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## Top 10 Research Questions Related to Physical Activity in Preschool Children

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The purpose of this article was to highlight important research needs related to physical activity in 3- to 5-year-old children. We identified research needs in 3 major categories: health effects, patterns of physical activity, and interventions and policies. The top research needs include identifying the health effects of physical activity, the effects of physical activity on the development of healthy weight, the effects of physical activity on learning and behavior, and the health implications of sedentary behavior. Research questions concerning patterns of physical activity include determining the prevalence of 3- to 5-year-olds meeting the current physical activity guidelines; the social and environmental factors that influence physical activity in home, preschool, and community settings; and how physical activity tracks into later childhood, adolescence, and adulthood. Research questions about interventions and policies include identifying the most effective strategies to promote physical activity in home, child care, and community settings and to reach diverse populations of young children, identifying effective intervention implementation and dissemination strategies, and determining the effectiveness of national, state, local, and institutional policies for increasing physical activity. In conclusion, research is needed to establish a full understanding of the health implications of physical activity in 3- to 5-year-old children, to better understand the nature of physical activity behavior in this group, and to learn how to promote physical activity in young children.

**Keywords:** child care, health, intervention, policy

The health implications of physical activity in adults have been well documented (U.S. Department of Health and Human Services [USDHHS], 2008), and substantial evidence also supports the health benefits of physical activity in middle childhood and adolescence (USDHHS, 2008). These benefits include higher cardiorespiratory fitness, improved muscular strength, lower body fatness, improved cardiovascular and metabolic health, increased bone mineral content and density, and reduced symptoms of depression and anxiety (USDHHS, 2008). However, the scientific evidence addressing the health effects of

physical activity in young children (e.g., children aged 3 to 5 years old) is very limited. This deficiency was noted by the Physical Activity Guidelines Advisory Committee (USDHHS, 2008), and for that reason, the 2008 *Physical Activity Guidelines for Americans* did not include recommendations for children in this age group (USDHHS, 2008). Nonetheless, researchers and practitioners generally agree that physical activity is important in young children. Young children certainly need some level of physical activity to develop normally, and physical activity aids in the development of fundamental motor skills (Clark, 1994). But little is known about the short-term or long-term health benefits of physical activity in 3- to 5-year-old children.

Despite the limitations of the relevant body of knowledge, authoritative organizations in four countries recently issued physical activity guidelines for 3- to 5-year-old

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children (Canadian Society for Exercise Physiology, 2012; Chief Medical Officers of England, 2011; Department of Health and Ageing, 2010; Institute of Medicine [IOM], 2011). Although the wording of the recommendations differs slightly, these organizations all recommend that young children engage in at least 3 hr of total physical activity each day (Canadian Society for Exercise Physiology, 2012; Chief Medical Officers of England, 2011; Department of Health and Ageing, 2010; IOM, 2011). The U.S. recommendation from the IOM defined it as 15 min or more of total physical activity per hour, which is equivalent to 3 hr if extrapolated to 12 waking hours (IOM, 2011). In addition, all four guidelines recommend total physical activity, which includes light-, moderate-, and vigorous-intensity activity (Canadian Society for Exercise Physiology, 2012; Chief Medical Officers of England, 2011; Department of Health and Ageing, 2010; IOM, 2011). This designation of total physical activity differs from guidelines for older children, adolescents, and adults, which recommend specified amounts of moderate- to vigorous-intensity physical activity. Including light-intensity physical activity for young children reflects their typical activity patterns, which consist of periods of light activity interspersed with short bursts of moderate- and vigorous-intensity physical activity (Bailey et al., 1995).

Since the release of the four countries' guidelines, two studies have reported the prevalence of children meeting the new guidelines (Gabel et al., 2013; Hinkley, Salmon, Okely, Crawford, & Hesketh, 2012). Researchers reported that 5.1% of children in an Australian study (Hinkley et al., 2012) and 73% of children in a Canadian study (Gabel et al., 2013) met the guideline. The vast difference in prevalence estimates is likely due to differences in how the studies operationalized the guideline and differences in accelerometer cut points selected for delineating light, moderate, and vigorous intensities of activity. These differences in operational definitions and accelerometer cut points hinder the assessment of children's actual prevalence of meeting the recommended amount of total physical activity.

In addition to new physical activity guidelines, tremendous development has taken place on the policy front related to young children's physical activity. This includes policies at multiple levels: national, state, local, and institutional. The recent report from the IOM (2011), *Early Childhood Obesity Prevention Policies*, acknowledged the importance of physical activity policies and recommended a number of potential actions that may increase the physical activity levels of 3- to 5-year-old children. Other national organizations have recognized the need for policies to increase physical activity of young children as a means to prevent obesity. These organizations include the Task Force on Childhood Obesity (White House Task Force on Childhood Obesity, 2010), Let's Move Child Care (Obama, 2012), Caring for Our Children (American

Academy of Pediatrics, American Public Health Association, & National Resource Center for Health & Safety in Child Care & Early Education, 2011), Head Start's I Am Moving, I Am Learning (Fox, Hallgren, Boller, & Turner, 2010), and the U.S. National Physical Activity Plan (Coordinating Committee of the National Physical Activity Plan, 2010).

In the United States, preschools are typically regulated at the state level, except for Head Start programs, which are monitored by the federal government. Very few states have standards that require daily physical activity. In a 2008 review of state standards for child care centers, only Alaska and Delaware required daily physical activity (Benjamin, Cradock, Walker, Slining, & Gillman, 2008; Van Stan, Lessard, & Dupont, 2013). In a review of state safety regulations for outdoor playground settings, only one third of state regulations completely addressed nationally recommended standards (Cradock, O'Donnell, Benjamin, Walker, & Slining, 2010). More recently, several states have added physical activity policy recommendations to their state regulations governing practices in preschools and child care centers (Van Stan et al., 2013). Delaware, for example, recently improved the quality of its statewide physical activity regulations (Van Stan et al., 2013). At the local level, New York City and Chicago have released new physical activity standards for child care centers (Public Health Law Center, 2013a, 2013b). Thus, many efforts have been made to improve physical activity policies in preschools and child care centers at multiple policy levels.

Although the development of physical activity guidelines and policies seems appropriate, given that obesity rates have increased in American preschoolers, it is clear that current guidelines and policies do not result from evidence-based research on the health benefits of physical activity in 3- to 5-year-old children. Hence, there is a great need for more research in this area. The purpose of this article is to highlight important research needs related to physical activity in preschool children.

## TOP 10 RESEARCH QUESTIONS

We identified research questions in three major categories. First, we propose research questions that address the effects of physical activity on health in young children. Second, we identify research questions related to the nature of physical activity behavior in preschoolers. Third, we propose research questions that address strategies for increasing physical activity in young children.

### Effects of Physical Activity on Health

We believe there is a critical need to better understand how physical activity and sedentary behavior impact health in

preschool-age children. Accordingly, we pose four research questions, which, when fully addressed in future investigations, will markedly expand our understanding of the significance of physical activity for the health of young children.

### *1. What Are the Health Effects of Physical Activity in 3- to 5-Year-Old Children?*

Both professionals and the lay public have long assumed that young children need physical activity to develop normally and to be healthy. It is generally understood and accepted that normal musculoskeletal development and development of normal fundamental movement patterns depend on children's engagement in substantial amounts of physical activity. Further, most people believe that young children are naturally very physically active, and only recently have researchers and health care professionals become concerned that many 3- to 5-year-old children may not be as physically active as they need to be for good health. Interest in the health effects of physical activity in young children has been prompted by increased rates of overweight and obesity in this age group (Ogden, Carroll, Kit, & Flegal, 2012). The concern has been reinforced by studies that used accelerometry to measure physical activity in 3- to 5-year-olds. These studies have shown that young children are not as physically active as common perception would suggest (Reilly, 2010).

Because the public generally has not seen physical activity in 3- to 5-year-olds as a problem, the research community has shown limited interest in studying the health effects of physical activity in this age group. Consequently, little is known about the relationship between physical activity and indicators of health status in young children (Okely, Salmon, Trost, & Hinkley, 2008; Timmons et al., 2012). Research is needed to examine the relationship between physical activity and health biomarkers known to be associated with health outcomes later in life. These include cardiometabolic risk factors such as blood pressure, blood lipids, and gluco-regulatory factors, as well as skeletal parameters, physical fitness, and measures of immune function. Studies are needed using the full range of research designs, including cross-sectional, longitudinal, and experimental designs. To significantly advance the body of knowledge, these studies should use state-of-the-art measures of physical activity including, whenever feasible, objective assessment via accelerometry. Further, such studies should consider the potential differential effects of different types and intensities of physical activity (e.g., light, moderate, vigorous) and the influence of demographic factors that may moderate the effects of physical activity on health outcomes (e.g., gender, race/ethnicity).

### *2. What Are the Effects of Physical Activity on the Development of Healthy Weight in 3- to 5-Year-Old Children?*

The prevalence of overweight and obesity has increased in recent decades, even among young children. Currently, 26.7% of U.S. children ages 2 to 5 years old are overweight or obese ( $\geq$  85th percentile; Ogden et al., 2012). Establishing a healthy weight in childhood is important, because obese children are more likely to become obese adults (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Although several studies have examined the association between physical activity and healthy weight in young children, the results are mixed. Some studies have found that regular physical activity is associated with lower fat mass, or that active children are leaner than inactive children (Janz et al., 2002; Moore, Nguyen, Rothman, Cupples, & Ellison, 1995). In contrast, in a review study, researchers concluded that body mass index was not associated with physical activity in preschool children (Hinkley, Crawford, Salmon, Okely, & Hesketh, 2008). As a result, the relationship between physical activity and healthy weight in young children has not been fully elucidated. In its recent report, *Early Childhood Obesity Prevention Policies*, the IOM (2011) noted the need for "prevention-oriented research to study the relationship between physical activity and risk of excessive weight gain over time in children" (p. 59). Longitudinal studies with rigorous measures are needed to fully examine the effects of physical activity on the development of healthy weight in 3- to 5-year-old children. Rigorous measures include objective measurement of physical activity with accelerometry and body composition with dual-energy X-ray absorptiometry. Because children in this age group grow rapidly, frequent assessments are needed to identify the longitudinal trajectories of weight gain and the effects of physical activity on the development of healthy weight.

### *3. What Are the Effects of Physical Activity on Learning in 3- to 5-Year-Old Children?*

Preschool programs often emphasize preacademic skills to lay the foundation for later education and academic achievement. Unfortunately, increased time spent on academics often comes at the price of time for free play and physical activity. Research in older children suggests a positive association between physical activity and academic achievement (Howie & Pate, 2012), but very few studies have examined the effect of physical activity on learning and behavior in younger children. Three studies identified cognitive and attention measures to use with young children, but they had small sample sizes (Fisher et al., 2011; Holmes, Pellegrini, & Schmidt, 2006; Son & Meisels, 2006). Physical activity may affect learning more significantly in younger children than in older children, because younger children are still developing cognitive

processes. In addition, regular, practiced physical activity may affect classroom behavior differently than would an acute bout of physical activity. Future studies will need to examine the behavioral and learning effects of different types of physical activity, as experts suggest greater benefits may occur from physical activity combined with other types of learning or social activities, such as martial arts or exercise integrated with academic lessons (Diamond, 2012). Also, children with behavior problems or learning disabilities may experience different effects of physical activity. A better understanding of the effects of physical activity on learning and behavior in young children may help to promote physical activity in preschools.

#### *4. What Are the Health Implications of Sedentary Behavior in 3- to 5-Year-Old Children?*

Because many people assume that 3- to 5-year-old children are very active, it is difficult for them to believe that sedentary behavior could have negative health implications for young children. However, accelerometry data show that preschoolers spend substantial amounts of time being sedentary. For example, one study found that across a total day of observation, children spent 45.5 min per hour in sedentary behavior (Byun, Blair, & Pate, 2013). Despite clear evidence that young children spend substantial amounts of time being sedentary, no substantial evidence to date documents the effects of sedentary behavior on young children's health. For example, although researchers have been interested in examining the relationship between sedentary behavior and body weight status in preschoolers (Byun, Liu, & Pate, 2013; LeBlanc et al., 2012), findings across studies have been inconsistent and consensus has not yet emerged.

Research employing the full range of research designs is needed to advance our understanding of the health implications of sedentary behavior in young children. In particular, prospective observational studies using objective measurement of sedentary behavior are needed. Such studies will be particularly important in examining the impact of sedentary behavior on development of body composition. Dose-response studies will help determine if a specific level of exposure to sedentary behavior is related to negative patterns of body composition. Further, such studies should examine potential interactive influences of physical activity and sedentary behavior on health outcomes, including weight status. Experimental studies that test strategies for reducing sedentary time in young children will further our knowledge of the impact of sedentary behavior on weight status and other health outcomes.

#### **Patterns of Physical Activity**

Future efforts to promote physical activity in young children through programmatic and policy initiatives will depend on

a full understanding of the nature of physical activity behavior in this age group. We propose three research questions that are aimed at creating a comprehensive understanding of the types and amounts of physical activity that are characteristic of young children and the factors that influence physical activity in this age group.

#### *5. What Is the Prevalence of Meeting Physical Activity Guidelines in Children of Preschool Age?*

The prevalence of physical activity has been studied widely in adults and adolescents, but few studies have investigated the prevalence in young children. To date, no consistent approach for monitoring physical activity and compliance with guidelines in young children has emerged. Studies to date have used different guidelines, different measures, and different methods of data reduction. Cross-sectional studies in the United States and internationally have utilized a variety of measures and typically have not included nationally representative samples of preschool-age children (Jurakic & Pedisic, 2012; Tucker, 2008). In a review article, Tucker (2008) concluded that 54% of preschoolers were sufficiently active (defined as  $\geq 60$  min of moderate-to-vigorous physical activity per day, which does not meet the current guidelines), indicating that a high proportion were not sufficiently active. Although many prevalence studies have used accelerometry, the true prevalence of meeting physical activity guidelines is dependent on the interpretation of accelerometry data (Beets, Bornstein, Dowda, & Pate, 2011). Accelerometry results are influenced by the methods used to reduce the data, including epoch length, definitions of wear time, count cut points or intensity thresholds, treatment of intensity levels (i.e., very light vs. sedentary), and other methods of data analysis (i.e., machine learning), making it difficult to compare results across studies (Timmons et al., 2012; Trost, 2007; Trost, McIver, & Pate, 2005). Consensus is needed regarding which guidelines, measures, and data reduction methods should be used in surveillance of physical activity in young children.

In addition to the lack of clear national prevalence data, no national survey has assessed policies and practices in child care centers or preschools, similar to those done in public and private grade schools (Brener, Kann, & Smith, 2003). Surveillance of child care centers, preschools, and other programs for young children would provide guidance for more national policy mandates related to physical activity. Standard sets of questionnaire items or interview probes have not been developed for use in this age group. Developing such items may be particularly difficult, given the variety of settings in which young children receive care (e.g., child care center, preschool, group home, parent or other family member caregiver). Consensus is needed on methods for surveying the social and physical environments in which children receive care, including measures of the policies that govern and practices that take place in those settings.

### *6. What Social and Physical Environmental Factors Influence the Physical Activity of 3- to 5-Year-Olds in the Home, Preschool, and Community Settings, and How Can These Influences Be Modified to Increase Physical Activity?*

Approximately 55% of preschool-age American children not yet in kindergarten are enrolled in center-based care (Federal Interagency Forum on Child & Family Statistics, 2012). But not all children in this age group are in some form of preschool. Almost 50% of children aged 0 to 4 years old with an employed mother have a relative as the primary care provider (Federal Interagency Forum on Child & Family Statistics, 2012). Most studies of correlates of physical activity in preschool children have been cross-sectional in nature and have centered on the preschool physical and social environment (De Craemer et al., 2012; Gunter, Rice, Ward, & Trost, 2012; Hinkley et al., 2008). Correlates of physical activity during the preschool day include number of field trips taken, group composition during activity (solitary, one on one with peer or adult, group of children, etc.), and access to balls and wheeled toys. Fewer studies have included correlates of physical activity during the out-of-school day; those studies identified parental physical activity, play equipment at home, and backyard size as significant correlates. Community offerings for children while at preschool have been studied (Hinkley et al., 2008), but it is unclear if these offerings are positively associated with young children's physical activity. In addition, longitudinal observational studies need to be undertaken to better understand the role of correlates over time in children enrolled in preschool and those who have alternate child care provisions.

### *7. How Does Physical Activity in 3- to 5-Year-Old Children Track Into Later Childhood, Adolescence, and Adulthood, and What Are the Health Implications of Different Physical Activity Trajectories?*

Tracking refers to the maintenance of relative rank or position within a group over time (Malina, 1996). Is a child who is active in preschool also active in elementary school, middle school, and high school, and as an adult? A limited number of studies have shown moderate tracking of physical activity behavior (most measured with objective measures) in preschool children for 2 to 3 years (Jones, Hinkley, Okely, & Salmon, 2013), but no studies have examined tracking as preschool children move through elementary school. A review of studies across age ranges has demonstrated that physical activity tracks moderately from older childhood to adulthood (Telama, 2009). However, the follow-up period in most of these studies was short, with a median of 9 years, and most of the studies relied on subjective measures of physical activity (Telama, 2009). Tracking of physical activity is important because

regular physical activity during young childhood may lead to an active lifestyle in later childhood, adolescence, and adulthood, which may ultimately lead to improved health outcomes. Studies that address tracking may also help to determine appropriate ages for interventions. Future studies need to begin following children in their early preschool years and continue following them into elementary school and beyond, using objective measures of physical activity.

### **Interventions and Policies to Promote Physical Activity**

Ultimately, we believe there will be a need to understand how physical activity can be increased effectively and efficiently in preschool-age children. We propose three research questions that, when fully addressed, will enable parents, educators, health care providers, and public health professionals to ensure that young children engage in the physical activity they need for healthy development.

### *8. What Are the Most Effective Strategies for Promoting Young Children's Physical Activity in the Child Care, Home, and Community Settings?*

Similar to older children, adolescents, and adults, multiple settings can be used to promote physical activity in 3- to 5-year-olds, and preschools are important settings for promoting physical activity in that age group (Ward, Vaughn, McWilliams, & Hales, 2010). Thus, the majority of physical activity interventions for young children have focused on preschool settings, with few in the community and home settings (Kreichauf et al., 2012; Reilly, 2010; Ward et al., 2010). Of the physical activity interventions in preschool settings, researchers have reported generally positive findings (Fitzgibbon et al., 2011; Pate, Brown, Saunders, Pfeiffer, & Dowda, 2013; Trost, Fees, & Dzewaltowski, 2008), but others have reported no differences in physical activity between intervention and control participants (Alhassan, Sirard, & Robinson, 2007; Reilly et al., 2006). Given these mixed findings, additional well-controlled randomized trials are needed to test the effectiveness of preschool interventions and to identify the essential elements of those interventions. Despite the mixed results of studies to date, the extant intervention literature suggests that some strategies may be useful for increasing young children's physical activity. These include: (a) access to open space, (b) additional time outside to be active, (c) the provision of portable materials (e.g., balls, scarves, hula hoops), and (d) teacher-planned and teacher-led activity during both indoor and outdoor sessions (IOM, 2011). It should be noted that many interventions in the preschool setting have included multiple components (e.g., providing materials that support physical activity; providing targeted professional development and consultation to teachers or coaches who lead activities; home-based component), and contributions of the individual components are not well

understood. Future studies are needed to verify the effectiveness of these strategies as well as to investigate other potential innovative strategies, such as changes in policies and use of technology.

More research on how to intervene in community and home settings is particularly needed. Interventions in community and home settings could include providing access to sports/movement activities in the community or conducting a family intervention to change family physical activity practices.

Finally, although some investigators have conducted interventions with diverse populations of preschoolers (Alhassan et al., 2007; Fitzgibbon et al., 2006, 2011), research to date has not identified which intervention approaches are most effective for girls and boys and for children of different race, ethnicity, and disability status. Hence, much remains to be done with respect to learning what physical activity interventions are needed for whom and how to make them readily available to preschoolers in their classrooms, homes, and communities.

#### *9. How Can Interventions to Increase Physical Activity Among 3- to 5-Year-Old Children Be Effectively Implemented and Disseminated?*

As research continues to identify effective strategies to increase physical activity in young children, researchers and practitioners need to better understand how to implement these programs in larger populations. Research from interventions with older children and adults suggests that a lack of positive outcomes may be due to differences in fidelity and the multiple factors that influence implementation (Horner, Rew, & Torres, 2006). For example, if a preschool director adopts a physical activity curriculum, the success of the program can depend on the characteristics and motivation of individual teachers in that preschool. A better understanding of the factors that influence implementation and the best ways to achieve successful implementation is needed.

Once effective physical activity programs are identified, they need to be disseminated widely to early childhood educators and public health practitioners to maximize the number of children who benefit from them. To date, most effective physical activity interventions have only reached the participants in physical activity research studies or in a limited number of formal physical activity groups. Systematic dissemination of preschool physical activity interventions to early childhood educators is sorely needed. Several methods of dissemination are available, including written guidelines and curricula, workshops, and onsite consultations with accompanying feedback and problem solving to overcome barriers to children's physical activity. Yet many of these methods have not been utilized or compared to each other to select the most efficient and cost-effective methods. Again, the translation of essential

components of physical activity interventions waits for a new generation of the best dissemination methods in preschools, homes, and other community-based settings.

#### *10. How Effective are National, State, Local, and Institutional Policies in Increasing Physical Activity of 3- to 5-Year-Old Children?*

Preschool policies, whether at the national, state, local, or institutional level, may influence young children's physical activity. Although much attention has been placed on physical activity policies in preschools and several states (Benjamin et al., 2008; Van Stan et al., 2013) and localities (Public Health Law Center, 2013a, 2013b) have begun to implement preschool physical activity policies, very little is known about compliance with these policies and their effectiveness in increasing children's physical activity. The Physical Activity Guidelines Midcourse Report (Physical Activity Guidelines for Americans Midcourse Report Subcommittee & President's Council on Fitness, Sports, & Nutrition, 2012) acknowledged the need to "conduct policy research to examine the effects of state and institutional policy innovations" (p. 15). The first step is to develop and assess knowledge of the policies, followed by compliance with those policies and then the effectiveness of the policies in changing children's physical activity. A recent example is the evaluation research Delaware conducted to assess child care providers' knowledge about the statewide physical activity regulations. Researchers found that the trainings resulted in increased knowledge of the new regulations (Van Stan et al., 2013). More research, however, is needed to assess the effectiveness of policies in increasing physical activity in 3- to 5-year-old children.

## CONCLUSIONS

The 2008 *Physical Activity Guidelines for Americans* (2008) did not include a physical activity recommendation for children younger than 6 years old because of a lack of scientific evidence linking physical activity to health outcomes in that group. To address this deficiency, we have proposed 10 questions that we believe should be answered by the research community. The questions span a wide range of issues, and answering the questions will require application of a diverse set of research designs and methodologies. Once the proposed research questions have been answered, we will have a much more robust understanding of physical activity and its health implications in young children. Further, and perhaps most importantly, practitioners will be armed with effective strategies for ensuring that young children are systematically provided with the physical activity they need to be healthy.

## REFERENCES

- 2008 *physical activity guidelines for Americans*. (2008). Washington, DC: U.S. Department of Health and Human Services. Retrieved from <http://www.health.gov/paguidelines>
- Alhassan, S., Sirard, J. R., & Robinson, T. N. (2007). The effects of increasing outdoor play time on physical activity in Latino preschool children. *International Journal of Pediatric Obesity*, *2*, 153–158.
- American Academy of Pediatrics, American Public Health Association, & National Resource Center for Health and Safety in Child Care and Early Education. (2011). *Caring for our children: National health and safety performance standards; guidelines for early care and education programs* (3rd ed.). Elk Grove Village, IL: American Academy of Pediatrics.
- Bailey, R. C., Olson, J., Pepper, S. L., Porszasz, J., Barstow, T. J., & Cooper, D. M. (1995). The level and tempo of children's physical activities: An observational study. *Medicine and Science in Sports and Exercise*, *27*, 1033–1041.
- Beets, M. W., Bornstein, D., Dowda, M., & Pate, R. R. (2011). Compliance with national guidelines for physical activity in U.S. preschoolers: Measurement and interpretation. *Pediatrics*, *127*, 658–664.
- Benjamin, S. E., Cradock, A., Walker, E. M., Slining, M., & Gillman, M. W. (2008). Obesity prevention in child care: A review of U.S. state regulations. *BMC Public Health*, *8*, 188. doi:10.1186/1471-2458-8-188
- Brener, N. D., Kann, L., & Smith, T. K. (2003). Reliability and validity of the School Health Policies and Programs Study 2000 questionnaires. *Journal of School Health*, *73*, 29–37.
- Byun, W., Blair, S. N., & Pate, R. R. (2013). Objectively measured sedentary behavior in preschool children: Comparison between Montessori and traditional preschools. *International Journal of Behavioral Nutrition and Physical Activity*, *10*, 2. doi:10.1186/1479-5868-10-2
- Byun, W., Liu, J., & Pate, R. R. (2013). Association between objectively measured sedentary behavior and body mass index in preschool children. *International Journal of Obesity*, *37*, 961–965.
- Canadian Society for Exercise Physiology. (2012). *Canadian physical activity guidelines and Canadian sedentary behaviour guidelines*. Retrieved from <http://www.csep.ca/guidelines>
- Chief Medical Officers of England. (2011). *Start active, stay active: A report on physical activity for health from the four home countries' chief medical officers*. London, England: Department of Health, Physical Activity, Health Improvement, and Protection.
- Clark, J. (1994). Motor development. In V. S. Ramachandran (Ed.), *Encyclopedia of human behavior* (pp. 245–255). San Diego, CA: Academic.
- Coordinating Committee of the National Physical Activity Plan. (2010). *The U.S. National Physical Activity Plan*. Retrieved from <http://www.physicalactivityplan.org/theplan.php>
- Cradock, A. L., O'Donnell, E. M., Benjamin, S. E., Walker, E., & Slining, M. (2010). A review of state regulations to promote physical activity and safety on playgrounds in child care centers and family child care homes. *Journal of Physical Activity and Health*, *7*(Suppl. 1), S108–S119.
- De Craemer, M., De Decker, E., De Bourdeaudhuij, I., Vereecken, C., Deforche, B., Manios, Y., . . . ToyBox Study Group. (2012). Correlates of energy balance-related behaviours in preschool children: A systematic review. *Obesity Reviews*, *13*, 13–28.
- Department of Health and Ageing. (2010). *National physical activity guidelines for Australians: Physical activity recommendations for 0–5 year olds*. Canberra, Australia: Commonwealth of Australia.
- Diamond, A. (2012). Activities and programs that improve children's executive functions. *Current Directions in Psychological Science*, *21*, 335–341.
- Federal Interagency Forum on Child and Family Statistics. (2012). *America's children: Key national indicators of well-being, 2012*. Washington, DC: U.S. Government Printing Office.
- Fisher, A., Boyle, J. M., Paton, J. Y., Tomporowski, P., Watson, C., McColl, J. H., & Reilly, J. J. (2011). Effects of a physical education intervention on cognitive function in young children: Randomized controlled pilot study. *BMC Pediatrics*, *11*, 97. doi:10.1186/1471-2431-11-97
- Fitzgibbon, M. L., Stolley, M. R., Schiffer, L. A., Braunschweig, C. L., Gomez, S. L., Van Horn, L., & Dyer, A. (2011). Hip-Hop to Health Jr. Obesity Prevention Effectiveness Trial: Postintervention results. *Obesity*, *19*, 994–1003.
- Fitzgibbon, M. L., Stolley, M. R., Schiffer, L., Van Horn, L., Kaufer Christoffel, K., & Dyer, A. (2006). Hip-Hop to Health Jr. for Latino preschool children. *Obesity*, *14*, 1616–1625.
- Fox, M. K., Hallgren, K., Boller, K., & Turner, A. (2010). *Efforts to meet children's physical activity and nutritional needs: Findings from the I Am Moving, I Am Learning implementation evaluation*. Washington, DC: Administration for Children and Families, U.S. Department for Health and Human Services.
- Gabel, L., Proudfoot, N. A., Obeid, J., Macdonald, M. J., Bray, S. R., Cairney, J., & Timmons, B. W. (2013). Step count targets corresponding to new physical activity guidelines for the early years. *Medicine and Science in Sports and Exercise*, *45*, 314–318.
- Gunter, K. B., Rice, K. R., Ward, D. S., & Trost, S. G. (2012). Factors associated with physical activity in children attending family child care homes. *Preventive Medicine*, *54*, 131–133.
- Hinkley, T., Crawford, D., Salmon, J., Okely, A. D., & Hesketh, K. (2008). Preschool children and physical activity: A review of correlates. *American Journal of Preventive Medicine*, *34*, 435–441.
- Hinkley, T., Salmon, J., Okely, A. D., Crawford, D., & Hesketh, K. (2012). Preschoolers' physical activity, screen time, and compliance with recommendations. *Medicine and Science in Sports and Exercise*, *44*, 458–465.
- Holmes, R. M., Pellegrini, A. D., & Schmidt, S. L. (2006). The effects of different recess timing regimens on preschoolers' classroom attention. *Early Child Development and Care*, *176*, 735–743.
- Horner, S., Rew, L., & Torres, R. (2006). Enhancing intervention fidelity: A means of strengthening study impact. *Journal for Specialists in Pediatric Nursing*, *11*, 80–89.
- Howie, E. K., & Pate, R. R. (2012). Physical activity and academic achievement in children: An historical perspective. *Journal of Sport and Health Science*, *1*, 160–169.
- Institute of Medicine. (2011). *Early childhood obesity prevention policies*. Washington, DC: National Academies.
- Janz, K. F., Levy, S. M., Burns, T. L., Torner, J. C., Willing, M. C., & Warren, J. J. (2002). Fatness, physical activity, and television viewing in children during the adiposity rebound period: The Iowa Bone Development Study. *Preventive Medicine*, *35*, 563–571.
- Jones, R. A., Hinkley, T., Okely, A. D., & Salmon, J. (2013). Tracking physical activity and sedentary behavior in childhood: A systematic review. *American Journal of Preventive Medicine*, *44*, 651–658.
- Jurakic, D., & Pedisic, Z. (2012). Prevalence of insufficient physical activity in children and adolescents: Review. *Paediatrica Croatica*, *56*, 321–326.
- Kreichauf, S., Wildgruber, A., Krombholz, H., Gibson, E. L., Vogeles, C., Nixon, C. A., . . . ToyBox Study Group. (2012). Critical narrative review to identify educational strategies promoting physical activity in preschool. *Obesity Reviews*, *13*(Suppl. 1), 96–105.
- LeBlanc, A. G., Spence, J. C., Carson, V., Connor, G. S., Dillman, C., Janssen, I., . . . Tremblay, M. S. (2012). Systematic review of sedentary behaviour and health indicators in the early years (aged 0–4 years). *Applied Physiology, Nutrition, and Metabolism*, *37*, 753–772.
- Malina, R. M. (1996). Tracking of physical activity and physical fitness across the lifespan. *Research Quarterly for Exercise and Sport*, *67*(Suppl. 3), S48–S57.
- Moore, L. L., Nguyen, U. S., Rothman, K. J., Cupples, L. A., & Ellison, R. C. (1995). Preschool physical activity level and change in body fatness in young children: The Framingham Children's Study. *American Journal of Epidemiology*, *142*, 982–988.



- Obama, M. (2012). Let's move! Raising a healthier generation of kids. *Childhood Obesity*, 8, 1. doi:10.1089/chi.2012.0800.obam
- Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2012). Prevalence of obesity and trends in body mass index among US children and adolescents, 1999–2010. *Journal of the American Medical Association*, 307, 483–490.
- Okely, A. D., Salmon, J., Trost, S. G., & Hinkley, T. (2008). *Discussion paper for the development of physical activity recommendations for children under 5 years*. Canberra, Australia: Commonwealth of Australia.
- Pate, R. R., Brown, W. H., Saunders, R. P., Pfeiffer, K., & Dowda, M. (2013). A multicomponent intervention increased physical activity in preschool children. *Circulation*, 127, AMP39.
- Physical Activity Guidelines for Americans Midcourse Report Subcommittee & President's Council on Fitness, Sports, and Nutrition. (2012). *Physical activity guidelines for Americans midcourse report: Strategies to increase physical activity among youth*. Washington, DC: U.S. Department of Health and Human Services.
- Public Health Law Center. (2013a). *Using local authority to create healthier child care settings: Chicago*. Retrieved from <http://www.publichealthlawcenter.org/sites/default/files/resources/Healthy%20Child%20Care%20-%20Chicago%20FINAL.pdf>
- Public Health Law Center. (2013b). *Using local authority to create healthier child care settings: New York City*. Retrieved from [http://www.publichealthlawcenter.org/sites/default/files/resources/Healthy%20Child%20Care%20-%20New%20York\\_July%202013\\_FINAL.pdf](http://www.publichealthlawcenter.org/sites/default/files/resources/Healthy%20Child%20Care%20-%20New%20York_July%202013_FINAL.pdf)
- Reilly, J. J. (2010). Low levels of objectively measured physical activity in preschoolers in child care. *Medicine and Science in Sports and Exercise*, 42, 502–507.
- Reilly, J. J., Kelly, L., Montgomery, C., Williamson, A., Fisher, A., McColl, J. H., . . . Grant, S. (2006). Physical activity to prevent obesity in young children: Cluster randomised controlled trial. *British Medical Journal*, 333, 1041. doi:10.1136/bmj.38979.623773.55
- Son, S. H., & Meisels, S. J. (2006). The relationship of young children's motor skills to later reading and math achievement. *Merrill-Palmer Quarterly: Journal of Developmental Psychology*, 52, 755–778.
- Telama, R. (2009). Tracking of physical activity from childhood to adulthood: A review. *Obesity Facts*, 2, 187–195.
- Timmons, B. W., LeBlanc, A. G., Carson, V., Connor, G. S., Dillman, C., Janssen, I., . . . Tremblay, M. S. (2012). Systematic review of physical activity and health in the early years (aged 0–4 years). *Applied Physiology, Nutrition, and Metabolism*, 37, 773–792.
- Trost, S. G. (2007). State-of-the-art reviews: Measurement of physical activity in children and adolescents. *American Journal of Lifestyle Medicine*, 1, 299–314.
- Trost, S. G., Fees, B., & Dziewaltowski, D. (2008). Feasibility and efficacy of a 'move and learn' physical activity curriculum in preschool children. *Journal of Physical Activity and Health*, 5, 88–103.
- Trost, S. G., McIver, K. L., & Pate, R. R. (2005). Conducting accelerometer-based activity assessments in field-based research. *Medicine and Science in Sports and Exercise*, 37(Suppl. 11), S531–S543.
- Tucker, P. (2008). The physical activity levels of preschool-aged children: A systematic review. *Early Childhood Research Quarterly*, 23, 547–558.
- U.S. Department of Health and Human Services. (2008). *Physical Activity Guidelines Advisory Committee report, 2008*. Washington, DC: Author.
- Van Stan, S., Lessard, L., & Dupont, P. K. (2013). The impact of a statewide training to increase child care providers' knowledge of nutrition and physical activity rules in Delaware. *Childhood Obesity*, 9, 43–50.
- Ward, D. S., Vaughn, A., McWilliams, C., & Hales, D. (2010). Interventions for increasing physical activity at child care. *Medicine and Science in Sports and Exercise*, 42, 526–534.
- Whitaker, R. C., Wright, J. A., Pepe, M. S., Seidel, K. D., & Dietz, W. H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *New England Journal of Medicine*, 337, 869–873.
- White House Task Force on Childhood Obesity. (2010). *White House Task Force on Childhood Obesity report to the president: Solving the problem of childhood obesity within a generation*. Retrieved from <http://www.letsmove.gov/white-house-task-force-childhood-obesity-report-president>