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WORKING
PAPER
SERIES

No. 2024-27

August 2024

Review of the influence of the built environment on early child development through an equity lens

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Research Summary

Why was the research done?

Understanding the influence of neighbourhood-level factors on a child's growth and development is important, especially from an equity perspective, yet significant evidence gaps remain. This study aims to review and summarise the literature on the direct and indirect relationships between individual built environment attributes, neighbourhood typologies, and various child development outcomes. Examining the causal pathways linking these attributes to developmental outcomes, the research also focuses on exploring these relationships within population groups experiencing disadvantage. This research provides a comprehensive understanding of how the places where children live impact their development, thereby informing equitable policies and interventions designed to foster healthier and more inclusive communities.

What were the key findings?

The key findings of this research reveal a significant increase in both the scope and volume of studies on the built environment and early childhood development. There is a growing recognition of the built environment's impact on early child development, along with a rise in the use of advanced spatial (Geographic Information Systems (GIS)) measurement tools and a focus on socio-emotional development. However, few studies address issues of causality. This research introduces a new framework to provide a structured approach for analysing and interpreting the complex interactions within the built environment with a focus on promoting equitable outcomes for all children.

What does this mean for policy and practice?

The findings of this scoping review can be used to inform the design and implementation of interventions that address the specific needs of children in diverse neighbourhoods, particularly those experiencing disadvantage. Future research informed by this review will strengthen the evidence-base and knowledge needed for developing and trialling real-world solutions in policy and practice. Possible policy and practice implications by creating a better understanding of the interactions between built environment attributes and early childhood developmental outcomes and identifying ideal thresholds of built environment attributes such as the amount of private versus public green space required to benefit young children's development. Practitioners can use these findings to create more inclusive and supportive environments that promote early child

development. The adoption of the new framework for understanding the mechanisms through which the built environment influences early child development can lead to more effective policies and practices to support the healthy development of all children.

Citation

Nathan, A., Arena, G., Lowe, M., Villanueva, K., Brinkman, S., Schipperijn, J., & Christian, H. (2024). 'Review of the influence of the built environment on early child development through an equity lens', Life Course Centre Working Paper Series, 2024-27 . Institute for Social Science Research, The University of Queensland.

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Acknowledgements/Funding Sources

This work was funded through the Australian Research Council's Centre of Excellence for Children and Families over the Life Course (#CE200100025). HC is supported by a National Heart Foundation Future Leader Fellowship (#102549) and a Kids Research Institute Australia - Ascend Senior Research Fellowship.

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Abstract

This review aimed to provide an overview of the current evidence base on the influence of built environment attributes on early child development through an equity lens and to present a conceptual framework of causal pathways to guide future research. A systematic approach was used to identify literature related to the neighbourhood built environment and early child health and development, with a focus on methodological approaches that provided insights into equity and mechanisms of causal inference. Findings reveal an increasing scope and volume of research examining associations between the built environment and early childhood development, particularly socio-emotional aspects. However, there is an absence of population-level mechanistic studies, leading to limited knowledge and contextual evidence on how to intervene based on causal pathways. A socio-ecological framework for early child development has been developed to better guide future research to understand the underlying mechanisms through which the built environment influences early child development from an equity perspective.

Introduction

The early years of life are crucial for a child's health, development and wellbeing [1, 2]. Early child development is a dynamic process of acquiring physical, social, emotional, and academic skills [3] and is influenced by complex interactions between biology, the environment and experience [1]. National and international progress measures [4, 5] for early child development domains [6] are collected regularly with the aim to inform policies and practices that benefit children and families and the wider community.

Early child development is often discussed in the context of where a child lives and grows, using socio-ecological frameworks [7, 8]. Multiple factors ranging from a child's immediate living and growing context (family and peer groups) to distant cultural or historical factors have been shown to influence the course of child development [1, 9, 10]. While extensive literature exists around children's immediate individual level factors (parenting practices, parent employment and education, household poverty) [11-14], the influence of neighbourhood level factors, beyond socio-economic disadvantage [8, 15, 16], remains less well understood [8, 17, 18].

The role of neighbourhood built environments is an emerging area of research in the context of early child development and wellbeing [16, 17, 19-21]. There is evidence showing various built environment attributes (e.g., housing density, walkability, traffic, green spaces, home yard space, access to child specific and parent specific destinations) are associated with child health behaviours (physical activity, sedentariness, diet quality) [22-24] and health outcomes such as weight status [25-30]. However, the role of the neighbourhood built environments in directly or indirectly influencing developmental outcomes is an important evidence gap. Our previous reviews of the literature, conducted a decade ago [17, 18] found of the few quantitative studies conducted at the time, direct relationships between some built environment attributes, specifically access to child-relevant destinations and facilities, parks, home outdoor space, and parent perceived safety and specific subdomains of early child development, such as motor skills [31] and socio-emotional development [32].

It is well established that children from neighbourhoods from a lower socio-economic area tend to have poorer health and developmental outcomes [33, 34]. Population level early child development is monitored nationally in Australia using the Australian Early Development Census [35] and in Canada using the Early Development Instrument [5]. The most recent Australian Early Development Census reports that children living in neighbourhoods experiencing the most socio-economic disadvantage are two to three times more vulnerable on one or more of the five key developmental domains (i.e., physical health and wellbeing, social competence, emotional maturity, language and cognitive skills (school-based), and

communication skills and general knowledge) [6] compared with children living in less disadvantaged areas. These disparities highlight the importance of understanding the needs of children experiencing socially structured disadvantage to inform evidence-based policy and practice, as well as place-based programs.

As an initial step, there is the need to intentionally consider how equity is reported in the existing literature linking built environments to early child development [36]. Health equity is defined as the absence of avoidable and unfair differences in health within and between populations [37]. Research studies can consider issues of equity by selecting defined disadvantaged populations or applying statistical approaches to assess differences between associations or interventions by relevant equity factors such as race/ethnicity, occupation, education, income, socioeconomic status, area-level deprivation etc. [38, 39]. In the context of the built environment this would involve understanding whether built environment attributes associated with early child development outcomes differ (in direction and/or effect size) for population groups experiencing disadvantage.

Understanding the causal inferences linking early experiences to long-term outcomes is important for informing effective strategies, interventions and policies for early child development. Causal inference helps unravel the complex interactions between biological factors and environmental experiences influencing child development [40]. This not only informs immediate interventions but also provides evidence for long-term developmental trajectories. Our previous reviews have presented theoretical frameworks of the likely mechanisms through which built environment attributes may facilitate or constrain early child development [17, 18]. Yet an important gap in synthesising research to inform evidence-based policy and practice, as well as place-based interventions, is the extent to which mechanistic pathways have been considered beyond the theoretical and applied methodologically. Research studies can contribute to understandings of causal inference pathways and mechanisms in several ways. For example, qualitative study designs to gather participants' experiences and perceptions or engage stakeholders in setting priorities or needs can complement experimental research through triangulation. Other ways include the use of Directed Acyclic Graphs (DAGs) to identify assumptions about relationships between and among factors in a causal way or applying statistical mediation analysis to understand underlying mechanisms or processes by which one factor influences another factor through a mediator variable.

It is timely that findings to date on built environment attributes and early child development be reviewed and synthesised, with a focus on how research studies have methodologically approached equity and

mechanisms of causal inference. Thus, the purpose of this review was to update our previous work and provide an overview of the current evidence base on the influence of built environment attributes on early child development through an equity lens and present a conceptual framework of causal pathways to guide future research.

Methods

This review is an update of two existing reviews of the relationship between the neighbourhood built environment and early child health and development [17, 18].

Search strategy

A systematic search approach was taken based on our earlier review published in 2015 [17]. Three major databases were searched (PubMed, ScienceDirect and Scopus) for peer-reviewed papers on the relationship between various built environment attributes and early child development outcomes. Key words and combinations of search terms included: Search 1: CHILD AND (Early childhood OR Development OR Play OR Wellbeing OR Physical OR Emotion OR Social OR Cognitive OR Communication OR Language) AND (Neighbourhood OR Environment OR Urban environment OR City OR Place OR Safety OR Traffic OR Land use OR Street connectivity OR Density OR Destination OR Facilities). Search 2: CHILD AND (Early childhood OR Development OR Play OR Wellbeing OR Physical OR Emotion OR Social OR Cognitive OR Communication OR Language) AND (Nature OR Green space OR Public open space OR Park OR Greenness). Search 3: CHILD AND (Early childhood OR Development OR Play OR Wellbeing OR Physical OR Emotion OR Social OR Cognitive OR Communication OR Language) AND (Home OR Home environment OR Yard OR Outdoor). No search terms specific to equity related content were included in the search strategy based on the inconsistency and poor indexing of relevant terms [36, 41].

All citations were exported and duplicates removed. Titles, abstracts, and full-text articles were screened for inclusion by authors. Reference lists of included articles were assessed to identify any additional articles.

Inclusion and exclusion criteria

The population of interest for this review was children up to eight years of age. Articles were included if the mean or median age reported for the sample was up to eight years. If an age range for the sample was reported without an average, articles with an upper range beyond eight years were excluded.

Only articles with an exposure measure of built environment attributes and outcome measure of early child development were included. The built environment was defined as any buildings, spaces or objects created or modified for people in which children have the opportunity to play, explore and be stimulated [17].

Quantitative, qualitative, and mixed-method study designs of urban population settings were included to consider different approaches taken to understand relationships between the built environment and early

child development. Only English language articles with accessible full texts published between January 2014 and May 2022 were included.

Information recorded

Data were extracted by multiple co-authors using an iteratively developed structured literature review table. Information extracted for all study designs included:

1. Characteristics of the study (e.g., study design, country etc.) and sample (e.g., sample size, age and sex of sample).
2. Methodological considerations of equity were identified and assigned a pre-identified code based on best-practices reported in the literature [36, 38, 39, 41, 42]. The codes were 'sample selection' and 'effect modification'.
3. Methodological considerations of the mechanisms or causal pathways were identified and assigned a pre-identified code based on best-practices reported in the literature [36, 43, 44]. The codes were 'qualitative component', 'use of DAGs to inform analysis', and 'mediation analysis'.

Additionally for quantitative studies:

4. Built environment measures were recorded as described by study authors alongside the type of measurement (e.g., objective, subjective etc.) and spatial scale (e.g., residential buffer, other setting buffer, administrative unit etc.) then thematically coded by attribute.
5. Early child development measures were recorded as described, including measurement type (e.g., objective, teacher report etc.) and instrument used (e.g., Australian Early Development Census, Strengths and Difficulties Questionnaire etc.), then thematically coded by domain.
6. Equity variables reported in quantitative studies were recorded and grouped by measurement level (i.e., individual-, household-, area-level) and were identified based on descriptions in the PROGRESS framework (i.e., place of residence, race/ethnicity/culture, occupation, gender/sex, religion, education, socioeconomic status and social capital) [39].

Extracted data were verified by at least two other research team members to ensure correct information and agreement in thematic coding. Any inconsistencies or disagreements were resolved through discussion between co-authors and mutual consensus was obtained.

Collating and summarising results

Findings on statistically significant relationship/s between built environment attributes and early child development reported in the subset of included articles identified as having an equity lens, were

narratively synthesised. The directionality of associations was considered. Qualitative evidence was also narratively synthesised, and reported here alongside relevant quantitative study findings, to further describe and unpack mechanisms through which built environment attributes influence early child development.

Results

A total of twenty seven articles were considered eligible for the review. Figure 1 details the screening process, where all exported articles were checked for duplicates, and then screened for full text review. Reasons for exclusion at full text screening level are also shown.

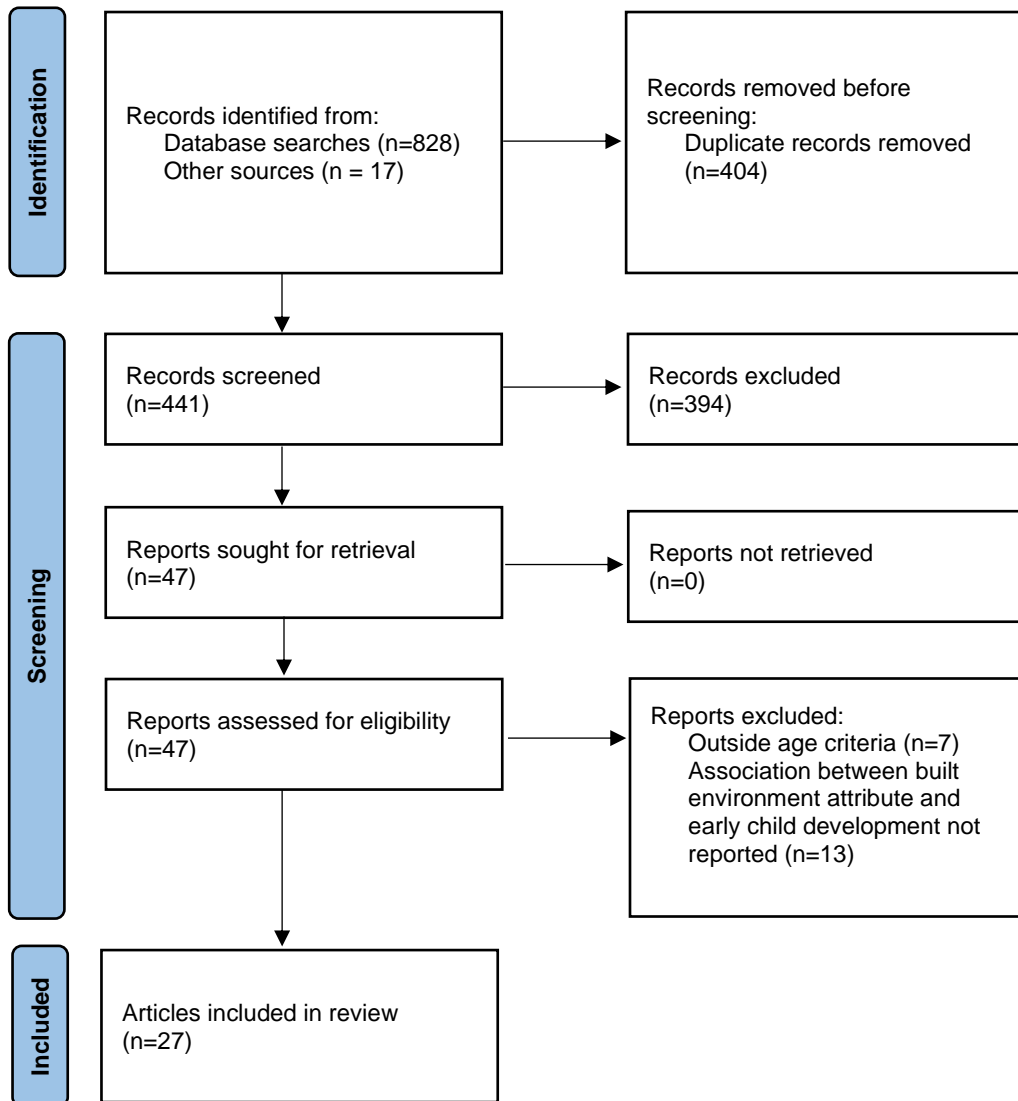


Figure 1: Flow diagram of article selection

Study characteristics

Characteristics of the included studies (n=27) are described in Table 1. In brief, there was a considerable increase in published literature post 2020 (n=18; 66.7%) and study designs were mostly quantitative cross-sectional (n=15; 55.6%), followed by quantitative longitudinal (n=7; 25.9%), mixed method designs (n=4; 14.8%) and qualitative research (n=1; 3.7%). Of the observational study designs, 13 were secondary analyses capitalising on existing cohort study data [32, 45-57]. No intervention or experimental study designs were identified. Studies were mostly conducted in Australia (n=13), followed by Europe (n=6), United Kingdom (n=5) and Canada (n=2). Only one was conducted in Asia [58] and none were from middle- and lower-income countries.

Table 1: Characteristics of included studies (n=27)

Characteristic	N	%
Year of publication		
Before 2014	2	7.4
2014-2016	1	3.7
2017-2019	6	22.2
2020-2022	18	66.7
Study design		
Quantitative - Cross-sectional	15	55.6
Quantitative - Longitudinal	7	25.9
Mixed methods	4	14.8
Qualitative	1	3.7
Country of study		
Australia	13	48.1
Europe	6	22.2
United Kingdom	5	18.5
Canada	2	7.4
Asia	1	3.7
Methodological considerations of equity*	9	33.3
Sample selection	6	22.2
Effect modification	3	11.1
Methodological considerations of mechanisms/causality*	13	48.1
Qualitative component	5	18.5
Use of Directed Acyclic Graph (DAGs) to inform analysis	4	14.8
Mediation analysis	6	22.2
Sample size[^]		
>100	0	0.0
101 – 1,000	7	31.8
1,001 – 10,000	10	45.5
>10,000	5	22.7
Sample age in years (mean/median)[^]		
<2 years	0	0.0
3-5 years	14	63.6
6-8 years	4	18.2
Age range reported	4	18.2

Notes: *Codes not mutually exclusive. [^]Sample characteristics reported for quantitative study designs only (n=22).

Overall, nine articles methodologically considered equity through sample selection, either selecting disadvantaged areas only [50, 59-61] or using an on/off diagonal approach to areas selected [62, 63]. Pioneered in Canada [64] and replicated in Australia [65], this approach involves creating a quintile matrix of level of disadvantage and levels of developmental vulnerability both at an area-level to identify and select areas 'off diagonal' areas (i.e., those performing better or worse in developmental vulnerability relative to area-level disadvantage) and 'on diagonal' areas (i.e., those performing as expected in developmental vulnerability relative to area-level disadvantage). The other methodological approach to equity we considered was statistical analysis involving 'effect modification', which was undertaken by three studies using equity indicators as the moderating variable [50, 56, 66].

Studies that considered the mechanisms and causal pathways through which the built environment influences early child development included a qualitative component to the study [59-61, 63, 67], used DAGs to inform analysis [46, 52, 55, 66] or undertook mediation analysis [32, 49, 51, 52, 55, 68].

Among the studies with a quantitative component, most focused on children between 3-5 years (n=14; 63.6%) and five studies had sample sizes over 10,000 [21, 52, 62, 66, 69].

Measurement of built environment attributes

Built environment attributes examined in quantitative studies included: public open space, housing, street connectivity, residential density, land-use mix, walkability, destinations, child relevant destinations, public transport, traffic, and aesthetics.

Public open space was the most studied built environment attribute (n=19), however only five studies investigated the quality (e.g., park attractiveness) of public open space and the association with early child development [21, 48, 50, 55, 56]. The majority of studies (n=14) measured built environment attributes objectively using Geographical Information Systems (GIS) [21, 46-48, 50, 52, 58, 62, 66, 68, 70, 71]. Subjective measures of built environment attributes were all parent/caregiver reported and included: public open space (specifically quality) [50, 55, 56]; housing [51, 71]; aesthetics [51, 72]; traffic [72]; land use mix [72]; street connectivity [72]; and walkability (i.e. walkable access to facilities [parks, playgrounds, play spaces]; street lighting; footpaths and roads; public transport; shopping facilities; and banks and medical clinics) [32].

While the majority of studies (n=15) used a child's residence (50 to 3000m) as the spatial scale to develop built environment variables [32, 45-47, 50, 52, 53, 57, 58, 66, 68-72], a few studies (n=4) used local administrative units such as postcodes [21, 32, 48, 49, 62]. Two studies used school (100m) and Early

Childhood Education and Care (ECEC, 500m) as the centre point for which to create built environment measures [68] while five studies did not specify spatial scales of interest when measuring built environment variables [51, 54, 55, 66, 71].

Measurement of early child development domains

The most studied early child development domain was social-emotional development, measured individually as social competence (n=16) and emotional maturity (n=13) or as a combination (n= 8). This was followed by physical development, language development, and cognitive development.

Early child development domains were measured by parent report using the validated Strengths and Difficulties questionnaire [73] in 12 studies [32, 47-53, 68, 71, 72]. Other parent report instruments included the Revised Rutter Parent Scale for Preschool [74] in one study [51] and the Children Short Mood and Feelings Questionnaire [75] in one study [52]. National population-level teacher report instruments, the Australian Early Development Census [35] and Canadian Early Development Instrument [5], were used in four studies [21, 62, 66, 70]. Only a handful of studies used objective, clinician administered tools to measure cognitive development [47, 57, 58], language development [46, 57], physical development [46], combined social-emotional development [69] and overall early child development [69].

Evidence summary of the influence of built environment attributes on early child development domains - overall

Table 2 summarises the volume of associations examined across all quantitative study designs for built environment attributes and the early child development measures examined. Public open space was the only built environment attribute studied as the exposure variable for all early child development domain outcomes. The influence of public open space on social and emotional development outcomes was the most commonly examined relationship in the included studies. Walkability and its sub-components of street connectivity, residential density, and land use mix were somewhat examined in relation to social and emotional development outcomes, rarely examined in relation to physical and language development outcomes, and never examined in relation to cognitive development outcomes. Access to destinations (including child-relevant destinations specifically), public transport, traffic exposure, and aesthetics were rarely or never analysed as predictors of early child development domains.

Table 2: Built environment attributes presented by each early child development outcome analysed across quantitative studies

		Early child development domain						
		Social	Emotional	Combined social-emotional	Physical	Cognitive	Language	Overall
Built environment attribute	Public open space	Green	Green	Light Green	Light Green	Yellow	Yellow	Light Green
	Housing	Yellow	Yellow	Red	Orange			
	Street connectivity	Yellow	Light Green	Orange	Yellow		Orange	
	Residential density	Orange	Yellow		Yellow		Yellow	
	Land use mix	Yellow	Yellow	Red	Orange		Red	
	Walkability	Orange			Red		Red	
	Destinations		Orange		Red		Red	
	Child-relevant destinations	Light Green	Light Green		Light Green			
	Public transport	Orange	Orange		Yellow		Yellow	
	Traffic	Yellow	Yellow	Red	Orange			
	Aesthetics	Light Green	Yellow	Orange				

Note: darker green cells indicate a larger number of associations analysed (i.e., 39-40); darker red cells indicate a fewer number of associations analysed (i.e., one); white cells indicate no associations analysed

The direction of significant associations was only recorded where there were four or more studies conducted. Few relationships between a built environment attribute and an early child development domain met this criterion and for the most part, null associations were reported. However, there was some evidence of housing (specifically larger amount of home yard space) being associated with reduced vulnerability in emotional development [21] but more vulnerability in social competence [70]. Children with no garden access had significantly higher scores for hyperactivity problems, peer problems, and conduct problems [71]. On the other hand, an increase in total amount of public open space was associated with lower odds of hyperactivity [47] and better prosocial behaviour [71]. Park quality appeared to be important, with access to an above average attractive park having lower odds of social vulnerability [70]. However, some studies also found greater distance to the nearest green space decreased the odds of developmental vulnerability on emotional maturity and social competence [21]. This may be explained by another study's findings of a non-linear dose response association with better development and quantity of green space [48].

Evidence summary of the influence of built environment attributes on early child development domains - studies considering equity only

In considering disadvantaged areas only, Villanueva and colleague's [60] mixed-methods research found housing affordability, tenure, and higher density public housing to be the only built environment attributes to consistently differentiate disadvantaged local communities with 'better than expected' and 'as expected' developmental vulnerability in at least one early child development domain. This was further supported through community perspectives (i.e., stakeholder interviews, service provider focus groups, parent focus groups) [61], collectively revealing how housing conditions intersect with early child development outcomes, particularly in disadvantaged communities. Other built environment attributes perceived as important for early child development by disadvantaged local communities included being able to physically access services, public transport availability, less traffic exposure, high-quality public open space and a mix of local family friendly destinations activities [61].

In applying an on/off diagonal approach to selecting and analysing disadvantaged areas and the odds of being developmentally on-track in specific domains, Collyer and colleagues [62] found that children had better physical development and poorer social and emotional development in areas with higher residential density. Having more cul-de-sacs in neighbourhoods was negatively associated with physical development but positively associated with emotional maturity. Furthermore, increased traffic and street connectivity were associated with poorer physical and emotional development; shorter distances to parks, learning, childcare and health services were associated with poorer physical and emotional development; and more services and public transport stops were associated with poorer emotional development [62]. This suggests that in the context of disadvantaged neighbourhoods, positive associations with built environment features seen in one domain of early child development may be negative in other domains.

Three studies used effect modification to statistically analyse whether the effect of a built environment attribute on early child development was dependent upon the value of any equity measure [50, 56, 66]. Overall, no moderation by education [50, 56], income [50, 66], perceived neighbourhood safety [56] or child indigenous status [56] measures were found to have a significant, differential impact on relationships between built environmental attributes and early child development outcomes. Using data from the Longitudinal Study of Australian Children, Putra and colleagues [54] found caregiver perceptions of better quality nearby green spaces were more strongly associated with higher prosocial behaviour among children who only spoke English at home (compared with multi-lingual children) and children living in more affluent areas (compared with children living in more remote, disadvantaged areas). Similarly, in a

deprived urban area in the UK, more green space was associated with fewer total and internalising behavioural difficulties in children of south Asian origin but found no such association for white British children. Compared with white British children, south Asian children spent less time playing outside in green spaces, and their parents were less satisfied with their green spaces, highlighting that satisfaction with the quality of local green spaces is a more important predictor of early child development than either quantity or use of green space among south Asian parents [50].

Evidence summary of the influence of built environment attributes on early child development domains - studies considering mechanisms/causality only

The majority of studies gave no methodological consideration to mechanisms through which built environment attributes may causally affect early child development outcomes (n=19; 63.3%).

Of the five articles to include a qualitative study component, four studies, including three from the Australian Kids in Communities study [60, 61, 63], employed a mixed methods study design and integrated qualitative and quantitative methods to enhance and strengthen understanding about the mechanisms through which built environment attributes influence early child development. The fifth study used group model building (integrating systems science and community-based participatory approach) to explore social and emotional wellbeing at various levels (i.e., micro- [e.g., family dynamics], meso- [e.g., quality of community services, programs], exo- [e.g., policies], macro- [e.g., social norms, values, belief systems]) of a child's environment to further empirical understanding of complex pathways [67]. In addition to mapping the complexity of attributes of the built environment influencing early child development, it also identified potential key leverage points for intervention in the (re)design of community spaces, practices, and policy in Canada. For example, the importance of co-location of services and programs based on a key reinforcing feedback loop of engagement in one type of service/program leading to connection with other relevant programs and supports [67]. Collectively, these studies with qualitative components emphasised the importance of community factors, housing, and social context in child development outcomes, and the need for holistic approaches that create nurturing environments for young children.

The use of DAGs to transparently and intentionally select confounder variables a priori to adjust for in analyses were reported in four studies [46, 52, 55, 66]. Six studies employed mediation analyses to consider the indirect pathways through which built environment attributes may influence early child development outcomes. Mediators analysed included children's physical activity [49, 52, 55, 68], social activity [52, 55], sleep [68] and time spent outdoors [68]. Caregivers' psychological distress [49, 55] and physical activity [49] have also been considered as mediator variables, along with housing quality [51] and

neighbourhood belonging [32]. However, for the most part, mediators analysed have not been found to explain mechanisms underlying the relationships between built environment attributes and early child development outcomes [49, 68]. Those with some evidence of mediation included children's physical activity (during leisure [52] and enjoyment of physical activity [55]) and social activity (organised with friends [52] and interaction with neighbours [55]), housing quality [51] and neighbourhood belonging [32].

Discussion

This review sought to synthesise existing findings and evaluate measures of the built environment and child development, with a focus on how research studies have methodologically approached equity and mechanisms of causal inference in order to guide future research in this area.

In comparison to the previous two reviews, this scoping review shows an increase in the scope and volume of research on the built environment and early childhood development. The rise in publications post-2020 highlights a growing recognition of the importance of the built environment on early child development. More recent studies also reflect an increased use of advanced spatial measurement tools like GIS, enabling more precise and objective development of measures of environmental attributes. The research places an emphasis on socio-emotional development, a shift from the earlier focus that was more evenly distributed across various developmental domains. This review update highlights the progress made since 2015 and points to new directions and methodologies that will further develop our understanding of how the built environment influences young children's development [17, 18].

For the most part, null findings were reported regarding the influence of parks and open spaces on social-emotional development. However, the handful of significant findings, when considered collectively alongside studies considering equity and causal pathways/mechanisms point to future research needs. Specifically, there is a need to consider access to home yard space alongside access to public open space. This has potential policy and practice implications by informing ideal thresholds such as the amount of private vs public green space needed to benefit young children's development.

A lack of variation in the exposure and outcome variable can hide differences in effects between different population groups. One identified reason for the failure to tackle inequalities has been an absence of population-level mechanistic studies and therefore knowledge and contextual evidence of what and how to intervene based on mechanistic understandings of the causal pathways involved [76]. For population groups experiencing disadvantage, it appears the pathways through which public open space impacts early child development may be more nuanced than at a population-level. Indicators of green space quality may have a greater relative importance for some population groups.

Few studies consider issues of causality. Future research can address this through the planned and intentional choice of confounders to adjust for by using DAGs, even when DAG variables are unavailable in analytic datasets. Based on the findings of this scoping review and our and others' prior work, we have developed a socio-ecological framework of early child development (Figure 2), to help visualise the

intricate pathways through which the built environment and other factors influence early child development. Our framework aims to provide an understanding of the underlying mechanisms influencing this dynamic, through the equity lens. The framework serves as a guide, offering a structured approach to analysing and interpreting the multifaceted interactions with the built environment while highlighting the complexities, and facilitating future research.

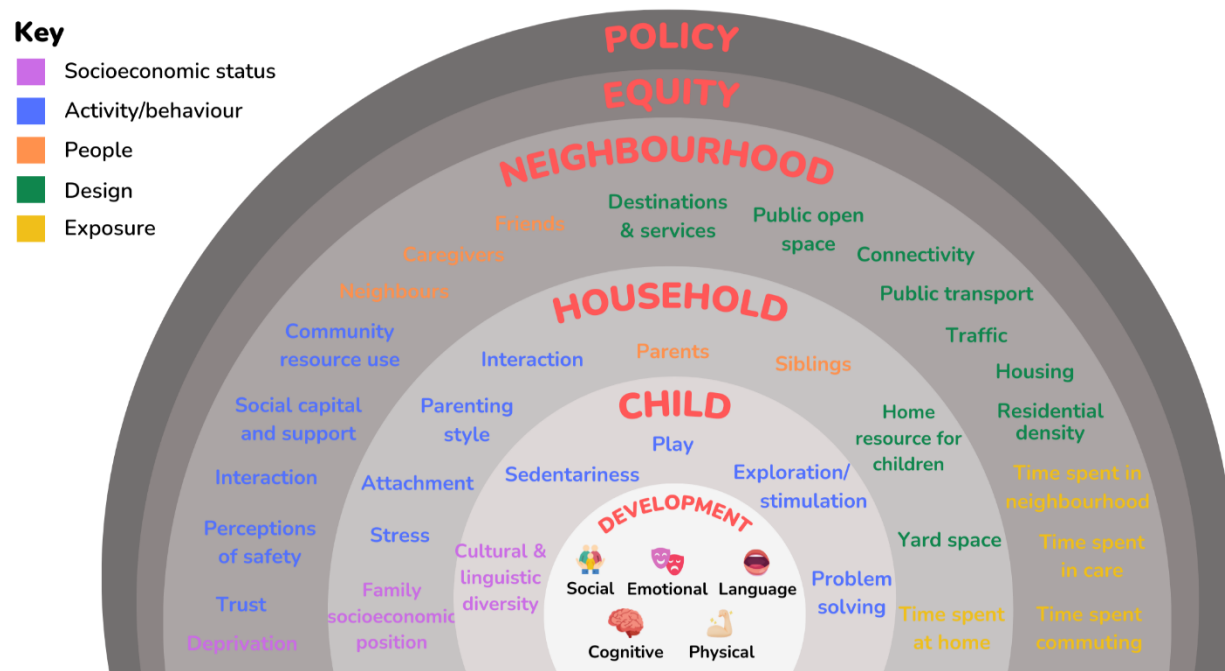


Figure 2: Early child development ecological framework

Drawing on Bronfenbrenner’s ecology systems theory [7], and the previous work by Christian et al. [17] and Villanueva et al. [18], each contextual layer has attributes that constrain or facilitate a child’s developmental opportunities. These contexts represent three interrelated dimensions related to early child development: design (encompassing sociological and structural/built aspects), people (comprising roles and relationships), and activity/behaviour (engagement within the given context). Each context has its own set of socioeconomic influences to consider.

However, an important aspect often overlooked in existing frameworks, and of importance when considering pathways and mechanisms through which the built environment influences early child development, is exposure. This essentially is the amount of time spent in a particular context, along with

the company and activities undertaken within it. This framework highlights the non-linear and interconnected pathways and mechanisms within and between these contexts. For example, the design of a neighbourhood can enable or hinder children's outdoor activities which in turn affects their opportunities for social interaction. This intra- and interrelatedness emphasizes the need for a comprehensive approach that unpacks these relationships, considering not only the direct influences but also the indirect and cumulative influences across different contexts and from the lens of equity.

Future research would benefit from a greater emphasis on qualitative and mixed methods approaches. While quantitative studies have provided valuable insights, qualitative and mixed methods can offer a deeper understanding of the interactions between built environment attributes and early childhood development. By incorporating the voices and experiences of parents, caregivers, and children themselves, researchers can uncover rich contextual information that complements quantitative findings, providing a more developed understanding of the complex nature of the built environment.

Major evidence gaps continue to exist within the built environment research space, specifically in i) reporting direct and indirect relationships between individual built environment attributes as well as neighbourhood typologies and different child development as well as overall child development outcomes, ii) unpacking causal pathways within these relationships and, iii) exploring those relationships among families and communities experiencing disadvantage [17, 18].

Conclusion

In summary, the findings of this scoping review highlight an increase in the breadth and volume of studies investigating the impact of the built environment on early childhood development, particularly socio-emotional development. This review exposes the absence of population-level mechanistic studies of the built environment and early child development which are required to provide contextual evidence on how to intervene based on causal pathways. A new socio-ecological framework for early child development is provided to better guide future research to understand the underlying mechanisms through which the built environment influences early child development through an equity perspective.

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