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The Importance of Physical Activity in Early Childhood Development

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Abstract

Programming in early childhood has become increasingly academic, with less consideration for whole-child development. This new emphasis has influenced not only pre-k programs, but also programs serving toddlers and infants. As a result of this focus on academic skills, children from birth to five years old are spending more time in sedentary, academically focused activities and less time in meaningful play and physical activity. Children are no longer afforded the time and opportunity to participate in the robust play activities that are one of the essential elements in whole-child development. This literature review focuses on research that advocates for physical activity opportunities for children. The research demonstrates the positive impact that physical activity has on brain development, executive function, overall well-being, and school readiness in the crucial development period of early childhood.

Keywords: Developmentally appropriate practice, early childhood, executive function, physical activity, school readiness, sedentary

The Importance of Physical Activity in Early Childhood

Early childhood teachers and professionals often advocate for what they see as the most important aspect of early childhood education: that children have the opportunity to learn through play (Allee-Herndon, K. A., & Roberts, S. K., 2020; Ginsburg, K., 2007; Hoskins & Smedley, 2018). However, these educators might be harder pressed to explain why play is important and how it helps prepare young children for their academic careers. The word "play" is often said in general terms, evoking various meanings based upon context and audience. The most commonly accepted definition is that play involves unstructured opportunities for children to learn through self-exploration. Hoskins & Smedley (2018) found that early childhood educators valued play as a way to enhance the social, emotional and academic development of children. It is not simply that children need opportunities to play; rather, that play is a key factor in child development. When children engage in play that includes robust physical activity, their brain development and executive functions increase (Diamond & Ling, 2016). These components, a developed brain and foundational development of executive function skills, are primary components for school readiness and indicators of future academic success.

Unfortunately, the implementation of the No Child Left Behind Act in 2002 and subsequently the Every Child Succeeds Act of 2015 have influenced the idea of what constitutes school readiness. There is now a greater focus on academics and less consideration of whole child development. This new emphasis has influenced not only pre-k programs, but also early childhood programs serving toddlers and infants. As the focus on academic skills has increased, children from birth to five years old are spending more time in sedentary, academically focused activities and less time in meaningful play and participating in less physical activity. The

problem with this shift is that children are no longer afforded the time and opportunity to participate in the robust play activities that are essential in whole child development.

Many studies support physical activity opportunities for children in the crucial development period of early childhood (Alee-Herndon, 2020; Becker et al. 2018; Chang et al. 2013; Guinhouya, 2012), whereas the acquisition of academic skills may be indicators of school readiness. The studies indicate the importance of the development of executive function and the effect of physical activity on school readiness.

The purpose of this literature review is to identify information that would be useful for early childhood stakeholders and practitioners to consider when developing programs or determining what activities are appropriate for children to ensure they are developing healthy minds and bodies while also building a strong foundation for school readiness and future academic success. The literature review focuses specifically on how physical activity is a crucial component of brain development, and how overall health and executive function (Chaddock-Heyman et al., 2013; Diamond, 2011; 2012; 2013; Carson et al., 2017) are essential components of whole child development and school readiness.

This literature review presents studies in journals, scholarly articles, and government publications that demonstrate the influence of physical activity levels on brain development, overall health, and well-being. The development of executive function in young children and the correlation of these to school readiness are also addressed. The key words used in gathering research from Gale Academic OneFile, ERIC, Google Scholar, and the World Cat.org dated from January 2011-2021 were children, brain, development, health, cognitive function, executive function, sedentary, school readiness and physical activity. The areas of physical activity, brain development, health, executive function, and school readiness were analyzed.

This literature review explains how physical activity impacts brain development, how physical activity helps with the development of executive function, and the importance of physical activity on the overall health and well-being of children. This review also identifies the connection between the areas of physical activity, executive function, and school readiness. Additionally, activity durations and movement recommendations appropriate for preschool-aged children are identified.

Literature Review

Physical Activity's Impact on Brain Development

The recent emphasis on academics in early childhood programing has resulted in children spending more time in sedentary, academic-based activities and less time actively engaged in meaningful play and the robust physical activity that is an integral aspect of whole child development. The increased sedentary activity presents a problem in early childhood since researchers have determined that physical activity positively affects brain development (Chaddock-Heyman et al., 2013; Hillman, 2014; Stevens-Smith 2016). The development of the brain depends on the health of the body, which is especially important in young children to foster mental and intellectual potential (Cadenas-Sánchez et al., 2016). Therefore, early childhood professionals and stakeholders need to consider the importance of movement and physical activity on whole-child development when determining program structure for our youngest learners.

The brain is a complex cellular structure, and its development is greatly influenced by movement and physical activity. The brain needs fresh oxygenated blood and water to survive; therefore, movement of even the simplest level is a necessary component in brain development in order to function property (Stevens-Smith, 2016). The impact of physical activity on brain

development goes beyond the function of basic survival: movement stimulates the neurons that enable the brain to receive information. When children are physically moving, they are developing neurological foundations (Stevens-Smith, 2016); these neurological foundations are the structural components of the brain. The ability to receive information, process that information, and make connections is the process of learning that is initiated by participating in physical activity.

Learning requires the creation of new neural connections, but unused previous connections are eliminated; therefore, the continued development of brain structure is critical during the early childhood years. Establishing a foundation for the ability to acquire new skills and the ability to process information is important since it is a use-it-or-lose-it situation when it comes to neural connections. Every time a person moves in an organized manner, full brain activation and integration occurs, and this activation allows learning to occur automatically (Stevens-Smith, 2016). In a 2014 study of the impact of physical activity intervention and enhancement of executive control in preadolescent children, Hillman et al. (2014) found a direct connection between participation in physical activity and heightened cognitive performance and brain function. The finding of this study demonstrates the positive effect of physical activity on development of executive control and correlates with findings from other that physical activity improves childhood cognition and brain health studies (DiLiegro et al., 2019, Guinhouya, 2012).

In addition to activating neurons, physical activity also as a positive impact on the development of physical brain structure. In 2015, Chaddock-Heyman et al. completed MRI scans of 42 children between nine and ten years to examine the impact of physical activity on brain structure. During their study, participants were classified as either “high-fit” or “low-fit” based on results of a physical fitness assessment, and MRI scans were completed on both groups. The

data revealed that "higher fit children have larger structural brain volumes in the hippocampus and dorsal striatum, two subcortical regions critical for memory and learning, as well as more efficient brain activation patterns" (Chaddock-Heyman et al., 2015, p. 8). The evidence of larger structural brain volumes in high fit children supports Stevens-Smith's (2016) findings that while children are physically moving, they are developing neurological foundations and brain structure. These findings emphasize the importance of physical activity in early childhood and demonstrate the connection of physical activity and brain development.

The connection between physical activity and brain development has also been documented through additional research conducted by Chaddock-Heyman et al. (2013). During their research project functional MRI scans were used to study the effect of physical activity on 32 eight- and nine-year-old children. The results demonstrated that children who participated in 60+ minutes of physical activity five days a week for nine months showed brain activation in the right anterior prefrontal cortex, suggesting that physical activity during childhood may enhance specific elements of prefrontal cortex function involved in cognitive control. These results demonstrate the positive impact that movement and physical activity have on how the brain develops and the connection between physical activity and development of executive function skills.

Physical Activity's Impact on Executive Function

The impact of physical activity can be seen not only in the structural foundation of brain development, but it also impacts executive function development in children. Psychologist Adel Dimond defines executive function skills as "inhibition (response inhibition [self-control—resisting temptations and resisting acting impulsively], interference control (attention and inhibition]), working memory, and cognitive flexibility (including thinking outside of the box,

acknowledging other perspectives, and ability to change plans quickly)" (Diamond, 2013, p.136). Executive functions help us to mentally play with ideas (wonder, work out and hypothesize thoughts); consider our choices before reacting; handle unique and unanticipated challenges; resist temptations; and stay focused on a task (Diamond, 2011; 2013). Without the development of executive function skills, children are not able to meaningfully participate in learning, engage in activities, and build relationships.

There is a clear connection between physical activity and development of executive function. Researchers Sean Mullen and Peter Hull explain that "Physical activity is a complex behavior that involves iterative planning, monitoring, ongoing adjustments, and inhibition of unwanted distractions. These same processes are manifestations of executive control and rely on established neural networks involving the prefrontal cortex" (Mullen & Hull, 2015, p. 1). Since these executive control functions start developing during the critical period of early childhood (Diamond & Lee, 2011), understanding the connection of physical activity and the development of executive function skills will have important implications for early childhood professionals when making decisions regarding development of early childhood programing.

Literature demonstrates the association between physical activity and executive function and the importance of inclusion of physical activity in early childhood programing. For example, a study by Meijer et al. (2020) of school-aged children during the 2016-2017 school year demonstrated a significant relationship between cardiovascular fitness and executive functions, including the speed information is processed, attention and working memory. Furthermore, another study found that executive functioning is associated with the long-term maintenance of physical activity participation (Mullen and Hall 2015). These key findings are also reflected in a study involving 221 children over a two-year span that investigated the impact of increasing

aerobic fitness activity for seven- and nine-year-olds. This study showed that students who participated in a 30-minute physical activity program after school had improved brain control and increased executive control compared to the control group that did have this extra activity in their day. (Hillman et al., 2014). These studies have provided insight into how physical activity has a positive influence on the development of executive function.

Research has shown that it is not just general movement activities, but rather a specific type of physical activity that promotes the development of executive function skills. Cook et al. (2019) studied a sample of preschool children from urban and rural low-income settings in South Africa to investigate the relationship between components of executive function, gross motor skills, and physical activity in the early years. They concluded that unstructured physical activity does not, in and of itself, enhance development of executive function. However, they found that "cognitively engaging physical activity that engages and challenges executive functions, such as structured physical activity games and team sports, may be necessary to improve executive functioning" as opposed to free unstructured play (Cook et al., 2019 p. 11). These findings mirrored Diamond & Ling (2016) findings: in order for executive function gains to be seen depends on the amount of time spent practicing and on the way an activity is presented and conducted. These findings indicate that purposeful physical activity has been shown to have a greater impact on the development of executive function, and the findings provide guidance for early childhood professionals as to what type of physical activity is needed when considering program design.

In addition to the literature that shows the positive impact physical activity on development of executive function in children, there is also evidence that indicates incorporating physical activity into daily activities can have a significant impact on the subgroup of children

that are impacted by socioeconomic disadvantages. Mala et al. (2020) researched the associations between physical activity and development of executive functions in a study of children from low-income, urban schools. Data collection for this research included administration of an executive functions tests on an iPad (which consisted of the List Sorting Working Memory Test, the Flanker task, the Dimensional Change Card Sort [DCCS] test), and the Pubertal Maturation Observational Scale (PMOS). The researchers used the results of a Physical Activity Questionnaire for Children (PAQ-C) to categorize children as either active or inactive. To determine the influence of physical activity on the acquisition of execution functioning skills, the results of the assessments were analyzed. The findings indicated that the children who were placed in the physically active group had more developed executive function skills compared to skills of the children that were in the inactive group. (Mala et al., 2020). Additionally, in another study researchers found that participating in physical activities including dance, yoga and exercise were found to be effective strategies for closing the gap between "more- and less- advantaged children" (Diamond & Lee, 2011, p. 963) The findings of these studies not only show the connection between physical activity and executive function but also that increased physical activity could have a positive on school readiness for children with socioeconomic disadvantages.

Literature also suggests that there is an important correlation between physical activity and executive function in children with either lower cognitive ability due to a-typical development or children who have underdeveloped executive function skills due to lack of opportunity. While reanalyzing data from three randomized control trials that investigated the effects of regular physical activity on cognition, Ishihara et al. (2017) found that cognitive improvements resulting from physical activity intervention were greater in children with lower

baseline cognitive performance. In another study of effective strategies for improving executive function in children the researchers determined that children with a lower baseline executive function displayed the most significant gains in executive function (Diamond & Lee, 2011). This research illustrations how the development of executive function skills are impacted by participation in physical activity. Additionally, the these studies also highlight the importance of providing opportunities for all children to participate in physical activity in early childhood, especially those who are not displaying the executive functioning skills that would be expected for children their age.

Physical Activity's Impact on Overall Health and Well-being

Physical activity not only has a positive impact on brain development and executive function; it also can significantly impact the overall health and well-being of children. The importance of physical activity on the overall health and well-being of children can be summarized in this statement from the World Health Organization: "In children and adolescents, physical activity improves physical fitness (cardiorespiratory and muscular fitness), cardiometabolic health (blood pressure, dyslipidemia, glucose, and insulin resistance), bone health, cognitive outcomes (academic performance, executive function), mental health (reduced symptoms of depression) and reduced adiposity" (Physical Activity, n.d, para.4). Given the positive impact of physical activity on whole-child development it should be a required component of all early childhood programs.

The importance of physical activity for young children is well documented through research, and recent studies have provided insight into how physical activity impacts the overall health and well-being of young children. For example, several types of physical activity, especially prone position for infants, total physical activity, and physical activity of at least

moderate to vigorous intensity, particularly for preschool-aged children, were consistently found to be favorable with a number of health indicators (Carson et al 2017). Additionally, findings indicate that higher amounts of physical activity are associated with a reduced risk of excessive increases in body weight and adiposity in children ages three to six years and physical activity is associated with favorable indicators of bone health in children ages three to six years (*Physical Activity Guidelines*, 2018). Furthermore, Guinhouya (2012) asserts that participation in regular physical activity has positive effects on bone health, reduces cardiovascular risk factors, and has positive impact on children's psychological well-being.

Physical activity not only positively affects overall health of children; it also positively contributes to overall development. Multiple studies on the impact of physical activity were analyzed by Zeng et al. (2017) during their investigation on effective physical activity interventions for preschooler children and they discovered that preschool children's motor skill outcomes displayed significant improvement after engaging in "activity-based interventions" (Zeng et al., 2017, p. 12). Other research indicates that the benefits of regular exercise can include regulating cardiovascular fitness and helping to regulate glucose and insulin levels (DiLiegro et al. 2019). Youth who are regularly active have a better chance of a healthy adulthood, and children and adolescents who are physically activity are less prone to developing chronic heart disease, hypertension, type 2 diabetes, or osteoporosis (U.S. Department of Health and Human Services, 2018). Research clearly indicates the positive impact of physical activity on the overall well-being and health of children and supports the importance of physical activity in the early years.

School Readiness

Generally accepted indicators of school readiness include language development, literacy, mathematics, science, creative arts, social and emotional development, approaches to learning, and physical health and development. However, recently published literature indicates that whereas academic skills can contribute to school readiness, other factors should be considered such as executive function skills. According to Nelson et al. (2017), executive function skills are part of the foundation of skills and abilities that are necessary to meet the expectation of elementary school. Researchers have indicated that development of executive function skills are higher indicators being prepared for the rigors of school than "IQ level, socioeconomic status, or entry-level reading or math scores" (Diamond & Ling, 2016., p 959). It is clear that cognitive function and social development are the foundation for school readiness (Mann et al., 2016). It is necessary to consider the impact of executive function on school readiness.

The importance of development of executive function skills and how these skills relate to school readiness has been well researched. One study that highlights the importance of executive function development was conducted by Moreno et al. (2017). This study included approximately 68 hours of observations in 17 high-quality preschool classrooms in two urban areas (Denver and Chicago). Using the self-created Preschool-Setting Executive Function (PSEF) test to study executive function behaviors in preschool classrooms, the researchers concluded that executive functions and self-regulation are strongly correlated with both school readiness and academic achievement (Moreno et al., 2017). A similar study by McLelland et al. (2014) found that children's behavioral self-regulation and executive function skills were indicators of children's future aptitude and a determining factor in future school endeavors. The

study of 208 prekindergarten and kindergarten students using the Head Shoulders Knees and Toes assessment suggests that aspects of executive function and a measure of behavioral self-regulation are important for learning mathematics. The results of the study found that interventions that improve math scores might also help in the development of executive function skills (McLelland et al., 2014). A study by Clark et al. (2012) also showed the connection between executive function and school readiness. This longitudinal study that assessed children at three years of age and then again at five years old found that executive control skills formed a critical foundation for academic skill acquisition in both boys and girls, specifically in the area of math (Clark et al., 2012). The results of this study also demonstrated a clear relationship between executive control and reading, finding strong correlations between latent executive function and early verbal comprehension and processing speed (Clark et al., 2012). Literature clearly indicates that executive function is an important component in determining school readiness. Efforts should be made by early childcare providers, administrators, and stakeholders to promote early executive function development particularly during the critical period of preschool.

Research also indicates that participation in physical activity can have a positive impact on school readiness and future academic success. For example, in a study among Finnish primary school children aged six to eight years, researchers found that lower levels of moderate to vigorous physical activity, higher levels of sedentary time, and particularly their combination were related to poorer reading skills in boys (Happala et al., 2017). Furthermore, another study indicated that higher levels of moderate to vigorous physical activity accompanied with lower levels of sedentary time were related to better reading skills in second and third graders. Additionally, an increase in independent reading skills were also noted in first grade boys, similar associations of physical activity and sedentary time with academic skills in girls (Happala

et al., 2017). In a study analyzing the association of school readiness with outdoor play and participation of outdoor play of preschool children, Becker et al. (2018) found that complex physical activity significantly influenced school readiness. Bunketorp et al. (2017) also found that an additional 30-45 minutes of ‘‘play and motion’’ (engaging, enjoyable, health-promoting, noncompetitive activities consisting of different sports or games with or without the use of equipment) had a positive impact on 269 Swedish school children’s academic success. Children who are physically active have higher reading and math scores than children who are less active and more sedentary.

The deliberate creation of an environment that promotes physical activity can have a positive impact on school readiness. Amin et al. (2017) studied children from 17 Massachusetts public schools and evaluated the connection between physical activity and math and reading scores. The schools that research participants attended were evaluated and were classified as either a high physical activity environment (high-PAE) or a low physical activity environment (low-PAE) based on implementation of physical education programing. To track their movement, participants wore an accelerometer for seven consecutive days during all waking hours, except when bathing or swimming. School records were used to determine math and reading scores. The results of the study concluded that 59% of students at low-PAE schools had advanced/proficient math scores compared to the 79% of students in a high-PAE school. Similarly, for English Language Arts, 39% of the students who attended a low-PAE school had advanced/proficient scores compared to 56% of students from a high-PAE school. This study demonstrates the beneficial role and impact of a school’s physical activity environment in contributing to children’s physical activity and academic performance.

Movement recommendations

It is not simply that children need opportunities to play but they specifically need to participate in physical activity and movement activities as part of their play. Recommended movement guidelines suggested by Tremblay et al. (2017) for toddlers "one to two years means at least 180 minutes of physical activities at any intensity, including energetic play, spread throughout the day—more is better" (Tremblay et al., 2017, p. 215); Research of best practices by the Center for Disease Control (2020) suggests "that preschool-aged children (ages three through five years) should be physically active throughout the day for growth and development" (*How Much*, 2020, par. 3). Furthermore, the same research also recommends "Preschool-aged children (ages three through five years) should be encouraged to move and engage in active play as well as in structured activities, such as throwing games and bicycle or tricycle riding (*How Much*, 2020, par. 3). In the Physical Activity Committees report to the Department of health they state: "Although the specific amount of activity needed to improve bone health and avoid excess fat in young children is not well defined, a reasonable target may be three hours per day of activity of all intensities: light, moderate, or vigorous intensity" (2018 Physical Activity Guidelines Advisory Committee, p. 49). While the recommendations of the Physical Activity committee recommend three hours of physical activity a day, Tremblay et al. are more specific in their recommendation "that preschoolers three to four years old should have at least 180 minutes spent in a variety of physical activities spread throughout the day, of which at least 60 minutes is energetic play—again, more is better" (Tremblay et al. 2017, pg. 215). Providing children with the appropriate amount of robust physical activity is crucial to their overall development.

Further research

Further research is needed to determine how to address children who are not able to participate in physical activity due to the presence of a movement disorder or condition that inhibits the ability to move independently. The implications of limited movement on not only their physical and gross motor skills and the impact on executive function development but also on their overall development will also need to be investigated. Cook et al. (2019) also indicated that further research should be conducted to understand if hyperactivity-impulse behaviors compound the negative relationship between physical activity and working memory. This review found limited research that investigated how specific activities and intensity affect the development of executive function skills. Future studies will be needed to address these gaps in research.

Conclusion

The increased focus on the academic skills of children as the key indicator for school readiness has resulted in children from birth to five years old spending more time in sedentary, academically focused activities and less time in meaningful play and physical activity. As a result, children are not provided the time and opportunity to participate in the robust play activities that are essential factors in whole child development.

This literature review presented research that explained how physical activity helps with not only brain development but also the development of executive function. Research demonstrates the importance of physical activity on the overall health and well-being of children. This review also identified the connection between the areas of physical activity and executive function and school readiness. Additionally, research findings regarding the importance of play on whole child development were explained. Activity durations and movement recommendations

appropriate for preschool aged children are identified. Finally, this review has provided information that childhood professionals, decision makers, stakeholders, and parents can use to help guide development of early childhood programing that focuses on brain development, executive function, overall well-being, and school readiness.

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