

Original Article

Association of motor competence and physical activity in children – does the environment matter?

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Abstract

Motor competence and physical activity (PA) have been associated with various health benefits as well as growth and development in children. Despite considerable efforts many children, however, are insufficiently active and display poor motor competence. This has, at least partially, been attributed to environmental changes over the past several decades. As motor competence provides the foundation for more advanced movement skills that facilitate participation in PA along with the fact that various lifestyle habits are established during childhood, motor development at young ages can have a significant impact on health later in life. Outdoor play is considered an important contributor towards motor development as it provides diverse movement challenges that stimulate motor competence and motivate to engage in PA. Nevertheless, motor competence does not develop naturally; rather it requires instruction and deliberate practice along with feedback in addition to free play. Accordingly, organized sports and physical education appear to be critical to ensure optimal motor development. Activities that stimulate motor development should consist of diverse movement experiences that affect neuromotor development and enhance motor competence. Key characteristics of such movement experiences are task flexibility and variation in difficulty in order to allow children to engage in challenging and manageable experiences. Sufficient practice time is also critical in addition to teamwork. Taken together, motor competence is an important aspect in the development of children that stimulates an active lifestyle. Even though outdoor play incorporates various features that are important for motor development, structured activities are required as well in order to ensure that children reach their full potential.

Keywords: locomotor skills, manipulative skills, stability skills, sports, outdoor play, motor development

Introduction

Over the last several decades there has been a trend towards an increased concentration of the population in cities, which is also referred to as urbanization (Machado-Rodrigues et al., 2014; McGranahan & Satterthwaite, 2014). This change in residential pattern is a reflection of an economic transition towards a service-based society. It does, however, also affect biological development and behavioral choices of human beings. Increased population density in cities, for example, has been associated with lack of space for play and PA, which, among other aspects, contributes to a more sedentary lifestyle (Finn, Johannsen, & Specker, 2002). In fact, Baranowski et al. (1993) argue that the environment is the strongest predictor of PA in young children as they showed higher activity levels in children during outdoor play as compared to indoors. Environmental changes, therefore, may be a critical influence on PA levels in children (Aubert et al., 2018; Pate et al., 2015). Along with low PA levels in children, motor competence has also declined over the past several decades (Bardid, Rudd, Lenoir, Polman, & Barnett, 2015; Brian et al., 2018) and available data indicates that only 50% of children are considered competent across a broad range of motor skills (Bryant, Duncan, & Birch, 2014; Hardy, Barnett, Espinel, & Okely, 2013).

Given the association of PA and motor competence with various health benefits this development has significant impact on future public health. In addition to beneficial associations with body weight, chronic disease risk and general growth and development (Leppänen et al., 2017; Piercy et al., 2018), PA has been associated with behavioral, cognitive and social outcomes (Lees & Hopkins, 2013; Timmons et al., 2012). Similarly, higher motor competence has been linked to improved physical, psychological and mental health as well as general well-being (Bremer & Cairney, 2016; Robinson et al., 2015; Stodden, Gao, Goodway, & Langendorfer, 2014). Motor competence is further associated with neurological development, which affects executive and cognitive function, including attention, language development and reading (Carson et al., 2016; Iverson, 2010; Viholainen et al., 2006). Motor competence and PA during early childhood, therefore, are key contributors for long-term physiological and psychological health (Schmutz et al., 2020). Motor competence is also considered a sustainable outcome that tracks from childhood into adolescence (Lima, Bugge, Pfeiffer, & Andersen, 2017). Accordingly, motor competence affects a person's behavioral capability and preferences for specific lifestyles and, therefore, can be a critical element in the promotion of an active lifestyle (Barnett, van

Beurden, Morgan, Brooks, & Beard, 2009; Lai et al., 2014). The fact that various lifestyle habits are established during childhood and track over time (Ahnert, Schneider, & Bös, 2009) further emphasizes the need to enhance the understanding of key components, including the environment, that facilitate motor development and PA during childhood.

Association of Motor Competence and Physical Activity

Motor competence has been established as a global term that refers to goal directed movements, which include large muscle groups or the whole body (Robinson et al., 2015). Commonly motor competence is divided into three categories: locomotor skills, object control and stability skills. Locomotor skills reflect the ability of moving the body through space (e.g., running, skipping, galloping, jumping, hopping, ...). Object control skills refer to the ability to move and manipulate objects in space (e.g., throwing, catching, kicking, dribbling, ...) and stability skills reflect the ability to maintain postural control (e.g., balancing, twisting, rolling, stopping, ...)(Payne & Isaacs, 2017). While engagement in various physical activities is critical for motor development, motor competence also provides the foundation for more advanced and specialized movement skills that subsequently facilitate participation in various forms of PA and sports (Barnett et al., 2016; Gallahue, Ozmun, & Goodway, 2012). Available data, therefore, indicates a reciprocal, synergistic relationship between motor competence and PA (Barnett, Morgan, Van Beurden, Ball, & Lubans, 2011; Kambas et al., 2012; Stodden et al., 2008). The directionality and strength of this association, however, has been suggested to vary with age (Stodden et al., 2008). Diverse movement experiences, particularly at young ages, facilitate motor development. As children start to compare their abilities to their peers with increasing age, actual and perceived motor competence, however, become a critical determinant for PA participation as higher motor competence is associated with increased enjoyment of PA and motivation towards an active lifestyle (Barnett et al., 2009; Lopes, Maia, Rodrigues, & Malina, 2012). This is also reflected by the fact that 90% of children with low motor competence have been shown to be insufficiently active (De Meester et al., 2018). Motor competence, therefore, has been suggested as an important component in the promotion of PA as it facilitates successful participation in various forms of PA. Low motor competence, on the other hand, may contribute to a withdrawal from PA (Cattuzzo et al., 2016; Logan, Webster, Getchell, Pfeiffer, & Robinson, 2015; Robinson et al., 2015), which potentially impairs subsequent motor development.

Particularly object control skills have been associated with higher moderate-to-vigorous PA (MVPA) in children, while the association between locomotor skills and MVPA is less consistent (Barnett et al., 2009; Hall, Eyre, Oxford, & Duncan, 2018; Xin et al., 2020). Stability skills also appear to have limited influence on MVPA. The beneficial effect of object control skills on MVPA may be attributed to the popularity of many ball games in children and adolescents (Barnett, Morgan, van Beurden, & Beard, 2008; Barnett et al., 2009). Further, object control skills may not be as integrated in daily PA as locomotor and stability skills and, therefore, children may not be exposed to movements promoting the development of manipulative skills during habitual activities. The limited exposure to manipulative skills may also have contributed to the fact that throwing has been considered the most difficult upper limb task in young children (Wong & Cheung, 2006). Better object control skills in boys compared to girls (Niemistö et al., 2019; Webster, Martin, & Staiano, 2019) may also contribute to observed sex differences in PA already at young ages (Andersen et al., 2017; Pate et al., 2015). Girls, on the other hand, display better locomotor skills (Niemistö et al., 2019; Webster et al., 2019), which could be related to differences in the types of PA and sports they engage in. There also appears to be a certain intensity threshold required to facilitate optimal motor development (Schmutz et al., 2020) as the association between motor competence and light PA has been limited (Xin et al., 2020).

Nature vs. Nurture in Motor Development

Motor development is influenced by individual as well as environmental factors and depends on a constructive interplay of nature and nurture (Schmutz et al., 2020). Access to outdoor play spaces appears to be an important contributor to motor development as such open spaces provide the freedom to move and stimulate diverse movement experiences (Fjørtoft, 2001). Different play opportunities and movement challenges during outdoor play are also commonly associated with activities where gross motor skills dominate (Storli & Hagen, 2010). Specifically, perceived functionality and diversity of the landscape have been shown to affect motor performance in children (Fjørtoft, 2001). It has further been shown that the outdoor environment enhances motivation and stimulates children's PA (Fjørtoft & Gundersen, 2007). Besides volume of PA, outdoor PA has also been associated with higher intensity compared to activities performed indoors (Panczyk, 1999), which, as mentioned previously, appears to be critical for motor development.

Research examining the association between living environment and motor competence, however, has shown equivocal results. Some studies showed higher motor competence in rural children compared to their urban peers (Drenowatz, Hinterkörner, & Greier, 2020; Niemistö et al., 2019) while other studies reported opposite results (Ujević, Sporis, Milanović, Pantelić, & Neljak, 2013). These inconsistencies may be attributed to the fact that additional aspects, such as participation in organized sports and social support, are critical for motor development (Niemistö et al., 2019). A recent review further emphasized the importance of practice for motor development in addition to opportunity (Barnett, Lai et al., 2016). Accordingly, planned PA programs

have been shown to be more effective in improving motor competence compared to free play (Logan, Robinson, Wilson, & Lucas, 2012; Van Capelle, Broderick, van Doorn, E Ward, & Parmenter, 2017; Wick et al., 2017).

Even though rudimentary movement patterns develop naturally, not all children achieve mastery in fundamental movement skills as they get older (Wong & Cheung, 2006). The limited association between PA and motor competence in preschool children (Schmutz et al., 2020) further indicates that motor competence does not develop naturally in the absence of instruction (Barnett, Lai et al., 2016; Payne & Isaacs, 2017; Robinson & Goodway, 2009). Even though outdoor play and physical space are important aspects for the promotion of sports participation and PA, access to outdoor play space alone is not sufficient to stimulate optimal motor development (Logan et al., 2012; Wick et al., 2017). Rather, a conscious effort appears to be required to facilitate motor development (Hardy, Reinten-Reynolds, Espinel, Zask, & Okely, 2012). Accordingly, deliberate practice, which includes diverse movement experiences that affect neuromotor development are critical for the enhancement of motor competence (Stodden et al., 2008).

Given the need for deliberate practice and structured PA, physical education (PE) should be considered a viable setting to promote motor development. Organized sports have also been shown to stimulate motor competence (Niemistö et al., 2019) but this setting may not be available for everybody. PE, on the other hand, allows to reach the majority of children independent of their socio-economic background and living environment, particularly if the school curriculum includes mandatory PE. There is also evidence for an increase in perceived competence and enjoyment of PA with targeted interventions during PE compared to traditional PE (Fu et al., 2013). Independent of the setting (organized sports, PE, outdoor play) approaches to improve motor competence should incorporate some key components (Table 1). In addition to sufficient activity time, task flexibility and variation in difficulty appear to be of particular importance as these characteristics allow children with diverse ability levels to engage in challenging but manageable movement experiences. Opportunities for teamwork and social support should be provided as well as these could further stimulate engagement in activities that enhance motor competence.

Table 1: Considerations for deliberate practice to stimulate motor competence (based on Kosel, 2010)

Task Flexibility & Variation in Difficulty	<ul style="list-style-type: none"> • Differences in task difficulty and movement experiences • New/unfamiliar activities and/or variation of known tasks • Task orientation with limited instruction on specific movement (feedback and encouragement for alternate solutions) • Self-selected approach to solve problem (enhances perceived competence) • Difficulty based on current abilities (challenging but achievable)
High activity time	<ul style="list-style-type: none"> • Limited waiting periods by providing multiple opportunities • Sufficient practice time • Opportunities for mistakes (trial and error)
Teamwork	<ul style="list-style-type: none"> • Inclusion of children in design and solution of tasks • Opportunity for peer support in order to master movement tasks

Conclusion

Even though there have been considerable efforts to stimulate PA in children, activity levels and motor competence have declined over the past several decades (Bardid et al., 2015; Brian et al., 2018). Locomotor, manipulative and stability skills, however, are the building blocks for more advanced movements and the engagement in PA and sports later in life. As the physical diversity of natural spaces provides various opportunities for learning and development, the outdoor environment is an important component in the facilitation of motor competence (Fjørtoft, 2001). Outdoor spaces, that emphasize motor development also have been shown to elicit higher levels of PA (Wadsworth et al., 2020), which further enhances motor development and subsequent PA along with positive health trajectories (Payne & Isaacs, 2017; Robinson et al., 2015). Additionally, instruction and deliberate practice warranted for the facilitation of optimal motor development (Barnett, Lai et al., 2016; Payne & Isaacs, 2017; Robinson & Goodway, 2009). The early childhood years are considered particularly important for motor development as actual and perceived motor competence are critical for the enjoyment of and motivation towards PA (Loprinzi, Davis, & Fu, 2015). Further, various lifestyle patterns are established during childhood (Nelson, Neumark-Stzainer, & Sirard, 2006). Accordingly, the facilitation of motor competence should start at young ages and include free play as well as structured exercise with appropriate instruction, encouragement and feedback in order to stimulate an active and healthy lifestyle (Gallahue et al., 2012; Logan et al., 2012; Robinson & Goodway, 2009).

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