Protocol

Interventions to Support Healthy Movement Behaviors Among Preschool Children in Early Childhood Education and Care Settings: Protocol for a Realist Synthesis

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Abstract

Background: A paradigm shift toward a broader view of movement behaviors emphasizes the importance of physical activity, sedentary behavior, and sleep across the 24-hour day. Despite these behaviors being positively associated with important health and development outcomes, research suggests that many preschool children worldwide fail to meet the World Health Organization 24-hour movement behavior guidelines. To improve adherence, interventions have often targeted early childhood education and care settings, key environments where children spend a substantial proportion of their day. However, evidence regarding the effectiveness of these interventions and their components is inconsistent. These inconsistencies highlight the complexity of movement behavior interventions, as movement behaviors are interdependent and influenced by multiple contextual factors. Considering this, a theory-driven approach is best suited to develop a deeper understanding of what works for whom, under which circumstances, and how, ultimately improving policy and intervention development.

Objective: The aim of this protocol is to investigate under which contextual circumstances interventions most effectively improve preschool children's 24-hour movement behaviors in early childhood education and care settings by developing an evidence-informed initial program theory that outlines for whom these interventions work, under what contexts, and through which mechanisms.

Methods: Findings from the synthesis will be reported in accordance with the RAMESES (Realist and Meta-Narrative Evidence Synthesis: Evolving Standards) publication standards. A literature search will be conducted to identify relevant peer-reviewed movement behavior intervention studies. Identified studies will be considered for inclusion based on predetermined inclusion criteria. Study screening, data extraction, and quality assessment will be independently conducted by 2 reviewers. The realist synthesis will apply a combined conceptual framework to develop potential context-mechanism-outcome configurations and an initial program theory, which will be refined—through piecemeal confirmation and/or disconfirmation—during the evidence synthesis.

Results: Duplicate screening, quality assessment, data extraction, relevance and rigor appraisal, and iterative program theory testing are planned for completion by the end of 2026. The primary review manuscript is targeted for submission by early 2027.

Conclusions: This review shifts away from the current literature's focus on intervention effectiveness and instead develops a more nuanced understanding of intervention implementation and effectiveness by applying theory-driven processes. The results of the synthesis intend to identify appropriate strategies to promote healthy 24-hour movement behaviors in the early years to inform the development, adaptation, and implementation of current and future interventions.

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KEYWORDS

physical activity; sedentary behavior; sleep; preschoolers; childcare centers; movement behaviors; 24-hour movement; health promotion; intervention; realist synthesis

Introduction

Movement plays an important role in young children's health and development. Physical activity (PA); sedentary behavior (SB), including screen time (ST); and sleep are shown to be linked to a range of health outcomes [1-3]. Nonetheless, previous research has traditionally focused on each movement behavior (MB) separately. A recent paradigm shift toward a broader view on young children's movement has focused on how children move throughout the day. Specifically, PA, SB (including ST), and sleep are considered part of the 24-hour MBs and should be considered together to promote positive health and development outcomes in preschool children.

The ideal combination to achieve optimal health and development outcomes consists of higher levels of PA, lower SB and ST, and sufficient sleep [4]. Subsequently, the World Health Organization (WHO) released international 24-hour MB guidelines that provide recommendations on time spent in each behavior for children younger than 5 years [5]. These guidelines stipulate that infants (aged 0-11.9 months) should spend at least 30 minutes in prone position; should not be restrained for more than 1 hour at a time; should avoid ST; and should have 12 to 17 hours of good-quality sleep, including naps. Toddlers (aged 1-2 years) should spend at least 180 minutes engaged in a variety of PA; should not be restrained for more than 1 hour at a time; should have no more than 1 hour of ST (recommended for those aged 2 years); and should have 11 to 14 hours of good-quality sleep, including naps, and aim to have regular sleep and wake times. Finally, preschool children (aged 3-4 years) should spend at least 180 minutes engaged in PA, with 60 minutes being engaged in moderate to vigorous PA (MVPA); should not be restrained for more than 60 minutes at a time; should be limited to 60 minutes of ST; and should have 10 to 13 hours of good-quality sleep, which may include a nap, and have regular sleep and wake times.

Despite the importance of meeting the 24-hour MB guidelines, international research has found that only a small proportion of children meet all the recommendations [6,7]. A meta-analysis of 11,768 preschool children from 23 countries reported only around 11% adhered to all guidelines, while around 9% did not adhere to any [7]. To increase adherence rates, intervention programs targeting these MBs have been developed. The early childhood education and care (ECEC) environment offers a unique and prime setting for promoting healthy development and MBs. Around 85% of children attend ECEC settings across Organisation for Economic Co-operation and Development countries [8], with 63% of children younger than 5 years enrolled in ECEC settings in England [9] and around 70,000 children aged 3 to 4 years registered in ECEC settings in Scotland [10]. Furthermore, children often spend a considerable amount of time in these settings, with data suggesting they spend approximately 23 hours a week attending ECEC [9].

There is a plethora of single-behavior change interventions, and these have been well documented in recent systematic reviews, with small effects found for PA [11] and moderate effects for SB and sleep duration [12,13]. Findings relating to multiple MB interventions are less clear and/or limited, often focusing on the daytime behaviors of PA and SB [14]. For example, one intervention aimed at increasing PA and reducing SB in preschool children through intervening at the ECEC policy level was successful only in significantly improving light PA. Although small improvements were observed for total PA, MVPA, and SB, these findings were not statistically significant [15]. However, an intervention aimed at increasing PA and reducing SB in preschool children through restructuring outdoor play and the environment, in addition to providing staff training within the ECEC, led to significant improvements in MVPA and total PA, but not in light PA, and significantly reduced SB. Despite initial improvements in behavior, long-term intervention effects were not found at 6- or 12-month follow-up [16]. Similar findings have been reported for interventions targeting all 24-hour MBs in preschool children, although evidence is more limited. For example, one intervention reported significant benefits in PA and media use but no significant improvement in sleep [17], whereas another intervention using parent-reported measures found increases in PA and sleep and smaller increases in ST compared with control [18].

ECEC settings offer significant opportunities to promote optimal MBs; however, many children still fail to meet the recommended guidelines [6,7], with children often not achieving sufficient levels of PA and spending approximately 60% of their time engaged in SB while attending ECEC [19,20]. This may be explained by many factors that can influence MBs in this setting, such as educator behavior, the presence and size of outdoor environments, and opportunities for activity [21], as well as the inconsistency and lack of information within ECEC frameworks regarding MB standards [22]. Considering this age group, it is important to understand how causal mechanisms are shaped and constrained by contexts not only in structured interventions but also during spontaneous bouts of activity, which children of this age group are naturally inclined toward [23].

The 24-hour MB paradigm highlights advances in holistic and individualized thinking about codependent behaviors [24]. As the MBs are interdependent and within a finite 24-hour period, change in one behavior results in a reciprocal change in another. Considering the differing interactions that often occur between those delivering and receiving the intervention under a particular context, behavior interventions are highly complex [25]. To develop a deeper understanding of what works for whom, under which circumstances, and how, we aim to conduct a realist

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synthesis to examine the interplay of context, mechanisms, and outcomes of interventions targeting the MBs in preschool children within ECEC settings. To do so, effective context-mechanism-outcome (CMO) configurations of intervention programs will be identified to gain a deeper understanding of the underlying causal mechanisms. This process will allow a program theory to be developed, which will offer potential recommendations for the development of new, or the adaptation of current, MB interventions. The following research questions are put forth: (1) Under which contextual circumstances do interventions most effectively improve preschool children's 24-hour MBs in ECEC settings? (2) Through which CMO configurations do these interventions achieve their effects? (3) What behavior change techniques are most used in effective interventions?

Consideration of these findings together will provide a comprehensive overview of the contextual factors that trigger mechanisms that enable the success of interventions aimed at improving preschool children's 24-hour MBs conducted within the ECEC setting. The expected findings will advance current theoretical understanding of how context and mechanisms interact to produce behavioral outcomes, while offering practical recommendations for tailoring intervention design and implementation.

Methods

Project Overview

This protocol is registered with PROSPERO (CRD420261449684). Findings of the synthesis will be reported in accordance with the RAMESES (Realist and Meta-Narrative Evidence Synthesis: Evolving Standard) publication standards [26].

Search Strategy

The search strategy was informed and designed by the research team, in consultation with the faculty librarian with extensive knowledge of the topic area. Search terms will be adapted and used to search the following databases: Web of Science, PubMed, Scopus, PsycInfo, and SPORTDiscus. The full search strategy can be found in Multimedia Appendix 1.

In addition to database searching, supplementary search methods were used, including identifying additional relevant studies through the research teams' personal knowledge of the literature and forward and backward citation searching to identify studies not retrieved by database searching alone. Searching for evidence in a realist synthesis is an iterative process, and therefore, changes to the search strategy or additional searches may be required as the synthesis progresses [26]. Any additions or alterations to the search strategy will be documented accordingly.

Study Screening

Titles and abstracts of identified papers through the search strategy will be collected and managed in EndNote (version 2025.3; Clarivate) [27]. Screening will be independently conducted by 2 reviewers (HM and JJ), and any discrepancies will be discussed and resolved with the research team. Full-text screening of selected papers will follow the same process.

Inclusion and Exclusion Criteria

The inclusion and exclusion criteria were developed using participant, intervention, control, outcome, and study design (PICOS) terms (Table 1).

Studies will be included if they report on interventions that (1) include typically developing, healthy children aged 3.0 to 4.9 years enrolled in an ECEC setting; (2) aim to intervene on at least 2 of the MBs as a measured outcome; (3) are conducted within the ECEC environment or a mixed environment consisting of the ECEC with a home environment component; (4) compare MBs from preintervention to postintervention and/or between intervention and control groups; and (5) use valid measures for 2 or 3 MB outcomes. Studies should be published in English and in a peer-reviewed journal with no limit on the earliest year of publication. Study designs may include randomized and nonrandomized controlled trials, comparison trials, and quasi-experimental studies.

Studies will be excluded from the synthesis if the mean age of participants falls outside the age range of 3.0 to 4.9 years, if they use a clinical sample, or if the sample consists of individuals with disabilities or atypical development. This population sample was chosen in accordance with the WHO 24-hour MB guidelines. While the guidelines are targeted at children younger than 5 years, subsequent recommendations for time spent in each behavior are discussed in relation to infants (less than 1 year), toddlers (aged 1-2 years), and preschool children (aged 3-4 years) due to the rapid changes that occur in children's development during this time [5]. Interventions that report and assess only 1 MB and/or do not use the ECEC and the main environment will also be excluded.

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Table 1. Inclusion and exclusion criteria based on the PICOS[a] framework.

	Inclusion criteria	Exclusion criteria
Population	• Typically developing, healthy children aged 3.0 to 4.9 years enrolled in an ECEC[b] setting	• A study population with a mean age of less than 3.0 years or more than 4.9 years • Clinical samples • Those with disability including atypical development
Intervention	• Movement behavior interventions that include at least 2 of the movement behaviors as a measured outcome • Interventions conducted within the ECEC environment or a mixed environment of the ECEC plus the home environment	• Movement behavior interventions that report only 1 behavior as a measured outcome • Interventions conducted only in the home or community environment
Control	• Comparison of movement behaviors from preintervention to postintervention • Comparison of movement behaviors between intervention and control groups	• No comparison
Outcome	• Assessment of 2 or 3 movement behavior outcomes	• Assessment of only 1 movement behavior outcome
Study design	• Randomized and nonrandomized intervention studies	• Single-case studies • Non-English papers

[a]PICO: participant, intervention, control, outcome, and study design.

[b]ECEC: early childhood education and care.

Quality Assessment

The Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies [28] will be used to assess the quality of included studies (Multimedia Appendix 2). Quality assessment will be conducted independently by the main author (HM) and an additional author (JJ) to minimize errors and reduce individual bias. Any discrepancies will be resolved by a third reviewer. Interrater reliability will be reported as a percentage of items without initial consensus. The tool rates studies as "strong," "moderate," or "weak" using the following six scales: (1) selection bias, (2) study design, (3) confounders, (4) blinding, (5) data collection methods, and (6) withdrawals and dropouts. Studies are then rated to give an aggregate overall score. "Strong" identifies studies in which no "weak" individual-scale rating has been identified, "moderate" identifies studies with 1 individual-scale rating being identified as "weak," and an overall "weak" score is given if 2 or more individual "weak" ratings were identified. This tool has acceptable content and construct validity and has been recommended for use in the assessment of public health interventions [29].

Data Extraction

Data will be independently extracted by 2 researchers. Any conflicts that arise from data extraction will be resolved through discussion with a third researcher. Key data on authors, publication year, country, study aims, design, methods, participants, intervention characteristics, measured outcomes, implementation context, and results will be extracted using a data extraction template to ensure that relevant information is extracted consistently across all documents (Multimedia Appendix 3).

Realist Synthesis

Overview

The realist synthesis aims to address the key question: "What works for whom, under what circumstances, how, and why?" An initial rough program theory (IRPT) will be developed and refined to produce a final program theory that highlights relevant CMO configurations, which provide insights into the underlying causal mechanisms explaining how and why interventions work [30,31]. The underlying mechanisms will be subdivided according to resources and reasoning [30]. Here, "resources" refer to the components and modalities the intervention provides, such as information, tools, opportunities, or support. "Reasoning" refers to the emotional and/or cognitive way in which individuals respond to the resources provided, for example, changes in beliefs, improvements in motivation, confidence, or skills. Recommendations will be developed in line with the final program theory to provide insight into the inner workings of MB interventions, which has the potential to inform the development and implementation of new and existing interventions.

IRPT Development

Relevant intervention papers identified through previous literature searches will be analyzed to develop an IRPT. The IRPT will be developed through the combination of realist methods and behavioral science, as both approaches allow the consideration of multiple interacting causes in their explanatory account [32]. The application of behavioral science provides understanding of what an intervention is doing and the reasoning behind how and why it works. The realist method complements this approach to provide understanding regarding for whom and

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in what contexts interventions are effective. The combined use of this conceptual framework is beneficial in the synthesizing and analyzing of complex behavior change interventions [32,33].

Therefore, the capability, opportunity, motivation, behavior (COM-B) model [34], the Behavior Change Theory (BCT) Taxonomy [35], and the Theory and Techniques Tool [36] will be used to develop the IRPT and to gain a deeper understanding of such complex interventions [25]. The COM-B model and the BCT Taxonomy posit that behavior is influenced by capability, opportunity, and motivation, with each BCT mapping onto 1 or more of the COM-B components. Furthermore, the Theory and Techniques Tool will identify the mechanisms of action that provide a clear understanding of the effects of individual BCTs on behavior [36]. Together, these frameworks provide a systematic approach to understanding behavior change interventions by linking behavior determinants with specific intervention techniques and their underlying mechanisms of action. The application of this integrated approach facilitates intervention precision, reproducibility, and stronger interpretation of intervention effectiveness.

It is important to note that the components of the COM-B model are not assumed to operate equally across preschool children and practitioners. In this context, children are often constrained by what they can and cannot do by practitioners who act as key agents of behavior change. For example, preschool children have limited control over the preschool environment, resulting in practitioners having the autonomy to modify the environment, make pedagogical decisions, and deliver intervention strategies, aligning more closely with the components of physical opportunity and reflective motivation. Similarly, preschool children's MBs are likely influenced by their physical and psychological capabilities, such as motor competence and the ability to understand tasks and activities. Some components may also be mapped to both children and practitioners, such as reflective and automatic motivation [34]. Here, behaviors from practitioners, such as intentional planning and self-efficacy beliefs, act as proximal mechanisms that trigger downstream mechanisms in children, such as habit building and enjoyment in performing the behavior.

The IRPT will highlight theorized contexts and mechanisms necessary to produce a desired outcome, otherwise known as CMO configurations. The development of the IRPT is an iterative process and will be reviewed and refined by the research team.

Program Theory Development

The inclusion of data to inform the development of the final program theory will consider whether evidence has enough rigor, relevance, and richness to inform CMO configuration development [37]. Realism does not adopt the hierarchy of evidence when considering study quality and instead posits that causal information that provides insight into the development of program theory can arise from studies that would normally be considered "poor quality" [37,38]. Therefore, data will be excluded only if deemed to provide insufficient evidence to contribute to the final program theory [26,39].

Data extracted will be mapped against the IRPT. Data extraction will focus on explanations and discussion regarding how an intervention is assumed to produce effective results. Data synthesis will be guided by realism to understand the contextual circumstances under which interventions most effectively improve preschool children's 24-hour MBs in ECEC settings. Extracted data will be synthesized according to the relationship between contexts, mechanisms, and outcomes. Data synthesis will result in the confirmation, refusal, or refinement of the final program theory, which highlights effective CMO configurations and subsequent mechanisms of action according to the BCT taxonomies and the COM-B model. Data extracted will be subdivided into different combinations of the 24-hour MBs, including (1) PA and SB; (2) PA and sleep; (3) SB and sleep; and (4) PA, SB, and sleep. Effective CMO configurations and mechanisms of action will be discussed regarding these combinations. Where applicable, links will be made between different combinations of the 24-hour MB and their effective CMO configurations to provide possible intervention strategies that will effectively promote all aspects of the 24-hour MBs.

Results

This protocol is registered with PROSPERO (CRD420261449684). Findings from the synthesis will be reported in accordance with the RAMESES publication standards for realist syntheses [26]. The review is anticipated to be completed within 6 months.

Findings of this review will produce program theories that identify what, when, how, and under what contexts interventions most effectively improve preschool children's 24-hour MBs in the ECEC setting. Furthermore, these results aim to inform the development, adaptation, and implementation of current and future policy interventions and designs. Findings will be disseminated through a peer-reviewed publication.

Discussion

Anticipated Findings

Despite ECEC settings being a natural environment for shaping and promoting healthy MBs, current evidence suggests that only around 14% of 3- and 4-year-old children worldwide successfully meet the WHO 24-hour MB guidelines [6], with further evidence demonstrating that children spend more time engaged in SB than PA while attending ECEC settings [19]. Furthermore, current interventions aimed at improving 24-hour MBs in this setting exhibit considerable inconsistency, underscoring the complexity of these interventions. As the effectiveness of behavior change interventions is impacted by multiple differing interactions between those delivering and receiving the intervention within a particular context [25], there is an urgent need to gain a deeper understanding of the underlying mechanisms and their outcomes under different contexts of MB interventions in this area.

The realist synthesis is well suited to address this research gap, as the development of a program theory aims to explain the underlying causal mechanisms of interventions targeting the MBs for preschool children within the ECEC context. While

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current systematic research places a focus on the effectiveness of MB interventions, the realist approach examines how different contexts may trigger mechanisms that influence intervention success, offering actionable explanations as to how and why interventions are effective [40,41]. Therefore, findings from the synthesis and generation of CMO configurations to produce a final program theory will advance theoretical understanding of how contexts and mechanisms interact to produce behavioral outcomes. Gaining this deeper understanding intends to offer practical recommendations that will inform the development, adaptation, and implementation of current and future policies and interventions.

Strengths and Limitations

There are several strengths to the present synthesis. First, to our knowledge, this is the first realist synthesis to adopt a comprehensive examination of ECEC-based interventions targeting 24-hour MBs. While current research largely focuses on single-behavior change interventions, the present review offers a holistic understanding of how interventions influence multiple behaviors, aligning with recent global policy shifts [24]. Furthermore, there is currently limited literature that investigates the MBs of children in the early years, and the present study adds to our understanding of how MBs in children aged 3 to 5 years can be promoted. However, the study does not consider all children in the early years (0-5 years), and further research is required on MB interventions for infants and toddlers. Additionally, the realist methodology enables a theory-driven explanation regarding how and why interventions are effective. Realism moves beyond questions of intervention effectiveness alone and instead aims to understand the relationship between contexts and mechanisms that produce behavioral outcomes, which addresses the complex and dynamic nature of behavior change interventions [37,42]. Finally, the integration of the combined conceptual framework is highly relevant and beneficial to provide a systematic approach to understanding complex behavior change interventions.

It is also important to acknowledge the limitations present. As studies included in the synthesis are limited to those published in the English language only, findings may not be applicable at a global level. Similarly, due to the limited time and resources available, the review does not consider gray literature, which may limit the representativeness of findings and make the review vulnerable to publication bias [29,43]. However, following RAMESES guidelines, studies are included in the review irrespective of design or quality, with a focus instead on whether the evidence has sufficient rigor, relevance, and richness to inform the development of the program theory [37]. In addition, a limitation of many realist syntheses is the lack of reporting on the mechanisms used to develop intervention strategies. Mechanisms are not directly observable, and many are only partially reported in studies; therefore, the development of the program theory depends on the available evidence. Furthermore, the 24-hour MB paradigm is a relatively novel concept, and there is a lack of intervention programs that aim to improve the collective MBs. While the present review aims to overcome this limitation by focusing on interventions that report on at least 2 MBs, sleep is widely excluded from such interventions. Therefore, although the results are indicative of the current evidence base, they should be interpreted with caution until further intervention programs targeting the 24-hour MBs as a whole become available.

Conclusions

The purpose of this realist synthesis is to develop a program theory that explains how, why, to what extent, and for whom interventions targeting the 24-hour MBs in preschool children within the ECEC setting are effective. Through the process of identifying contextual factors, triggered mechanisms, and behavior outcomes of MB interventions, this synthesis allows a more nuanced understanding of intervention implementation and effectiveness. The findings may also have potential theoretical and practical implications for future MB intervention research. Through identifying effective CMO configurations, appropriate strategies for promoting healthy MB in the early years within ECEC settings will be provided to inform the development, adaptation, and implementation of current and future policy interventions and designs.

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Data Availability

All data generated or analyzed during this study are included in this paper (and its multimedia appendices).

Generative AI Use

The authors declare that generative AI was not used in the preparation of this manuscript.

Authors' Contributions

Conceptualization: HM, CP, MH, FB
Methodology: HM, CP, FB

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Investigation: HM, JJ
Data curation: HM
Writing—original draft: HM
Writing—review & editing: HM, JJ, CP, MH, FB
Project administration: HM, FB
Supervision: CP, MH, FB
Funding acquisition: MH, FB

Conflicts of Interest

None declared.

Multimedia Appendix 1

Systematic review search strategy.
[PDF File (Adobe PDF File), 129 KB-Multimedia Appendix 1]

Multimedia Appendix 2

Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies.
[PDF File (Adobe PDF File), 107 KB-Multimedia Appendix 2]

Multimedia Appendix 3

Data extraction template.
[PDF File (Adobe PDF File), 70 KB-Multimedia Appendix 3]

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Abbreviations

CMO: context-mechanism-outcome
COM-B: capability, opportunity, motivation, behavior
ECEC: early childhood education and care
MB: movement behavior
MVPA: moderate to vigorous physical activity
PA: physical activity
PICO: participant, intervention, control, outcome, and study design
RAMESES: Realist and Meta-Narrative Evidence Synthesis: Evolving Standards
SB: sedentary behavior
ST: screen time

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