



Review

Importance, unique aspects and guidelines, and building blocks of early childhood physical activity from a socioecological perspective

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ABSTRACT

Although the benefits of physical activity are established across all age groups, researchers have recently noted that there is uncertainty as to which correlates and determinants of physical activity contribute to well-informed interventions and policies, particularly for the time frame of early childhood. The following narrative review highlights salient factors related to physical activity during early childhood, particularly in the United States, with respect to a socioecological framework. Discussion of factors at the individual (demographic, genetic), interpersonal (family support and perceptions of competence), organizational (e.g., preschool attended, preschool quality, teacher characteristics), community (availability, use, and perceptions of play spaces), and policy levels is included. While researchers often work within a public health framework that focuses on moderate-to-vigorous physical activity, or total (light-to-vigorous) physical activity, this may not fully align with how young children move. The importance of structured and unstructured play, risky play, and nature-based play are highlighted. Implications for basic and applied scientists, clinicians, and practitioners are addressed. Suggestions for future work include consideration of the context of physical activity, associations with other health behaviors, and further examination of the interpersonal and community level factors.

1. Introduction

Physical inactivity is considered a global pandemic and has been cited as being responsible for more than 5 million deaths worldwide and over \$67 billion of economic burden per year.^{1,2} Evidence suggests that physical activity is associated with myriad positive health outcomes in adults, adolescents, and children.³ Additional evidence suggests that physical activity is associated with lower risk for excessive increases in adiposity and favorable characteristics associated with health, in particular bone health, in children 3–6 years old.³ Although the benefits of physical activity are established across all age groups, researchers have recently noted that there is uncertainty as to which correlates and determinants of physical activity contribute to well-informed interventions and policies.⁴ This is particularly true for the time frame of early childhood, which is a time when rapid changes in physical, social, cognitive, and language ability occur.^{5,6} Engaging in physical activity starting in the early childhood years can strengthen development of several health characteristics, including cognitive development.⁷ The following narrative review highlights salient factors related to physical activity during early childhood, particularly in the United States (U.S.), with respect to a

socioecological framework (Fig. 1). Its purpose is to provide an overview of available evidence addressing all levels of the social ecological framework with the goal of inspiring future research in addition to activities that can be performed by clinicians and practitioners. A narrative review is used due to the need to synthesize information in this area with the recognition that full, systematic consideration of all levels of the socioecological approach would create too large of an undertaking for journal requirements.

2. Importance of physical activity in early childhood

Early childhood (infancy: birth to 1–2 years [y], toddler: 18 months–3 y, preschool: 3–5 y) is a critical period for children's development, which can have life-long impacts on health and well-being. Development is broadly defined as the changes children experience with age,⁸ and those changes are the result of genes, environment, and the interaction between genes and the environment.⁹ Physical activity is related to each of five generally accepted domains of development in early childhood: physical health and well-being, emotional maturity, social, language and communication, and cognition.¹⁰ Thus, physical activity is a key component of development during early childhood.

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Abbreviations	
NASPE	National Association for Sport and Physical Education
WHO	World Health Organization
CDC	The Centers for Disease Control and Prevention
CSAW	Childcare Survey of Activity and Wellness
ECERS	Early Childhood Environment Rating Scale
GPS	Global positioning systems
NAP SACC	Nutrition and Physical Activity Self-Assessment for Child Care
ACSM	American College of Sports Medicine
IOM	Institute of Medicine
MVPA	Moderate-to-vigorous physical activity
TPA	Total physical activity
US	United States
UK	United Kingdom
y	years

In infants, there is low to moderate quality evidence that physical activity is positively associated with favorable levels of adiposity, motor skill development, and cognitive development.¹¹ In toddlers, there is moderate quality evidence of an association between physical activity with bone and skeletal health.¹¹ In preschoolers, there is low to high quality evidence of a positive association of physical activity with improved adiposity, motor skill development, psychosocial health, and cardio metabolic indicators.^{11,12} While the 2018 U.S. Physical Activity Guidelines Scientific Committee¹³ concluded there was insufficient evidence for effects of physical activity on cognition in children < 6 y of age, there is some preliminary evidence to support a positive association with cognition¹⁴ and self-regulation¹⁵ in this age group. Taken together, evidence exists to support that physical activity during early childhood is related to future health outcomes.

One aspect of physical activity during early childhood worth highlighting is the potential for lifelong benefits^{16–19} Early life exercise has been tied to adult exercise and body mass in the animal model²⁰ and in humans.^{21–23} One way physical activity during early childhood can have long-term effects is illustrated in Stodden et al.'s²⁴ framework, which explains theoretical relationships among physical activity, motor competence, perceived motor competence, and health-related fitness and

subsequent ties to risk of obesity. During early childhood, higher physical activity is related to higher fitness, leading children into a positive spiral of engagement, resulting in a healthier weight. With lower levels of physical activity and fitness at a younger age, children enter a negative spiral of disengagement, which leads to unhealthy weight status. Stodden et al.'s²⁴ framework suggests that relationships among these health-related variables (including physical activity) and their directions can differ by age, highlighting the importance of examining particular periods during child development. A more recent framework has been developed by Hulteen et al.²⁵ which also supports the importance of foundational movement skills, while recognizing cultural/geographic differences in what skills are considered foundational, and additional physical and psychological factors which may influence motor skills development like self-efficacy. Importantly, Hulteen et al.'s²⁵ framework supports that a motor proficiency barrier exists, wherein children without foundational movement skills are unable to be physically active later in life.

3. Movement in early childhood – unique aspects

While we are often working within a public health framework that is interested in moderate-to-vigorous physical activity, or total (light-to-vigorous) physical activity, this may not fully align with how young children move. Further consideration as to what constitutes moderate-to-vigorous physical activity in young children is needed. As highlighted by a landmark paper by Bailey et al.,²⁶ children move in short, sporadic bursts. There may be important information in the patterns of young children's movement which researchers have not fully considered.

Movement takes many forms during childhood, and intensity is not the only important factor dictating the conferred benefits. For example, the social and environmental context are very important to social and cognitive development in early childhood and should be accounted for in the study of children's movement.²⁷ The early childhood period is also critically important for the development of fundamental or foundational motor skills which children will use later in life.^{24,25} The physical literacy framework incorporates motor competence, fitness, and perceived competence, all of which dictate whether a child is a capable mover or not.²⁸ Monitoring fine and gross motor skill use and development may be particularly relevant in this age group.

One aspect of movement which distinguishes early childhood is the central role of play, which is a key driver in children's motor and social

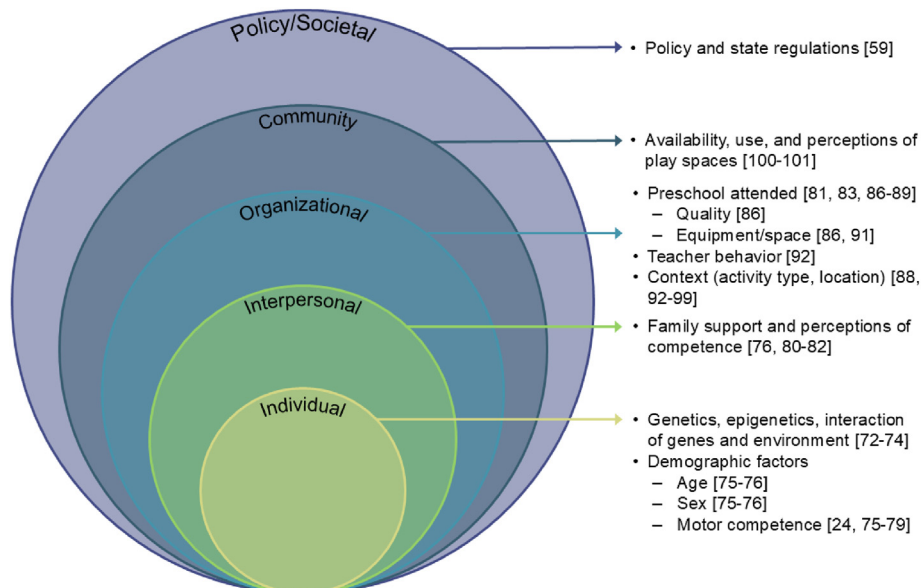


Fig. 1. Overview of socio-ecological levels covered in this review (number in brackets indicate reference number from the reference list).

development. Play is “engaging in an activity for enjoyment and recreation rather than a serious or practical purpose.”²⁹ While play in general is beneficial to children, three specific types of play (structured/unstructured, risky, and nature) warrant further discussion as they each have unique purposes and benefits.

Unstructured play is free play, where children perform gross motor skills and exert energy in a freely chosen form.³⁰ Structured play is planned and designed with a purpose, such as increased performance or skill development, which is generally led by a parent, teacher, or coach.³¹ While some research supports that structured play is of a higher intensity,³¹ unstructured play is beneficial for social and emotional well-being.^{32,33} Both unstructured and structured play are important because they afford different benefits and opportunities for children to learn.

Risky play is “thrilling and exciting forms of physical play that involve uncertainty and a risk of physical injury,”³⁴ such as playing at higher heights or speeds or with dangerous tools or near dangerous elements, rough and tumble play, hitting things, or being unsupervised. In addition to providing opportunity for physical activity, risky play is associated with motor competence,³⁵ ability to assess and manage risks,³⁶ psychological outcomes^{35,37} and overall health.³⁵ Approximately 10% of children’s free-play involves elements of risk,³⁸ but children also vicariously experience risk by watching others participate in risky play. Acceptability of risky play has declined over time but it is an important part of development, so we need to be able to give children these experiences.^{39,40}

Nature-based play is also very important because it has been related to greater emotional and social resilience^{41,42} and can positively impact several variables like physical activity, motor competence, and health-related fitness.³² Play in nature tends to be more imaginative and creative than more manufactured play environments.^{32,42,43} Some have even suggested that children are suffering from “nature deficit disorder” due to the decline in time spent outdoors and the concomitant rise in time spent indoors, often with screen-based media.⁴⁴ While the quality of evidence for the benefits of nature-based play was rated as “satisfactory” (out of “excellent,” “good,” “satisfactory,” or “poor”) in a recent review, indicating that more high-quality research is needed,³² providing opportunities to play in natural environments is clearly important in this age group.

It is also important to note that there are other aspects of movement development that should be considered during early childhood. Examples in infants are ability to perform basic spontaneous and reflexive movements,⁴⁵ time spent in restrictive implements (e.g., indoor swing, high chair), development of skills like crawling, and tummy time.⁴⁶ Higher tummy time has been associated with acquisition of gross motor skills.⁴⁶ Examples in toddlers are development of independent walking and transitioning between positions (e.g., standing to stooping).⁴⁷ Many gross motor skills are developed during early childhood, and they are unique to the time period.

Overall, movement during early childhood takes place in many forms. Total and moderate-to-vigorous physical activity are not the only important physical activity outcomes in early childhood, although total physical activity is the focus of current public health guidelines for young children.^{3,48,49} The remainder of this paper focuses on what is known with respect to total and moderate-to-vigorous physical activity in preschool populations, as the bulk of the evidence examining relationships with overall health addresses these two variables in this population.

4. Guidelines, surveillance, and prevalence

4.1. Guidelines

In 2002, the National Association for Sport and Physical Education (NASPE) recommended toddlers participate in 30 minutes (min) and preschoolers participate in 60 min of structured physical activity per day, and both groups should participate in at least 60 min of unstructured physical activity per day and not be sedentary for more than 60 min at a

time.⁵⁰ Additionally, NASPE recommended that young children should develop motor skills as building blocks for more complex movements, and they should have access to indoor and outdoor areas that meet or exceed recommended safety standards for performing large muscle activities. While specific amounts of time were not recommended for infants, the same general recommendations were made, while also specifying infants should participate in physical activities which focus on exploring their environment.

In 2011, the Institute of Medicine released guidelines that child care centers should provide toddlers and preschoolers at least 15 min per hour of total physical activity.⁵¹ These guidelines also recommended provision of outdoor time, both structured and unstructured physical activity opportunities, and opportunities which promote cognitive and social development, and that sitting or standing be limited to no more than 30 min at a time. The Institute of Medicine also recommends provision of several specific environmental features, such as shade, and open grassy areas. While guidelines for infants were more general, it was recommended that they be provided with daily opportunities to freely explore their environments, spend time on the ground interacting with adults, and, for children under 6 months of age, have tummy time.

Around the same time, guidelines from Australia,⁵² Canada,⁵³ and the United Kingdom⁵⁴ all suggested 180 min a day of total physical activity for preschool-aged children, with some also recommending the same for toddlers.^{52,53} More recently, these countries and the World Health Organization (WHO) have released 24-hour (h) movement guidelines which address physical activity, sedentary time, and sleep.^{48,49,55,56} Recommendations for preschool children are 180 min per day of total physical activity, at least 60 min of which is moderate-to-vigorous, with no more than 60 min of sedentary screen time. Preschool children are recommended to obtain 10–13 h of sleep as well.

Similarly, WHO guidelines exist for 24-h movement in infants and toddlers. Infants are recommended to be physically active several times a day in many different ways, with at least 30 min of accumulated tummy time (play on your belly) spread throughout the day. Further, infants should not be restrained for more than an hour at a time. The associated sleep guidelines vary from 12 to 17 h (including naps) depending on the age. Toddlers are recommended to participate in at least 180 min of various types of physical activities and not to be restrained for more than 1 h at a time or sit for large periods of time. No sedentary screen time is recommended for infants or one-year-olds, while two-year-olds are recommended to have less than an hour of sedentary screen time. Between 11 and 14 h of quality sleep are recommended.

The first national guidelines in the U.S. to include preschool-aged children, 3–5 years of age, were released in 2018 and suggested that preschoolers should be physically active throughout the day, adult caregivers should encourage active play and structured activities, and that specific activity types (hopping, skipping) are recommended for bone health.³ However, a specific amount of physical activity was not provided, and no guidance was provided for infants or toddlers. [Table 1](#) shows the different guidelines, and which forms of physical activity are addressed in each. Although various guidelines exist, surveillance is necessary in order to determine if guidelines are being met.

4.2. Surveillance

Surveillance is important to not only monitor adherence to guidelines but also to assess progress towards public health goals, like the Healthy People 2030 initiative in the U.S. Unfortunately, there is little on-going surveillance of early childhood physical activity at the individual level.⁵⁷ The National Health and Nutrition Examination Survey has not consistently captured accelerometry data in this age group, only including 3–5 year-old children in the 2013–2015 cycles and the 2012 supplemental National Youth Fitness Survey. The National Survey of Children’s Health asks parents of 0–5-year-old children about time spent playing outdoors, screen time, and sleep, but these do not directly map to current recommendations.

Table 1
Guidelines for movement behaviors of young children.

	NASPE [Birth to 5 y]	IOM [Birth to 5 y]	US [3–5 y]	Australia [Birth to 5 y]	Canada [0–4 y]	UK [Birth to 5 y]	WHO [Birth to 5 y]
Sedentary							
Limit restraining (no specific amount)	X						
Restrained for < 1 h at a time				X	X		X
Limit sitting/standing to ≤ 30 min at a time		X					
Sedentary for < 1 h at a time	X						
No screen time				X	X		X
No sedentary screen time				X	X		X
< 1 h sedentary screen time				X	X		X
Choose educational activities				X	X		X
Physical activity							
Structured (no specific amount)		X	X				
30 min structured	X						
60 min structured	X						
60 min unstructured	X						
Variety			X	X	X	X	X
15 min per hour TPA		X					
TPA for no specific amount of time			X				
Tummy time (no specific amount)		X					
30 min tummy time				X	X	X	X
180 min TPA				X	X	X	X
60 min MVPA						X	X
60 min energetic play				X	X		
Energetic play (no specific amount)				X	X		
MVPA (no specific amount)							X
Throughout the day/several times a day			X	X	X	X	X
Outdoor		X				X	
Indoor	X	X					
Caregivers/adults	X	X	X	X			
Bone health activities			X				
Exploration	X	X		X			
Environment	X	X					
Movement skills	X						
Cognitive/social development		X					
Punishment		X					
Play			X	X	X	X	X
Risk				X			
Sleep							
Consistent sleep/wake times				X	X		X
12–17 h				X	X		X
11–14 h				X	X		X
10–13 h				X	X		X

IOM: Institute of Medicine; MVPA: moderate-to-vigorous physical activity; NASPE: National Association for Sport and Physical Education; TPA: total physical activity; US: United States; UK: United Kingdom; WHO: World Health Organization; y: year; h: hour; min: minute.

Surveillance can also be used to monitor policies and practices of childcare programs. The Centers for Disease Control and Prevention (CDC) recently launched the Childcare Survey of Activity and Wellness (C-SAW) in four pilot states to examine physical activity policy in child care centers, specifically.⁵⁸ The Achieving a State of Healthy Weight State Profiles by the National Resource Center for Health and Safety in Child Care and Early Education provides state-level regulations regarding 47 standards recommended by the Centers for Disease Control and Prevention within the topics of healthy infant feeding, nutrition, physical activity, and screen time.⁵⁹ These few surveillance systems that exist address multiple levels of physical activity, but they are not tied together or systematically examined together in a way that would provide an overall assessment of how well young children are moving and have access to environments that encourage them to move.

In addition to the need for a comprehensive assessment of surveillance at multiple levels, researchers need to consider what physical activity outcomes, domains, or contexts are important. As previously noted, there has been a focus on total or moderate-to-vigorous physical activity, yet for the early childhood age group it may be motor competence or various types of play (e.g., nature, risky) that are driving future physical activity participation. Round table discussions amongst early childhood movement experts may be one way to move forward with a better plan for which variables are important to assess in surveillance efforts and how they can be assessed comprehensively across multiple domains.

4.3. Prevalence

Although surveillance information with respect to physical activity during early childhood is limited, there are some sources of information providing insight. Pate et al.⁶⁰ found that about 50% of preschoolers were meeting the Institute of Medicine 15 min/h guideline in two different samples in the U.S., with more boys meeting the guidelines than girls (~55% vs. 39%). Researchers in Australia⁶¹ found that only 5% of children were meeting the 180 min/day guideline, while a study in Portuguese children reported that over 90% met the UK/Australia/Canada 180 min/day guideline and the Canadian recommendation of 60 min/day of moderate-to-vigorous physical activity.⁶² Regarding 24-h movement guidelines, about 9%–13% have been shown to be simultaneously meeting all guidelines for sleep, physical activity, and sedentary.^{63–65} Overall, there is a great deal of variability in preschoolers' adherence to guidelines.

With respect to infants and toddlers, even less information is known. For infants, evidence from an Australian sample suggests that about 30% meet tummy time recommendations, 57% meet requirements of not being restrained for more than an hour at a time, 27.9% meet screen time guidelines, 58.7% meet sleep guidelines, and 3.5% meet all the guidelines.⁶⁶ For toddlers, data from a Canadian sample indicate that 99.3% meet physical activity guidelines and 82.1% meet sleep guidelines, but only 15.2% meet the screen time recommendations, with the prevalence

of meeting all three recommendations being 11.9%.⁶⁷ These data suggest that there is work to be done in terms of assessment of early childhood physical activity and highlight the fact that elucidating which variables are correlates and determinants of physical activity is important.

5. The socio-ecological model

Ecological frameworks are highly relevant for examining characteristics related to movement. The socio-ecological model addresses various levels, from individual to society/policy^{68–71} (Fig. 1). The individual level refers to personal factors, and the interpersonal level addresses interactions between people (e.g., parents and children). Next is the organizational level, which consists of places like school or home. Community reflects the greater community where the individual resides and incorporates the built and social environments. Last, the society level is also referred to as the policy level. Since it is difficult to fully address all possible aspects of the model and all possible variables at its various levels, the following text highlights some relevant variables that are associated with physical activity in the early childhood years and important to consider moving forward in the field.

5.1. Individual level

5.1.1. Genetics

At the individual level “the regulation of behavioral traits is influenced by complex multifactorial and redundant genetic, epigenetic, and other biological systems.”⁷² There are a few studies that show that genetic influence on physical activity varies by age,⁷³ for example, the genetic influence on physical activity is higher toward the end of puberty and then fades at later ages.⁷² Evidence suggests that environmental influence specific to sports participation is greater in earlier adolescence, but by about 17–18 y the genetic influence really starts to appear⁷⁴ and then continues so that over age 18 y, genes largely explain individual differences in sports participation.⁷⁴ It remains unknown what happens in early childhood. Much of the work in which we have learned about genetic influence is performed in an animal model, and individuals have not addressed these types of variables in the time frame that would correspond to early childhood. Some focused work on the early childhood years would be helpful in determining the individual and combined influences of genetics and environment.

5.1.2. Demographic factors, including motor competence

Several demographic variables have been shown to be associated with physical activity in early childhood. Generally, researchers have reported associations with age and sex, but given the time frame of early childhood an important factor is motor competence.^{75,76} There is evidence suggesting low to moderate relationships ($r = 0.16–0.48$) between motor competence and physical activity in early childhood.⁷⁷ More importantly, evidence suggests that motor skill interventions improve physical activity during early childhood⁷⁸ and that children in the low tertile of motor competence showed less time in moderate-to-vigorous physical activity and vigorous physical activity than both the intermediate tertile and the high tertile, particularly for locomotor skills.⁷⁹ While motor competence is a key developmental construct during early childhood,²⁴ warranting its consideration as an important outcome variable, it also has relationships with physical activity as an independent variable. Researchers have suggested reciprocal relationships between the two exist and that the nature of the relationships changes across childhood and adolescence,²⁴ thus highlighting the importance of examining motor competence and its influence during early childhood.

5.2. Interpersonal level

5.2.1. Parent perception of athletic competence, family support

There is less evidence of variables associated with physical activity during early childhood at the interpersonal level. One variable that

applies to early childhood and later times across childhood and adolescence is family support for physical activity.⁸⁰ Family support refers to encouraging children to be physically active, engaging with children in physical activity, providing transportation, watching children engage, and telling children physical activity is good for their health. Dowda et al.⁸⁰ reported that family support was positively associated with children's moderate-to-vigorous physical activity. A second salient factor is parent's perception of athletic competence, which was positively associated with both moderate-to-vigorous physical activity and total physical activity in another investigation.⁸¹ Another contributing factor could be parent physical activity, which has shown a weak association to young children's physical activity.⁸² However, few investigations have shown any other interpersonal variables to be related to young children's physical activity.⁷⁶

5.3. Organizational level

5.3.1. Preschool attended

Dating back to 2002, Finn et al.⁸³ showed the importance of the preschool itself with respect to physical activity in preschool children. Over half (59%) of children 5 y of age or younger are in a non-parental care arrangement, for an average of 27 h per week,^{84,85} suggesting that children spend a lot of time in these environments. Further studies have also noted the importance of the center.^{81,86–89} The following text describes multiple factors at preschool that may be related to physical activity.

5.3.2. Preschool quality

Tools to assess preschool quality exist, and one commonly used instrument is the Early Childhood Environment Rating Scale (ECERS),⁹⁰ now in its third edition (<https://ers.fpg.unc.edu/>). The elements examined with the ECERS include space and furnishings, personal care routine, language and literacy, learning activities, interaction, and program structure. Researchers have shown that children spent more time in moderate-to-vigorous physical activity in preschools that had a higher quality score on the ECERS.⁸⁶

5.3.3. Equipment/space

Aspects of equipment and space that are not well captured with the ECERS could also be considered contributors to preschool quality and are potentially related to physical activity. Preschools in which children were more physically active had less fixed playground equipment (and more portable equipment), less use of electronic media, and larger playgrounds.⁸⁶ In another analysis using motor competence as the outcome, classroom size to child ratio, playground size, and electronic media use were related.⁹¹ Thus, for two different movement-related outcomes, physical activity and motor competence, there are common variables at the organizational level associated with both (namely, playground size and electronic media use), yet there were also different factors related to each as well. This highlights the importance of considering multiple aspects of movement in order to capture a better picture.

5.3.4. Teacher behavior

In one particular study in which direct observation was used, researchers found that activities arranged by teachers represented 16% of the intervals that were coded as moderate-to-vigorous physical activity and that 81% of the observations were adult initiated.⁹² Thus, the influence of adults can be key for behaviors occurring in preschool.

5.3.5. Context

Physical activity context is related to equipment and space and is a lesser studied construct, but it can provide rich information about types of activities in which preschool children engage. In terms of percent of direct observation intervals, one study showed that 27% of the outdoor intervals that were spent in moderate-to-vigorous physical activity were performed with balls or objects in their hands, 23% in open space, 14%

on fixed equipment, 14% using wheel toys, and 11% with sociodramatic props.⁹² Understanding the contexts that elicit more moderate-to-vigorous physical activity can be useful for creating interventions to increase physical activity.

Direct observation is often the best method to determine context. However, it is burdensome on data collection staff who are coding, and it is difficult to train the observers to be reliable with each other.⁹³ Further, early childhood environments can be confusing settings. For example, a child may be playing with blocks instead of a fireperson's hat in the sociodramatic play area. That can cause confusion as to whether one should code the location or the actual activity in which the child is engaging, regardless of location (i.e., code blocks because that is where the child is or code sociodramatic play because that is what the child is doing). Our research team has engaged in some work in this area. We examined how often children were actually doing the activity that matches the center created for that activity, and we found that in some places they were engaging in the matching activity and location, but in others they were doing something completely different.^{94,95} Thus, the coding rules adopted by research teams can play a role in determining context.

The previous example relates to indoor context, but outdoor context is also important because higher levels of physical activity are generally recorded outside versus inside.^{88,92} Additionally, researchers have shown that there may be differences in physical activity by time of day (e.g., morning versus afternoon recess) and/or differences in how much physical activity is attained across time within a particular time period (e.g., children engage in more physical activity at the beginning of recess versus the end of recess.^{96–98}) For example, using a device-based assessment approach with global positioning systems (GPS) monitors and accelerometers, our research team examined hot spots (periods with more intense physical activity) and cold spots (periods with less intense physical activity) at different times of the day (morning, lunch, afternoon) in preschool children.⁹⁶ Results showed that the location of hot and cold spots changed both within (intrapersonal) and between outdoor periods (interpersonal). Examining the nuances of context could provide valuable information from an intervention perspective. For example, preschool staff may want to incorporate some structured activity at times when children are not moving as much.

Some preliminary examination of toddlers' physical activity has shown that context matters for very young children as well.⁹⁹ Sitting/squatting, standing, and walking were primary activity types across childcare and home settings (76.5%–93.7% of time). Outdoors at childcare they are performing many push and pull activities and spending time in open space but engaging in riding activities at home. Also, at childcare in the gymnasium setting they like to crawl. In the classroom toddlers are engaging in a large amount of sociodramatic play, while in the home setting they often lie down and perform educational activities. Again, this information emphasizes how toddlers are spending their time in different contexts depending on organization type (childcare vs. home). This type of information helps with understanding how to intervene in order for children to attain more physical activity.

5.4. Community level

There is not yet much evidence at the community level. One research team reported that frequency of visits to active play spaces and time spent outside on weekends were associated with physical activity in preschoolers, but only for boys.¹⁰⁰ Lack of footpaths was associated with less physical activity for girls. Another research team reported that backyard size and perception of neighborhood dangers were inversely associated, while perceived neighborhood safety, presence of sidewalks, and public playground use were positively associated with physical activity at particular times of the day in rural preschool children.¹⁰¹ Thus, lack of evidence at the community level precludes any major conclusions about associations.

5.5. Policy or societal level

There are a few examples of activities attending to the policy level. The CDC recommended 47 standards addressing topics of healthy infant feeding, nutrition, physical activity, and screen time to be incorporated into statewide regulations for childcare programs.⁵⁹ We chose eight that were relevant to physical activity and scored them. Provision of play space was the most commonly supported standard (unpublished data). In terms of center-based childcare, we found only 3 states at the upper quartile of the presence of policy that meets standards. It is unknown how the presence of policy relates to actual physical activity; however, the fact that so few states have policies that meet standards for physical activity is noteworthy. Additionally, the Nutrition and Physical Activity Self-Assessment for Child Care (NAP SACC) is an assessment tool for childcare centers to assess how much physical activity promoting they are conducting in terms of policy.¹⁰² In 24 states they are assessing the status of policies at the centers and then choosing which policies centers would like to address.¹⁰³ NAP SACC is a great example of how addressing policy can help make real changes in childcare centers. Finally, clinicians are using tools such as Bright Futures that provide guidelines for variables to assess at well child visits.

5.6. Multilevel

The previous sections noted research supporting associations with variables from single levels of the socio-ecological framework with physical activity. Although some researchers have conducted studies addressing multiple levels, there is less evidence available for multilevel work. Often, researchers have implemented interventions that address multiple levels but do not necessarily examine the contributions variables from those levels make to physical activity.¹⁰⁴ Existing studies often include multilevel factors related to obesity rather than physical activity per se (e.g., Boonpleng et al.¹⁰⁵). One example of multilevel findings is found in the previously mentioned study by Dowda et al.⁸⁰ who showed that in addition to the interpersonal variables, preschool quality was associated with preschool children's physical activity. A similar investigation in the same study showed that classroom size/child ratio, teacher education, playground size, electronic media use, and trips to outside organizations were associated with motor competence.⁹¹ This indicates that variables from multiple levels of the socio-ecological framework are affiliated with motor skills, which was previously noted as another important form of movement in this age group. Despite the existence of some evidence of the influence of multilevel factors, more investigation needs to be completed in this area.

6. Conclusions and recommendations

Early childhood is an important time to establish physical activity behaviors. It is paramount to recognize that all forms of movement should be considered in this age group, such as risky play, unstructured play, and social play - not just the classic moderate-to-vigorous framework that exists for older children, adolescents, and adults. Beyond this, the methods by which movement is assessed can impact the presence and magnitude of associations between physical activity and its correlates.⁷⁶ Tied to this is the notion that researchers should determine which forms of movement are most important in this age group for surveillance efforts and creation of guidelines.

Most reviews conclude that more research is needed, and while it is commonly held it is true for the current investigation as well. However, there are particular correlates and determinants of physical activity during early childhood that demand attention because certain levels of the socioecological framework (i.e., individual level) are better represented with evidence than others (i.e., community level).⁴ Additionally, despite the fact that an area such as the individual level may have more evidence than others, there are particular aspects from that level that warrant further attention (e.g., genes and the gene by environment

interaction). In order to effectively address gaps in the research literature, there is a clear need for longitudinal studies and studies that include populations from underrepresented groups, including individuals with disability and chronic disease. To best address remaining issues at hand, individuals who are interested in basic science, applied science, clinical settings, and practitioners should work together to identify overarching themes common across areas. We specifically recommend work in the following, additional areas:

- Consideration of physical activity patterns and context such as how, where, when, and with whom it occurs, in addition to focus on different types of movement common in these populations (e.g., risky play, nature-based)
- Individual level – Further examination of how physical activity relates to associated health behaviors, such as sleep and sedentary behavior, more exploration of genetic and epigenetic factors, in addition to their interactions with environment
- Interpersonal level – More work should be conducted with social influences from parents, family, caregivers, and other significant sources, in addition to examination of the confluence of these social influences
- Organizational level – Further exploration of teacher behavior and salient features of facilities and space
- Community level – Further examination overall and specific to influence of the built environment and accessibility of programs that are relevant to this age group
- Policy/society level – Examination of policies related to physical activity is necessary and then exploration of if/how policy creation improves health
- Consideration of how various forms of physical activity may associate differently with each level of the socioecological framework
- Further examination of multilevel influences on physical activity
- More focus on the infant and toddler time periods, as existing research is limited and these time frames may be particularly important, especially with respect to the different forms of movement

With respect to clinicians, it is important to ensure they are familiar with the physical activity guidelines and willing and able to address movement in their well child visits. According to Lobelo et al.,¹⁰⁶ only 26% of pediatric residency programs report education on physical activity. Also, depending on insurance type, 60% or fewer pediatric visits contained documentation of counseling for physical activity or referral for physical activity. If physical activity were included as a vital sign for children under five years of age, there would be an automatic means to check in on this important aspect of development. Bright Futures, a national initiative focusing on health promotion and prevention, is led by the American Academy of Pediatrics.¹⁰⁷ This initiative provides a framework for which characteristics to assess at all developmental stages. If information obtained through following Bright Futures were entered into electronic medical records, it would provide valuable information as a potential surveillance tool as well. Additionally, if clinicians were able to provide resources for parents such as a toolbox, it may be beneficial.

Practitioners also play an important role, and there are several types of practitioners who are involved with care in early childhood settings. If practitioners could undergo training to learn to help children experience the many forms of movement that exist, it could help expose them to new ways to move and build skills. Additionally, training practitioners in how to teach basic movement skills would set the stage for future success with movement. Finally, similar to clinicians, if practitioners were able to provide resources for parents such as a toolbox, it may be beneficial.

In conclusion, although this narrative review could not include all possible variables that influence early childhood movement, it provides an overview of available evidence addressing all levels of the social ecological framework. Another strength is that it highlights future research ideas and suggestions for clinicians and practitioners. Limitations include a heavy focus on work based in the U.S. and the narrative

format, which does not provide as much rigor as a systematic review. Regardless, the idea is to inspire future research and activities that can be performed by clinicians and practitioners. A multidisciplinary approach with a translational focus will be key to moving forward, and the attention to early childhood is paramount given that many movement-related skills are rapidly developing during this time frame.

CRedit authorship contribution statement

Karin Allor Pfeiffer: Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization. **Kimberly A. Clevenger:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization.

Declaration of competing interest

Karin Allor Pfeiffer is an Editorial Board Member for Sports Medicine and Health Science and was not involved in the editorial review or the decision to publish this article. Otherwise, the authors have no conflicts of interest to declare.

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