimize MVPA (Sallis et al., 1997; McKenzie et al., 1996; Luepker et al., 1996) could provide a meaningful physical activity opportunity.

In-class physical activity breaks

Another potential approach is to provide structured physical activity breaks during regular school hours (Salmon, 2010). Examples include Instant Recess® and Take 10!®. Research suggests that these physical activity breaks can provide significant increases in physical activity, are associated with improvements in weight status, and can also lead to increased physical fitness, improved attention in class, and improved academic performance (Barr-Anderson et al., 2011; Mark and Janssen, 2009; Spiegel and Foulk, 2006; Whitt-Glover et al., 2011; Katz et al., 2010; Donnelly et al., 2009; Mahar, 2011; Kibbe et al., 2011). Although physical activity breaks provide a short duration of physical activity, the evidence suggests that sporadic bursts of physical activity can be beneficial to health (Glazer et al., 2013; Holman et al., 2011).

Methods

To assess the value and impact of school-based programs and interventions to increase physical activity for school-age children, we compared costs, reach (including minorities and low-income families), effects on physical activity gains, and cost-effectiveness for the following four types of program options:

1. After-school program, typically from 3 to 6 PM. The option includes programs that are either fee-based or subsidized and either on-site or off-site.
2. Extended school day (40 to 60 min longer) with increased time for PE class, mandatory for all students. This option would require a trained PE teacher competent in implementing evidence-based curricula.
3. In-class activity consisting of two 10-minute breaks of structured physical activities, implemented by playing exercise videos (such as Instant Recess® or Take10!®). This option does not require extra personnel such as PE teachers. These types of activity breaks could be incorporated into the existing school day, or the school day could be lengthened slightly (by 20 min) to allow the breaks to be incorporated without displacing other planned classroom activities.
4. Before-school activity program, with volunteer or professional supervision available 30 min before school during regular school days for students to participate in physical activities, informal sports, or interscholastic sports.

Because active commuting programs and the factors that influence them vary widely, we did not attempt to include an active commuting program in this economic analysis.

Estimates of program costs and costs for students

For this analysis, program costs considered the total annual cost per participating child to operate the program on an on-going basis, regardless of sources of funds. All costs are reported in 2012 dollars. The cost figures were estimated from published cost analyses, when available, or imputed based upon resource utilization (Haddix et al., 2003), including program personnel costs, supplies and materials, equipment, program overhead costs such as facilities costs (30% of direct costs), and, when applicable (such as for off-site after-school programs), transportation costs. Teacher and program personnel wages were based on the median national wage rate from Bureau of Labor Statistics (2012a, 2012b) data (hourly rate = $24.06) (Bureau of Labor Statistics, 2012b). This hourly rate was multiplied by 30% fringe and benefit and 40% overhead to arrive at estimated hourly personnel costs (i.e., $44/h). To determine cost per year per child, we assumed a school year length of 180 school days and an average of 30 students per class. Nationally, the average school year is 179 days and the average class size is 21 for elementary schools and 27 for secondary schools (National Center for Education Statistics, 2013). Equipment costs related to physical activity breaks included $15 per DVD and $100 for a DVD player.

Cost estimates for after school programs are based on costs reported by the Afterschool Alliance. In 2009 the alliance reported that the average cost of after-school care, including summer programming, is $3190 per child (2009 dollars, or $3345 in 2012 dollars adjusted by average Consumer Price Index-Urban Consumers, CPI-U (Bureau of Labor Statistics, 2012a)), with parents paying an average of $2400 of this (2009 dollars, or $2517 in 2012 dollars); the balance of the costs is subsidized by the school district or other sources (Earle and Afterschool Alliance, 2009). After-school programs costs were prorated for 180 school days from 210 days including summer programs (National Center for Education Statistics, 2013).

The program operating cost excludes costs incurred for the development of the program, research purposes, participant-specific cost (e.g., purchase of sneakers), or other intangible societal cost (e.g., loss of productivity due to volunteering). We did not include potential effects on health care costs (such as injuries, improved health, and reduced health care utilizations) or costs related to productivity and welfare (such as increased future earnings, or economic benefits related to reduced pregnancy and crimes). Costs for students were the out-of-pocket costs paid by students and their families to attend a program but did not include activity-specific supplies that the students have to purchase, such as special shoes and helmets.

Program reach

Values for program reach for after-school programs were drawn from Afterschool Alliance research (After School Alliance, 2009), which reports that only 15% of all students participate. Several factors affect participation. Off-site

after-school programs are likely to reach fewer than 15% of all students due to program availability, accessibility, and parent concerns about transportation and safety. Our analysis assumed that extended school days with PE programs, physical activity programs before school, or physical activity breaks would be mandatory and would, therefore, reach 100% of students, including low-income and minority students.

General approach to effectiveness and cost-effectiveness estimation

To compare the cost efficiency of the different typical programs, we first estimated the time spent in physical activities and intensity level (e.g., moderate physical activity or vigorous physical activity) per student for each program based on published literature. We then standardized effectiveness by calculating the higher metabolic equivalent (MET) intensities (MET-hours gained) per person per day as a result of the intervention. A MET represents the ratio of energy expended divided by resting energy expenditure, which is either measured or estimated from body size. Following validated classification systems, including the Compendium of Physical Activity, different types and intensity of activities are coded into METs as moderate physical activity (MPA) at 3.0 METs, moderate-to-vigorous physical activity (MVPA) at 4.5 METs, and vigorous physical activity (VPA) at 6.0 METs (Ainsworth et al., 2011; Fletcher et al., 2001). MET-hours gained are derived by multiplying the METs associated with the activity promoted in the intervention by the time spent performing the activity using hours as the unit of analysis. Estimating MET-hours as effectiveness measures accounts for the major parameters of physical activity, including frequency, duration, and intensity. For this analysis, we assumed that all of the physical activities were MVPA and used a MET value of 4.5 (Ainsworth et al., 2011).

Interestingly, whether physical activity opportunities are offered during or after school, most program participants accumulate approximately 20 min of MVPA daily on average during school days. Beets and colleagues studied 25 after-school programs and found that children attended such programs for an average of 125 min per day, rather than the full length of a typical program, i.e., 180 min (Beets et al., 2009). They spent approximately 26.6 min per day in physical activity, which was estimated to gain 1.5 MET hours per person per day (30 min of MPA, or 20 min of MVPA). Trost and colleagues objectively measured 147 students from 7 after-school programs and found that the average accumulation of MVPA was 20.3 min, or 1.5 MET hours per person per day as well (Trost et al., 2008). The amount of physical activity gained was similar for daily PE classes employing an evidence-based program. Research measuring physical activity by observation or accelerometer indicates that 35–40% of class time in typical PE classes is spent in MVPA (McKenzie et al., 2006; Fairclough and Stratton, 2005; van Beurden et al., 2003; Lonsdale et al., 2013). However, recent systematic reviews suggest that implementing a standardized, evidenced-based PE curricula can add 6 min of MVPA per day or increase the amount of class time spent in MVPA from 44% to 54% (Lonsdale et al., 2013; Bassett et al., 2013). Therefore, we estimated that a 40–60 minute evidence-based PE class would provide 20–30 min of MVPA. The in-class physical activity breaks have lower demands on time, because they are only 10 min each. The confined environment and set time limit facilitate a focused 10 min of physical activity. If two breaks are offered each day, students can gain 20 min of MVPA (Bassett et al., 2013). There is no information regarding physical activity level for before-school programs; we assumed that students may gain up to 20 min of MVPA in a 30-minute before-school program designed to engage participants in physical activity. For each type of program, cost- effectiveness was calculated as the annual program operating cost divided by MET hours gained per child.

Results

Table 1 displays cost estimates, cost assumptions, reach, minutes of MVPA accrued per year per child converted to MET hours gained per year, and cost-effectiveness estimates.

We estimated the after-school program to cost $2867 per school year per child (range $2000 to $3800) for an on-campus program (Earle and Afterschool Alliance, 2009). This cost is usually shared between physical activity and academic enrichment budgets; thus, the proportional cost for the physical activity program would likely be less. Off-site after-school programs were estimated to cost an additional $180 per child annually for transportation, for a total of $3047 ($2180 to $3980).

Lengthening the school day by 60 min to incorporate mandatory PE class was estimated to cost $264 per child. This was based on an hourly base teacher's salary of $24.06 multiplied by 30% fringe and benefit and 40% overhead (i.e., $44/hour), and assumed 180 school days and a one-hour PE class comprising 30 students each day.

We estimated no additional cost for time spent leading brief in-class physical activity breaks. Teachers can lead the breaks, or a student can be assigned to load up videos or DVDs and lead the break activity. The costs of videos are about $15 each; if variety is needed, a class could get 5 (one for each school day) or could switch with other classes in the school. Thus, an initial investment was estimated to be $0.50 per child, assuming the classrooms already have a DVD player. If the school needs to buy a DVD player for every class, and there is an average of 30 students per class, the cost would grow to $3.83 per child per year. After the first year, the cost is probably less than 50 cents per child if new exercise DVDs are ordered. The cost analysis assumed that the school day is not lengthened to accommodate the physical activity breaks. If the school day is lengthened by 20 min, the cost would be one-third of the extended-day PE program, or $86/child above the cost of the DVD player and DVDs.

Because there were no published examples of before-school physical activity programs, we assumed a 30-minute physical activity program involving 20 min of MVPA. Previous research suggests that relying on volunteers for a before-school program is not feasible. Strelow et al. (2002) described using volunteers in a middle school to promote physical activity and reported that no one volunteered to work before school. As a result, we have not assessed the cost of a program using volunteers. However, it is worth noting that the before-school program would likely incur greater societal level costs than the other programs if it relied on volunteers (Moodie et al., 2009). Rather, we assessed the cost if a teacher leads the activities as half of a one-hour PE class, i.e., $132.

As shown in Table 1, costs and cost-effectiveness varied considerably across the four types of programs. The most important driver of program cost is program length (e.g., 3 h for after-school program, and 20 min for 2 physical activity breaks) followed by teacher-to-student ratio (e.g., after-school program for older elementary school children is 1:6 (Trost et al., 2008); PE class for middle and high school students is 1:30). However, physical activity effectiveness in terms of MET-hours gained was similar across program types. As a result, program cost is the driving factor of cost-effectiveness. Cost-effectiveness was $0.01 per MET-hour gained for the in-class physical activity breaks assuming DVD players need to be purchased, $0.49 for instructor-led physical activity before school, $0.98 for extended school day with mandatory PE, and $10.62 for on-site after-school programs.

Discussion

Our economic analysis identified two alternatives that are significantly superior in terms of reach and cost per student: (1) Extending the school day with mandatory PE participation and (2) offering short (10-minute) physical activity breaks during regular classroom hours. After-school programs are more expensive and have a lower reach but offer other benefits (such as childcare and homework assistance) that may justify their higher costs. But due to the significantly greater operating costs (because of much higher teacher-student ratios) and low rates of participation, after-school programs were a less cost-effective option to increase physical activity for the vast majority of students. Before-school programs are inexpensive, but feasibility and adoption of this program are likely to be very low.

Similar to previous research, the current findings suggest that school-based strategies to increase physical activity, including school PE, in-class activities, and after-school programs, can increase physical activity among youth (Heath et al., 2012; Kriemler et al., 2011; Lonsdale et al., 2013). In addition, the current finding that extending the school day with mandatory PE and incorporating short physical activity breaks during class were the most cost-effective strategies is

Table 1
Comparison of costs, reach, and cost-effectiveness of programs that could potentially result in greater levels of physical activity among youth.

Evaluation dimensions	Programs						
	After-school program			Longer day	In-class	Before-school program	
	After-school program on-site, fee-based	After school targeting low income	After school off-site	Daily PE	Two 10-minute physical activity breaks	Volunteer-led	Teacher-led
School level(s) served	All	All	All	Middle and high school	All	All	All
Operating cost per year per child (2012 dollars)	$2867 (range $2000 to $3800), which is prorated for 180 school days from 210 days including summer program for $3345; ($3345/210 days * 180 days) = $2867	$2867 on average	$3047 (i.e., $2867 + $180)	$264	$3.83 for DVD player; $0.50 for videos	Negligible	$132
Cost assumptions	3 h/day; teacher–student ratio ≈ 1:6	3 h/day; teacher–student ratio ≈ 1:6	3 h/day; teacher–student ratio ≈ 1:6; transportation $1/day for 180 school days	1 h/day; $44/teacher/h (salary + benefits + overhead); teacher-student ratio 1:30	DVD player purchased for each classroom of 30 students; school day is not lengthened; if school day is lengthened, the cost goes up $86/child	0.5 h/day; assumes administrative costs absorbed by school	0.5 h/day; $44/ teacher/ h; teacher–student ratio 1:30
Cost for family	$2517	Subsidized	$2517+ (may be subsidized)	No additional cost	No additional cost	No additional cost	No additional cost
Reach	17% in elementary, 12% in middle school, and 7% in high school, voluntary	Likely >17% in elementary, 12% in middle school, and 7% in high school, voluntary	< 17% in elementary, 12% in middle school, and 7% in high school, voluntary	100%, mandatory participation	100%, mandatory participation	Unknown, but likely low	100%, mandatory participation
Reaches low-income and minorities	Some	Yes	Some	Yes	Yes	Some	Yes
Minutes of MVPA accrued per year per child	20 min per day = 1.5 MVPA, for 180 days = 270 MET-hours-gained per year	20 min per day or 270 MET-hours-gained per year	Likely around or less than 20 min per day and thus 270 or less MET-hours-gained	20–30 min per day[a] or 270–405 MET-hours-gained per year	20 min per day or 270 MET-hours-gained per year	20 min per day or 270 MET-hours-gained per year	20 min per day or 270 MET-hours-gained per year
Cost effectiveness (cost/MET-hours-gained)	$10.62 (i.e., $2867/270)	$10.62 (i.e., $2867/270)	$11.29 (i.e., $3047/270)	$0.65–$0.98 (i.e., $264/405 to $264/270)	$0.002–$0.01 (i.e., $0.50/270 to $3.83/270)	Negligible	$0.49 (i.e., $132/270)

[a] Assumes 50% of PE classes will be in MVPA and that classes are in 40–60 minute duration.

consistent with the results of a recent review. Bassett and colleagues reported that implementation of mandatory PE and classroom activity breaks resulted in the greatest increases in energy expenditure among youth (Bassett et al., 2013). However, the current research extends previous research by providing information about the relative cost-effectiveness of these different strategies.

Barriers exist for each of the strategies. One barrier is inertia—few people are ready to embrace change. Given a sluggish economy, the likelihood of increasing taxes to pay for increased costs of a longer school day may be slim, especially in communities with limited resources and an inadequate tax base. However, if schools have large fields, adequate facilities and relatively limited numbers of students, it may be possible for all students to take PE at the same time, for example, engaging in aerobic exercise or Zumba. However, if the physical space available for PE is limited, then PE would have to be staggered throughout the day. This means that some teachers might come later or leave earlier or that others would have more breaks or prep time during the school day. It is likely that districts could face opposition from teachers' unions to attempts to extend the school day. Nevertheless, cities like Chicago have been able to lengthen the school day in spite of opposition (Omer, 2012).

Barriers to school physical activity breaks include teacher reluctance to participate in activity breaks, lack of space, lack of time, and, in some cases, the need for teacher training (Whitt-Glover et al., 2011; Yancey et al., 2014). However, evaluations of interventions employing these types of physical activity breaks suggest that it is feasible to implement these at relatively low cost and using existing staff and facilities (Whitt-Glover et al., 2011; Barr-Anderson et al., 2011). One challenge to implementing before-school programs is staffing. Professional staff are typically busy preparing for the school day and not available for before-school activities, and relying on volunteers to staff a before-school program may not be feasible (Strelow et al., 2002). After-school programs have limited reach due to low participation; only 15% of youth participate in after-school programs (Earle and Afterschool Alliance, 2009). In addition, these programs have only modest impacts on physical activity (Trost et al., 2008), due in part to the range of activities included. There will always be a need, however, to continue after-school programs as long as children need supervision after school. There is a good reason to take advantage of this opportunity to encourage more physical activity among youth. Even using the 10-minute break method at the start of each after-school session and at the beginning of each hour could potentially generate 30 min of physical activity in a 3-hour program.

This analysis has some limitations. We focused on operating costs for the programs examined. As a result, we did not include development and implementation costs, nor did we examine societal-level costs. However, we also did not include potential societal level benefits such as reduced health care costs as a result of increased physical activity. In addition, although we described barriers to implementation for each strategy, these barriers could not be quantified and incorporated into the cost-effectiveness estimates.

Conclusion

The current analysis extends previous research by providing information about the relative cost-effectiveness of different strategies for promoting school-based physical activity. The results can guide decisions about utilization of limited school resources. As the evidence of the risks of physical inactivity continues to mount (Lee et al., 2012), it will become increasingly important to structure routine physical activity into the daily lives of both youth and adults. Inserting activity breaks throughout the day is appropriate, especially when youth must sit behind desks in a classroom and adults have sedentary jobs. Activity breaks are frequently recommended when people suffer from musculoskeletal problems associated with sedentary behaviors, or to prevent such problems in the first place. Introducing such routine breaks in school from an early age may ultimately translate into the introduction and sustainment of physical activity breaks in the workplace, which will have a substantial salutary effect on the nation's health.

Conflict of Interest

The authors declare that there are no conflicts of interests.

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References

Active Living Research, 2009. Active Education: Physical Education, Physical Activity and Academic Performance.
After School Alliance, 2009. America After 3 pm: The Most In depth Study of How America's Children Spend Their Afternoons.
Ainsworth, B.E., Haskell, W.L., Herrmann, S.D., Meckes, N., Bassett Jr., D.R., Tudor-Locke, C., Greer, J.L., Vezina, J., Whitt-Glover, M.C., Leon, A.S., 2011. Compendium of Physical Activities: A Second Update of Codes and MET Values. Med. Sci. Sports Exerc. 43, 1575–1581.
Barr-Anderson, D.J., Auyoung, M., Whitt-Glover, M.C., Glenn, B.A., Yancey, A.K., 2011. Integration of short bouts of physical activity into organizational routine a systematic review of the literature. Am. J. Prev. Med. 40, 76–93.
Bassett, D.R., Fitzhugh, E.C., Heath, G.W., Erwin, P.C., Frederick, G.M., Wolff, D.L., Welch, W.A., Stout, A.B., 2013. Estimated energy expenditures for school-based policies and active living. Am. J. Prev. Med. 44, 108–113.
Beets, M.W., 2012. Enhancing the translation of physical activity interventions in afterschool programs. Am. J. Lifestyle Med. 6 (4), 328–341 (July/August).
Beets, M.W., Beighle, A., Erwin, H.E., Huberty, J.L., 2009. After-school program impact on physical activity and fitness: a meta-analysis. Am. J. Prev. Med. 36, 527–537.
Brownson, R.C., Boehmer, T.K., Luke, D.A., 2005. Declining rates of physical activity in the United States: what are the contributors? Annu. Rev. Public Health 26, 421–443.
Bureau of Labor Statistics, 2012a. Consumer price index [online]Available: ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt (Accessed September 21, 2012).
Bureau of Labor Statistics, 2012b. Current employment statistics median earning data by industry [online]Available: http://www.bls.gov/ces/#data (Accessed September 21 2012).
Castelli, D.M., Hillman, C.H., Buck, S.M., Erwin, H.E., 2007. Physical fitness and academic achievement in third- and fifth-grade students. J. Sport Exerc. Psychol. 29, 239–252.
Centers for Disease Control and Prevention, 2010. The Association Between School Based Physical Activity, Including Physical Education, and Academic Performance. US Department of Health and Human Services, Atlanta, GA.
Chomitz, V.R., Slining, M.M., Mcgowan, R.J., Mitchell, S.E., Dawson, G.F., Hacker, K.A., 2009. Is there a relationship between physical fitness and academic achievement? Positive results from public school children in the northeastern United States. J. Sch. Health 79, 30–37.
Donnelly, J.E., Greene, J.L., Gibson, C.A., Smith, B.K., Washburn, R.A., Sullivan, D.K., Dubose, K., Mayo, M.S., Schmelzle, K.H., Ryan, J.J., Jacobsen, D.J., Williams, S.L., 2009. Physical Activity Across the Curriculum (PAAC): a randomized controlled trial to promote physical activity and diminish overweight and obesity in elementary school children. Prev. Med. 49, 336–341.
Earle, A., Afterschool Alliance, 2009. Roadmap to Afterschool for All.
Fairclough, S., Stratton, G., 2005. Physical activity levels in middle and high school physical education: a review. Pediatr. Exerc. Sci. 17, 217.
Fletcher, G.F., Balady, G.J., Amsterdam, E.A., 2001. Exercise standards for testing and training: a statement for healthcare professionals from the American Heart Association. Circulation 104, 1694–1740.
Glazer, N.L., Lyass, A., Esliger, D.W., Blease, S.J., Freedson, P.S., Massaro, J.M., Murabito, J.M., Vasan, R.S., 2013. Sustained and shorter bouts of physical activity are related to cardiovascular health. Med. Sci. Sports Exerc. 45 (1), 109–115. http://dx.doi.org/10.1249/MSS.0b013e31826beae5 (Jan).
Haddix, A.C., Teutsch, S.M., Corso, P.S., 2003. Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation. Oxford University Press, New York.
Heath, G.W., Parra, D.C., Sarmiento, O.L., Andersen, L.B., Owen, N., Goenka, S., Montes, F., Brownson, R.C., 2012. Evidence-based intervention in physical activity: lessons from around the world. Lancet 380, 272–281.
Holman, R.M., Carson, V., Janssen, I., 2011. Does the fractionalization of daily physical activity (sporadic vs. bouts) impact cardiometabolic risk factors in children and youth? PLoS One 6, e25733.
IOM, 2005. Preventing Childhood Obesity. National Academies Press, Washington DC.
IOM, 2012. Accelerating progress in obesity prevention: solving the weight of the nation, an expert report from the institute of medicine. http://www.iom.edu/Reports/2012/Accelerating-Progress-in-Obesity-Prevention.aspx.
Katz, D.L., Cushman, D., Reynolds, J., Njike, V., Treu, J.A., Walker, J., Smith, E., Katz, C., 2010. Putting physical activity where it fits in the school day: preliminary results of the ABC (activity bursts in the classroom) for fitness program. Prev. Chronic Dis. 7, A82.

Kibbe, D.L., Hackett, J., Hurley, M., Mcfarland, A., Schubert, K.G., Schultz, A., Harris, S., 2011. Ten Years of TAKE 10!(®): integrating physical activity with academic concepts in elementary school classrooms. Prev. Med. 52 (Suppl. 1), S43–S50. http://dx.doi.org/10.1016/j.ypmed.2011.01.025 (Epub 2011 Jan 31).

Kimm, S.Y., Glynn, N.W., Kriska, A.M., Fitzgerald, S.L., Aaron, D.J., Similo, S.L., Mcmahon, R.P., Barton, B.A., 2000. Longitudinal changes in physical activity in a biracial cohort during adolescence. Med. Sci. Sports Exerc. 32, 1445–1454.

Kriemler, S., Meyer, U., Martin, E., Van Sluijs, E.M.F., Andersen, L.B., Martin, B.W., 2011. Effect of school-based interventions on physical activity and fitness in children and adolescents: a review of reviews and systematic update. Br. J. Sports Med. 45, 923–930.

Lee, S.M., Burgeson, C.R., Fulton, J.E., Spain, C.G., 2007. Physical education and physical activity: results from the School Health Policies and Programs Study 2006. J. Sch. Health 77, 435–463.

Lee, I.M., Shiroma, E.J., Lobelo, F., Puska, P., Blair, S.N., Katzmarzyk, P.T., 2012. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet 380, 219–229.

Levin, S., McKenzie, T.L., Hussey, J.R., Kelder, S., Lytle, L., 2001. Variability of physical activity in physical education lessons across elementary school grades. Meas. Phys. Educ. Exerc. Sci. 5, 207–218.

Lonsdale, C., Rosenkranz, R.R., Peralta, L.R., Bennie, A., Fahey, P., Lubans, D.R., 2013. A systematic review and meta-analysis of interventions designed to increase moderate-to-vigorous physical activity in school physical education lessons. Prev. Med. 56, 152–161.

Luepker, R.V., Perry, C.L., Mckinlay, S.M., Nader, P.R., Parcel, G.S., Stone, E.J., Webber, L.S., Elder, J.P., Feldman, H.A., Johnson, C.C., et al., 1996. Outcomes of a field trial to improve children's dietary patterns and physical activity. The Child and Adolescent Trial for Cardiovascular Health. CATCH collaborative group. J. Am. Med. Assoc. 275, 768–776.

Mahar, M.T., 2011. Impact of short bouts of physical activity on attention-to-task in elementary school children. Prev. Med. 52 (Suppl. 1), S60–S64.

Mark, A.E., Janssen, I., 2009. Influence of bouts of physical activity on overweight in youth. Am. J. Prev. Med. 36, 416–421.

McKenzie, T.L., Nader, P.R., Strikmiller, P.K., Yang, M., Stone, E.J., Perry, C.L., Taylor, W.C., Epping, J.N., Feldman, H.A., Luepker, R.V., Kelder, S.H., 1996. School physical education: effect of the Child and Adolescent Trial for Cardiovascular Health. Prev. Med. 25, 423–431.

McKenzie, T.L., Catellier, D.J., Conway, T., Lytle, L.A., Grieser, M., Webber, L.A., Pratt, C.A., Elder, J.P., 2006. Girls' activity levels and lesson contexts in middle school PE: TAAG baseline. Med. Sci. Sports Exerc. 38, 1229–1235.

Moodie, M., Haby, M., Galvin, L., Swinburn, B., Carter, R., 2009. Cost-effectiveness of active transport for primary school children — walking school bus program. Int. J. Behav. Nutr. Phys. Act. 6, 63.

National Center for Education Statistics, 2013. Digest of Education Statistics: Advance Release of Selected 2013 Tables [Online]. Institute of Education Sciences, U.S. Department of Education, Washington, DC (Available: http://nces.ed.gov/programs/digest/d13/tables/dt13_203.90.asp [Accessed July 18 2014]).

Nelson, M.C., Gordon-Larsen, P., 2006. Physical activity and sedentary behavior patterns are associated with selected adolescent health risk behaviors. Pediatrics 117, 1281–1290.

Omer, S., 2012. Chicago Pushes Longer School Days as Key to Achievement: 'We Had to Do Something', (p.July 28).

Posner, J.K., Vandell, D.L., 1994. Low-income children's after-school care: are there beneficial effects of after-school programs? Child Dev. 65, 440–456.

Sallis, J.F., McKenzie, T.L., Alcaraz, J.E., Kolody, B., Faucette, N., Hovell, M.F., 1997. The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. Sports, play and active recreation for kids. Am. J. Public Health 87, 1328–1334.

Salmon, J., 2010. Novel strategies to promote children's physical activities and reduce sedentary behavior. J. Phys. Act. Health 7 (Suppl. 3), S299–S306.

Spiegel, S.A., Foulk, D., 2006. Reducing overweight through a multidisciplinary school-based intervention [ast]. Obesity 14, 88–96.

Strelow, J.S., Larsen, J.S., Sallis, J.F., Conway, T.L., Powers, H.S., McKenzie, T.L., 2002. Factors influencing the performance of volunteers who provide physical activity in middle schools. J. Sch. Health 72, 147–151.

Tebes, J.K., Feinn, R., Vanderploeg, J.J., Chinman, M.J., Shepard, J., Brabham, T., Genovese, M., Connell, C., 2007. Impact of a positive youth development program in urban after-school settings on the prevention of adolescent substance use. J. Adolesc. Health 41, 239–247.

Telama, R., Yang, X., Viikari, J., Valimaki, I., Wanne, O., Raitakari, O., 2005. Physical activity from childhood to adulthood: a 21-year tracking study. Am. J. Prev. Med. 28, 267–273.

Tompkins, C.L., Hopkins, J., Goddard, L., Brock, D.W., 2012. The effect of an unstructured, moderate to vigorous, before-school physical activity program in elementary school children on academics, behavior, and health. BMC Public Health 12, 300.

Troiano, R.P., Berrigan, D., Dodd, K.W., Mâsse, L.C., Tilert, T., McDowell, M., 2008. Physical activity in the United States measured by accelerometer. Med. Sci. Sports Exerc. 40, 181–188.

Trost, S.G., Rosenkranz, R.R., Dzewaltowski, D., 2008. Physical activity levels among children attending after-school programs. Med. Sci. Sports Exerc. 40, 622–629.

U.S. Department Of Health And Human Services, 2008. Physical Activity Guidelines for Americans.

Van Beurden, E., Barnett, L.M., Zask, A., Dietrich, U.C., Brooks, L.O., Beard, J., 2003. Can we skill and activate children through primary school physical education lessons? "move it groove it"—a collaborative health promotion intervention. Prev. Med. 36, 493–501.

Vandell, D.L., Corasaniti, M.A., 1988. The relation between third graders' after-school care and social, academic, and emotional functioning. Child Dev. 59, 868–875.

Whitt-Glover, M.C., Ham, S.A., Yancey, A.K., 2011. Instant Recess (R): a practical tool for increasing physical activity during the school day. Prog. Community Health Partnersh. 5, 289–297.

Yancey, A.K., Whitt-Glover, M., Porter, A.T., Herrmann, A.K. (Eds.), 2014. Role of Recess and Activity Breaks During the School Day. Human Kinetics, Champaign, IL.