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A review and call for research

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Corresponding Author: Dr. Hayley Christian, PhD

Corresponding Author's Institution: The University of Western Australia

First Author: Hayley Christian, PhD

Order of Authors: Hayley Christian, PhD; Stephen R Zubrick, PhD; Foster Sarah, PhD; Billie Giles-Corti, PhD; Fiona Bull, PhD; Lisa Wood, PhD; Matthew Knuiman, PhD; Sally Brinkman, PhD; Stephen Houghton, PhD; Bryan Boruff, PhD

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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.



THE UNIVERSITY OF  
WESTERN AUSTRALIA  
*Achieving International Excellence*

Centre for the Built Environment and Health  
The University of Western Australia  
M707, 35 Stirling Highway  
CRAWLEY WA 6009

T 6488 8501  
E hayley.christian@uwa.edu.au

CRICOS Provider Code: 00126G

Courier address: 55 Broadway, Nedlands

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 19<sup>th</sup> 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 ( $\leq 7$  years) child health and development

measures.’ ‘Table 2. Studies of the neighborhood physical environment and young children’s ( $\leq 7$  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/and 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 Krafft 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 the 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  $\leq 7$  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.*

- Krahnstoever Davison K, Lawson CT. Do attributes in the physical environment influence children's physical activity? A review of the literature, *International Journal of Behavioral Nutrition and Physical Activity* 2006, 3:19.
- Dunton GF, Kaplan J, Wolch J, Jerrett M, Reynolds Physical environmental correlates of childhood obesity: a systematic review. *Obesity Reviews* (2009) 10, 393-402.
- Ferreira I, Van der Horst K, Wendel-Vos W, Kremers S, van Lenthe FJ, Brug J. Environmental correlates of physical activity in youth - a review and update. *Obesity Reviews*. 2007 Mar;8(2):129-54.
- Heath GW, Brownson RC, Kruger J, Miles R, Powell KE, Ramsey LT, and the Task Force on Community Preventive Services. The Effectiveness of Urban Design and Land Use and Transport Policies and Practices to Increase Physical Activity: A Systematic Review. *Journal of Physical Activity and Health* 2006, 3, Suppl 1,S55-S76
- Panter JR, Jones AP, van Sluijs EM. Environmental determinants of active travel in youth: a review and framework for future research. *Int J Behav Nutr Phys Act.* 2008 Jun 23;5:34.
- Pont K, Ziviani J, Wadley D, Bennett S, Abbott R. Environmental correlates of children's active transportation: a systematic literature review. *Health & Place.* 2009 Sep;15(3):827-40.
- Committee on Environmental Health, Tester JM. The built environment: designing communities to promote physical activity in children. *Pediatrics.* 2009 Jun;123(6):1591-8.
- Grigsby-Toussaint DS, Chi SH, Fiese BH; STRONG Kids Project Writing Group. Where they live, how they play: neighborhood greenness and outdoor physical activity among preschoolers. *Int J Health Geogr.* 2011 Dec 14;10:66.
- Loptson K, Muhajarine N, Ridalls T; Smart Cities, Healthy Kids Research Team. Walkable for whom? Examining the role of the built environment on the neighbourhood-based physical activity of children. *Can J Public Health.* 2012 Jul 26;103(9 Suppl 3):eS29-34.
- Veitch J, Salmon J, Ball K. Individual, social and physical environmental correlates of children's active free-play: a cross-sectional study. *Int J Behav Nutr Phys Act.* 2010 Feb 2;7:11.

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:

1. Kiernan G, Axford N, Little M, Murphy C, Greene S, Gormley M. The school readiness of children living in a disadvantaged area in Ireland. *J Early Child Res*. 2008;6(2):119-44.
2. Burdette HL, Whitaker RC. A national study of neighborhood safety, outdoor play, television viewing, and obesity in preschool children. *Pediatrics*. 2005;116(3):657-62.
3. Kimbro R, Brooks-Gunn J, McLanahan S. Young children in urban areas: Links among neighborhood characteristics, weight status, outdoor play, and television watching. *Soc Sci Med*. 2011;72(5):668-76.
4. Aarts M-J, de Vries S, van Oers H, Schuit A. Outdoor play among children in relation to neighborhood characteristics: a cross-sectional neighborhood observation study. *Int J Behav Nutr Phys Act*. 2012;9(1):98-109.
5. Crystal D. *Linguistics*. England: Penguin Books; 1990.
6. Irwin L, Siddiqi A, Hertzman C. *Early Child Development: A Powerful Equalizer*. WHO's Social Determinants of Health. Vancouver, BC: Human Early Learning Partnership (HELP);2007.
7. Shonkoff J, Phillips DE. *Committee on Integrating the Science of Early Childhood Development. From Neurons to Neighborhoods : The Science of Early Childhood Development*. Washington, DC, USA: National Academies Press; 2000.
8. Hertzman C, Keating DP. *Developmental health and the wealth of nations: Social, biological, and educational dynamics*: Guilford Press; 1999.



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

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4 **ABSTRACT**  
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6 This review examines evidence of the association between the neighborhood built  
7 environment, green spaces and outdoor home area, and early (0-7 years) child health and  
8 development. There was evidence that the presence of child relevant neighborhood  
9 destinations and services were positively associated with early child development domains of  
10 physical health and wellbeing and social competence. Parents' perceptions of neighborhood  
11 safety were positively associated with children's social-emotional development and general  
12 health. Population representative studies using objective measures of the built environment  
13 and valid measures of early child development are warranted to understand the impact of the  
14 built environment on early child health and development.  
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32 **Keywords:** Neighborhood, Environment, Child development, Child Health, Play.  
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34 **Word count:** 3556 (text without reference list)  
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4 **INTRODUCTION**  
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6 Healthy child development is an enabler of human capability allowing children to reach  
7 maturity and participate in economic, social and civic life(1, 2). Child development involves  
8 the biological, psychological and emotional changes that occur between birth and  
9 adolescence(3). The main areas of development include cognitive, social and emotional,  
10 speech and language, and fine and gross motor skills(4-7).Neural pathways in the brain are  
11 established in early childhood through movement and sensory stimulation(8), highlighting the  
12 importance of play, social interaction and physical activity for children’s cognitive, **social-**  
13 **emotional, physical and language** development(9-14).  
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27 The early years is a critical stage of development for children because it is the time when the  
28 foundations for health, emotional well-being and life success are laid(15). National progress  
29 measures of early child development are increasingly being used by countries such as Canada  
30 and Australia to track key developmental domains in the early years(16-18). Results from the  
31 Australian Early Development census (AEDC) **showed** that communities (suburbs) vary  
32 significantly in the proportion of children who are developmentally **vulnerable (defined as**  
33 **children who score below the 10th percentile of the national AEDC population)(19).**  
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43 Addressing these disparities in developmental vulnerability requires a better understanding of  
44 the determinants of such variability(20).  
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50 There is considerable evidence and current research activity around the genetic, biological,  
51 familial and physiological influences on early child development(4, 8, 21). **However, the**  
52 **influence of the physical environment on young children’s development is less well**  
53 **understood(22-24).**The ecological model of development acknowledges that individuals  
54 should be studied within the contexts of which development occurs(25). These contexts  
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4 include family and friends, childcare/school, and the community/neighborhood(24). The  
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6 outdoor home and neighborhood physical environments are important components of the  
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8 neighborhood environment and to date have received the least research focus and enquiry **in**  
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10 **the field of child development research.**

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15 The family home is the most proximate environmental influence on a young child's  
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17 development and where they spend a large amount of time. While the negative impact of poor  
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19 or overcrowded housing conditions on children's health is well documented(26, 27), much  
20  
21 less is understood about the impact of the home outdoor space on early child health and  
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23 development(28). For instance, a yard provides young children with space to play, be active,  
24  
25 explore and be stimulated, all of which are important for healthy child development(29, 30).

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28 **In contrast, children living in higher density housing have limited access to private open**  
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30 **space, thus the accessibility and design of public open space is particularly important(31, 32).**

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

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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

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4 cognitive skills and: 1) the neighborhood built environment (e.g., residential density, safety  
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6 from traffic and access to goods and services); 2) neighborhood green spaces (e.g., nature  
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8 access, parks); and 3) the home outdoor area (e.g., presence of yard). The evidence is  
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10 summarized to provide explanatory context to population trends in early child health and  
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12 development (as measured by indices such as the Early Development Index). This paper  
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14 provides recommendations to guide future empirical research of the impact of the  
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16 neighbourhood environment on early child health and development(46, 47).  
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## 22 METHODS

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24 The literature was searched for articles focused exclusively on young children ( $\leq 7$  years) and  
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26 the home outdoor and neighbourhood physical environment. A number of electronic data  
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28 bases were searched for relevant published articles including: Medline; PubMed; ProQuest  
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30 social science journals; ScienceDirect; Google Scholar; and PsychInfo (Figure 2). The search  
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32 strategy consisted of a key word search using ‘child’ AND either ‘development’, ‘cognitive’,  
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34 ‘social’, ‘emotion’, ‘communication’, ‘language’, ‘physical’, ‘play’, ‘physical activity’,  
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36 ‘wellbeing’ AND either ‘built environment’, ‘neighbourhood’, ‘environment’ ‘urban  
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38 environment’, ‘city’, ‘place’, ‘traffic’, ‘safety’, ‘land use’, ‘street connectivity’, ‘density’,  
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40 ‘destination’, ‘facilities’. To find articles on the home outdoor area and green spaces, and  
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42 child development the search was repeated using the same keywords listed above, in the same  
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44 order using AND either ‘home environment’, ‘home’, ‘yard’, ‘outdoor space/area’, then  
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46 subsequently AND either ‘nature’, ‘green space’, ‘greenness’, ‘public open space’, ‘park’.  
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48 Article titles and abstracts were examined for appropriateness for full-text review. The  
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50 reference lists of the selected articles were examined for additional eligible articles.  
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INSERT FIGURE 2

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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

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4 physical environment and domains of early ( $\leq 7$  years) child health and development and table  
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6 2 includes studies of the neighborhood physical environment and the behavioral facilitators  
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8 (play & physical activity) of early ( $\leq 7$  years) child health and development.  
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13 INSERT TABLES 1 & 2  
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### 18 **Safety**

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20 The most studied neighborhood environmental correlate was parent perceived safety. There  
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22 were some evidence that parent perceptions of neighborhood safety are associated with young  
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24 children's social and emotional behavior(48-50) and general health(51, 52), even after  
25  
26 adjustment for socio-demographic factors. For example, in a large Australian study of 4-5  
27  
28 year olds, children's conduct problems were associated with parent perceptions of poor  
29  
30 neighborhood safety ( $p < 0.01$ ) and parent perceptions of neighborhood cleanliness were  
31  
32 associated with pro-social behavior ( $p < 0.001$ )(48). A single study examining the association  
33  
34 between parent perceived neighborhood safety and children's cognitive development found  
35  
36 no association(53). In young children, the amount of outdoor play as well as the time spent  
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38 outside unaccompanied at the front of the house or on the street was negatively associated  
39  
40 with street traffic(54, 55), however most studies reported no association between features of  
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42 neighborhood safety (e.g., safety from traffic and crime) and measures of outdoor play and  
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44 physical activity(56-61).  
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### 52 **Access to child-relevant destinations and services**

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54 Four studies reported a significant association between domains of early child development  
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56 and the presence of child relevant neighborhood destinations (e.g., recreation center, library,  
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58 school) and services (e.g., child care centers)(49, 51, 62, 63). A large US study of 22,797  
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4 children 1-5 years found that limited perceived access to amenities (recreation/community  
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6 center, library, sidewalks, park/playground) was associated with less time spent in peer play  
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8 and fewer family outings(49). Furthermore, in Australia, differences in developmental  
9  
10 vulnerability (children who score<10<sup>th</sup> percentile of the national AEDC population) across  
11  
12 states and territories existed even after adjusting for socio-demographic factors and some of  
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14 these differences were explained by the different mix of services that support children and  
15  
16 families from birth to school age(62).  
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## 22 **Green spaces**

23  
24 Two thirds (n=22) of the studies examined the relationship between neighborhood green  
25  
26 spaces and early child health and development and related behaviors, with most reporting a  
27  
28 positive association. Most of these studies examined outdoor play and/or physical activity.  
29  
30 Overall, outdoor play and physical activity in the early years was positively associated with  
31  
32 neighborhood greenness(64, 65), access to nature(66), green public open space(67, 68),  
33  
34 parks(69)and playgrounds(70, 71). In an observational study of 262 children aged 3-12 years,  
35  
36 levels of play in barren spaces were about half as much as in spaces with trees and grass(67).  
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43 Fewer studies examined the relationship between green spaces and domains of early child  
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45 development, however there was some evidence to suggest that green spaces may be  
46  
47 important for young children's cognitive(72, 73) and motor(9, 66, 74) development. A small  
48  
49 US study of low-income families found that following relocation to a new home, children  
50  
51 whose homes improved the most in terms of greenness (amount of nature in yard viewed  
52  
53 from house windows) tended to have the highest levels of cognitive functioning following the  
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55 move(72). Findings also demonstrate the influence of landscape features on young children's  
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57 motor development. In a number of related quasi-experimental studies of 5-7 year olds  
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4 (n=75), Fjørtoft showed that children provided with a natural landscape (forest) in which to  
5  
6 play, experienced a significant increase in motor fitness, balance and coordination compared  
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8 with children who played only in traditional outdoor playgrounds(9, 66, 74).  
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## 10 11 12 **Other neighborhood features**

### 13 *Housing density*

14  
15 High density housing has the potential to positively impact early child development through  
16  
17 increased opportunities for social interaction between neighbors and potentially greater  
18  
19 density of proximate amenity and services. However, it may also constrain opportunities for  
20  
21 play because the lack of private and public indoor and outdoor space limits children's ability  
22  
23 to play(27, 75). Only one study examined the impact of type of residence on young children's  
24  
25 outdoor play. In a large sample (n=2173) of 4-6 year olds, Aarts and colleagues reported that  
26  
27 living in a flat or apartment was associated with less outdoor play for girls (relative rate  
28  
29 (RR)=0.73; 95%CI=0.59-0.89) but not boys(68). Five studies examined the impact of  
30  
31 residential density on young children's outdoor play and physical activity(55, 68, 76-78) with  
32  
33 three studies showing no association(55, 68, 76) No studies examined the effect of  
34  
35 residential density (either high density living or urban sprawl) on domains of early child  
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37 development.  
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### 47 *Quality of streets and neighborhood facilities*

48  
49 One of the few studies to comprehensively objectively measure the neighborhood built  
50  
51 environment, reported a positive association between outdoor play and the presence of  
52  
53 informal play areas such as sidewalks (RR=1.44-1.66; p<0.05)(55). In the same Dutch study,  
54  
55 less connected streets (as measured by presence of roundabouts) and street lighting was  
56  
57 associated with less outdoor play in boys only (RR=1.14; 95% CI=1.07-1.22 and RR=0.78;  
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4 95% CI=0.97-0.86, respectively) whilst the presence or quality of formal outdoor facilities  
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6 (e.g., play grounds, school yards) was unrelated to outdoor play(55). In a 1995 Swiss study,  
7  
8 the amount of time five year old children spent outside unaccompanied at the front of the  
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10 house or on the street was positively associated with perceived attractiveness of the  
11  
12 neighborhood surroundings(54). No studies in this review examined the relationship between  
13  
14 neighborhood walkability or liveability, street connectivity, sidewalks, lighting, transit, and  
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16 aesthetics and domains of early child development such as language, cognitive and  
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18 communication skills.  
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### 24 *Outdoor home area*

25  
26 The outdoor home environment (i.e., front/backyard) is a particularly important space that  
27  
28 provides opportunity for young children to play, explore and be active. Only three studies  
29  
30 examined this relationship(68, 79, 80). One study found that not having a garden at home  
31  
32 where children can play resulted in more outdoor play in 4-6 year old Dutch girls(68). In  
33  
34 contrast a small Australian study identified that the home outdoor space may be important for  
35  
36 providing equipment for facilitating play and physical activity and developing motor  
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38 skills(79).  
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## 45 **DISCUSSION**

46  
47 This review examined 32 quantitative studies of the relationship between the neighborhood  
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49 physical environment and early child health and development. There was strong empirical  
50  
51 evidence that neighborhoods which are safe from traffic and which have green spaces (i.e.,  
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53 nature, public open space, parks, playgrounds) are associated with behaviors (i.e., outdoor  
54  
55 play and physical activity) that facilitate early child health and development. **These findings**  
56  
57 **support previous reviews focused on older aged children(41, 42, 81).** There was also evidence  
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4 that the presence of child relevant neighborhood destinations (e.g., recreation center, library,  
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6 school) and services (e.g., child health) are positively associated with the developmental  
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8 domains of physical health and wellbeing and social competence, and negatively associated  
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10 with children’s vulnerability to developmental delay. Finally, there was some evidence that  
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12 parent’s perceptions of neighborhood safety were positively associated with young children’s  
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14 social-emotional development and general health.  
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20 **In line with other reviews of the relationship between the physical environment and**  
21 **children’s physical activity(41-43),** our review found that many features of the neighborhood  
22  
23 environment have not been objectively examined to determine their influence on early child  
24  
25 health and development. Moreover, in many of the studies, the neighborhood built  
26  
27 environment was not the primary focus of the paper and was one of several correlates of child  
28  
29 development examined. Further research is needed to test the proposed relationships and  
30  
31 pathways between the home and neighborhood built environment, the behaviors that facilitate  
32  
33 children’s development as well as specific early child development outcomes(5). Moreover,  
34  
35 this review highlights that the neighborhood physical environment may be more important for  
36  
37 some domains of early child health and development (e.g., physical health and well-being and  
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39 social competence) than others (e.g., language and communication skills).  
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47 Our review did not identify any empirical studies examining the influence of the presence and  
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49 quality of nature and green spaces on domains of early child health and development. Yet,  
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51 green spaces are important because of the types of play facilitated in these environments.  
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53 Children’s play in natural environments is more diverse, imaginative, and creative than  
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55 children’s play in other settings(82).Further research is required to examine the effect of  
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57 green spaces on early child health and development and to investigate if the physical activity  
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4 benefits associated with access to high quality parks(83, 84) translate to young children's  
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6 physical, social and cognitive development.  
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10 This review highlights the need for cross-country comparison studies on the impact of high  
11 density living on early child health and development. High density living has been shown to  
12  
13 be associated with older children's classroom behavior and reading ability(85).Children  
14  
15 living in high density houses may be exposed to high levels of traffic noise contributing to  
16  
17 psychological distress, poorer auditory discrimination and lower reading ability(86,  
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19 87).Given preliminary evidence of the effects of high density living on older children's  
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21 development, further research of the impact of high density living on early child health and  
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23 development is warranted.  
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31 Poorly designed urban environments can adversely impact on child development. Many  
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33 Australian and US cities are characterized by urban sprawl(88, 89). New suburban  
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35 neighborhoods on the urban fringe have reduced access to local shops, services and public  
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37 transit(90, 91)which may result in children spending more time in cars commuting, more time  
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39 indoors under adult-supervision and less time playing, exploring and interacting with people  
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41 and their environment(92). **Conversely, the characteristics of urban sprawl may provide**  
42  
43 **children with other potential benefits. Single family detached houses provide children with**  
44  
45 **greater access to a yard for daily play and activities. Paired with this, conventional suburban**  
46  
47 **developments typically comprise more cul-de-sacs, thus minimizing traffic exposure within**  
48  
49 **the vicinity of the home and providing safer near-home play spaces(41, 93-95). However, to**  
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51 **date no empirical studies of the effects of urban sprawl on child development have been**  
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53 **conducted and further research is required.**  
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4 Future research should also consider the nexus between housing design and its implications  
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6 for children’s outdoor play opportunities, health and development. Trends towards larger  
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8 houses on smaller blocks have precipitated the demise of the once iconic suburban backyard,  
9  
10 with observable repercussions for where and how children play(88). Moreover, yards are  
11  
12 increasingly designed and landscaped as adult oriented spaces for entertaining and relaxation  
13  
14 rather than as an inviting outdoor realm for children’s play and exploration(92). With less  
15  
16 space available for outdoor play, time spent indoors has increased and this can reduce active  
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18 play, exploration and physical activity, and increase sedentary behaviors such as television  
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20 viewing, with possible negative consequences for early child health and development.  
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23  
24 **The limited (if any) private open space available in higher density residential areas adds**  
25  
26 **weight to the importance of providing accessible child-appropriate public open spaces in the**  
27  
28 **local neighborhood (e.g., apartment grounds and nearby parks).**  
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34 This review has identified a number of plausible hypotheses that require testing (Table 3).  
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36 There exists opportunity in at least two countries (Australia and Canada) to comprehensively  
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38 examine the influence of features of the neighborhood built environment on early child health  
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40 and development. At a population level, Canada and Australia have both established a  
41  
42 comprehensive national progress measure of early child health and development(16-  
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44 18).Potential influences such as the built environment must be investigated to better inform  
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46 strategies and programs for early intervention to improve the health and developmental  
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48 trajectory of children. A summary of this review’s recommendations for future research are  
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50 outlined in Table 3.  
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INSERT TABLE 3 ABOUT HERE

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4 **Study limitations**  
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6 A limitation of this review may be its focus on the early years rather than all children,  
7  
8 however, the early years is a critical stage of development for children and if not supported  
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10 and nurtured could have significant ramifications for later life. This review focused on the  
11  
12 neighborhood physical environment. Future reviews may wish to also summarize evidence of  
13  
14 the influence of the neighborhood social environment and neighborhood level socio-  
15  
16 economic factors on early child health and development. A strength of this study was the  
17  
18 inclusion of the home outdoor space as an important provider of opportunities and constraints  
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20 for early child health and development. However, this review did not specifically include  
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22 studies of early child health and development-related behaviors and outcomes in settings such  
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24 as childcare and school.  
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31 **Conclusions**  
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33 Our review found evidence of a positive association between young children’s outdoor play  
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35 and physical activity and the presence of safe and green neighborhood places to be active.  
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37 There was evidence that the presence of child relevant neighborhood destinations and  
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39 services are positively associated with child development domains of physical health and  
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41 wellbeing and social competence, and negatively associated with children’s vulnerability to  
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43 developmental delay. There was also some evidence that parent’s perceptions of  
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45 neighborhood safety were positively associated with young children’ social-emotional  
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47 development and general health. However, this review identified an absence of population-  
48  
49 level studies examining the impact of: a) urban sprawl; b) high density living, outdoor space  
50  
51 and traffic exposure; c) the outdoor home environment; and d) nature and parks on *early*  
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53 child health and development. This review highlights the need for population-level studies  
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55 examining the role of the individual as well as the cumulative exposure of neighborhood  
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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.



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

Hayley Christian,<sup>1,2</sup> Stephen R Zubrick,<sup>2</sup> Sarah Foster,<sup>1</sup> Billie Giles-Corti,<sup>3</sup> Fiona Bull,<sup>1</sup> Lisa Wood,<sup>1</sup> Matthew Knuiiman,<sup>4</sup> Sally Brinkman,<sup>2</sup> Stephen Houghton,<sup>5</sup> Bryan Boruff<sup>6</sup>.

<sup>1</sup>Centre for the Built Environment and Health, School of Population Health, The University of Western Australia, Crawley, WA, Australia; <sup>2</sup>Telethon Kids Institute, The University of Western Australia, Crawley, WA, Australia; <sup>3</sup>McCaughey VicHealth Centre for Community Wellbeing, Melbourne School of Population Health, University of Melbourne, Melbourne, Australia; <sup>4</sup>School of Population Health, The University of Western Australia, Crawley, WA, Australia; <sup>5</sup>Centre for Child & Adolescent Related Disorders, Graduate School of Education, The University of Western Australia, Crawley, WA, Australia; <sup>6</sup>School of Earth and Environment, The University of Western Australia, Crawley, WA, Australia.

### **Author responsible for correspondence:**

Asst/Prof Hayley Christian  
Centre for the Built Environment and Health  
School of Population Health (M707)  
The University of Western Australia  
35 Stirling Highway  
Crawley WA 6009 Australia  
Email: [hayley.christian@uwa.edu.au](mailto:hayley.christian@uwa.edu.au)  
Telephone: 61-8-6488-8501  
Fax: 61-8-6488-1188

Table 1. Studies of the neighborhood physical environment and domains of early ( $\leq 7$  years) child health and development

<b>Author; Country; Year<sup>a</sup></b>	<b>Study design</b>	<b>Sample: Size; Age; Gender</b>	<b>Built environment measures (Subjective/Objectively measured)</b>	<b>Early child health and development measures</b>	<b>Key findings</b>
Barnett et al(1) Australia 2012	Cross sectional	76; Mean age 4.1 years; 45% boys	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.	Gross motor (locomotor and object control) skill development.	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.
Brinkman et al(2) Australia 2012	Cross sectional	261147; 5 years; 45% boys	Objective: Maternal and child health and preschool services available by Australian state and territory.	Developmental vulnerability for 5 developmental domains (Physical wellbeing, social competence, emotional maturity, language and cognitive skills, communication skills and general	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.

				knowledge)	
Edwards & Bromfield (3) Australia 2009	Cross sectional	4983; 4-5 years; 51% boys	Objective: Neighborhood physical disorder 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	Social and emotional functioning: Pro-social behavior, Conduct problems	Children's conduct problems associated with parent perceptions of neighborhood safety. Perceptions of safety mediated the relationship between neighborhood socio-economic status and conduct problems. Parent perceptions of neighborhood cleanliness were associated with pro-social behavior. Neighborhood physical disorder and parent-report neighborhood facilities not associated with social-emotional functioning.
Fan & Chen(4) USA 2012	Cross sectional	53023; 6-17 years; 51% boys	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)	General health status	Neighborhood physical resources, environmental threats and collective efficacy associated with children's general health status and mediated by family functioning.
Kenney(5) USA 2012	Cross sectional	22797; 1-5 years; Gender not reported	Subjective (parent-report): Neighborhood amenities (sidewalks, park/playground, recreation/community	Peer play, Parent initiated activities (reading to child and family	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.

			center, library), Physical condition (litter/garbage, poorly kept housing, vandalism), Neighborhood safety for children	outings)	Perceived neighborhood safety for children not associated with peer play or parent initiated activities.
Kiernan et al(6) Ireland 2008	Cross sectional	Structured interviews of 89 mothers; Mean age children 4.8 years; 54% girls;	Subjective (parent-report): Quality of Environment Rating Scale (problem in neighborhood with crime, antisocial behavior and the environment)	Cognitive and social-emotional skills, School readiness (teacher report)	Neighborhood environment not significantly associated with children's cognitive and social- emotional school readiness.
Kuo & Taylor(7) USA 2004	Cross sectional	452; 5-18 years; 79% boys; formal ADHD diagnosis	Subjective (parent-report): Setting of 49 common after- school and weekend activities grouped as green outdoors, built outdoors, indoors	Attention-deficit /hyperactivity disorder (ADHD) symptoms	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.
Miller & Votruba- Drzal(8) USA 2013	Longi- tudinal	6050; 9 months-5 years; Gender not reported	Objective: Urbanicity (large urban, small urban, suburb, rural) Subjective (parent-report): Regular center-based, home-based, or parent-care	Academic (reading and math) skills	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.
Rosenberg et	Cross	70;	Subjective (parent-report):	Child's	Environmental factors contribute to frequency of

al(9) Canada 2011	sectional	mean age 5.2 years; 56% boys	Environment restriction (35 physical and human environmental factors at home, neighborhood and in the educational setting e.g., distance between home and recreational center).	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.
To et al(10) Canada 2001	Cross sectional	123350; 0-3 years; 61.4% boys	Subjective (parent-report): Neighborhood safety and problems	Poor developmental attainment (motor, social and development scale)	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.

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Table 2. Studies of the neighborhood physical environment and young children's ( $\leq 7$  years) play & physical activity.

Author; Country; Year <sup>a</sup>	Study design	Sample: Size; Age; Gender	Built environment measures (Subjective/Objectively measured)	Play & physical activity measures	Key findings
Aarts et al(11) The Netherlands 2010	Cross sectional	6470; 4-12 years (34% 4- 6years, 49% boys)	Subjective (parent-report): Neighborhood type, Type of residence, Home garden, Residential density, Presence of neighborhood green or water, Traffic, Sidewalks & bike lanes, Street connectivity, Destinations & facilities, Satisfaction with play facilities, public and green space	Outdoor play (parent report minutes/week)	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.
Aarts et al(12) The Netherlands 2012	Cross sectional	3651; 4-12 years (34% 4-6 years, 51% boys)	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	Outdoor play (parent report minutes/week)	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.

Bringolf-Isler et al(13) Switzerland 2010	Cross sectional	1081; 6-14 years (24% 6-7 tears); 51% boys	Subjective (parent-report): Traffic, Garden/green space, Crime, Local play spaces Objective (GIS): Population density, Main street density, Road type length, Green space	Vigorous outdoor play (parent-report hours/day)	For 6-10 year olds, parent perceived traffic and playing in neighbor's garden, or nearby woods/fields positively associated with vigorous outdoor play. Higher main street density near home associated with less vigorous outdoor play. No association between vigorous outdoor play and perceived access to green space, crime or local play spaces or, objectively measured population density, road type length or green space.
Burdette & Whitaker(14) USA 2005	Cross sectional	3141; 3 years; 53% boys	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)	Outdoor play (parent report hours/day)	Mothers' perception of neighborhood safety was not related to preschool children's outdoor play time.
Chuang et al(15) USA 2013	Cross sectional	706; 3-5 years; Gender not reported; Low SES	Subjective (parent-report) Yard or open play space, Usable play equipment (swings, slides climbing, etc.) in yard, Traffic, Parks, walking trails or	Physical activity frequency/week and sport participation (parent-report)	Significant ethnic differences in the home physical activity environment. Less African-American preschoolers had a yard or open space or usable play equipment in the yard compared with Hispanics. More parents of African-American than Hispanic children reported that the street they live in has a sidewalk/paved path.

			outdoor/indoor recreation centers within safe walking of home, Street live in has a sidewalk/paved path		No associations observed with perceived traffic, or perceived parks, walking trails or outdoor/indoor recreation centers within safe walking distance of home.
Copperman & Bhat(16) USA 2007	Cross sectional	1104; 5-17 years; Gender not reported	Objective (GIS): Zoning (urban/rural), No. restaurants & food stores, Multi-family housing units, Commercial/industrial acreage, Transportation network (average block size area, miles of bike lanes)	Out-of-home, weekend recreational activity participation	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.
De Vries et al(17) Holland 2010	Cross sectional	448; 6-11 years; 48% boys	Objective (observation): Type of residence, Sports facilities, Recreation facilities, Play facilities, Green space, Presence of water, Presence of dirt Traffic safety, Walking/cycling infrastructure, Activity-friendliness of the neighborhood	Walking for recreation (parent-report trips/week)	No built environment measures were significantly associated with walking for recreation.
Fjortoft &	Quasi	75 (61%)	Objective (GIS and GPS):	Play	Children provided with a natural landscape in

Saegie;(18) Fjortoft;(19) Forjtoft(20) Norway 2000; 2001; 2004	experi- mental	experiment group); 5-7 years; 51% boys	Natural environment vs. traditional playground (slope, roughness, mapped vegetation, function, habitat change)	(functional play activities, symbolic and construction), Motor development (motor fitness)	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.
Frank et al(21); Kerr et al(22) USA 2007	Cross sectional	3161; 5-20 years; (27% 5-8 years); 50% boys	Objective (GIS): Residential density, Intersection density, Land use mix, Recreation space, Commercial space	Walking (in last 2 days, parent-report)	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.
Grigsby- Toussaint et al(23) USA 2011	Cross sectional	365; 2-5 years; 52% boys	Objective (GIS): Greenness (Normalized Difference Vegetation Index-NDVI)	Outdoor play time (parent- report minutes/ average day)	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.
Huttenmoser (24) Switzerland 1995	Cross sectional	926; 5 years; Gender not reported	Subjective (parent-report): Street traffic, Neighborhood attractiveness	Time spent outdoors, independent outdoor play, social interaction (Number playmates) and motor skills	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.

Kimbro et al(25) USA 2011	Cross sectional	1822; 5 years; 51% boys	Subjective (mother-report): Public housing, Type of housing, Fearful about child playing outdoors due to violence Objective (interviewer rated): Neighborhood physical disorder (physical condition of the yard, street, and surrounding buildings)	Outdoor play (parent-report hours/weekday)	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.
Lovasi et al(26) USA 2011	Cross sectional	428; 2-5 years; 47% boys; Low income	Objective (GIS): Population density, Land use mix, Transit density, Intersection density, Crime, Traffic volume & pedestrian accidents, Sidewalks, Aesthetics, Tree density, Park & playground access	Physical activity (accelerometer measured-mean counts/min)	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.
Marino et al(27) USA 2012	Cross sectional	2529; 3-4 years; 51% boys	Subjective (parent-report): Yard around home, Park/playground near home, Visited park/playground	Home outdoor play (parent-report hours/weekday)	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.

Quigg et al(28) USA 2011	Inter- vention	156 (completed follow up); 5-10 years; 46% boys	Intervention (natural experiment): Upgrade of community playgrounds.  Subjective (parent-report): Neighborhood perceptions	Physical activity (accelerometer measured – mean total daily)	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.
Roemmich et al(29) USA 2006	Cross sectional	59; 4-7 years; 54% boys	Objective (GIS): Housing density, Street connectivity, Park area, Recreational area, Residential area	Physical activity (accelerometer measured - mean counts/day)	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.
Sallis et al(30) USA 1993	Cross sectional	346; Mean 4.4 years; 50% boys; 58% Mexican- American	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	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.
Sallis et al(31) USA 2002	Cross sectional	781; 6-17 years; (18% 6-8 years, 51% boys)	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)	No neighborhood physical environment or park- related variables were associated with young children's vigorous physical activity.

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

Spurrier et  
 al(32)  
 Australia  
 2008

Cross  
 sectional

280;  
 Mean 4.8  
 years;  
 50% boys

Subjective (parent-report):  
 Community facilities  
 (library, playground)  
 Objective (observation):  
 Size of backyard,  
 No. pieces outdoor play  
 equipment,  
 Paved area for bike riding

Outdoor  
 playtime  
 around the  
 home and other  
 outdoor areas  
 (parent-report)

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.

Tappe et  
 al(33)  
 USA  
 2013

Cross  
 sectional

724;  
 6-11 years;  
 51% boys

Subjective (parent-report):  
 Street connectivity,  
 Walking/cycling facilities,  
 Neighborhood aesthetics,  
 Traffic safety,  
 Safety from crime,  
 Stores/service destinations  
 Recreation destinations  
 Appropriate play spaces  
 Objective (GIS):  
 Walkability Index  
 (intersection density, land  
 use mix, retail floor area  
 ratio),

Physical  
 activity  
 (accelerometer  
 measured and  
 parent-report)

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.

Proximity high quality park

Taylor et al(34) USA 1998	Observational	262; 3-12 years; gender not reported	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	Cross sectional	219; 5-6 years; 51% boys	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; <sup>a</sup> Full reference details for articles reviewed:

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Table 3. Recommendations for further research

Recommendation	Specific examples
Test plausible research questions/hypotheses:	<p data-bbox="562 373 2033 443">What is the impact of high density living, urban sprawl and other residential morphologies on early child health and development outcomes?</p> <p data-bbox="562 459 2033 491">Does the presence and quality of nature and green spaces influence early child health and development outcomes?</p> <p data-bbox="562 515 2033 547">What are the implications of housing design for children’s outdoor play opportunities, health and development?</p> <p data-bbox="562 571 2033 641">What are the role of individual as well as the cumulative exposures of neighborhood environment attributes upon young children’s health and development?</p> <p data-bbox="562 665 2033 775">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?</p> <p data-bbox="562 799 2033 869">How does the built environment interact with socio-cultural factors to influence early child health and development?</p>
Develop theoretical model:	<p data-bbox="562 946 2033 1048">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.</p>
Methodological issues:	<p data-bbox="562 1128 2033 1160">Conduct large population representative studies across countries with different urban environments.</p> <p data-bbox="562 1184 2033 1216">Use valid and reliable population measures of early child health and development (e.g., Early Development Index).</p> <p data-bbox="562 1240 2033 1272">Use objective measures of the built environment (i.e., Geographic Information Systems derived measures).</p> <p data-bbox="562 1295 2033 1366">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</p>

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.

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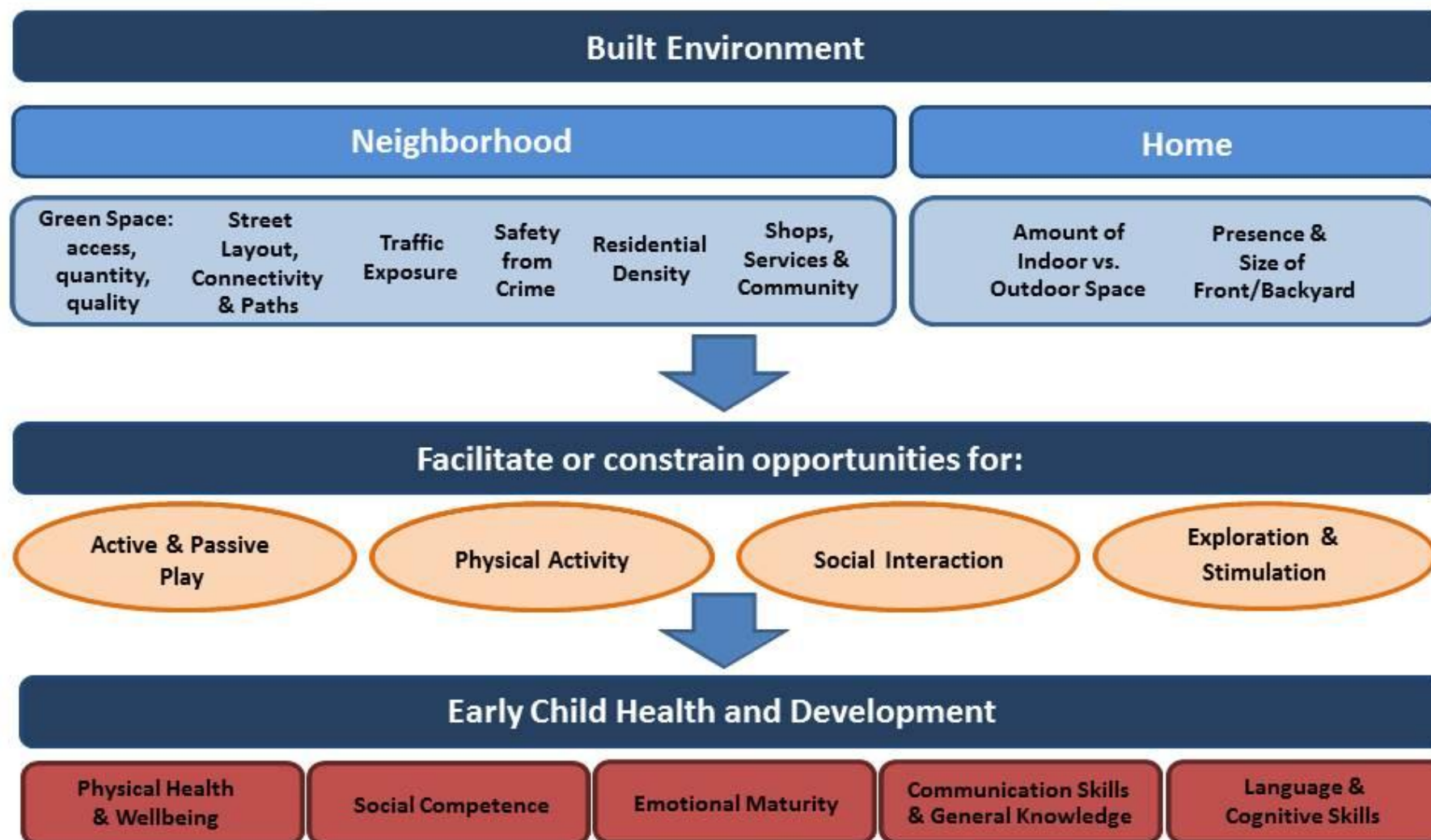


Figure 1: Model of how the neighborhood physical environment may facilitate or constrain healthy child development.

**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:**

<p><b>Child AND</b></p> <ul style="list-style-type: none"> <li>• Early childhood</li> <li>• Development</li> <li>• Play</li> <li>• Wellbeing</li> <li>• Physical</li> <li>• Emotion</li> <li>• Social</li> <li>• Cognitive</li> <li>• Communication</li> <li>• Language</li> </ul>	<p><b>AND</b></p> <p>Search one:</p> <ul style="list-style-type: none"> <li>• Built environment</li> <li>• Neighborhood</li> <li>• Environment</li> <li>• Urban environment</li> <li>• City</li> <li>• Place</li> <li>• Safety</li> <li>• Traffic</li> <li>• Land use</li> <li>• Street connectivity</li> <li>• Density</li> <li>• Destination</li> <li>• Facilities</li> </ul>	<p>Search two:</p> <ul style="list-style-type: none"> <li>• Nature</li> <li>• Green space</li> <li>• Public open space</li> <li>• Park</li> <li>• Greenness</li> </ul>	<p>Search three:</p> <ul style="list-style-type: none"> <li>• Home</li> <li>• Home environment</li> <li>• Yard</li> <li>• Outdoor</li> </ul>
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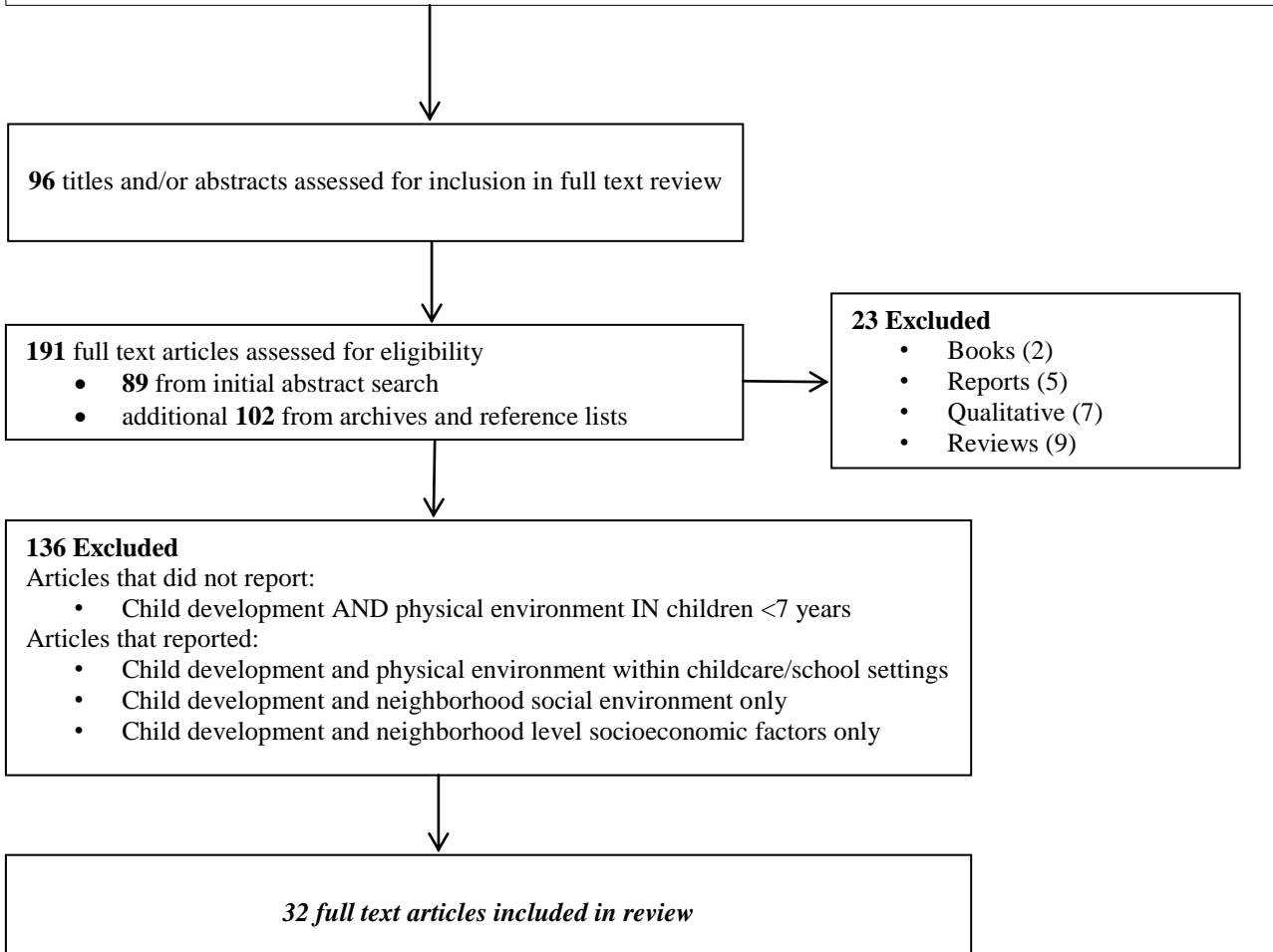


Figure 2: Literature Search Strategy

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**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

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