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The Built Environment and Outdoor Physical Activity in Middle Childhood: A Narrative Review and Implications for Child-Friendly Neighbourhood Design

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ABSTRACT

Middle childhood represents a critical developmental period during which children progressively develop independent mobility, social competence, environmental awareness, and physical activity habits. Outdoor physical activity is influenced not only by individual and interpersonal characteristics but also by the spatial and environmental conditions of children's everyday surroundings. Although numerous studies have examined associations between built-environment characteristics and children's physical activity, existing evidence remains distributed across multiple environmental dimensions, age groups, and disciplinary perspectives. Consequently, the implications of these findings for child-friendly neighbourhood design remain insufficiently integrated. This narrative review aims to synthesise existing evidence concerning the relationship between built-environment characteristics and outdoor physical activity during middle childhood, identify the principal environmental dimensions associated with activity opportunities, and develop an integrated perspective to inform child-friendly neighbourhood and outdoor environment design. A narrative literature review incorporating a structured search approach was adopted. Relevant literature was identified through Scopus, Web of Science, and Google Scholar using combinations of keywords relating to middle childhood, physical activity, built environments, neighbourhood characteristics, and outdoor spaces. The literature was organised through thematic synthesis, with particular attention to environmental characteristics, reported associations with physical activity, and implications for spatial design. Five interrelated environmental dimensions were identified: (1) accessibility and proximity, (2) street connectivity and walk ability, (3) traffic and perceived safety, (4) green and open spaces, and (5) recreational facilities and activity opportunities. The synthesis suggests that environmental support for children's outdoor physical activity cannot be adequately understood through individual spatial attributes alone. Rather, the accessibility, perceived safety, usability, and activity affordances of neighbourhood environments may operate together to shape opportunities for outdoor participation. Furthermore, the availability of outdoor spaces does not necessarily ensure their accessibility, usability, or actual utilisation. This review proposes an integrated, five-dimensional perspective for understanding the built environment as a neighbourhood-scale system supporting outdoor physical activity during middle childhood. Its principal contribution lies in translating fragmented environment–activity evidence into a conceptual structure relevant to child-friendly spatial design. Future research should examine interactions among environmental dimensions and investigate how objectively measured spatial characteristics, children's environmental perceptions, and observed activity behaviours jointly explain outdoor physical activity.

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Key Words

Built environment, Middle childhood, Outdoor physical activity, Child-friendly neighbourhood, Environmental affordances, Urban design, Walk ability

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INTRODUCTION

Middle Childhood and Outdoor Physical Activity: Middle childhood constitutes an important developmental period characterized by substantial changes in children's physical capabilities, cognitive development, social relationships, and independence. Developmental literature commonly distinguishes early childhood from middle childhood, although the precise age boundaries vary across theoretical perspectives and institutional definitions[1]. Piaget and DelGiudice[2-3] discuss developmental processes relevant to children approximately 6–11 years of age. Similarly, the Centers for Disease Control and Prevention distinguishes developmental characteristics of children aged 6–8 years and 9–11 years[4]. During this period, children progressively acquire greater independence in everyday activities, develop more complex peer relationships, and demonstrate increasing awareness of their social and physical surroundings. Children aged 9–11years, in particular, tend to exhibit greater autonomy, stronger peer-group identification, and more advanced cognitive and emotional capabilities. These developmental changes have important implications for children's interactions with outdoor environments. As children become increasingly capable of exploring neighborhood spaces, their opportunities for outdoor physical activity may extend beyond adult-supervised recreational settings to include streets, pedestrian routes, neighborhood open spaces, and other accessible environments.

Physical activity is generally defined as bodily movement produced by skeletal muscles that require energy expenditure[5]. Within this broad definition, outdoor physical activity encompasses multiple forms of movement, including walking, cycling, recreational exercise, and active play .Active play represents a particularly relevant form of physical activity during childhood. Tremblay[6] characterize active play as a form of intrinsically motivated, relatively unstructured activity that may involve moderate-to-vigorous physical exertion without necessarily following externally imposed rules.Unlike organized sports, outdoor activity may occur spontaneously within children's everyday environments. Its occurrence is therefore closely connected to the availability and characteristics of neighborhood spaces. However, existing physical activity research frequently combines children and adolescents across broad age ranges, commonly extending from approximately 5–17 years. Such approaches provide valuable evidence concerning physical activity patterns but may obscure developmental differences between younger children, children in middle childhood, and adolescents. In particular, children in middle childhood occupy a transitional position between relatively dependent early childhood and increasingly autonomous adolescence. Their outdoor activities may therefore be especially sensitive to the interaction between environmental accessibility, parental restrictions, perceived safety, and opportunities for independent movement. A more focused synthesis of the built environment and outdoor physical activity during middle childhood is consequently warranted.

Built Environment as a Context for Children's Physical Activity: Children's physical activity does not occur independently of its spatial context. Rather, movement, recreation, and active play take place within environments that provide different opportunities, constraints, and experiences.

The built environment encompasses the human-made physical characteristics of everyday surroundings, including residential neighborhoods, streets, pedestrian infrastructure, public spaces, recreational facilities, and the spatial organization of communities. Previous studies indicate that children's physical activity occurs across multiple environmental settings, including homes, schools, recreational areas, and neighborhood spaces. Cain[7] reported that children's and adolescents' physical activity varied across everyday settings, with outdoor environments providing important opportunities for moderate-to-vigorous physical activity. Similarly, Kelso[8] identified buildings, streets, and sidewalks as important locations in which children and adolescents accumulated physical activity, indicating that everyday urban spaces may contribute substantially to activity opportunities beyond formal parks and recreational areas. Research examining spatial characteristics of children's and adolescents' activity locations has further demonstrated that physical activity may occur during movement through streets, neighborhood facilities, non-green urban spaces, and green environments[9]. Collectively, these findings suggest that neighborhood environments should not be understood merely as routes connecting residential areas to recreational destinations. Instead, streets, sidewalks, and other everyday spaces may themselves function as locations for physical activity.

The environmental characteristics of these spaces may influence children's activity through several pathways. First, physical characteristics may directly determine whether particular movements are possible. For example, continuous pedestrian routes can provide opportunities for walking, while unobstructed open spaces may accommodate running and active play. Second, environmental conditions may influence children's perceptions and experiences. Street appearance, spatial enclosure, vegetation, and environmental quality may affect how children and their care givers evaluate outdoor environments. Third, neighborhood characteristics may shape opportunities

for social interaction. Spaces that support informal encounters, peer interaction, and collective play may provide additional reasons for children to spend time outdoors. Previous studies have identified associations between children's physical activity and various environmental characteristics, including pedestrian infrastructure, street accessibility, neighborhood design, and land-use characteristics[10-11-12-13-14]. Thorleifsdottir[15] also highlighted the relevance of neighborhood environmental diversity to children's activity opportunities. Nevertheless, the available evidence remains distributed across numerous environmental variables and research traditions. This fragmentation creates difficulties when attempting to translate individual empirical findings into coherent principles for child-friendly neighborhood design.

Research Gaps: Three interrelated research gaps motivate the present review.

Limited Developmental Specificity: A substantial proportion of research examining physical activity and the built environment considers broad populations of children and adolescents. Although this approach enables comparisons across age groups, it may overlook environmental relationships specific to middle childhood. Children in this developmental period experience increasing independence while remaining subject to parental supervision and restrictions. Consequently, built-environment characteristics that influence adolescent mobility may not operate in the same manner among children aged approximately 6–11years. The first research gap therefore concerns the need to interpret existing evidence specifically in relation to middle childhood.

Fragmentation of Environmental Characteristics: Previous studies have examined numerous built-environment characteristics, including accessibility, street connectivity, pedestrian infrastructure, traffic conditions, green spaces, recreational facilities, and neighborhood safety. However, these characteristics are frequently investigated as separate explanatory variables. Such an approach may identify associations between particular environmental attributes and physical activity but provides a limited understanding of how multiple environmental conditions collectively shape children's opportunities for outdoor activity. For example, the presence of a neighborhood playground may be insufficient to encourage physical activity when pedestrian access is poor or surrounding traffic conditions create safety concerns. Similarly, highly connected street networks may support walking but may not necessarily provide suitable spaces for informal outdoor play. An integrated interpretation is therefore needed to distinguish the contributions of individual environmental dimensions while considering their potential interactions.

Insufficient Translation into Environmental Design: Research examining the built environment and physical activity has frequently been framed around public health outcomes, physical activity levels, and behavioral correlates. Although these perspectives are valuable, their findings do not automatically translate into actionable recommendations for environmental designers. From a spatial design perspective, it is necessary to determine not only whether environmental characteristics are associated with physical activity, but also how those characteristics can inform neighborhood organization, pedestrian environments, public open spaces, and recreational opportunities. Accordingly, the third research gap concerns the limited integration of existing evidence into a coherent design-oriented understanding of child-friendly neighborhood environments.

Research Aim and Questions: The aim of this study is to synthesize existing literature concerning relationships between built-environment characteristics and outdoor physical activity during middle childhood and to examine the implications of these relationships for child-friendly neighborhood design. The review addresses two research questions:

- RQ1: What built-environment characteristics have been associated with outdoor physical activity among children in middle childhood?
- RQ2: What implications can be derived from existing evidence for child-friendly neighborhood and outdoor environment design?
- The corresponding research objectives are:
- RO1: To identify and synthesize the principal built-environment characteristics associated with children's outdoor physical activity.
- RO2: To interpret the existing evidence from an environmental design perspective and propose an integrated conceptual structure for child-friendly neighborhood environments.

Research Contribution: The contribution of this review is threefold. First, it foregrounds middle childhood as a developmentally meaningful period for understanding relationships between the built environment and outdoor physical activity. Second, it organizes fragmented environmental evidence into five interrelated dimensions: accessibility and proximity, street connectivity and walk ability, traffic and perceived safety, green and open spaces, and recreational facilities and activity opportunities. Third,

it develops a design-oriented interpretation of these dimensions, emphasizing the distinction between environmental availability, accessibility, usability, and actual utilization. Rather than treating individual environmental characteristics as independent determinants of physical activity, the review conceptualizes the neighborhood as an interconnected spatial system in which multiple environmental conditions may jointly support or constrain children's outdoor activity opportunities.

MATERIALS AND METHODS

Research Design: This study employed a narrative literature review incorporating a structured literature search and thematic synthesis. A narrative review was considered appropriate because the research aimed to integrate findings from studies examining heterogeneous environmental characteristics, activity behaviors, developmental groups, and methodological approaches. Unlike a meta-analysis, which generally requires sufficiently comparable quantitative outcomes, the present review sought to identify recurring environmental themes, interpret relationships across different research contexts, and examine their implications for spatial design. The review therefore focused on qualitative integration of published findings rather than statistical aggregation of effect sizes. The methodological approach comprised three principal activities: identification of relevant literature, thematic organization of environmental characteristics, and interpretative synthesis of findings.

Literature Search Strategy: Relevant literature was identified through academic searches conducted using Scopus, Web of Science, and Google Scholar. Search terms were selected to reflect the three principal components of the research topic: the target population, physical activity behaviors, and built-environment characteristics. Population-related terms included “middle childhood” and “children friendly”.Physical activity terms included “physical activity”,“physical activity behavior”, and “outdoor activity”.Environmental terms included “built environment”, “environmental features”,“community”,“neighborhood”, and “outdoor space”.The term “influencing factors” was additionally used to identify studies examining potential correlates of physical activity. These terms were combined to identify literature addressing relationships between children's physical activity and environmental conditions. The searches also considered studies involving broader populations of children and adolescents where the findings provided relevant evidence concerning neighborhood environments and outdoor physical activity. Such studies were interpreted cautiously because their results could not necessarily be attributed specifically to children in middle childhood.

Literature Selection and Relevance: Literature was considered relevant when it addressed at least one of the following areas: children's outdoor physical activity, active play, neighborhood accessibility, street environments, traffic or perceived safety, green and open spaces, or recreational facilities. Particular attention was given to studies reporting associations between environmental characteristics and children's activity opportunities or behaviors. Research addressing broader environmental experiences, public-space characteristics, or general physical activity was also considered where it contributed to the interpretation of environmental design implications. Because the review was narrative rather than systematic, the synthesis was organized according to thematic relevance rather than a quantitative screening procedure. No pooled effect estimates or formal meta-analytic comparisons were undertaken.

Thematic Analysis and Evidence Synthesis: The literature was examined to identify recurring built-environment characteristics and their reported relationships with physical activity. Environmental characteristics were subsequently grouped according to conceptual similarity and their potential relevance to neighborhood design. Five themes were identified:

- Accessibility and proximity.
- Street connectivity and walk ability.
- Traffic and perceived safety.
- Green and open spaces.
- Recreational facilities and activity opportunities.

Within each theme, the synthesis considered the environmental characteristics discussed in previous studies, their reported associations with physical activity, and their potential implications for spatial design. Where studies suggested different relationships between similar environmental characteristics and activity outcomes, these differences were retained rather than treated as evidence of a uniform effect. The resulting thematic structure was used to develop an integrated interpretation of neighborhood environments as interconnected systems supporting children's outdoor activity opportunities.

Scope and Methodological Considerations: The review primarily addresses built-environment characteristics and their relationships with outdoor physical activity. It does not attempt to establish causal relationships or

quantify the relative importance of individual environmental dimensions. Furthermore, the inclusion of studies involving broader age groups means that some findings should be regarded as contextual evidence rather than direct evidence specific to middle childhood. The proposed conceptual framework should therefore be interpreted as a synthesis-derived structure requiring subsequent empirical examination.

RESULTS AND DISCUSSION

Overview of the Identified Environmental Dimensions: The thematic synthesis identified five principal built-environment dimensions relevant to children's outdoor physical activity. These dimensions represent different but potentially interconnected aspects of neighborhood environments. Accessibility and proximity concern the spatial relationship between children's everyday locations and opportunities for outdoor activity. Street connectivity and walkability concern the organization and physical characteristics of movement networks. Traffic and perceived safety relate to environmental conditions that may influence children's and caregivers' willingness to use outdoor spaces. Green and open spaces concern the availability and environmental qualities of outdoor settings. Recreational facilities and activity opportunities concern the extent to which neighborhood environments provide spaces and features suitable for different forms of physical activity. Although these dimensions can be analyzed separately, their practical implications are closely connected. For example, a recreational facility may provide opportunities for active play, but its potential contribution to children's everyday activity may depend on whether it can be reached conveniently and safely. The following sections examine each dimension and its implications for child-friendly neighborhood design.

Accessibility and Proximity: Accessibility and proximity are important characteristics of neighborhood environments because they influence children's opportunities to reach outdoor activity spaces. During middle childhood, children's daily movements are commonly organized around residential areas, schools, and nearby community facilities. Consequently, neighborhood spaces located within children's everyday activity environments may provide particularly relevant opportunities for physical activity. Zhou[16] highlighted the importance of residential neighborhood environments as locations for children's everyday activities. From a spatial perspective, proximity refers primarily to the distance between an activity destination and children's everyday locations. Accessibility, however, represents a broader concept involving the ease with which a destination can be reached. A recreational space may be geographically close to a child's home but difficult to access because of disconnected pedestrian routes, physical barriers, or traffic conditions. Therefore, geographical proximity should not be regarded as equivalent to effective accessibility.

This distinction is important when interpreting associations between neighborhood environments and physical activity. Shorter distances may reduce the time and effort required to reach outdoor spaces. However, the availability of nearby destinations does not necessarily ensure that children can or will use them. Children's opportunities for independent movement may also be influenced by parental supervision and perceptions of neighborhood safety. From a design perspective, these observations suggest that child-friendly neighborhood planning should consider both the distribution of outdoor activity spaces and the quality of the routes connecting them to residential environments. Providing recreational facilities within neighborhoods may be insufficient when access routes are inconvenient, discontinuous, or perceived as unsafe. Accessibility should be evaluated as a combination of destination proximity, pedestrian continuity, route convenience, and practical opportunities for children to reach outdoor spaces.

Street Connectivity and Walk ability: Street connectivity and walk ability represent another important dimension of neighborhood environments. Street connectivity generally concerns the extent to which streets and pathways form an interconnected movement network. Walk ability concerns the degree to which the physical environment supports pedestrian movement. These characteristics may influence children's physical activity by shaping opportunities for walking, cycling, active transportation, and informal outdoor play. However, the relationship between street-network configuration and children's activity is not necessarily straightforward. Veitch[17] identified neighborhood street characteristics, including cul-de-sac environments, as relevant to children's outdoor play. Similarly, Brockman[18] reported that green spaces and cul-de-sac environments were associated with active play among children aged 10–11years. Research conducted in Beijing also identified cul-de-sac streets as locations associated with extended play and spatially varied street environments[19]. These findings suggest that streets with limited traffic may provide conditions conducive to informal outdoor play.

Nevertheless, different street configurations may support different types of physical activity. Holt[20] compared children's perceptions of physical activity environments across neighborhoods with contrasting street layouts and identified differences associated with walk ability and active transportation. This indicates that the environmental characteristics

supporting active transportation may not be identical to those supporting stationary or informal outdoor play. For example, highly connected street networks may provide direct pedestrian routes and multiple destination choices. In contrast, low-traffic residential streets may provide opportunities for children to remain in outdoor spaces and engage in informal play. Consequently, the relationship between street connectivity and children's physical activity should be interpreted in relation to the type of activity being considered. A street environment favorable for walking to school may not necessarily be equally favorable for prolonged outdoor play. This distinction has important implications for neighborhood design. Rather than assuming that a single street-network configuration is universally preferable, planners should consider how different spatial arrangements support different forms of children's movement and recreation. Child-friendly street design should balance pedestrian connectivity with the provision of low-traffic, accessible, and usable spaces for informal outdoor activity.

Traffic and Perceived Safety: Traffic conditions and perceived safety constitute a critical dimension of the relationship between neighborhood environments and children's outdoor physical activity. Children's opportunities to engage in outdoor activity are influenced not only by the physical characteristics of neighborhood spaces but also by how those spaces are evaluated by children and care givers. For children in middle childhood, parental perceptions may be particularly important because independent mobility remains subject to varying degrees of adult supervision. Handy[21] examined neighborhood characteristics associated with children's outdoor activity and highlighted the relevance of environmental conditions such as cul-de-sac streets, residential yards, neighborhood crime, and social interaction. These characteristics suggest that neighborhood safety cannot be understood solely through the presence or absence of traffic hazards. Instead, perceived safety may involve several interconnected dimensions, including road conditions, neighborhood social environments, and the perceived suitability of spaces for children's activities. Farley[22] provided evidence concerning the relationship between access to safe play environments and children's physical activity. Christian[23] further examined relationships involving neighborhood characteristics, parental perceptions, and children's developmental or outdoor activity experiences. Together, these studies indicate that the perceived safety of neighborhood environments may influence children's opportunities to participate in outdoor activities. Research conducted in New Zealand also identified street connectivity, traffic conditions, and street scape characteristics as relevant considerations for children's activity and mobility[24]. Nevertheless, traffic safety and perceived safety should be conceptually distinguished.

Traffic safety concerns physical conditions such as vehicle movement, traffic speed, and potential conflicts between pedestrians and vehicles. Perceived safety concerns how individuals interpret environmental risks. Although these dimensions may be related, objectively safer environments are not necessarily perceived as safe by all caregivers. Similarly, positive perceptions of safety do not necessarily imply the absence of environmental hazards. This distinction is particularly important when translating research findings into design recommendations. Improving traffic conditions may create safer physical environments, but encouraging children's outdoor activity may also require attention to visibility, pedestrian comfort, and caregivers' perceptions. Child-friendly neighborhood design should integrate traffic-risk reduction with environmental characteristics that support perceived safety and confidence in children's outdoor mobility.

Green and Open Spaces: Green and open spaces represent important components of neighborhood environments because they provide locations and environmental conditions that may support outdoor recreation and physical activity. These environments include parks, neighborhood green spaces, public open areas, landscaped streets, and other outdoor spaces incorporating natural elements. Research has associated green environments with multiple dimensions of human health and well-being. de Vries[25] examined relationships involving green-space characteristics and health-related outcomes, indicating that both the presence and quality of green environments are relevant to environmental experiences. Although such findings are not necessarily specific to children in middle childhood, they provide contextual support for considering green-space quality alongside spatial availability. Machado-Rodrigues[26] examined environmental characteristics relevant to children's physical activity and health-related outcomes, highlighting the importance of neighborhood environmental conditions. The attractiveness of outdoor environments may also influence how individuals perceive and select recreational spaces. Capitanio[27] discussed the relevance of urban landscape characteristics to environmental experiences and recreational opportunities. Similarly, Schipperijn[28] examined green-space characteristics associated with physical activity, including environmental features such as walking routes and landscape elements. These studies suggest that green spaces should not be evaluated exclusively according to their quantity or geographical distribution. Environmental quality, spatial configuration, and opportunities for different activities may also influence their potential use.

From a design perspective, the relationship between green spaces and physical activity can be interpreted through the concept of environmental affordances. Environmental affordances concern the possibilities for action that an environment provides in relation to users' capabilities and perceptions. Zhang[29] discussed relationships between environmental characteristics, perception, and behavioral opportunities through an affordance-oriented perspective. Applied to middle childhood, this perspective suggests that green spaces may support outdoor physical activity when their physical characteristics provide opportunities for movement, exploration, recreation, and social interaction. However, the presence of greenery alone does not establish that space is suitable for children's physical activity. For example, landscaped spaces may provide visual amenities without offering accessible areas for active play. Conversely, open spaces with relatively simple physical characteristics may support multiple forms of movement when they are accessible and sufficiently usable. Green-space planning should consider environmental quality, accessibility, spatial usability, and opportunities for diverse forms of children's outdoor activity rather than relying solely on the provision of vegetation or park area.

Recreational Facilities and Activity Opportunities: Recreational facilities and activity opportunities constitute the fifth environmental dimension identified in the review. This dimension includes playgrounds, sports facilities, play equipment, multipurpose outdoor spaces, and pedestrian or cycling infrastructure. Such facilities may support physical activity by providing spaces and physical features appropriate for different forms of movement. However, recreational opportunities should not be understood exclusively in terms of formal sports facilities.

Children's outdoor physical activity may include spontaneous running, informal games, walking, cycling, and peer interaction. Consequently, spaces that accommodate flexible and unstructured activities may be important alongside purpose-built recreational infrastructure. Mangunsong[30] discussed the relevance of spatial characteristics and social interaction to children's outdoor experiences. From an environmental design perspective, this suggests that spatial organization may influence not only the types of activities possible within a setting but also opportunities for interaction among children.

Open, unobstructed spaces may accommodate running and other movement-intensive activities. In contrast, spaces incorporating seating, spatial enclosure, or smaller gathering areas may provide opportunities for social interaction and less physically demanding activities. These observations indicate that different spatial characteristics may support different behavioral opportunities. Previous research has also identified associations between physical activity and pedestrian infrastructure, environmental aesthetics, social interaction, and neighborhood safety[31]. Other studies have reported relationships between outdoor physical activity and characteristics such as pedestrian amenities, sidewalk accessibility, street frontage, commercial density, and intersection density. Machado-Rodrigues further examined the relevance of walking and cycling infrastructure to physical activity among children. Conversely, environmental barriers, traffic conditions, and neighborhood disadvantages have been identified as potential constraints on children's physical activity. Taken together, these findings suggest that the relationship between recreational infrastructure and children's physical activity involves more than the numerical provision of facilities. The location, accessibility, spatial characteristics, and practical usability of recreational environments may influence whether they provide meaningful opportunities for activity. Child-friendly neighborhoods should provide a diversity of accessible and usable outdoor environments capable of accommodating both structured recreation and informal physical activity.

Interrelationships Among Environmental Dimensions: The preceding synthesis indicates that built-environment characteristics should not be interpreted exclusively as independent factors. Instead, the five identified dimensions may interact in ways that shape children's opportunities for outdoor physical activity. Accessibility and proximity determine whether activity destinations can be reached conveniently. Street connectivity and walk ability influence the characteristics of movement routes. Traffic and perceived safety may affect whether children and caregivers consider these routes and destinations suitable for use. Green and open spaces provide environmental settings for outdoor experiences. Recreational facilities and activity opportunities influence the range of activities that particular spaces can accommodate. These dimensions may therefore operate in complementary or constraining ways. For example, a nearby park may offer diverse recreational opportunities, but its contribution to children's outdoor activity may be limited when surrounding streets are difficult to cross. Similarly, a well-connected pedestrian network may provide opportunities for walking but offer limited support for informal play when accessible recreational spaces are absent. Conversely, a neighborhood combining convenient access, pedestrian continuity, perceived safety, usable open spaces, and diverse activity opportunities may

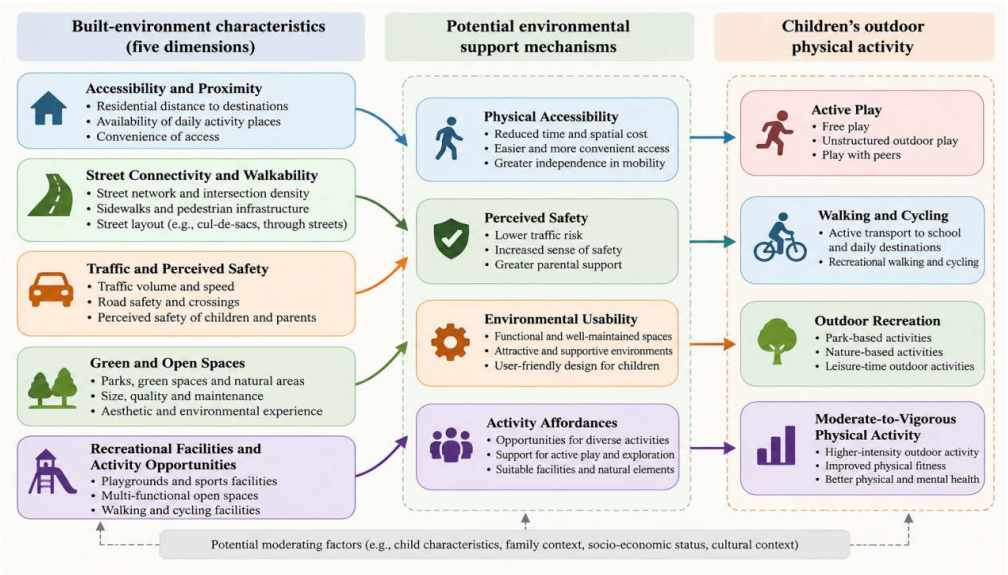


Figure 1. An Integrated Conceptual Framework of Built-Environment Support for Outdoor Physical Activity in Middle Childhood.

Note: The framework represents conceptual relationships synthesized from the reviewed literature rather than empirically validated causal pathways.

provide a broader range of conditions supportive of outdoor physical activity. These relationships should not be interpreted as evidence that all five dimensions exert equivalent effects or that their combined influence has been empirically established. Rather, they represent a conceptual interpretation derived from thematic synthesis. This interpretation highlights the need to move beyond isolated environmental attributes towards an understanding of neighborhood environments as interconnected spatial systems.

Based on the synthesis of the reviewed literature, an integrated conceptual framework is proposed to illustrate the potential relationships between built-environment characteristics and outdoor physical activity in middle childhood (Figure 1). The framework comprises three interconnected components: five key built-environment dimensions, four potential environmental support mechanisms, and four categories of outdoor physical activity. Specifically, accessibility and proximity, street connectivity and walk ability, traffic and perceived safety, green and open spaces, and recreational facilities and activity opportunities are conceptualized as environmental dimensions that may support children's outdoor physical activity through physical accessibility, perceived safety, environmental usability, and activity affordances. These mechanisms may contribute to opportunities for active play, walking and cycling, outdoor recreation, and moderate-to-vigorous physical activity. Furthermore, individual characteristics, family circumstances, socioeconomic conditions, and cultural contexts may influence these relationships. Rather than assuming that individual environmental attributes independently determine children's activity behaviors, the proposed framework emphasizes the interconnected nature of neighborhood environments and their potential contribution to children's outdoor activity opportunities. Importantly, the framework represents a conceptual synthesis of existing literature rather than an empirically validated causal model.

Environmental Availability, Accessibility, Usability, and Utilization: An important conceptual distinction emerging from the synthesis concerns the difference between environmental availability, accessibility, usability, and actual utilization. These concepts represent related but non-equivalent aspects of children's outdoor environments. Availability refers to whether a particular outdoor space or facility exists within the neighborhood. Accessibility concerns whether children can reach that space conveniently and under suitable conditions. Usability concerns whether the characteristics of space enable children to undertake relevant activities. Utilization refers to whether children actually use the space for outdoor activities. A neighborhood may contain several parks or playgrounds, indicating relatively high environmental availability. However, these facilities may be difficult to reach because of traffic barriers or disconnected pedestrian routes. In this situation, environmental availability does not necessarily translate into accessibility.

Similarly, an accessible space may provide limited opportunities for physical activity when its spatial

characteristics are unsuitable for children's preferred forms of movement. Even when a space is available, accessible, and usable, actual utilization may remain influenced by factors beyond the built environment, including individual preferences, peer relationships, parental support, and everyday routines. Therefore, the presence of supportive environmental characteristics should not be equated with observed physical activity. This distinction provides an important basis for interpreting existing evidence and developing future research designs. Studies measuring the number or proximity of recreational spaces may capture environmental availability or accessibility without necessarily measuring usability or actual activity behavior. Likewise, studies measuring physical activity levels may not fully explain which environmental characteristics influence children's choices. A more comprehensive understanding requires consideration of the relationships among these different concepts.

Implications for Child-Friendly Neighborhood Design: The synthesis suggests that child-friendly neighborhood design should extend beyond the provision of individual recreational facilities. Instead, planning and design strategies should consider how different environmental components operate together to support children's everyday activities. On the neighborhood scale, the distribution of outdoor spaces should be considered alongside pedestrian accessibility and movement networks. At the street scale, pedestrian continuity and opportunities for active transportation should be balanced with traffic conditions and spaces suitable for informal play. At the site scale, green and recreational spaces should provide usable environments capable of supporting different types of activity. The findings also suggest that environmental design should distinguish between spaces that are physically present and spaces that provide meaningful opportunities for children's activities. This distinction has implications for the evaluation of child-friendly environments. For example, assessments based solely on the quantity of playgrounds or green spaces may provide an incomplete representation of environmental support for physical activity. More comprehensive assessments could consider proximity, route conditions, traffic safety, environmental quality, and the diversity of activity opportunities. The proposed five-dimensional framework therefore provides a conceptual basis for organizing environmental design considerations. It should not, however, be interpreted as a validated design assessment instrument. Further empirical research is necessary to determine whether the identified dimensions can be operationalized into reliable indicators and whether their relationships with children's activity vary across neighborhood contexts.

Theoretical Implications: The principal theoretical implication of this review concerns the need to interpret the built environment as a system of activity opportunities rather than a collection of isolated physical characteristics. Existing studies demonstrate that children's physical activity may be associated with multiple aspects of neighborhood environments. However, the identification of individual associations does not necessarily explain how children experience and use their surroundings. An affordance-oriented interpretation offers one possible conceptual perspective. From this perspective, the relevance of environmental characteristics depends not only on their physical existence but also on the opportunities for action they provide to particular users. For children in middle childhood, these opportunities may be shaped by developing physical capabilities, environmental awareness, independence, and social relationships. Consequently, the same physical environment may provide different opportunities for children of different ages or developmental characteristics. This perspective also highlights the importance of distinguishing objective environmental attributes from children's perceptions and actual behaviors. A spatial feature may be measurable through environmental observation but may not necessarily be perceived or used in the same manner by all children. The present review therefore supports a more integrated understanding of relationships among physical environmental characteristics, perceived opportunities, and outdoor activity behaviors. Nevertheless, these relationships remain conceptual propositions rather than empirically validated causal mechanisms.

Limitations and Future Research: Several limitations should be acknowledged. First, the study adopted a narrative review approach rather than a systematic review or meta-analysis. Although thematic synthesis enabled the integration of heterogeneous research findings, the approach does not provide quantitative estimates of associations between environmental characteristics and physical activity. Second, the reviewed literature included studies involving broader populations of children and adolescents. Consequently, not all findings can be generalized specifically to children in middle childhood. Third, the included studies addressed different physical activity outcomes, including active play, walking, cycling, active transportation, and general physical activity. These outcomes may respond differently to build-environment characteristics. Fourth, the five-dimensional framework was developed through interpretative synthesis rather than statistical validation. Its conceptual usefulness therefore requires further empirical examination.

Future research should prioritize studies specifically involving children in middle childhood and

distinguish between different forms of outdoor physical activity. Research combining objective environmental measurements, children's activity monitoring, and environmental perception assessments would be particularly valuable. Longitudinal and intervention-based studies could also provide stronger evidence concerning the potential effects of environmental changes on children's physical activity. Additionally, future studies should examine whether relationships among environmental dimensions differ across urban forms, residential densities, social contexts, and cultural settings. Finally, the proposed framework could inform the development of design evaluation indicators, although their reliability, validity, and practical applicability would require systematic testing.

CONCLUSION

This narrative review examined existing literature concerning relationships between built-environment characteristics and outdoor physical activity during middle childhood, with particular emphasis on implications for child-friendly neighborhood design. The synthesis identified five principal environmental dimensions: accessibility and proximity, street connectivity and walk ability, traffic and perceived safety, green and open spaces, and recreational facilities and activity opportunities. These dimensions represent recurring themes in research examining children's physical activity and neighborhood environments. The findings indicate that environmental support for children's outdoor physical activity cannot be adequately understood through the presence of individual spatial characteristics alone. Instead, opportunities for outdoor activity may depend on how different environmental conditions operate together within children's everyday neighborhoods.

A central conceptual contribution of this review is the distinction between environmental availability, accessibility, usability, and actual utilization. The presence of outdoor spaces does not necessarily indicate that children can reach them conveniently, use them for relevant activities, or engage in physical activity within them. Accordingly, environmental design approaches that focus exclusively on the quantity or distribution of recreational facilities may overlook important aspects of children's everyday experiences. From a design perspective, the review proposes that child-friendly neighborhoods should be considered as interconnected spatial systems incorporating accessible destinations, supportive pedestrian environments, appropriate safety conditions, usable green and open spaces, and diverse recreational opportunities. The proposed five-dimensional framework provides a structured interpretation of existing evidence and offers a conceptual foundation for future research and environmental design assessment. However, the framework should be regarded as an interpretative synthesis rather than a validated causal model. Further research is needed to examine the relationships among environmental characteristics, children's perceptions, independent mobility, and observed outdoor physical activity. By integrating fragmented evidence and emphasizing its spatial design implications, this review contributes to a more comprehensive understanding of how neighborhood environments may support outdoor physical activity during middle childhood.

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