Motor development in relation to 24-hour movement behaviours among preschool-aged children: a scoping review

Desarrollo motor en relación con los comportamientos de movimiento de 24 horas en niños preescolares: una revisión de alcance

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Received: 16-01-26
Accepted: 30-04-26

How to cite in APA

Jamaludin, A. N., Koh, D., Mazalan, N. S., & Ramdan, M. R. (2026). Motor development in relation to 24-hour movement behaviours among preschool-aged children: a scoping review. *Retos, 80,* 592-605. https://doi.org/10.47197/retos.v80.118582

Abstract

Introduction: This scoping review examined 24-hour movement behaviours and motor development in preschool-aged children. A search of Web of Science and Scopus identified 17 eligible studies, revealing positive associations between physical activity and motor competence, while evidence on sedentary behaviour and sleep remained limited.
Objective: This review synthesised empirical evidence on associations between 24-hour movement behaviours physical activity, sedentary behaviour, and sleep and motor development among preschool-aged children, while identifying methodological approaches, contextual influences, and research gaps.
Methodology: Conducted following Arksey and O'Malley's framework, a systematic search of Web of Science and Scopus identified empirical studies examining 24-hour movement behaviours and motor development in preschool-aged children. Included studies were synthesised to identify key findings and research gaps.
Results: 17 studies met inclusion criteria. Physical activity consistently demonstrated positive associations with motor competence, particularly in locomotor and object control domains. Evidence on sedentary behaviour and sleep was limited and heterogeneous. Variation in study design, instruments, and contextual factors including parental attitudes, school environments, and teacher practices reduced cross-study comparability.
Conclusions: Physical activity positively relates to motor competence in preschool-aged children, especially in locomotor and object control skills. Evidence on sedentary behaviour and sleep remains limited. Parental and school factors influence motor development. Future research should adopt standardised approaches in underrepresented regions such as Southeast Asia and Malaysia.

Keywords

24-hour movement behaviours; motor development; physical activity; preschool-aged children; sedentary behaviour.

Resumen

Introducción: Esta revisión exploratoria examinó los comportamientos de movimiento de 24 horas y el desarrollo motor en niños en edad preescolar. Una búsqueda en Web of Science y Scopus identificó 17 estudios elegibles, revelando asociaciones positivas entre la actividad física y la competencia motora, mientras que la evidencia sobre el comportamiento sedentario y el sueño fue limitada.
Objetivo: Esta revisión sintetizó la evidencia empírica sobre las asociaciones entre los comportamientos de movimiento de 24 horas actividad física, comportamiento sedentario y sueño y el desarrollo motor en niños preescolares, identificando enfoques metodológicos e influencias contextuales.
Metodología: Siguiendo el marco de Arksey y O'Malley, una búsqueda sistemática en Web of Science y Scopus identificó estudios empíricos sobre comportamientos de movimiento de 24 horas y desarrollo motor en niños preescolares. Los estudios fueron sintetizados para identificar hallazgos clave y lagunas de investigación.
Resultados: Diecisiete estudios cumplieron los criterios de inclusión. La actividad física demostró asociaciones positivas con la competencia motora, particularmente en locomoción y control de objetos. La evidencia sobre el comportamiento sedentario y el sueño fue limitada y heterogénea. La variación en diseño e instrumentos incluyendo actitudes parentales y entornos escolares redujo la comparabilidad entre estudios.
Conclusiones: La actividad física se relaciona positivamente con la competencia motora en niños preescolares, especialmente en locomoción y control de objetos. La evidencia sobre el comportamiento sedentario y el sueño es limitada. Los factores parentales y escolares influyen en el desarrollo motor. Las investigaciones futuras deben adoptar métodos estandarizados y culturalmente apropiados en regiones subrepresentadas como el Sudeste Asiático y Malasia.

Palabras clave

Actividad física; comportamiento sedentario; comportamientos de movimiento de 24 horas; desarrollo motor; niños en edad preescolar.

Introduction

Early childhood represents a critical period of rapid growth and skill acquisition, during which daily movement behaviours play an essential role in shaping developmental outcomes (Grady et al., 2025). Increasingly, research has adopted the 24-hour movement paradigm, which conceptualises physical activity, sedentary behaviour, and sleep as interrelated components influencing children's physical, cognitive, and psychosocial development (World Health Organization, 2019). Within this integrated framework, motor development, encompassing both gross and fine motor skills, is considered a foundational domain that supports long-term physical competence, readiness for formal learning, and social participation. Evidence suggests that greater engagement in physical activity has been associated with higher motor competence and coordination, whereas prolonged sedentary behaviour, particularly screen-based engagement, may be associated with limited opportunities for motor skill development (Bakht et al., 2025; Carson et al., 2016; Tremblay et al., 2017). These findings are consistent with research highlighting the important role of physical activity in supporting motor competence and fundamental movement skills during early childhood (Ruiz-Pérez & Palomo-Nieto, 2022). Sleep also contributes to motor learning through processes related to neural consolidation and physiological recovery (Filho et al., 2025). Despite growing interest in these associations, the existing literature remains methodologically heterogeneous and dispersed across different research designs and measurement approaches, highlighting the need for a clearer synthesis of current evidence (Klotzbier & Schott, 2025). In addition, the rapid expansion of research following the adoption of integrated 24-hour movement guidelines in early childhood has resulted in a growing body of recent evidence that warrants focused synthesis.

Notably, much of the most recent empirical work has emerged within the past few years, reflecting evolving measurement approaches and renewed theoretical interest in integrated movement behaviours. The adoption of the 24-hour movement framework has shifted research from examining behaviours in isolation toward understanding their combined and interactive influence on child development (Swindell et al., 2025). Previous studies indicate that physical activity, sedentary behaviour, and sleep may contribute differently to motor competence, yet findings remain inconsistent due to variations in assessment tools, study populations, and analytical approaches (Adolph & Hoch, 2019; Altenburg et al., 2024). While several reviews have explored aspects of movement behaviours in early childhood, most have focused on single behavioural domains or broader health outcomes rather than providing a comprehensive mapping of how integrated 24-hour movement behaviours relate specifically to motor development in preschool-aged children. Notably, no prior review has comprehensively examined the integrated relationship between all three 24-hour movement behaviours — physical activity, sedentary behaviour, and sleep — and motor development specifically in preschool-aged children. Physical activity, sedentary behaviour, and sleep are co-dependent components constrained within a finite 24-hour period; an increase in one behaviour necessarily displaces the others, making their integrated examination essential for understanding child development outcomes. Consequently, a structured synthesis that captures methodological trends, conceptual patterns, and emerging gaps within this focused population remains limited.

A scoping review is particularly appropriate given the heterogeneity of the available evidence and the exploratory aim of mapping the extent and nature of existing research. Unlike previous reviews that primarily emphasised physical activity or examined broader developmental outcomes, the present review concentrates specifically on preschool-aged children and integrates all three components of the 24-hour movement cycle within a single conceptual framework. By synthesising recent empirical evidence, this review aims to clarify how different movement behaviours are measured, how they relate to motor development outcomes, and where methodological and conceptual gaps persist within the literature.

Therefore, this scoping review aims to map existing evidence and identify research gaps regarding the relationship between 24-hour movement behaviours and motor development among preschool-aged children.

Method

This study employed a scoping review methodology to systematically map the breadth and characteristics of research examining the relationship between 24-hour movement behaviours and motor development among preschool-aged children. Scoping reviews are particularly suited for emerging and conceptually complex fields where the aim is to explore the extent, range, and nature of existing evidence rather than to evaluate intervention effectiveness or produce pooled effect estimates (Arksey & O'Malley, 2005; Tricco et al., 2018). Unlike systematic reviews, which typically include formal critical appraisal and narrowly focused research questions, the present study adopted an exploratory mapping approach to identify research patterns, measurement strategies, and conceptual gaps within recent literature. The review followed the six-stage framework proposed by Arksey and O'Malley (2005) and was reported in accordance with the PRISMA-ScR guidelines to enhance transparency and methodological clarity. A formal protocol was not registered; however, established scoping review methodological guidance was followed to ensure transparency and methodological rigour.

Step (1): Identifying the Research Questions

The review was guided by three research questions

1. What types of evidence exist regarding the relationship between 24-hour movement behaviours (physical activity, sedentary behaviour, and sleep) and motor development among preschool-aged children?
2. How have previous studies measured and reported associations between each movement behaviour and different domains of motor development?
3. What methodological patterns and research gaps emerge within this body of literature?

These questions defined the conceptual scope of the review and informed subsequent methodological decisions.

Step (2): Identifying Relevant Studies

A structured search strategy was conducted across two multidisciplinary databases, Scopus and Web of Science. The final database search was conducted on 4th December 2025. The search focused on studies published between 2023 and 2025, with the temporal scope intentionally restricted to capture contemporary evidence emerging following the widespread adoption of integrated 24-hour movement behaviour frameworks and recent methodological developments in early childhood movement research. This decision reflects the rapid expansion of empirical studies adopting integrated movement paradigms and updated measurement approaches in recent years. Earlier foundational evidence has been synthesised in previous reviews; therefore, the present scoping review prioritises recent research to identify current trends, methodological advancements, and emerging directions within the field. Search terms were developed from three core concepts—movement behaviours, motor development, and preschool populations—and included keywords such as "24-hour movement behaviours," "physical activity," "sedentary behaviour," "sleep," "motor development," and "preschool children," combined using Boolean operators (AND/O).

Step (3): Selecting Eligible Studies

All records retrieved from the database searches were exported and organised prior to screening, and eligibility was determined through a structured multi-stage selection process. Duplicate entries were removed before titles and abstracts were independently screened by two reviewers against predefined inclusion criteria, followed by full-text assessment of potentially relevant articles, with discrepancies resolved through discussion until consensus was achieved to minimise selection bias. Studies were included if they involved preschool-aged children, typically within the 3–4-year age range or the broader preschool category as defined by the original studies, examined at least one component of the 24-hour movement behaviour framework, and reported measurable motor development outcomes, including gross motor skills, fine motor skills, or composite motor competence, with only empirical studies published in peer-reviewed journals retained for synthesis. Studies were excluded if they focused primarily on non-preschool populations, lacked quantifiable motor development indicators, or represented non-

empirical publications such as editorials or commentaries. The complete study selection pathway is illustrated in the PRISMA-ScR flow diagram.

Step (4): Charting the Data

Data from included studies were extracted using a structured charting framework developed in Microsoft Excel. Extracted variables included author, year of publication, study design, sample characteristics, movement behaviour components assessed, motor development outcomes, measurement instruments, and key findings. The charting process was iterative, allowing refinement of categories as familiarity with the literature increased and patterns emerged across studies, thereby facilitating consistent comparison and thematic organisation.

Step (5): Collating, Summarising, and Reporting the Evidence

A descriptive-analytical synthesis was conducted to map relationships between movement behaviours and motor development outcomes. Rather than evaluating methodological quality, the synthesis focused on identifying cross-study patterns, differences in measurement approaches, and trends across study designs. Findings were organised thematically according to movement behaviour components to align with the research questions and support a structured narrative. No formal methodological quality appraisal was conducted, consistent with the objectives of scoping review methodology.

Step (6): Discussing the Findings

The final stage involved interpreting the mapped evidence within the broader context of early childhood development research. Particular attention was given to identifying methodological gaps, such as the predominance of cross-sectional designs, heterogeneity in assessment tools, and the limited representation of sleep-related research. The temporal scope of the review was recognised as a deliberate focus on contemporary research developments, enabling identification of current methodological trends while acknowledging that earlier foundational studies were not included. These insights informed the discussion of future research directions and practical implications.

Results

A comprehensive search of the Web of Science and Scopus databases initially yielded 1,250 records aligned with the objectives of this scoping review. In the initial identification phase, records that failed to meet the preliminary eligibility criteria were excluded. These included systematic reviews, meta-analyses, book series, non-English publications, studies published outside the 2023 to 2025 timeframe, and articles unrelated to the social sciences, movement behaviours, or early childhood populations. This screening process resulted in the exclusion of 245 records.This left 209 records for the screening stage, where 171 duplicates were detected and eliminated. Consequently, 38 full-text articles were retrieved for detailed evaluation.

Across the included studies, most employed cross-sectional designs, with a smaller number adopting longitudinal or intervention-based approaches. Physical activity emerged as the most frequently examined component of the 24-hour movement behaviour framework, whereas sedentary behaviour and sleep were comparatively underrepresented. This distribution suggests that current research remains unevenly focused, with limited attention given to the integrated and co-dependent nature of movement behaviours within a 24-hour cycle. Across the reviewed studies, most evidence (n = 17) indicates that higher levels of physical activity are associated with improved motor competence, particularly in locomotor and object-control skills. This pattern was consistently observed across diverse contexts, suggesting that active engagement plays a fundamental role in motor skill development during early childhood. This indicates a need for more longitudinal and intervention-based research.

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higher levels of physical activity are associated with improved motor competence, particularly in locomotor and object-control skills. This pattern was consistently observed across diverse contexts, suggesting that active engagement plays a fundamental role in motor skill development during early childhood.

However, findings related to sedentary behaviour were inconsistent. While some studies reported negative associations between screen-based sedentary time and motor development, others found no significant relationship. These inconsistencies may be attributed to differences in measurement approaches, types of sedentary activities assessed, and variations in study design. Sleep was examined less frequently, and the available evidence remains limited and inconclusive. A small number of studies suggested that sleep quality may be associated with aspects of fine motor development, particularly among children experiencing sleep-related difficulties. However, the lack of consistent findings highlights a significant gap in the literature and underscores the need for further investigation.

Differences across studies were partly attributable to variations in measurement instruments, including the TGMD-2, TGMD-3, and BOT-2, as well as differences in demographic characteristics and environmental contexts. Additionally, variations in study design, particularly the predominance of cross-sectional approaches, limit the ability to draw consistent conclusions regarding causal relationships. These methodological differences contribute to inconsistencies in reported findings and highlight the complexity of interpreting relationships within the integrated 24-hour movement behaviour framework.

The synthesis identified six overarching thematic categories: (1) family and environmental influences, (2) psychosocial and emotional factors, (3) cognitive outcomes, (4) demographic and individual differences, (5) instructional and pedagogical influences, and (6) assessment and measurement approaches. Across these themes, evidence suggests that motor development is influenced not only by movement behaviours but also by a range of contextual, psychological, and environmental factors. Family involvement, school environments, and broader societal conditions were consistently identified as important influences shaping children's movement opportunities and developmental outcomes. In addition, psychosocial and cognitive factors appear to interact with motor competence, indicating that motor development is embedded within a broader developmental system.

Figure 1. Flow diagram of research selection process using Preferred Reporting Items for Systematic Reviews (PRISMA-ScR) (Tricco et al., 2018) (Tricco et al., 2018)

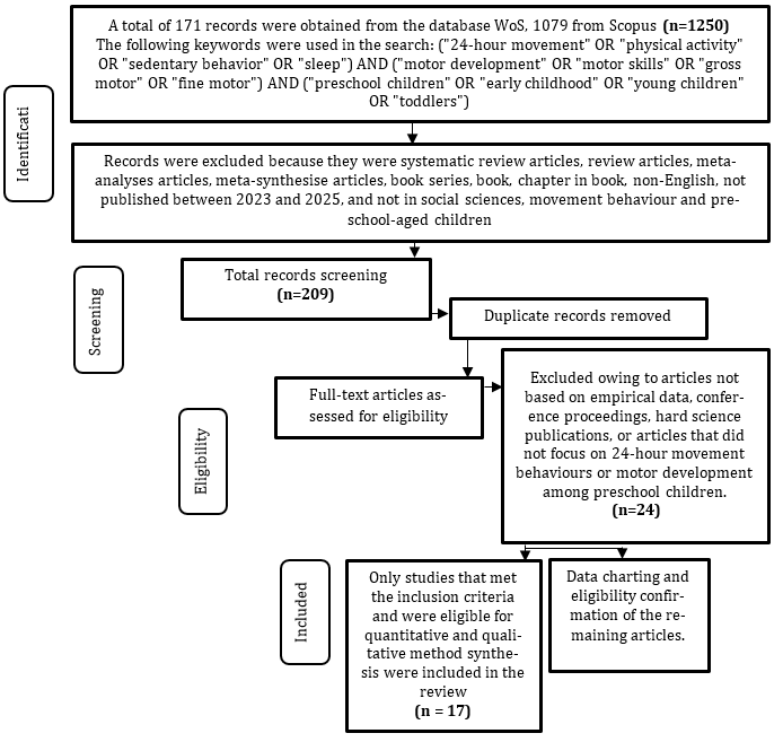

Table 1 provides an overview of the seventeen empirical studies included in this scoping review, organised according to the objective of exploring the relationships between 24-hour movement behaviours and motor development among preschool-aged children. Across the body of evidence, physical activity was most frequently associated with positive motor competence outcomes across the included studies, particularly in relation to locomotor and object-control skills. In contrast, sedentary behaviour demonstrates inconsistent associations and is frequently influenced by demographic characteristics such as gender, BMI, and socio-economic background. Sleep, although examined less extensively, appears to play a meaningful role in fine motor development, particularly among children with sleep-related difficulties

The decision to include only studies published between 2023 and 2025 was made to ensure that the synthesis reflects the most recent empirical advancements. This period captures contemporary movement trends in early childhood, post-pandemic behavioural changes, and improvements in measurement techniques. It also corresponds with heightened global interest in the 24-hour movement paradigm, meaning that studies conducted within this timeframe are more likely to align with current methodological standards and theoretical frameworks. Focusing on the latest evidence reduces the risk of conceptual discrepancies associated with older models and strengthens the relevance of the review's conclusions for present-day early childhood settings.

Findings across the included studies also show that motor development is shaped by a broader set of contextual and psychosocial influences. Parental attitudes, school environments, and conditions arising from the COVID-19 pandemic all affect children's movement opportunities. Psychosocial attributes such as coping abilities, self-concept, and other non-cognitive traits interact with motor competence, suggesting that motor skills contribute to emotional, behavioral, and social functioning. Cognitive domains like memory and visual perception also show reciprocal associations with motor ability. Notably, variability in assessment instruments, including the TGMD-2, TGMD-3, and BOT-2, underscores ongoing inconsistencies in how motor competence is classified and measured across studies.

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Table 1. Charting the data

Author/Year	Variables	Impact	Sub-Theme	Theme
Padli et al. (2025)(Padli et al., 2025)	IV: Parental involvement DV: Motor development	Parents recognise benefits but prioritise academics; need for education.	Parental perceptions	Family & Environmental Influences
Quenzer-Alfred (2025)(Quenzer-Alfred, 2025)	IV: COVID-19 restrictions DV: Motor performance	Pandemic caused motor decline; partial improvement post-transition.	Pandemic effects	
Campos-Campos et al. (2024)(Campos-Campos et al., 2024)	IV:BMI DV: Locomotion skills	Negative BMI–locomotion relationship; normal-weight children perform better.	BMI and locomotion	
Nobre et al. (2023) (Nobre et al., 2023)	IV:BMI, school environment, cognition DV: Motor competence	BMI, cognition, environment predict motor skills.	Environmental & individual factors	
Silva & Pereira (2025) (Silva & Pereira, 2025)	IV: Motor development DV: Entrepreneurial traits	Better motor skills linked to adaptive entrepreneurial traits.	Motor & life skills	Psychosocial & Emotional Factors
Hannah et al. (2025) (Hannah et al., 2025)	IV: Low motor competency DV: Coping behaviours	Children struggle with coping and motor skill development.	Coping challenges	

Galán-Arroyo et al. (2024)(Galán-Arroyo et al., 2024)	IV: Physical fitness DV: Self-concept	Physical fitness strongly correlates with self-concept.	Self-concept and fitness	
Paéz-Herrera et al. (2024) (Páez-Herrera et al., 2024)	IV: PA levels Moderator: Motor development DV: Visual perception/memory	Motor competence enhances PA–cognition relationship.	Motor competence moderation	Cognitive Outcomes
Katanic et al. (2025) (Katanić et al., 2025)	IV: Motor abilities DV: Cognitive abilities	Motor abilities linked to cognition; movement skills not significant.	Motor–cognition link	
Lee et al. (2023) (Lee et al., 2023)	IV: Demographics, weight, motor ability DV: PA & SB patterns	Clear disparities in MVPA and sedentary behaviour.	Movement disparities	Socio-Demographic & Individual Differences
Deliceoğlu et al. (2025) (Deliceoğlu et al., 2025)	IV: Motor skills programme; gender DV: Motor skills & sensory integration	Programme not impactful; clear gender differences.	Gender differences	
Kavalci & Kalkavan (2023) (Kavalci & Kalkavan, 2023)	IV: Gender, age, school type DV: Motor skills	Motor skills differ by demographic factors.	Developmental variation	
Kiram et al. (2025) (Kiram et al., 2025)	IV: TACSSPORT e-module DV: Motor skills	E-module improves motor skills; innovative tool.	Digital interventions	Instructional & Pedagogical Influences
Geirnaert et al. (2025) (Geirnaert et al., 2025)	IV: Teacher beliefs/curricula DV: Integration of motor development	Misconceptions hinder systematic curricular inclusion.	Teacher understanding	
Barros et al. (2022) (Barros et al., 2022)	IV: School-time PA DV: FMS	MVPA linked with object control in PE group.	School PA	
Palmer et al. (Palmer et al., 2025)	IV: TGMD-2 vs TGMD-3 DV: Motor skill classification	Moderate agreement; TGMD-3 more lenient in classifying average skills.	Motor skill classification	Assessment & screening

Background of the Research Included In the Review

The studies included in this review were conducted across a wide range of geographical, cultural, and educational contexts, reflecting the growing global interest in understanding the relationship between 24-hour movement behaviours and motor development among preschool-aged children. The included research employed diverse methodological designs and utilised contemporary assessment instruments to evaluate movement behaviours and motor competence. This diversity of settings and approaches provides important contextual insight into how movement-related behaviours are examined across different populations and research environments.

Figure 2 presents the geographic distribution of the seventeen studies examined in this review. The research spans eleven countries, with the United States contributing the largest number of studies (n = 3). Indonesia, Brazil, Turkey, and Chile each contributed two studies, while Serbia, Portugal, Germany, Belgium, Australia, and Spain each contributed one. This international spread highlights the growing global interest in understanding how 24-hour movement behaviours relate to motor development among preschool-aged children, reflecting attention across multiple continents and diverse sociocultural contexts.

Figure 2. Number of research based on countries

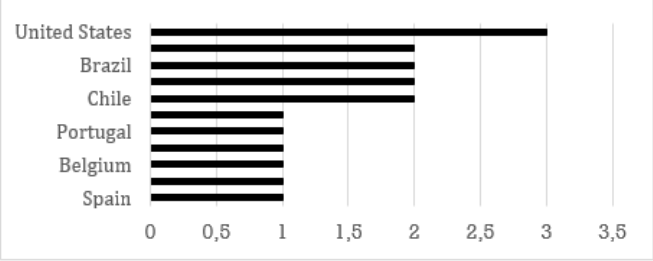

Figure 3 illustrates the distribution of publication years for the 17 studies included in this scoping review. Most of the studies were published in 2025 (n = 11), signalling a notable increase in scholarly attention toward understanding how 24-hour movement behaviours relate to motor development in preschool-aged children. A smaller proportion of studies appeared in 2024 (n = 3) and 2023 (n = 3).

This pattern indicates that research examining physical activity, sedentary behaviour, and sleep as integrated components of the 24-hour movement framework has gained substantial momentum in the most recent year, highlighting the field's rapid growth and contemporary relevance.

Figure 3. Year of publication in Wos and Scopus database

As shown in Table 1, most studies examining physical activity and motor competence relied on cross-sectional designs, whereas studies focusing on sleep and sedentary behaviour were fewer and more heterogeneous. This imbalance in the evidence base may contribute to the observed inconsistencies and highlights the need for more comprehensive and longitudinal research approaches.

Discussion

The findings of this scoping review provide a comprehensive mapping of contemporary evidence examining how the integrated spectrum of 24-hour movement behaviours relates to motor development during the preschool years. While physical activity emerged as the most frequently reported behaviour associated with motor competence, particularly in locomotor and object-control skills, this pattern should be interpreted in the context of methodological dominance rather than definitive evidence of causal strength. The predominance of cross-sectional designs across the included studies limits the ability to establish directional relationships, suggesting that physical activity appears more consistently reported rather than conclusively more influential.

In contrast, findings related to sedentary behaviour remain inconsistent, with some studies indicating negative associations with motor development and others reporting no significant relationships. These inconsistencies may reflect differences in how sedentary behaviour is operationalised, particularly the distinction between passive screen time and cognitively engaging sedentary activities. Additionally, variations in study design and contextual factors, such as home environment and parental regulation, may further contribute to divergent findings.

Similarly, the limited and heterogeneous evidence regarding sleep highlights a significant gap in the literature. Although some studies suggest that sleep quality may influence fine motor development, the lack of consistent findings indicates that sleep remains underexplored within the integrated 24-hour movement behaviour framework. This gap is particularly important given that sleep interacts with both physical activity and sedentary behaviour within a constrained daily time structure.

From a theoretical perspective, these findings align with ecological and dynamic systems frameworks, which conceptualise motor development as emerging from complex interactions between individual, environmental, and behavioural factors. The observed influence of family context, school environment, and psychosocial characteristics supports the notion that motor development cannot be understood through isolated behavioural components. Instead, it reflects a dynamic interplay between movement behaviours and broader developmental systems.

Importantly, the persistence of fragmented research approaches, in which movement behaviours are frequently examined independently, highlights a critical limitation in the current evidence base. This fragmentation may partially explain the inconsistencies observed across studies and underscores the need for more integrative research designs that capture the co-dependent nature of behaviours within

a 24-hour cycle. Although no included studies were conducted in Malaysia, the international evidence provides relevant insights for comparable early childhood contexts. Variations in access to play spaces, educational practices, and sociocultural norms may influence children's movement opportunities and developmental outcomes. These findings emphasise the importance of developing contextually responsive strategies, including teacher training, family engagement, and the design of movement-supportive learning environments.

Overall, this scoping review contributes by mapping existing evidence, identifying key patterns and inconsistencies, and highlighting significant gaps in the literature. Future research should prioritise longitudinal and theory-driven approaches, as well as the use of standardised measurement tools, to better understand how integrated movement behaviours influence motor development across diverse populations.

Table 2. Thematic Mapping of Movement Behaviours and Motor Development

Category	Independent Variables	Mediating / Moderating Variables	Dependent Variables
Behavioural Factors	Physical activity (MVPA, LPA) [3,4,7,8,12,17] Sedentary behaviour [11,15] Sleep duration/quality [9]	Cognitive functioning [2,6,8] Psychosocial factors [5,7] Environmental exposure (PE classes, settings) [10,13]	Motor competence [1–17] Locomotor skills [1,3,4,10] Object control skills [4,10] Fine motor coordination [9]
Developmental Outcomes	Motor interventions, e-modules [7] Structured PE participation [10]	Motor development as mediator [12,14]	Improved motor skills [1–17] Cognitive readiness [2,6] Academic-related behaviours [3]
Contextual Enablers	Parental involvement [1] Teacher knowledge [6] Play space availability [11]	Curriculum design [6] School infrastructure [11,13]	Increased PA opportunities [3,4,10] Reduced sedentary time [11] Supportive environments [6,13]

Limitation and Recommendations

This scoping review offers a comprehensive perspective on existing studies examining the relationship between motor development in preschoolers and the 24-hour movement framework, which comprises physical activity, sedentary behavior, and sleep.The evidence consistently shows that physical activity plays a central role in strengthening motor competence, while research on sedentary behaviour and sleep remains comparatively limited and fragmented. The studies reviewed also vary widely in methodological design and theoretical grounding, indicating the need for more coherent and comprehensive research frameworks.

The synthesis further highlights the influence of contextual factors such as parental attitudes, preschool environments, and teaching practices, all of which shape children's movement opportunities and the development of motor skills. These findings reinforce the importance of adopting a holistic developmental lens, recognising that children's daily behaviours do not operate in isolation but interact to influence motor outcomes. The review highlights significant literature gaps and stresses the importance of conducting methodologically rigorous research that is regionally grounded, with a particular focus on Southeast Asia. It also suggests that integrated 24-hour movement frameworks offer a promising path for supporting healthy motor development in young children.

Looking ahead, future research should expand beyond the predominant focus on physical activity to give equal attention to sedentary behaviour and sleep. Despite their potential impact on motor development, these components remain understudied. There is a clear need to examine how factors such as screen exposure, restricted movement opportunities within preschool settings, and inadequate sleep duration contribute to variations in motor competence and broader developmental patterns. Additionally, the heavy reliance on cross-sectional research designs limits insights into causality. Longitudinal and experimental studies are therefore essential to clarify developmental mechanisms and evaluate the effectiveness of interventions that aim to optimise movement behaviours.

Research must incorporate greater cultural and contextual diversity, including samples from Southeast Asia and Malaysia, to accurately represent the unique environments and daily routines that shape how children remain active. Standardisation of motor assessment tools is equally important, as inconsistencies across measures pose challenges for comparing findings. Importantly, future research would bene-

fit from adopting integrated theoretical models that connect movement behaviours with motor, cognitive, and psychosocial development, providing more holistic and ecologically valid explanations of early childhood development.

Implications

This scoping review provides a comprehensive examination of the complex links between 24-hour movement behaviours and early motor development, offering a synthesis that is both theoretically grounded and empirically robust. By integrating findings from diverse disciplines, the review clarifies how physical activity, sedentary routines, and sleep patterns each contribute to variations in motor competence among preschool children. The evidence supports fundamental developmental theories such as ecological, dynamic systems, and embodied cognition perspectives. At the same time, it highlights significant omissions in the current literature, specifically the lack of integration regarding sleep and sedentary behavior within established developmental models. These omissions highlight the need for more sophisticated research approaches, including harmonised measurement protocols, advanced analytical techniques, and longitudinal studies capable of tracing developmental pathways over time. Collectively, the review establishes a stronger conceptual foundation for future scholarship, encouraging deeper theoretical integration and greater methodological refinement to more accurately capture the dynamic processes shaping motor development in early childhood.

In the Malaysian context, the insights generated hold substantial policy and practical relevance. Rising sedentary behaviours, increased digital screen exposure, and variability in preschool infrastructure across KEMAS, PERPADUAN, private, and religious preschools suggest an urgent need for system-wide attention to children's movement patterns. The findings reinforce the importance of embedding the WHO 24-Hour Movement Guidelines within the Malaysian Preschool Standard Curriculum (KSPK) to ensure balanced attention to physical activity, reduced sedentary time, and healthy sleep practices. To support consistent developmental opportunities across diverse preschool settings, it is essential to equitably invest in early childhood facilities such as safe playgrounds, open movement areas, and structured motor skill programmes.

Strengthening educator capacity is equally crucial. Nationwide training in motor development assessment tools (e.g., TGMD-3, BOT-2) and in movement-focused pedagogical strategies would elevate teaching quality and improve early identification of motor delays. Parent education initiatives should also be prioritised to address widespread misconceptions that privilege academic tasks over play-based, movement-rich learning. Finally, Malaysia would benefit from establishing a national research agenda centred on 24-hour movement behaviours and child development, enabling culturally relevant, evidence-based policymaking and ensuring that early childhood interventions are responsive to local needs and developmental priorities.

Conclusions

This review brings together contemporary research to examine how a full day's movement behaviors, including physical activity, sedentary time, and sleep, contribute to the motor development of children of preschool age. The evidence consistently indicates that physical activity plays a central role in enhancing motor competence, whereas sedentary behaviour and sleep remain comparatively understudied despite their recognised importance within the 24-hour movement framework. The wide variation in study designs, measurement tools, and theoretical approaches further demonstrates the need for more cohesive, conceptually grounded research.

The review also highlights the crucial influence of contextual factors such as parental attitudes, teacher practices, and preschool environments, all of which shape children's opportunities for movement and skill acquisition. At the same time, the limited representation of studies from Southeast Asia particularly Malaysia and reveals a substantial gap in region-specific evidence. Collectively, these insights point to the urgency of conducting more rigorous, longitudinal, and culturally informed research to better understand how daily behavioural patterns influence early motor development. Strengthening the empirical foundation in this area is vital for informing early childhood policies, educational practices, and targeted interventions aimed at supporting healthier developmental outcomes.

Acknowledgements

The authors would like to express their sincere gratitude to Universiti Kebangsaan Malaysia (UKM) for the institutional support provided throughout the conduct of this study. Special appreciation is extended to the Faculty of Education, UKM, for the academic guidance and resources that facilitated the completion of this scoping review. The authors also wish to thank all researchers and scholars whose published works contributed to the body of evidence synthesised in this review.

Financing

This work was funded by a research grant (GUP-2024-038) from Universiti Kebangsaan Malaysia.

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