Title: The influence of the neighborhood physical environment on early child health and development: A review and call for research

Abstract: This review examines evidence of the association between the neighborhood built environment, green spaces and outdoor home area, and early (0-7 years) child health and development. There was evidence that the presence of child relevant neighborhood destinations and services were positively associated with early child development domains of physical health and wellbeing and social competence. Parents’ perceptions of neighborhood safety were positively associated with children’s social-emotional development and general health. Population representative studies using objective measures of the built environment and valid measures of early child development are warranted to understand the impact of the built environment on early child health and development.
29th January 2015

Dr Jamie Pearce
Editor-in-Chief
Health & Place

Dear Dr Pearce,

RE: JHAP-D-14-00377. The influence of the neighborhood physical environment on early child health and development: A review and call for research.

As requested in your email 19th December 2014, we have revised and resubmit the above manuscript, based on the feedback provided by yourself and the two reviewers. Below, we indicate how specific comments have been addressed. Edits to the manuscript have been highlighted in yellow.

Editor:

In particular, the point made by R1 regarding the role of yards for an international readership is important.

Text referring to the role of yards for early child health and development has been edited to reflect a more international readership. See Introduction (page 4, paragraph 2) and Discussion (page 13, paragraph 3; page 14, paragraph 4).

Other key things to be addressed are:

1. a deeper engagement with the literature on physical environment and children's health & physical activity as highlighted by R2

The Introduction and Discussion have been edited to acknowledge studies on the physical environment and physical activity and play in older children. References have been added to the text (see page 5, 11 and 12) and tables as per R2 suggestions.

2. clarification at the outset of the age range of children the paper is engaging with

The age range of children the paper focusses on has been clarified in the Abstract and Introduction.

3. Tidying up the tables as suggested by R1

The headings for tables 1 and 2 have been edited for clarity. ‘Table 1. Studies of the neighborhood physical environment and early (≤7 years) child health and development
measures.’ ‘Table 2. Studies of the neighborhood physical environment and young children’s (≤7 years) play & physical activity.’ This has also been clarified in the Results text – see page 8, paragraph 1. The findings of no association comments in Table 1 and 2 have been separated from the other text to make it clearer where no association was found.

Reviewer #1:
This is smoothly written and is a helpful summary of research on younger children. I have a few comments.

1. I felt the most interesting part of this was having some focus the yard which is really under studied and is much more important than the neighborhood for young children who are likely not allowed out of it unsupervised. A more international approach might also make more of the kinds of yards—house yards, apartment grounds, nearby green space.

See response to Editor’s comment.

2. Figure 1 should perhaps include the highly important factor of parental perceptions about such issues as danger and safety and social norms about such issues as unsupervised play. The purely environmental cast of the figure seems a stretch with young children as parental/social perceptions/norms/practices so dominate how they can use the environment. This could give the review a bit more of a critical edge.

The focus of this review is specifically on neighborhood and outdoor home physical environment factors that influence early child health and development and not on ALL factors that influence early child health and development. We acknowledge that parent perceptions (e.g., stranger danger), parenting practices and a number of other family and neighbourhood level social and cultural environmental factors influence early child health and development, however these factors are outside the scope of this review. The purpose of this review paper was to assess evidence of the relationship between early (0-7 years) child health and development and: 1) the neighborhood built environment; 2) neighborhood green spaces; and 3) the home outdoor area.

As outlined in the methods (study eligibility criteria) and limitations section, this review focused on the neighborhood physical environment and did not summarize evidence of the neighborhood social or policy environment, neighborhood level socio-economic factors or individual child or parent level factors. Our review is purposely restricted and the intent of Figure 1 was to depict a possible theoretical pathway through which the neighborhood and outdoor home physical environment can facilitate or constrain opportunities for play, physical activity, social interaction and exploration and stimulation which are important ‘behaviors’ for domains of early child health and development. Therefore, we have added the suggested additional factors to Table 3 – Develop theoretical model recommendations for further research.

3. I imagine there were many findings of no association. It would be helpful to deal with these in table 1 or at least in the narrative.

The findings of no association and association are indicated in Table 1 and 2 in the ‘Key Findings’ column. The findings of no association comments have been separated from the other text to make it clearer where no association was found. The results text also highlights where no association was found: “A single study examining the association between parent
perceived neighborhood safety and children’s cognitive development found no association(1).” “……however there were mixed findings of an association between outdoor play and neighborhood incivilities(2, 3).” “…while the presence or quality of formal outdoor facilities (e.g., play grounds, school yards) was unrelated to outdoor play(4).”

4. **Make it clearer earlier that the paper is only about young children under 7.**

See response to Editor’s comment 2.

5. **On page 7 I assume the perceptions of safety being measured are parents' perceptions. Can this be made clearer.**

The text has been edited on page 7 to make this clearer.

6. **ON page 12 the authors critique urban sprawl but say there are no studies of the relationship between sprawl and child development. In fact "sprawl" could potentially be good for children giving them access to larger yards and possibly undeveloped nearby areas they can explore. It might be good to note the potential benefits of such areas—again substantiating the authors' call for more research. Also suburban developments come in a lot of flavors, time periods, etc from high density employment centers to ranchettes. Some more acknowledgement of this variety rather than a categorization into "high density living" vs "urban sprawl" (table 3) would be helpful.**

The text on page 13 (paragraph 3) has been edited to reflect the potential benefits of urban sprawl in terms of increased yard space. Table 3 Recommendations for further research have been edited to acknowledge the need for further research to investigate how different residential morphologies impact early child health and development.

7. **Tables 1 and 2 need headings that make it a lot clearer as to how they are different.**

See response to Editor comment 3.

8. **Clearly social factors that influence children's movement in and around neighbourhoods are more complex than used here as a number of studies using qualitative work unpack (e.g Kraftl et al. 2013; Ergler et al. 2013; Mackett et al. 2008). Although your study was not interested in this fine grained understanding these studies were after, it should at least have acknowledged under the limitations that you had only a very narrow focus on the social environment.**

The study limitations (page 15) highlights that this review focused on the neighborhood physical environment and that future reviews may wish to also summarize evidence of the influence of the neighborhood social environment and neighborhood level socio-economic factors on early child health and development.

**Reviewer #2:**

1. **I wonder though whether some relevant literature from the physical activity and public health field may have been missed in the introduction and literature review.**

Please see response to Editor’s comment 1.
2. **Abstract - Page 2 - Lines 12-15:** I suggest to revise to: Parents' perceptions of neighbourhood safety were positively associated with children's social-emotional development and general health.

This edit has been made.

3. **Introduction – Page:** Generally, I suggest to be specific upfront about what child age range you are referring to when using descriptions such as 'the early years', young children', early child development'. Do you mean preschool-aged children (2-5 years) or young primary school children (6-10 years), or both? I see in the Methods you mention that the literature review focused on children ≤ 7 years. I suggest to state the targeted age group earlier - in the Introduction.

Please see response to Editor’s comment 2.

4. **Lines 19-20:** suggest to use the term 'linguistic' rather than language to be consistent with the use of adjectives in this sentence, i.e. '..cognitive, social...and physical development.'

Language development is the process by which children come to acquire, comprehend, and use language during early childhood. Whereas, linguistics is the broader scientific study of languages(5). Thus we believe that the term language development is the more appropriate term to use in this specific instance. The sentence has been edited to help with consistency.

5. **Line 34:** Write 'showed' rather than 'show'.

This edit has been made.

6. **Lines 36-37:** What does 'developmentally at risk' mean? I suggest to be more specific here.

The text has been edited to include how ‘developmentally vulnerable’ has been defined in the Australian Early Development Census: “...(defined as children who score below the 10th percentile of the national AEDC population).”

7. **Lines 46-49:** This sentence would need some references given it states 'There is considerable evidence and current research activity around...'.

References have been added to support this statement (6-8).

8. **Lines 49-53:** I suggest to re-word the sentence 'However, the role played by the physical environment in which young children...' Maybe something like: However, the influence of the physical environment on young children's play and development is less well understood.

This edit has been made.

9. **Page 4 - Lines 1-2:** I do not quite agree with this statement. In physical activity and public health research, many studies have been conducted on the relationships...
between the physical environment (including built and natural environment) and children's physical activity, outdoor play, active travel, obesity (see some example references below). Whilst I acknowledge that the focus of this paper is on the relationship between the physical environment and 'broader child development domains' (physical health, social competence, cognitive skills etc), I think it is important to acknowledge this existing literature in the Introduction of the paper. Especially, since the authors refer a lot to children's physical activity and outdoor play as behaviours that facilitate early child health and development.


This sentence has been edited to be specific to early child development research. The Introduction and Discussion have been edited to acknowledge studies (reviews) on the physical environment and physical activity and play in children (see page 5, 11 and 12) and 8 additional studies have been added to Table 2.

10. Methods - Page 6 - Line 53 and subsequent paragraph: In line with my comment 9), I wonder why possibly relevant studies from the physical activity and public health field were not picked up in this literature search/review. Many studies/reviews from this field (see example references in comment 8) have investigated relationships between
the physical environment and children’s physical activity, outdoor play, active travel in the neighbourhood. Some studies examining relationships around child physical activity and outdoor play were included in this review (Table 1) but I think more studies might be relevant for this paper than currently included. Were these papers perhaps excluded because the focus is on young children \( \leq 7 \) years? Although, many of the included studies have a greater age range, e.g. Kuo & Taylor 2004 5-18 years; Fan & Chen 6-17 years, Sallis et al 6-17 years.

The reviewer is correct. Studies of the relationship between the physical environment and children’s physical activity and play were only included in this review if they focused on young children (i.e., \( \leq 7 \) years). The abstract and introduction have been edited to clarify this from the outset and the methods (eligibility criteria) states that ‘Articles focused exclusively on young children (\( \leq 7 \) years) and the home outdoor and neighbourhood physical environment.’ Studies examining active school travel were excluded because the focus of this review was on the home and neighborhood physical environment and not the school setting.

11. Results - Page 8 - Line 9 and line 36: ‘Four studies reviewed reported…’ 'Almost 60% \((n=14)\) of studies reviewed examined…' I suggest to delete the word 'reviewed'. This is a review paper so it is clear that the studies you refer to in the Results are reviewed studies. I would amend this throughout the manuscript.

These edits have been made.

12. Line 24: What is meant by developmental vulnerability? Could you explain this for readers not familiar with this terminology?

‘Developmental vulnerability’ has now been defined in the text.

13. Discussion - In general, a comparison of findings from this review with findings from similar reviews would be useful. Have other reviews been previously conducted that examined the relationships between the physical environment and children’s early child health and development, or behaviours relevant to a healthy child development? If so, I suggest to refer to them in the Introduction and Discussion. This review highlights gaps in the literature and makes recommendations for future research. But without a comparison with similar reviews I wonder whether these research gaps have not already been addressed in other reviews.

The introduction (page 5) and discussion (page 11 and 12) have been edited to make reference to reviews of the relationship between the physical environment and behaviors (physical activity and play) relevant to child development. To our knowledge no other reviews have examined evidence of the relationship between the neighborhood physical environment and the home outdoor environment and early child health and development. The discussion text has been edited to acknowledge similarities with other reviews in relation to recommendations for future research (e.g., need for objective measures of the physical environment). We believe that all other recommendations for future research have not been addressed in other reviews and are unique and specific to early child development.
We trust that the changes made are satisfactory and that you now regard this manuscript suitable for publication in Health & Place. Queries and correspondence related to this paper can be directed to Asst/Prof Hayley Christian, either by email (hayley.christian@uwa.edu.au) or telephone (+618 6488 8501).

Yours sincerely,

Asst/Prof Hayley Christian

References:

The influence of the neighborhood physical environment on early child health and development: A review and call for research
ABSTRACT

This review examines evidence of the association between the neighborhood built environment, green spaces and outdoor home area, and early (0-7 years) child health and development. There was evidence that the presence of child relevant neighborhood destinations and services were positively associated with early child development domains of physical health and wellbeing and social competence. Parents’ perceptions of neighborhood safety were positively associated with children’s social-emotional development and general health. Population representative studies using objective measures of the built environment and valid measures of early child development are warranted to understand the impact of the built environment on early child health and development.

Keywords: Neighborhood, Environment, Child development, Child Health, Play.

Word count: 3556 (text without reference list)
INTRODUCTION

Healthy child development is an enabler of human capability allowing children to reach maturity and participate in economic, social and civic life(1, 2). Child development involves the biological, psychological and emotional changes that occur between birth and adolescence(3). The main areas of development include cognitive, social and emotional, speech and language, and fine and gross motor skills(4-7). Neural pathways in the brain are established in early childhood through movement and sensory stimulation(8), highlighting the importance of play, social interaction and physical activity for children’s cognitive, social-emotional, physical and language development(9-14).

The early years is a critical stage of development for children because it is the time when the foundations for health, emotional well-being and life success are laid(15). National progress measures of early child development are increasingly being used by countries such as Canada and Australia to track key developmental domains in the early years(16-18). Results from the Australian Early Development census (AEDC) showed that communities (suburbs) vary significantly in the proportion of children who are developmentally vulnerable (defined as children who score below the 10th percentile of the national AEDC population)(19). Addressing these disparities in developmental vulnerability requires a better understanding of the determinants of such variability(20).

There is considerable evidence and current research activity around the genetic, biological, familial and physiological influences on early child development(4, 8, 21). However, the influence of the physical environment on young children’s development is less well understood(22-24). The ecological model of development acknowledges that individuals should be studied within the contexts of which development occurs(25). These contexts
include family and friends, childcare/school, and the community/neighborhood(24). The outdoor home and neighborhood physical environments are important components of the neighborhood environment and to date have received the least research focus and enquiry in the field of child development research.

The family home is the most proximate environmental influence on a young child’s development and where they spend a large amount of time. While the negative impact of poor or overcrowded housing conditions on children’s health is well documented(26, 27), much less is understood about the impact of the home outdoor space on early child health and development(28). For instance, a yard provides young children with space to play, be active, explore and be stimulated, all of which are important for healthy child development(29, 30).

In contrast, children living in higher density housing have limited access to private open space, thus the accessibility and design of public open space is particularly important(31, 32). Beyond the immediate home, the characteristics of the surrounding natural and built environments (i.e., places and spaces created or modified by people), can provide important resources and exposures relevant for early child health and development(5). The physical design and characteristics of the neighborhood environment are well established influences on a range of social and health outcomes among adult populations(33-38). Potential developmentally salient physical characteristics of neighborhoods include access to and the quality of local facilities and services (e.g., recreation centers and libraries), retail (e.g., food outlets), recreational opportunities (e.g., parks and nature), street traffic, public transportation, and the physical quality of child-related care, educational and health care facilities(39, 40).
Moreover, the relationship between the neighborhood and outdoor home physical environment and early child health and development may be mediated by ‘behaviors’ that facilitate early child health and development (e.g., play, physical activity, social interaction and exploration and stimulation). Reviews of the correlates of children’s physical activity and outdoor play indicate that built environment features such as walk/bicycle paths, presence of cul-de-sac roads, access to parks, recreational facilities, other local destinations and public transport are positively associated with children’s physical activity, while high traffic exposure and crime are negatively associated with children’s physical activity (41-44). However very few studies focus on young children (i.e., ≤7 years) or consider the effect of the outdoor home environment on young children’s physical activity. Nevertheless, they provide guidance as to the pathways through which the built environment influences early child development. For example, neighborhoods characterized by high street traffic and a lack of local attractive parks may restrict children’s opportunities for play and interaction with other children in common play spaces such as the front yard and local park. A reduction in young children’s opportunities for play and social interaction negatively impacts on their social-emotional competence (12, 14, 45). Figure 1 depicts the theoretical pathway through which the neighborhood and outdoor home physical environment can facilitate or constrain opportunities for play, physical activity, social interaction and exploration and stimulation which are important ‘behaviors’ for domains of early child health and development.

This paper reviews evidence of the relationship between early (0-7 years) child development domains of physical health, social competence, emotional maturity, and language and
cognitive skills and: 1) the neighborhood built environment (e.g., residential density, safety from traffic and access to goods and services); 2) neighborhood green spaces (e.g., nature access, parks); and 3) the home outdoor area (e.g., presence of yard). The evidence is summarized to provide explanatory context to population trends in early child health and development (as measured by indices such as the Early Development Index). This paper provides recommendations to guide future empirical research of the impact of the neighbourhood environment on early child health and development (46, 47).

METHODS

The literature was searched for articles focused exclusively on young children (≤7 years) and the home outdoor and neighbourhood physical environment. A number of electronic data bases were searched for relevant published articles including: Medline; PubMed; ProQuest social science journals; ScienceDirect; Google Scholar; and PsychInfo (Figure 2). The search strategy consisted of a key word search using ‘child’ AND either ‘development’, ‘cognitive’, ‘social’, ‘emotion’, ‘communication’, ‘language’, ‘physical’, ‘play’, ‘physical activity’, ‘wellbeing’ AND either ‘built environment’, ‘neighbourhood’, ‘environment’ ‘urban environment’, ‘city’, ‘place’, ‘traffic’, ‘safety’, ‘land use’, ‘street connectivity’, ‘density’, ‘destination’, ‘facilities’. To find articles on the home outdoor area and green spaces, and child development the search was repeated using the same keywords listed above, in the same order using AND either ‘home environment’, ‘home’, ‘yard’, ‘outdoor space/area’, then subsequently AND either ‘nature’, ‘green space’, ‘greenness’, ‘public open space’, ‘park’. Article titles and abstracts were examined for appropriateness for full-text review. The reference lists of the selected articles were examined for additional eligible articles.
Journal articles that met the following criteria were included: Published in English in the last 30 years (between 1982 and March 2013); quantitative; peer reviewed; full text; child health and development focus; physical environment related (Figure 2). Articles that examined the physical environment within childcare or school-based settings (including travel to school) were excluded as were articles that exclusively examined neighbourhood social environment factors (e.g., collective efficacy) or neighbourhood level socio-economic factors (e.g., income).

A total of 32 articles met the inclusion criteria. Evidence of the association between the neighborhood physical environment and early child health and development were grouped into four categories: 1) Safety; 2) Access to child-relevant destinations and services; 3) Green spaces; and 4) Other neighborhood features (including housing density, quality of streets and neighborhood facilities, outdoor home area). Evidence of how neighborhood characteristics facilitate or constrain opportunities for play, physical activity, social interaction, exploration and stimulation (i.e., the behaviors through which the neighborhood physical environment is likely to influence early child health and development) are also presented.

RESULTS

Studies were mostly conducted in the USA, Australia and Europe with just over two thirds (69%) examining the behaviors (e.g., outdoor play and physical activity) through which children develop social-emotional competence, language and communication skills, rather than domains of early child development per se. Table 1 includes studies of the neighborhood
physical environment and domains of early (≤7 years) child health and development and table 2 includes studies of the neighborhood physical environment and the behavioral facilitators (play & physical activity) of early (≤7 years) child health and development.

____________________________________

INSERT TABLES 1 & 2

____________________________________

Safety

The most studied neighborhood environmental correlate was parent perceived safety. There were some evidence that parent perceptions of neighborhood safety are associated with young children’s social and emotional behavior (48-50) and general health (51, 52), even after adjustment for socio-demographic factors. For example, in a large Australian study of 4-5 year olds, children’s conduct problems were associated with parent perceptions of poor neighborhood safety (p<0.01) and parent perceptions of neighborhood cleanliness were associated with pro-social behavior (p<0.001) (48). A single study examining the association between parent perceived neighborhood safety and children’s cognitive development found no association (53). In young children, the amount of outdoor play as well as the time spent outside unaccompanied at the front of the house or on the street was negatively associated with street traffic (54, 55), however most studies reported no association between features of neighborhood safety (e.g., safety from traffic and crime) and measures of outdoor play and physical activity (56-61).

Access to child-relevant destinations and services

Four studies reported a significant association between domains of early child development and the presence of child relevant neighborhood destinations (e.g., recreation center, library, school) and services (e.g., child care centers) (49, 51, 62, 63). A large US study of 22,797
children 1-5 years found that limited perceived access to amenities (recreation/community center, library, sidewalks, park/playground) was associated with less time spent in peer play and fewer family outings(49). Furthermore, in Australia, differences in developmental vulnerability (children who score < 10th percentile of the national AEDC population) across states and territories existed even after adjusting for socio-demographic factors and some of these differences were explained by the different mix of services that support children and families from birth to school age(62).

**Green spaces**

Two thirds (n=22) of the studies examined the relationship between neighborhood green spaces and early child health and development and related behaviors, with most reporting a positive association. Most of these studies examined outdoor play and/or physical activity. Overall, outdoor play and physical activity in the early years was positively associated with neighborhood greenness(64, 65), access to nature(66), green public open space(67, 68), parks(69) and playgrounds(70, 71). In an observational study of 262 children aged 3-12 years, levels of play in barren spaces were about half as much as in spaces with trees and grass(67).

Fewer studies examined the relationship between green spaces and domains of early child development, however there was some evidence to suggest that green spaces may be important for young children’s cognitive(72, 73) and motor(9, 66, 74) development. A small US study of low-income families found that following relocation to a new home, children whose homes improved the most in terms of greenness (amount of nature in yard viewed from house windows) tended to have the highest levels of cognitive functioning following the move(72). Findings also demonstrate the influence of landscape features on young children’s motor development. In a number of related quasi-experimental studies of 5-7 year olds
(n=75), Fjørtoft showed that children provided with a natural landscape (forest) in which to
play, experienced a significant increase in motor fitness, balance and coordination compared
with children who played only in traditional outdoor playgrounds(9, 66, 74).

Other neighborhood features

Housing density

High density housing has the potential to positively impact early child development through
increased opportunities for social interaction between neighbors and potentially greater
density of proximate amenity and services. However, it may also constrain opportunities for
play because the lack of private and public indoor and outdoor space limits children’s ability
to play(27, 75). Only one study examined the impact of type of residence on young children’s
outdoor play. In a large sample (n=2173) of 4-6 year olds, Aarts and colleagues reported that
living in a flat or apartment was associated with less outdoor play for girls (relative rate
(RR)=0.73; 95%CI=0.59-0.89) but not boys(68). Five studies examined the impact of
residential density on young children’s outdoor play and physical activity(55, 68, 76-78) with
three studies showing no association(55, 68, 76) No studies examined the effect of
residential density (either high density living or urban sprawl) on domains of early child
development.

Quality of streets and neighborhood facilities

One of the few studies to comprehensively objectively measure the neighborhood built
environment, reported a positive association between outdoor play and the presence of
informal play areas such as sidewalks (RR=1.44-1.66; p<0.05)(55). In the same Dutch study,
less connected streets (as measured by presence of roundabouts) and street lighting was
associated with less outdoor play in boys only (RR=1.14; 95% CI=1.07-1.22 and RR=0.78;
95% CI=0.97-0.86, respectively) whilst the presence or quality of formal outdoor facilities (e.g., play grounds, school yards) was unrelated to outdoor play(55). In a 1995 Swiss study, the amount of time five year old children spent outside unaccompanied at the front of the house or on the street was positively associated with perceived attractiveness of the neighborhood surroundings(54). No studies in this review examined the relationship between neighborhood walkability or liveability, street connectivity, sidewalks, lighting, transit, and aesthetics and domains of early child development such as language, cognitive and communication skills.

*Outdoor home area*

The outdoor home environment (i.e., front/backyard) is a particularly important space that provides opportunity for young children to play, explore and be active. Only three studies examined this relationship(68, 79, 80). One study found that not having a garden at home where children can play resulted in more outdoor play in 4-6 year old Dutch girls(68). In contrast a small Australian study identified that the home outdoor space may be important for providing equipment for facilitating play and physical activity and developing motor skills(79).

**DISCUSSION**

This review examined 32 quantitative studies of the relationship between the neighborhood physical environment and early child health and development. There was strong empirical evidence that neighborhoods which are safe from traffic and which have green spaces (i.e., nature, public open space, parks, playgrounds) are associated with behaviors (i.e., outdoor play and physical activity) that facilitate early child health and development. These findings support previous reviews focused on older aged children(41, 42, 81). There was also evidence
that the presence of child relevant neighborhood destinations (e.g., recreation center, library, school) and services (e.g., child health) are positively associated with the developmental domains of physical health and wellbeing and social competence, and negatively associated with children’s vulnerability to developmental delay. Finally, there was some evidence that parent’s perceptions of neighborhood safety were positively associated with young children’ social-emotional development and general health.

In line with other reviews of the relationship between the physical environment and children’s physical activity(41-43), our review found that many features of the neighborhood environment have not been objectively examined to determine their influence on early child health and development. Moreover, in many of the studies, the neighborhood built environment was not the primary focus of the paper and was one of several correlates of child development examined. Further research is needed to test the proposed relationships and pathways between the home and neighborhood built environment, the behaviors that facilitate children’s development as well as specific early child development outcomes(5). Moreover, this review highlights that the neighborhood physical environment may be more important for some domains of early child health and development (e.g., physical health and well-being and social competence) than others (e.g., language and communication skills).

Our review did not identify any empirical studies examining the influence of the presence and quality of nature and green spaces on domains of early child health and development. Yet, green spaces are important because of the types of play facilitated in these environments. Children’s play in natural environments is more diverse, imaginative, and creative than children’s play in other settings(82). Further research is required to examine the effect of green spaces on early child health and development and to investigate if the physical activity
benefits associated with access to high quality parks(83, 84) translate to young children’s physical, social and cognitive development.

This review highlights the need for cross-country comparison studies on the impact of high density living on early child health and development. High density living has been shown to be associated with older children’s classroom behavior and reading ability(85). Children living in high density houses may be exposed to high levels of traffic noise contributing to psychological distress, poorer auditory discrimination and lower reading ability(86, 87). Given preliminary evidence of the effects of high density living on older children’s development, further research of the impact of high density living on early child health and development is warranted.

Poorly designed urban environments can adversely impact on child development. Many Australian and US cities are characterized by urban sprawl(88, 89). New suburban neighborhoods on the urban fringe have reduced access to local shops, services and public transit(90, 91) which may result in children spending more time in cars commuting, more time indoors under adult-supervision and less time playing, exploring and interacting with people and their environment(92). Conversely, the characteristics of urban sprawl may provide children with other potential benefits. Single family detached houses provide children with greater access to a yard for daily play and activities. Paired with this, conventional suburban developments typically comprise more cul-de-sacs, thus minimizing traffic exposure within the vicinity of the home and providing safer near-home play spaces(41, 93-95). However, to date no empirical studies of the effects of urban sprawl on child development have been conducted and further research is required.
Future research should also consider the nexus between housing design and its implications for children’s outdoor play opportunities, health and development. Trends towards larger houses on smaller blocks have precipitated the demise of the once iconic suburban backyard, with observable repercussions for where and how children play(88). Moreover, yards are increasingly designed and landscaped as adult oriented spaces for entertaining and relaxation rather than as an inviting outdoor realm for children’s play and exploration(92). With less space available for outdoor play, time spent indoors has increased and this can reduce active play, exploration and physical activity, and increase sedentary behaviors such as television viewing, with possible negative consequences for early child health and development.

The limited (if any) private open space available in higher density residential areas adds weight to the importance of providing accessible child-appropriate public open spaces in the local neighborhood (e.g., apartment grounds and nearby parks).

This review has identified a number of plausible hypotheses that require testing (Table 3). There exists opportunity in at least two countries (Australia and Canada) to comprehensively examine the influence of features of the neighborhood built environment on early child health and development. At a population level, Canada and Australia have both established a comprehensive national progress measure of early child health and development(16-18). Potential influences such as the built environment must be investigated to better inform strategies and programs for early intervention to improve the health and developmental trajectory of children. A summary of this review’s recommendations for future research are outlined in Table 3.

INSERT TABLE 3 ABOUT HERE
Study limitations

A limitation of this review may be its focus on the early years rather than all children, however, the early years is a critical stage of development for children and if not supported and nurtured could have significant ramifications for later life. This review focused on the neighborhood physical environment. Future reviews may wish to also summarize evidence of the influence of the neighborhood social environment and neighborhood level socio-economic factors on early child health and development. A strength of this study was the inclusion of the home outdoor space as an important provider of opportunities and constraints for early child health and development. However, this review did not specifically include studies of early child health and development-related behaviors and outcomes in settings such as childcare and school.

Conclusions

Our review found evidence of a positive association between young children’s outdoor play and physical activity and the presence of safe and green neighborhood places to be active. There was evidence that the presence of child relevant neighborhood destinations and services are positively associated with child development domains of physical health and wellbeing and social competence, and negatively associated with children’s vulnerability to developmental delay. There was also some evidence that parent’s perceptions of neighborhood safety were positively associated with young children’ social-emotional development and general health. However, this review identified an absence of population-level studies examining the impact of: a) urban sprawl; b) high density living, outdoor space and traffic exposure; c) the outdoor home environment; and d) nature and parks on early child health and development. This review highlights the need for population-level studies examining the role of the individual as well as the cumulative exposure of neighborhood
environment features upon young children’s health and development. These studies need to include objective measures of the built environment that are specific to the early years. Future research needs a more thorough analysis, both conceptual and applied, about how young children’s well-being is affected by different built form and the long term impact of changes to the built environment on early child health and development. This research would provide the evidence-base to inform the planning, design, building and retro-fitting of neighborhoods that are sensitive to children’s needs.
Acknowledgements

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Competing interests

No competing financial interests were declared by the authors of this paper.
**Reference list**


The influence of the neighborhood physical environment on early child health and development: A critical review and call for research

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Fax: 61-8-6488-1188
Table 1. Studies of the neighborhood physical environment and domains of early (≤7 years) child health and development

<table>
<thead>
<tr>
<th>Author; Country; Year&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Study design</th>
<th>Sample: Size; Age; Gender</th>
<th>Built environment measures (Subjective/Objectively measured)</th>
<th>Early child health and development measures</th>
<th>Key findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barnett et al (1) Australia 2012</td>
<td>Cross sectional</td>
<td>76; Mean age 4.1 years; 45% boys</td>
<td>Subjective (parent-report): Visits to play spaces (local playground, playground in another area, parks/ovals with no play equipment, sports venue, specialist outdoor activity center, indoor play center), Toys/equipment at home suitable for outdoor physical activity.</td>
<td>Gross motor (locomotor and object control) skill development.</td>
<td>Having skill-related equipment present in the home play space was positively associated (non-significant) with locomotor and object control skill after age adjustment. A supportive environment in terms of toys and equipment may help develop motor skill competence. Motor skill correlates differ according to skill category and are context specific with child level correlates appearing more important. Visits to local play spaces not associated with motor skill development.</td>
</tr>
<tr>
<td>Brinkman et al (2) Australia 2012</td>
<td>Cross sectional</td>
<td>261147; 5 years; 45% boys</td>
<td>Objective: Maternal and child health and preschool services available by Australian state and territory.</td>
<td>Developmental vulnerability for 5 developmental domains (Physical wellbeing, social competence, emotional maturity, language and cognitive skills, communication skills and general</td>
<td>After adjusting for socio-economic and demographic factors, differences existed in developmental vulnerability. Some of these differences could be explained by the different mix of services that support children and families from birth to school age across Australian states and territories.</td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>N</td>
<td>Age</td>
<td>Gender</td>
<td>Objective</td>
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<tr>
<td>Edwards &amp; Bromfield (3) Australia 2009</td>
<td>Cross sectional</td>
<td>4983; 4-5 years; 51% boys</td>
<td>Objective: Neighborhood physical disorder</td>
<td>Subjective (parent-report): Neighborhood facilities (parks and play spaces, street lighting, footpaths and roads, access to public transport, shops and basic services), Neighborhood safety and cleanliness</td>
<td>Social and emotional functioning: Pro-social behavior, Conduct problems</td>
</tr>
<tr>
<td>Fan &amp; Chen (4) USA 2012</td>
<td>Cross sectional</td>
<td>53023; 6-17 years; 51% boys</td>
<td>Subjective (parent-report): Neighborhood physical resources (sidewalks, park/playground, recreation/community center, library), Environmental threats (litter/garbage, poorly kept housing, vandalism), Collective efficacy (includes child safety)</td>
<td>General health status</td>
<td>Neighborhood physical resources, environmental threats and collective efficacy associated with children’s general health status and mediated by family functioning.</td>
</tr>
<tr>
<td>Kenney (5) USA 2012</td>
<td>Cross sectional</td>
<td>22797; 1-5 years; Gender not reported</td>
<td>Subjective (parent-report): Neighborhood amenities (sidewalks, park/playground, recreation/community)</td>
<td>Peer play, Parent initiated activities</td>
<td>Less time spent in peer play was associated with living in a neighborhood with the poorest physical conditions and limited amenities. Less family outings also associated with fewer neighborhood amenities.</td>
</tr>
<tr>
<td>Study/Year</td>
<td>Design</td>
<td>Sample Size</td>
<td>Sample Characteristics</td>
<td>Measures</td>
<td>Findings</td>
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<tr>
<td>Kuo &amp; Taylor (2004)</td>
<td>Cross-sectional</td>
<td>452; 5-18 years; 79% boys; formal ADHD diagnosis</td>
<td>Subjective (parent-report): Setting of 49 common after-school and weekend activities grouped as green outdoors, built outdoors, indoors</td>
<td>Attention-deficit/hyperactivity disorder (ADHD) symptoms</td>
<td>Green outdoor activities reduced ADHD symptoms significantly more than activities conducted in other settings (indoors or built outdoor), even when activities were matched across settings. Findings were consistent across age, gender, and income groups; community types; geographic regions; and diagnoses.</td>
</tr>
<tr>
<td>Miller &amp; Votruba-Drzal (2013)</td>
<td>Longitudinal</td>
<td>6050; 9 months-5 years; Gender not reported</td>
<td>Objective: Urbanicity (large urban, small urban, suburb, rural) Subjective (parent-report): Regular center-based, home-based, or parent-care</td>
<td>Academic (reading and math) skills</td>
<td>Children in large urban and rural areas entered kindergarten with less advanced academic skills than children in small urban areas and suburbs. Lower achievement for rural children was partly explained by increased use of home-based, rather than center-based, child care whilst at preschool.</td>
</tr>
<tr>
<td>Rosenberg et al (2007)</td>
<td>Cross-sectional</td>
<td>70;</td>
<td>Subjective (parent-report): Child’s</td>
<td></td>
<td>Environmental factors contribute to frequency of</td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>Sample Size</td>
<td>Mean Age</td>
<td>Boys</td>
<td>Environment Restriction</td>
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<tr>
<td>al(9) Canada 2011</td>
<td>Cross-sectional</td>
<td>Mean age 5.2 years; 56% boys</td>
<td>Environment restriction (35 physical and human environmental factors at home, neighborhood and in the educational setting e.g., distance between home and recreational center).</td>
<td>Participation pattern in: Activities of Daily Living - ADL (e.g. dressing); Instrumental ADL (e.g. setting the table); play; leisure; social participation; and education participation in everyday activities such as play, leisure, social participation, education and activities of daily living. Environmental factors not associated with participation diversity, enjoyment, independence or parental satisfaction.</td>
<td></td>
</tr>
<tr>
<td>To et al(10) Canada 2001</td>
<td>Cross-sectional</td>
<td>123350; 0-3 years; 61.4% boys</td>
<td>Subjective (parent-report): Neighborhood safety and problems</td>
<td>Poor developmental attainment (motor, social and development scale)</td>
<td>In children aged 2-3 years, living in a neighborhood perceived as being low in safety was associated with 57% higher odds of poor developmental attainment. No association was found for children aged 1 year.</td>
</tr>
</tbody>
</table>
Table 2. Studies of the neighborhood physical environment and young children’s (≤7 years) play & physical activity.

<table>
<thead>
<tr>
<th>Author; Country; Year&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Study design</th>
<th>Sample: Size; Age; Gender</th>
<th>Built environment measures (Subjective/Objectively measured)</th>
<th>Play &amp; physical activity measures</th>
<th>Key findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aarts et al (11) The Netherlands 2010</td>
<td>Cross sectional</td>
<td>6470; 4-12 years (34% 4-6 years, 49% boys)</td>
<td>Subjective (parent-report): Neighborhood type, Type of residence, Home garden, Residential density, Presence of neighborhood green or water, Traffic, Sidewalks &amp; bike lanes, Street connectivity, Destinations &amp; facilities, Satisfaction with play facilities, public and green space</td>
<td>Outdoor play (parent report minutes/week)</td>
<td>Associations with outdoor play (4-6 year olds): Living in a city green or rural area or town center (+, girls) Living in a semidetached/duplex residence or rental property (+, boys) Living in a detached residence or flat/apartment (-, girls) Presence of water (+, boys) Absence of a garden (+, girls) No association was found for residential density, presence of neighborhood green, traffic, sidewalks or bike lanes, street connectivity, destinations/facilities or satisfaction with play facilities, public or green space.</td>
</tr>
<tr>
<td>Aarts et al (12) The Netherlands 2012</td>
<td>Cross sectional</td>
<td>3651; 4-12 years (34% 4-6 years, 51% boys)</td>
<td>Objective (observation): Residential density, Land use mix, House maintenance, Outdoor play facilities, Public space (green and water), Sidewalks and bike paths, Street connectivity, Traffic and crime safety</td>
<td>Outdoor play (parent report minutes/week)</td>
<td>Associations with outdoor play (4-6 year olds): Sidewalks (+, boys and girls) Street connectivity (-, boys and girls) Pedestrian crossings (+, boys and girls) Home zones (+, boys) Street lighting (-, boys) Residential density, land use mix, house maintenance, outdoor play facilities, public space, bike paths and crime safety not associated with outdoor play.</td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>Sample Size</td>
<td>Age Range</td>
<td>Gender</td>
<td>Subjective Measures</td>
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<tr>
<td>Bringolf-Isler et al (2010)</td>
<td>Cross-sectional</td>
<td>1081</td>
<td>6-14 years (24% 6-7 years); 51% boys</td>
<td></td>
<td>Subjective (parent-report): Traffic; Garden/green space; Crime; Local play spaces</td>
</tr>
<tr>
<td>Burdette &amp; Whitaker (2005)</td>
<td>Cross-sectional</td>
<td>3141</td>
<td>3 years; 53% boys</td>
<td></td>
<td>Subjective (mother-report): Neighborhood safety=Neighborhood Environment for Children Rating Scales (how often see loitering adults, gang activity, drunks or drug dealers “hanging around,” and disorderly or misbehaving groups of youths or adults in neighborhood)</td>
</tr>
<tr>
<td>Chuang et al (2013)</td>
<td>Cross-sectional</td>
<td>706</td>
<td>3-5 years; Gender not reported; Low SES</td>
<td></td>
<td>Subjective (parent-report): Yard or open play space, Usable play equipment (swings, slides climbing, etc.) in yard, Traffic, Parks, walking trails or</td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>Participants</td>
<td>Objective (GIS):</td>
<td>Objective (observation):</td>
<td>Conclusion</td>
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<tr>
<td>Copperman &amp; Bhat (16)</td>
<td>Cross sectional</td>
<td>1104; 5-17 years; Gender not reported</td>
<td>Outdoor/indoor recreation centers within safe walking distance of home, Street live in has a sidewalk/paved path</td>
<td>No associations observed with perceived traffic, or perceived parks, walking trails or outdoor/indoor recreation centers within safe walking distance of home.</td>
<td></td>
</tr>
<tr>
<td>De Vries et al (17)</td>
<td>Cross sectional</td>
<td>448; 6-11 years; 48% boys</td>
<td>Zoning (urban/rural), No. restaurants &amp; food stores, Multi-family housing units, Commercial/industrial acreage, Transportation network (average block size area, miles of bike lanes)</td>
<td>Walking for recreation (parent-report trips/week)</td>
<td>Active recreation associated with living in an area with high proportion of commercial/industrial acreage and multi-family units. Active recreation associated with living in an area with larger average block size area (lower residential density). Zoning and food outlets not associated with weekend recreational activity.</td>
</tr>
<tr>
<td>Fjortoft &amp; Quasi</td>
<td>Quasi section</td>
<td>75 (61%)</td>
<td>Play</td>
<td>No built environment measures were significantly associated with walking for recreation.</td>
<td>Children provided with a natural landscape in...</td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>Sample Size</td>
<td>Age</td>
<td>Gender</td>
<td>Objective (GIS)</td>
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<tr>
<td>Saegie; Fjortoft; Forjtoft</td>
<td>Experimental group</td>
<td>5-7 years; 51% boys</td>
<td>Natural environment vs. traditional playground (slope, roughness, mapped vegetation, function, habitat change)</td>
<td>Motor development (motor fitness)</td>
<td>which to play, had a statistically significant increase in motor fitness, balance and coordination. Landscape features influence physical activity, play and motor development in young children.</td>
</tr>
<tr>
<td>Frank et al; Kerr et al</td>
<td>Cross-sectional</td>
<td>3161; 5-20 years; (27% 5-8 years); 50% boys</td>
<td>Objective (GIS): Residential density, Intersection density, Land use mix, Recreation space, Commercial space</td>
<td>Walking (in last 2 days, parent-report)</td>
<td>Living near (within 1km from home) recreation spaces was associated with walking in 5-8 year olds. Among low-income and non-white youth, variables showed weaker associations. Residential density, intersection density, land use mix, and commercial space were not associated with walking in 5-8 year olds.</td>
</tr>
<tr>
<td>Grigsby-Toussaint et al</td>
<td>Cross-sectional</td>
<td>365; 2-5 years; 52% boys</td>
<td>Objective (GIS): Greenness (Normalized Difference Vegetation Index-NDVI)</td>
<td>Outdoor play time (parent-report minutes/average day)</td>
<td>Higher levels of neighborhood greenness associated with higher levels of outdoor play time—one unit increase in neighborhood greenness increased outdoor playtime by 3 minutes.</td>
</tr>
<tr>
<td>Huttenmoser</td>
<td>Cross-sectional</td>
<td>926; 5 years; Gender not reported</td>
<td>Subjective (parent-report): Street traffic, Neighborhood attractiveness</td>
<td>Time spent outdoors, independent outdoor play, social interaction (Number playmates) and motor skills</td>
<td>Time spent outside unaccompanied (front of house or on street) associated with street traffic, dangerousness and perceived attractiveness of living surroundings. Time spent outside unaccompanied associated with improved motor skill development. Children living on small residential street with little and slow-moving traffic had more friends in their neighborhood.</td>
</tr>
<tr>
<td>Authors</td>
<td>Study Type</td>
<td>Sample Size</td>
<td>Age</td>
<td>Gender</td>
<td>Study Design</td>
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<tr>
<td>Kimbro et al (25)</td>
<td>Cross-sectional</td>
<td>1822; 5 years; 51% boys</td>
<td>Subjective (mother-report): Public housing, Type of housing, Fearful about child playing outdoors due to violence</td>
<td>Outdoor play (parent-report hours/weekday)</td>
<td>Children living in public housing had more hours of outdoor play. Neighborhood physical disorder associated with more outdoor play. Children living in an apartment had less hours of outdoor play. Mother perceived fear about child playing outdoors not associated with outdoor play.</td>
</tr>
<tr>
<td>Lovasi et al (26)</td>
<td>Cross-sectional</td>
<td>428; 2-5 years; 47% boys; Low income</td>
<td>Objective (GIS): Population density, Land use mix, Transit density, Intersection density, Crime, Traffic volume &amp; pedestrian accidents, Sidewalks, Aesthetics, Tree density, Park &amp; playground access</td>
<td>Physical activity (accelerometer measured-mean counts/min)</td>
<td>Land use mix, traffic safety and tree density associated with physical activity. No association between population density, crime, intersection density, sidewalks, aesthetics, or park/playground access and physical activity.</td>
</tr>
<tr>
<td>Marino et al (27)</td>
<td>Cross-sectional</td>
<td>2529; 3-4 years; 51% boys</td>
<td>Subjective (parent-report): Yard around home, Park/playground near home, Visited park/playground</td>
<td>Home outdoor play (parent-report hours/weekday)</td>
<td>Outdoor play at home associated with having a yard near home to play in and visiting a park or playground in the last month. Having a park or playground within walking distance of home not associated with home outdoor play time.</td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>Sample Size</td>
<td>Age &amp; Gender</td>
<td>Intervention/Measure</td>
<td>Findings</td>
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</tr>
<tr>
<td>Quigg et al (28)</td>
<td>Intervention</td>
<td>156 (completed follow up); 5-10 years; 46% boys</td>
<td></td>
<td>Intervention (natural experiment): Upgrade of community playgrounds. Physical activity (accelerometer measured – mean total daily)</td>
<td>For children in the intervention compared to the control community, total activity increased for those with BMI z-scores less than 0.4 and decreased for those with BMI z-scores greater than 0.4. No evidence that children in the intervention community had a statistically significant difference in physical activity, compared to those living in the control community.</td>
</tr>
<tr>
<td>Roemmich et al (29)</td>
<td>Cross sectional</td>
<td>59; 4-7 years; 54% boys</td>
<td></td>
<td>Objective (GIS): Housing density, Street connectivity, Park area, Recreational area, Residential area Physical activity (accelerometer measured - mean counts/day)</td>
<td>Neighborhoods with increased housing density and a greater proportion of park area associated with greater physical activity. No association with street connectivity or proportion of recreational or residential area.</td>
</tr>
<tr>
<td>Sallis et al (30)</td>
<td>Cross sectional</td>
<td>346; Mean 4.4 years; 50% boys; 58% Mexican-American</td>
<td></td>
<td>Subjective (parent-report): 13 play spaces within walking distance of home (e.g., friend’s yard, playground), Outdoor and indoor toys. Physical activity in the home (kcal/kg/min) Time outdoors (% intervals). Observation</td>
<td>Three environmental variables (convenient play spaces, time and frequency in play spaces) associated with physical activity. Time outdoors associated with physical activity. Outdoor toys not associated with physical activity.</td>
</tr>
<tr>
<td>Sallis et al (31)</td>
<td>Cross sectional</td>
<td>781; 6-17 years; (18% 6-8 years, 51% boys)</td>
<td></td>
<td>Subjective (parent-report): Neighborhood characteristics (Presence of sidewalks, heavy traffic, hills, street lights, unattended dogs, enjoyable scenery, see people walking Vigorous physical activity (accelerometer measured – minutes/day)</td>
<td>No neighborhood physical environment or park-related variables were associated with young children’s vigorous physical activity.</td>
</tr>
</tbody>
</table>
for exercise, high crime),
Park characteristics (Access to playgrounds, parks, or gyms; distance in miles from home to park; safety of nearest park),
Safe to play outdoors without adult supervision

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Sample Size</th>
<th>Mean Age</th>
<th>Sex Distribution</th>
<th>Assessment Methodology</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spurrier et al (32)</td>
<td>Cross-sectional</td>
<td>280; Mean 4.8 years; 50% boys</td>
<td>Objective (observation): Size of backyard, No. pieces outdoor play equipment, Paved area for bike riding</td>
<td>Outdoor playtime around the home and other outdoor areas (parent-report)</td>
<td>Size of backyard and amount of outdoor play equipment associated with more outdoor play. Home paved area for bike riding and perceived presence of community facilities not associated with outdoor play.</td>
<td></td>
</tr>
<tr>
<td>Tappe et al (33)</td>
<td>Cross-sectional</td>
<td>724; 6-11 years; 51% boys</td>
<td>Objective (GIS): Walkability Index (intersection density, land use mix, retail floor area ratio),</td>
<td>Physical activity (accelerometer measured and parent-report)</td>
<td>Lower parent perceived street connectivity and higher perceived neighborhood aesthetics associated with more neighborhood physical activity. Perceived safety from crime and walking/cycling infrastructure associated with more physical activity in public open space. Perceived access to local destinations associated with total physical activity. Perceived access to play spaces associated with parent-report and accelerometer measured total physical activity. No association between physical activity objective measures of neighborhood walkability.</td>
<td></td>
</tr>
</tbody>
</table>
Taylor et al. (34)
USA 1998

Objective (observation):
Green outdoor spaces (64 urban public housing outdoor spaces) observed on 4 occasions (37 high and 27 low vegetation via aerial photos)

Play (functional, constructive, exploratory, rule-bound conventional), Creative play (pretend and rule-bound).

Observation

In barren spaces levels of play were approximately half as much as those found in spaces with more trees and grass. Incidence of creative play was significantly lower in barren spaces than in relatively green spaces.

Timperio et al. (35)
Australia 2004

Subjective (parent-report):
Traffic density, Road safety, Strangers, Sporting facilities, Public transport in the local area

Walking and cycling (parent-report frequency of trips to neighborhood destinations)

Boys whose parents believed there was heavy traffic in their area were almost three times more likely, and girls whose parents believed that public transport was limited in their area were 60% less likely than other children to walk or cycle at least three times per week. Parent perceptions about road safety, strangers and access to sporting facilities not associated with walking or cycling.

+ positive association; - negative association; * Full reference details for articles reviewed:

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Specific examples</th>
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</thead>
<tbody>
<tr>
<td>Test plausible research questions/hypotheses:</td>
<td>What is the impact of high density living, urban sprawl and other residential morphologies on early child health and development outcomes? Does the presence and quality of nature and green spaces influence early child health and development outcomes? What are the implications of housing design for children’s outdoor play opportunities, health and development? What are the role of individual as well as the cumulative exposures of neighborhood environment attributes upon young children’s health and development? How do behaviors that facilitate children’s development (i.e., play, physical activity, social interaction, exploration and stimulation) mediate the relationship between the neighborhood and outdoor home physical environment and early child health and development outcomes? How does the built environment interact with socio-cultural factors to influence early child health and development?</td>
</tr>
<tr>
<td>Develop theoretical model:</td>
<td>Further development and refinement of the theoretical model through which the outdoor home and neighborhood environment influence early child health and development. Include mediators such as parent perceptions and social-cultural factors.</td>
</tr>
<tr>
<td>Methodological issues:</td>
<td>Conduct large population representative studies across countries with different urban environments. Use valid and reliable population measures of early child health and development (e.g., Early Development Index). Use objective measures of the built environment (i.e., Geographic Information Systems derived measures). Use context-specific measures of the built environment that match child development-related behaviors and outcomes of interest (i.e., objective measures of traffic, crime and disorder vs. parent-report general measures of</td>
</tr>
</tbody>
</table>
neighborhood safety).

Conduct longitudinal studies to elucidate the built environment determinants of early child health and development outcomes and the long term impact of changes to the built environment on early child health and development.

Initiate interdisciplinary research and collaboration between researchers from the fields of child development, child psychology, population health, epidemiology, geography, urban planning and design and recreational planning.

Determine how to best delineate a ‘neighborhood’ in relation to early child development outcomes. Different features of the built environment may exert their influence at varying distances from a child’s home highlighting the importance of the scale of analysis.

| Intervention research and knowledge transfer: | Identify and test points for intervention and use the evidence-base to inform the planning, design, building and retro-fitting of neighborhoods in order to optimize healthy child development. |
Figure 1: Model of how the neighborhood physical environment may facilitate or constrain healthy child development.
Search of electronic databases: MEDLINE, PubMed, ProQuest social science journals, ScienceDirect, Google Scholar & PsychINFO

Limits: English language, peer-reviewed, published 1982-2013

Key words AND combinations:


AND one:

- Built environment
- Neighborhood
- Environment
- Urban environment
- City
- Place
- Safety
- Traffic
- Land use
- Street connectivity
- Density
- Destination
- Facilities

AND two:

- Nature
- Green space
- Public open space
- Park
- Greenness

AND three:

- Home
- Home environment
- Yard
- Outdoor

96 titles and/or abstracts assessed for inclusion in full text review

191 full text articles assessed for eligibility
- 89 from initial abstract search
- additional 102 from archives and reference lists

23 Excluded
- Books (2)
- Reports (5)
- Qualitative (7)
- Reviews (9)

136 Excluded
Articles that did not report:
- Child development AND physical environment IN children <7 years
Articles that reported:
- Child development and physical environment within childcare/school settings
- Child development and neighborhood social environment only
- Child development and neighborhood level socioeconomic factors only

32 full text articles included in review

Figure 2: Literature Search Strategy
Author/s:
Christian, H; Zubrick, SR; Foster, S; Giles-Corti, B; Bull, F; Wood, L; Knuiman, M; Brinkman, S; Houghton, S; Boruff, B

Title:
The influence of the neighborhood physical environment on early child health and development: A review and call for research

Date:
2015-05-01

Citation:
Christian, H; Zubrick, SR; Foster, S; Giles-Corti, B; Bull, F; Wood, L; Knuiman, M; Brinkman, S; Houghton, S; Boruff, B, The influence of the neighborhood physical environment on early child health and development: A review and call for research, HEALTH & PLACE, 2015, 33 pp. 25 - 36

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