

Future Directions for Movement Behavior Research in the Early Years

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The early years, often defined as the first 4 years of life,¹ is a significant period of development that has important implications for lifelong health.² Therefore, ensuring children's early experiences and environments support healthy physical, cognitive, and social-emotional development is crucial.² Physical activity has been identified as one key behavior that can strengthen healthy development in the early years.³⁻⁵ Furthermore, the early years represent a critical window for establishing lifelong physical activity habits.^{4,6} International guidelines indicate that physical activity should be considered along with sedentary behavior and sleep,⁴ as these 3 movement behaviors make up the entire 24-hour period and the interactions among these behaviors can influence health.⁷⁻⁹ In comparison to other age groups, research on movement behaviors in the early years is less developed.^{8,10}

The early years is comprised of 3 age groups: <1 year (infants), 1–2 years (sometimes referred to as toddlers), and 3–4 years (sometimes referred to as preschoolers).^{1,11} Within each age group there are different developmental milestones that have implications on optimal movement behavior patterns.^{1,2,11} Due to the developmental stage, children of the early years have less independence from caregivers (eg, parents), compared to older age groups.² Consequently, the influence of home and early childhood care and education (ECCE) settings on movement behaviors is particularly important for this age group. Early intervention is needed in these settings to promote healthy movement behavior patterns.^{8,10}

The Behavioral Epidemiology Framework (BEF) outlines a systematic sequence of research studies to improve health behaviors and ultimately improve population health.¹² This framework can be useful to evaluate or assess the progress of research on specific health behaviors.¹² Owen and colleagues proposed a BEF with 6 sequential phases of studies, while recognizing that sometimes new research evidence in one phase may result in going back to conduct research in previous stages.^{12,13} This commentary is organized around these 6 BEF phases (see Figure 1) to describe the state of evidence on movement behaviors in the early years and highlight future directions for research. The commentary will primarily focus on systematic review evidence.

Phase 1: Health Indicators

Current Evidence

A 2020 systematic review examining the association between all movement behaviors and health indicators across the lifespan included 13 studies, all from high-income countries, that focused on children of the early years.⁸ Based on one study in infants (<1 y), 2 in toddlers (1–2 y), and 10 in preschoolers (3–4 y), the authors concluded that meeting the 24-hour movement guidelines or the composition of movement behaviors was not associated with adiposity in toddlers but was favorably associated with physical (ie, adiposity, bone and skeletal health) and social-emotional development (ie, health-related quality of life, social-cognitive development, and behavioral and emotional problems) in preschoolers.⁸ Of note, 10 of the 13 includes studies were cross-sectional.⁸ Furthermore, most studies focused on associations with adiposity, with less or no information on other significant physical (eg, motor), cognitive, and social-emotional development health indicators.⁸ Finally, only 2 included studies used novel data analysis approaches, such as compositional analyses.⁸ A review published in 2023 identified 8 studies in children <6 years that used compositional analyses. Consistent associations were observed between the composition of movement behaviors and cognitive development (ie, executive function, working memory, vocabulary) and some indicators of physical development (ie, motor development, fitness). Though similar research gaps were identified as in the 2020 review.⁹

Future Research Directions

- Conduct high-quality studies using longitudinal and experimental designs.⁸
- Take a holistic perspective on health though the inclusion of cognitive and social-emotional development indicators.^{8,9}
- Use data analysis approaches that account for the codependent nature of movement behaviors and consider the optimal composition of movement behaviors to maximize health.⁹
- Consider how the accumulation of movement behaviors (eg, bouts, frequency, timing) impacts health.¹⁴
- Diversify study samples to determine if higher risk groups exist by examining moderating variables (eg, sex, race/ethnicity, socioeconomic status, urban–rural location, country income groupings [eg, low-income, middle-income, high-income]).⁸

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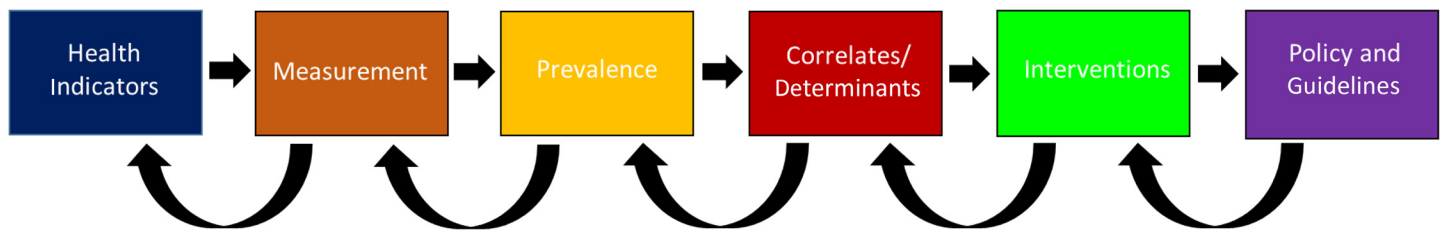


Figure 1 — Behavioral epidemiology framework for movement behavior research in the early years. Adapted from Sallis et al.¹² and Owen et al.¹³

- Focus on children aged <3 years (ie, infants and toddlers),⁹ and examine how movement behaviors predict current and subsequent health indicators.

Phase 2: Measurement

Current Evidence

A 2022 systematic review that examined the quality of movement behavior questionnaires for the early years, highlighted that minimal tools exist that assess all movement behaviors, especially for children aged <3 years (ie, infants and toddlers).¹⁵ The authors concluded that all 6 questionnaires identified had insufficient validity and reliability.¹⁵ Though these questionnaires were developed/adapted for different countries around the world, none were developed/adapted for low-income countries and only one questionnaire was adapted for a middle-income country (ie, Brazil).¹⁵ One challenge in measuring movement behaviors in the early years via questionnaire is children's movement tends to be more sporadic, less structured, and it varies based on developmental stage.¹⁶ As such, caregivers find it challenging to accurately estimate time spent in movement behaviors.¹⁵ Accelerometers, another common field-based measurement tool, can measure the sporadic nature of children's movement.¹⁶ A 2022 systematic review that examined the quality of accelerometer measures of movement behaviors in the early years found some evidence to support the reliability and validity of this measurement instrument, especially for preschoolers (defined in the review as 3–5 y).¹⁶ However, accelerometers also have limitations. For instance, they are expensive. Additionally, they require a number of subjective decisions for data reduction and there is large variability in the literature regarding these decisions.^{15,16} Furthermore, they do not capture the type (eg, screen time, organized sport) and context of movement behaviors.¹⁵

Future Research Directions

- Develop and evaluate an instrument or combination of instruments to accurately and reliably assess all movement behaviors across all age groups in the early years, and in varying contexts (eg, urban–rural location, different country income groupings, different climates) and settings (eg, ECCE, home).^{15,16}
- Develop standardized protocols for measurement instruments to enable comparisons across studies and the pooling of data.¹⁶

Phase 3: Prevalence

Current Evidence

In 2019, Guidelines on Physical Activity, Sedentary Behavior, and Sleep for Children under 5 Years of Age were released by the

World Health Organization (WHO).⁴ These guidelines aligned with country-specific guidelines that were released earlier in other countries (eg, Canada, Australia, South Africa).^{1,11,17} It was reported in a 2020 systematic review and meta-analysis that only 11% of children in the early years (aged 1–6 y) across 26 studies from 14 countries met 24-hour movement guidelines prior to COVID-19.¹⁰ A total of 24 studies used a cross-sectional design and 22 studies were conducted in high-income countries.¹⁰ Furthermore, there was a large variability in proxy-report and device-based measures.¹⁰ Restrictions associated with managing the COVID-19 pandemic may have made this critical public health issue worse.¹⁸ Overall, limited evidence exists on the prevalence of movement behaviors in children <3 years (ie, infants and toddlers) both before and after March 11, 2020 when COVID-19 was declared a pandemic.^{8,18}

Future Research Directions

- Conduct longitudinal studies to examine how movement behaviors track throughout and beyond the early years.
- Conduct studies in low-income and middle-income countries to examine if prevalence differs between country income groupings.
- Employ harmonized procedures for measuring the prevalence of movement behaviors.¹⁸
- Focus on children aged <3 years (ie, infants and toddlers), because these younger age groups have specific movement behavior recommendations.

Phase 4: Correlates/Determinants

Current Evidence

When examining correlates/determinants of movement behaviors, they are often organized using levels of a socioecological framework (eg, intrapersonal, interpersonal, institutional, community, policy)¹⁹ enabling multiple factors across settings to be taken into account. Several systematic reviews on the correlates/determinants of individual movement behaviors exist. For instance, Art and colleagues identified 21 reviews on the correlates/determinants of physical activity in the early years.²⁰ An emerging approach is considering the integrative nature of movement behaviors, thereby examining if there are important correlates/determinants for overall movement behavior patterns.⁸ A systematic review only identified 2 studies examining the correlates of meeting 24-hour movement guidelines in the early years.⁸ Both studies were cross-sectional, conducted in high-income countries and only examined demographic correlates. Therefore, it is difficult to draw conclusions on the key correlates/determinants that should be targeted in future interventions and initiatives globally.^{8,18}

Future Research Directions

- Conduct studies where the primary objective is to examine correlates/determinants of integrated movement behaviors so thoughtful and theory-based consideration can be given for the correlates/determinants examined.
- Conduct longitudinal studies to determine if key correlates/determinants change throughout the early years.²⁰
- Consider correlates/determinants across multiple levels of the socioecological framework as well as the interaction of these correlates/determinants between levels.²⁰
- Prioritize research in low- and middle-income countries to be inclusive of potential cultural differences.²⁰
- Conduct studies to investigate the impact of major global trends and challenges (eg, urbanization, digitization, climate change) on movement behaviors.
- Focus on children aged <3 years (ie, infants and toddlers) to determine if key correlates/determinants differ compared to children ≥3 years (eg, preschoolers).

Phase 5: Interventions

Current Evidence

Given the codependent nature of movement behaviors, increases in one movement behavior (eg, physical activity), will result in decreases in another movement behavior(s) (eg, sedentary behavior or sleep or both).^{1,4,11} Most interventions to date in the early years have targeted individual movement behaviors or 2 movement behaviors (eg, physical activity and sedentary behavior) sometimes combined with other health behaviors (eg, dietary intake).²¹ Furthermore, evaluations of intervention efficacy or effectiveness have also considered movement behaviors separately.²¹ Overall, interventions are particularly lacking among children aged <3 years (ie, infants and toddlers).²¹ Furthermore, there is the potential for interventions to have unintended consequences, such as increasing health inequities; however, the impact of existing interventions on inequities are unclear.²²

Future Research Directions

- Develop and evaluate contextually relevant and scalable movement behavior interventions that have the potential to have population-wide impact while reducing health inequities within and between countries.
- Measure how interventions change the composition of movement behaviors.
- Develop and evaluate movement behavior interventions in children aged <3 years (ie, infants and toddlers) and measure the maintenance of behavior change.

Phase 6: Guidelines and Policy

Current Evidence

A scoping review on population-level (ie, cities, states/provinces, countries) movement behavior policies within the ECCE setting identified 43 policy documents, with a large variation in recommendations, including many that were vague.²³ Furthermore, the policy documents were primarily from high-income countries and only 3 included all movement behaviors.²³ Just over quarter of

these 43 policy documents included tools for policy evaluation.²³ These findings may be explained by the fact many policy documents were developed prior to 2019 when the WHO released guidelines on movement behaviors.⁴ The WHO also released standards in 2021 for movement behaviors in the ECCE setting to support the implementation of the movement behavior guidelines.^{23,24} Guideline development can help identify evidence gaps and spark new research that can inform guideline updates.¹ The WHO has indicated they will update movement behavior guidelines in 10 years.^{1,4} Recent and ongoing technological and analytical advances will be key factors to consider for guideline updates, including: (1) advancements in screen technology, warranting more nuanced screen time recommendations regarding screen time patterns (eg, type, device, content, context) not just duration,²⁵ (2) advancements in how researchers analyze movement behavior data enabling the understanding of optimal movement behavior compositions through compositional data analysis methods,⁹ and (3) advancements in artificial intelligence enabling the consideration of individual differences and needs regarding optimal health through precision medicine.²⁶

Future Research Directions

- Through collaboration between government and nongovernment stakeholders, develop, implement, and evaluate population-level policies in the ECCE setting that have specific recommendations aligned with WHO guidelines and standards.²³
- Incorporate evaluation tools and resources to facilitate the evaluation of population-level movement behavior policies.
- Continue to build the evidence base regarding screen time patterns, optimal compositions of movement behaviors, and precision health/medicine for guideline updates.
- Encourage countries without movement behavior guidelines for the early years, to adapt/adopt WHO guidelines while taking into account any country-specific contextual nuances.

Summary

The early years are a key developmental period to establish healthy movement behavior patterns for both short- and long-term health and well-being.^{2,6} Although research in this area is growing, a number of key research gaps are highlighted in this article. Research addressing phases 1 to 4 evidence gaps is necessary for addressing evidence gaps in subsequent BEF phases, including interventions (phase 5), updates to national and international movement behavior guidelines (phase 6) as well as population-level policies (phase 6).¹² Across BEF phases there were consistent trends that research is particularly needed that focuses on: all movement behaviors, children aged <3 years (ie, infants and toddlers), and low- and middle-income countries. Research that addresses health inequities in movement behaviors within and between countries to support a healthy start in our youngest generation of children is essential to improving population health globally and universally as part of COVID-19 pandemic recovery efforts and efforts in achieving the United Nations' Sustainable Development Goals for 2030.²⁷

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