

Healthy Higher Density Living For Kids

***THE EFFECTS OF HIGH DENSITY HOUSING ON
CHILDREN'S HEALTH AND DEVELOPMENT:***

***A literature review to inform policy
development in Western Sydney***

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- Healthy Higher Density Living Issues Paper
- Healthy Higher Density Living Summary Survey Report

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EXECUTIVE SUMMARY



Context and Objectives

This report considers the question, *“what are the effects of high-density housing on children?”*

The question is timely. Urbanisation in Australia is undergoing a rapid shift from the historical model of 'sprawl' to one of 'densification'. In the City of Parramatta, 75% of all new dwellings built between 2011 and 2016 were high-density, with the number of separate dwellings declining over the same period (ABS 2011, ABS 2016). This trend to build 'upwards' is one strategy in pursuit of the '30 minute city' ideal, proposed in the Commonwealth Government's recent Smart Cities Plan (2016).

The question is also important. While the densification model may be a welcome change, the approach to planning developments has not kept pace with the shifting demographics of high-density residents.

Twenty-five per cent of Parramatta's preschool children now live in high-density housing (ABS 2011) – it is no longer the preserve of 'DINKS' (dual-income-no-kids) or 'empty nesters'. Yet children are a neglected population in planning for our more consolidated urban future. Few policies or guidelines consider the unique needs of this population, despite the early childhood environment being a critical influence on lifelong health and wellbeing (Randolph 2006, Birrell & McCloskey 2016, Easthope & Tice 2011, NSW Government Planning and Environment 2014).

The question targets an area of uncertainty. Studies in adults suggest a range of potential benefits from higher density living, including increased rates of active transportation and lower rates of obesity and overweight (Sallis et al. 2012, Haigh et al. 2011). However, there is substantially less evidence examining the association between high density and health outcomes for children.

This report employs a mixed-methods approach, drawing on academic literature through a 'rapid

review of reviews', a review of relevant child-friendly high-density housing guidelines, a case study, and key stakeholder interviews; to maximise the policy relevance of our findings.

KEY FINDINGS

The evidence evades a simplistic categorisation of high-density housing as either 'good' or 'bad' for health – the impact of high-density housing on child health is context dependent. The particular child, their social environment, the dwelling and building, and the surrounding neighbourhood are all layers within an ecological system of influence (Bronfenbrenner 1994).

Furthermore, review-level evidence regarding the effects of medium and high-density housing on the health of children is limited, of low quality, and often conflicting in findings. Most studies use a cross-sectional methodology design, making it difficult to establish causality (Villanueva et al. 2016).

The effects of high-density housing on children can be considered within three domains of child development outcomes:

- Physical health and development;
- Psychosocial wellbeing and mental health; and
- Language, cognitive and communication skills.

Effects on physical health and development

The effect of high-density housing on physical health is mixed:

There is weak evidence suggesting children in higher density suburbs tend to have lower rates of obesity and overweight.

- Gender seems to be an important moderator.
- There is moderate evidence that living in high-density housing is associated with increased

children's active school transport, although this may be accompanied by a reduction in outdoor play.

- There is more convincing evidence of the detrimental effect of increased motor vehicle traffic on children's health, although 'density done well' should result in reduced traffic exposure due to increased walking and public transport use (The Committee for Sydney 2016).
- Falls from windows and balconies seem to be increased in higher density, although recent legislative changes in New South Wales aim to improve safety and reduce this risk (NSW Government Fair Trading 2016).

It is also possible that relationships between density and health outcomes are non-linear. For example, expert opinion postulates the existence of a threshold effect, with mid-rise buildings promoting children's physical activity but high-rise buildings inhibiting it, because in the latter parents cannot supervise children's outside play directly from the home (Giles-Corti et al. 2012). This theory requires further investigation, and again the result may vary depending on factors such as children's age. Surprisingly, the role of neighbourhood walkability in higher density was not often included in the included reviews, despite strong evidence of its association with increased physical activity in adults.

Effects on psychological wellbeing and mental health

- There is some evidence that young children living in high-rise apartments show higher rates of behavioural problems
- Mothers of young children in high-rise dwellings seem to have higher rates of psychological distress.

There is limited literature considering children's mental health in high density, and the majority of studies focus specifically on high-rise buildings. Whether the effects are in fact due to a third

(confounding) factor such as chronic noise exposure, or can be offset by other factors (such as strong social networks or proximity to high quality green space) remains to be thoroughly examined.

Effects on language, cognitive & communication skills

There is inconsistent evidence regarding children's cognitive and language development in high density, although chronic noise exposure in itself is clearly detrimental to reading acquisition, cognitive skill development, and behaviour.

KEY RECOMMENDATIONS

A checklist incorporating recommendations for children and families has been developed (see section 5.2 of the full document), which complements the NSW Apartment Design Guide and the Healthy Urban Development Checklist (NSW Government Department of Planning and Environment 2015; NSW Government Department of Health 2009). The most of important components of this checklist are:

1. Apartments/Units

- a) **Allow for parental supervision** of child play areas (e.g. place family units on ground or lower levels, with windows facing out onto shared courtyards or play spaces).
- b) **Include sufficient family-sized dwellings** in high-density developments, to encourage social interaction and provide greater accommodation choice for families.

2. Buildings

- a) **Incorporate play and social spaces** for different ages into building design (e.g. playrooms, playgrounds, gathering spaces for teens, and common/multipurpose rooms).
- b) **Co-locate family dwellings** closer to the ground floor, clustered together (facilitating play among children), and preferably in low- and mid-rise buildings ("human scale").

3. Neighbourhoods

- a) **Embed traffic safety** with effective traffic calming measures (e.g. reduced speed limits, shared streets, landscaping and temporary street closures).
- b) **Ensure play and green spaces** are nearby (within 300m) to facilitate child independent mobility. Spaces should be safe and clean, and have equipment/natural features of interest for children of varying ages, incorporating challenge while maintaining safety.
- c) **Provide food security** with fresh food/ supermarkets available within walking distance (especially in areas of lower socioeconomic status).

4. Governance

- a) **Engage children** in the process of building and precinct design, as supported by built4kids, a "good practice guide to creating child-friendly built environments" (NSW Commission for Children and Young People 2009).
- b) **Protect child-focus in strata by-laws** and remove by-laws that restrict or ban children from safe, age-appropriate common area play. A building's child-friendly status should be clear to incoming tenants and prospective buyers.

The child friendly high-density checklist (see section 5.2 of the full document) will help translate these principles into policy action at the local government level, while the accompanying indicators (see section 5.3 of the full document) will enable us to monitor progress.

It is clear from our research that not all high-density housing is created equal.

While thoughtful, high quality high density offers opportunities to improve children's health and development, these opportunities need to be proactively and explicitly planned for in order to avoid the potential harm from careless high-density development.

READING LIST

Local research:

- Fokkema L, Wearne K, O'Neill M. (2017) Healthy Higher Density Living: Summary Survey Report.
- Heenan R. (2017). Healthy High Density for Kids. The effects of high-density housing on children's health and development: a literature review to inform policy development in Western Sydney.

Literature

- Giles-Corti B, Ryan R, Forster S. (2012). Increasing density in Australia: maximising the health benefits and minimising the harm. Report to the National Heart Foundation of Australia, Melbourne. Available from: www.heartfoundation.org.au/images/uploads/publications/Increasing-density-in-Australia-Evidence-Review-2012-trevor.pdf

REFERENCE DOCUMENTS AND TOOLS

Local research:

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Acronyms

ABS	Australian Bureau of Statistics
AEDC	Australian Early Development Census
CALD	Culturally and Linguistically Diverse
CoP	City of Parramatta
LGA	Local Government Area
SES	Socioeconomic status
WSLHD	Western Sydney Local Health District

1. Introduction

This report aims to help optimise the health and development of children in the setting of ongoing housing densification in the City of Parramatta local government area. The City of Parramatta land use team has expressed a particular interest in this topic, and this report has been prepared for them as the primary intended audience. The evidence on the health and development effects of high-density housing on children is examined, in order to inform evidence-based recommendations. The paper utilises four sources of evidence: a rapid literature review, a collation of existing guidelines, presentation of an illustrative case study, and key stakeholder interviews. The rapid review examines the review-level evidence on this topic in the published medical and health literature. The review of guidelines examines what recommendations other cities and countries make regarding this question. Thirdly, a relevant case study is presented to illustrate elements of child friendly higher density built environments in practice. Finally, key stakeholder interviews with staff at City of Parramatta and Western Sydney Local Health District enrich the review-level evidence with initial qualitative data arising within the local context.

All evidence is analysed and discussed within the context of Western Sydney. The paper concludes by making recommendations to inform and support different levels of government, urban planners, architects, property developers, and public health professionals in making decisions about child friendly urban planning and housing design in Parramatta.

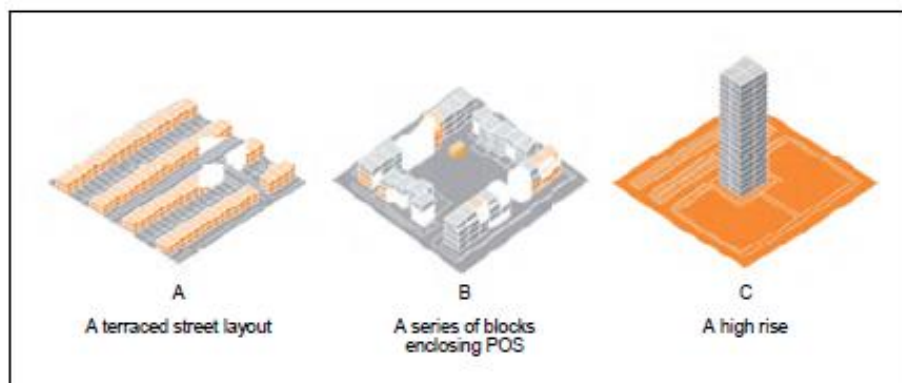
1.1 Background

1.1.1 What is 'high density' housing?

'High density' housing has multiple possible interpretations (Landcom 2011). There is no standard classification for levels of density in Australia, although NSW Department of Planning & Environment has adopted density thresholds for Growth Centres (Australian Bureau of Statistics 2016, personal communication, 28th September, Landcom 2011, NSW Government Department of Planning and Environment 2006). Throughout this report the term 'high density' is used primarily to refer to residential buildings with three or more storeys. This definition is used in order to align with the threshold used by the City of Parramatta Council land use team, as this report has been prepared with their end use in mind (L. Fokkema 2016, personal communication, 28th October). However, in the literature, 'density' is often used as an umbrella term encompassing different types of density as well as dwelling types, including:

1. Residential density, i.e. numbers of dwellings per hectare, noting that a certain level of density might be achieved through a variety of architectural forms (see figure 1a),
2. Population density, i.e. numbers of persons residing per hectare, and
3. Dwelling types typically associated with high density (specifically: flats, units, apartments, or "high-rise" buildings (henceforth "apartments") (see figures 1 and 2)(ABS 2006b, Haigh et al. 2011, Landcom 2011).

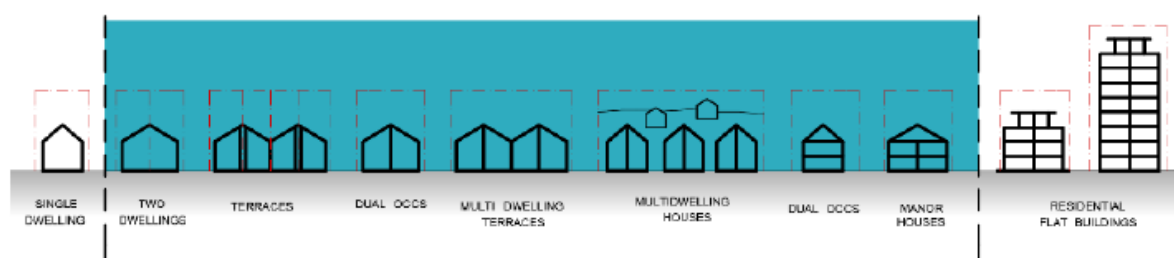
FIGURE 1: DIFFERENT ARCHITECTURAL FORMS THAT ACHIEVE THE SAME DENSITY (75 DWELLINGS PER HECTARE)



NB: POS = Public Open Space
Source: Giles-Corti et al. 2012

Therefore, a broader definition of high density was taken in the literature review to capture as much relevant research as possible, while noting that much of the literature also avoids defining 'high density'. Findings relating to specific architectural forms rather than density are noted where possible, acknowledging that for a given level of residential density there may be certain architectural forms which are more optimal for health than others (Giles-Corti et al. 2012). This avoids a 'physically deterministic approach', recognising instead that density is not destiny and that the resultant health and developmental impacts of place are subject to multiple interrelated environmental, sociocultural and personal factors (Bronfenbrenner 1994, Woolcock et al. 2010).

FIGURE 2: THE SPECTRUM OF RESIDENTIAL DEVELOPMENTS



NB: Approximating low-density on left, medium-density in centre (shaded blue), and high density on right
Source: NSW Government Department of Planning and Environment 2016

1.1.2 Demographic trends: growing proportions of children living in higher density

The number of children living in high-density housing in the City of Parramatta (CoP) local government area (LGA) is greater than the Sydney average and growing (Table 1 and Figure 3). This trend is most prominent for the early childhood group (aged 0-4 years), where the proportion living in high-density housing in the CoP LGA is almost double that of Greater Sydney (26.1% compared to 13.5% respectively) (.id n.d. a, from ABS Census 2011 data). The proportion of this age group living in high-density housing grew by 40% from 2006 to 2011. Ten times more preschool children moved into high-density housing compared to separate houses between 2006 and 2011 in the City of Parramatta (1425 compared to 150 children; Figure 3, .id n.d. a, from ABS Census 2006 and 2011 data). Primary school children are also increasingly living in high density in CoP, with 15% of Parramatta's children aged 5-11 years living in high-density housing in 2011, up from 12.4% in 2006. This compares to 7.4% across greater Sydney (.id n.d. a, from ABS Census 2006 and 2011 data). In absolute terms, this equates to an additional 532 children aged 5-11 living in high density in 2011 compared to 2006, compared to 63 fewer children living in detached houses over the same time period (.id n.d. a, from ABS Census 2006 and 2011 data). Finally, City of Parramatta LGA also has a higher proportion of children living in families with very low household incomes compared to the state average (CoP n.d.), thus the risks of compounding vulnerability should also be considered in this context. The growing numbers of children living in high-density housing in CoP supports close consideration of their specific health and development needs.

TABLE 1: PROPORTION OF CHILDREN LIVING IN HIGH-DENSITY HOUSING (I.E. APARTMENTS IN 3 STOREY AND LARGER BLOCKS)

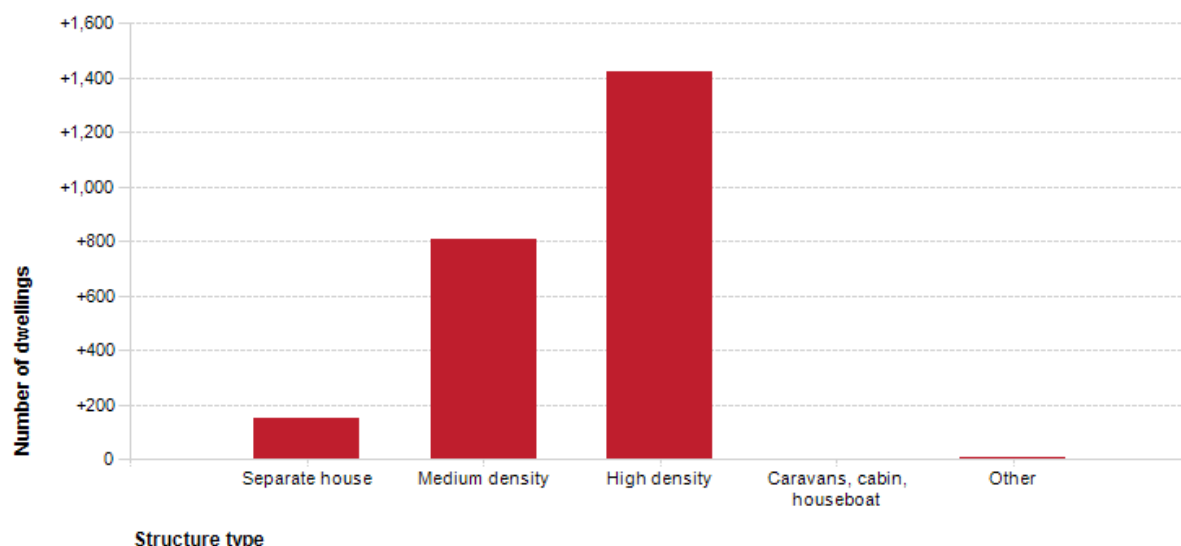
Age group	City of Parramatta	Greater Sydney	New South Wales
0-4 years	26.1%	13.5%	9.1%
5-11 years	15.5%	7.4%	4.9%

Source: .id n.d. a, from ABS 2011 Census data

FIGURE 3: CHANGE IN DWELLING STRUCTURE BETWEEN 2006 AND 2011, FOR CHILDREN 0-4 YEARS, CITY OF PARRAMATTA

Change in dwelling structure, 2006 to 2011

City of Parramatta - Children aged 0 to 4 years



Source: Australian Bureau of Statistics, Census of Population and Housing, 2006 and 2011 (Enumerated data)
Compiled and presented by .id, the population experts.



Source: .id n.d. a

The growth in the proportion of children living in apartments is likely to continue or even accelerate, as a shortage of detached dwellings is predicted in Sydney (Birrell & McCloskey 2016). The reasons for this are multifaceted. Firstly, older ‘baby boomers’ tend to occupy many of the freestanding dwellings. This is likely to continue unless that generation decides to move into high-density dwellings, thus ‘freeing up’ low-density houses for families (Birrell & McCloskey 2016). Census data from 2006 and 2011 show that the trend for the retired and elderly is to remain in separate housing rather than move into high- or medium-density housing (.id n.d. a). In addition, half as many stand-alone houses are currently being built across Sydney compared to medium- and high-density dwelling types, and the latter are likely to be more affordable (due to more supply as well as smaller land ‘footprint’). As such, this dwelling type may be especially attractive for young couples entering the housing market for the first time. This group is also most likely to be starting a family (Birrell & McCloskey 2016, Easthope and Tice 2011). Outside the 20-39 year old age group, the highest growth in the City of Parramatta over the next 10 years will be in 0-4 year old children, likely due to this group of young adults starting families (.id n.d. b). Despite these predicted demographic trends, most planning documents do not explicitly acknowledge the likelihood or consider the implications of raising children in high-density homes (Randolph 2006, Birrell & McCloskey 2016, Easthope & Tice 2011, NSW Government Planning and Environment 2014). Thus the demographic, building and affordability trends may result in misalignments between which demographic groups new housing is designed for, what housing stock is available and affordable, and the populations who actually end up living in such dwellings.

1.1.3 The trend towards densification in Australia

It is not surprising that more families with children are living in high-density housing, given that urban consolidation – rather than outward ‘suburban sprawl’ – is increasingly the main strategic approach to growth at all levels of government in Australia. The recent national *Smart Cities Plan* advocates for the connectivity of ‘30 minute cities’ and emphasises the importance of green urban spaces (Commonwealth of Australia 2016). This *Plan* acknowledges that increasing numbers of people are opting to live in areas of higher residential density. It also recognises that along with such densification comes the need to actively consider the urban design and amenities that will optimise the wellbeing of those pursuing a more compact home (Commonwealth of Australia 2016). At the state level *A Plan for Growing Sydney* notes the need to match investment in social infrastructure with increased population growth (NSW Government Department of Planning and Environment 2014). Similarly, at the LGA level, *Parramatta 2038* acknowledges that the increase in high-density housing is likely to present challenges in terms of provision of child-friendly public space (Parramatta City Council 2013, City of Parramatta Council n.d.). It is important to consider the effects of this type of growth on potentially vulnerable populations such as children, who have been described as “canaries in the mine” of Australia’s new urban areas (Malone 2006). This focus on children is further supported when we consider that optimising early childhood health and development at a population level is critical to minimising social inequities and improving health throughout the life course (Pillas et al. 2014, Marmot 2010).

For an equity-focused approach to child health in City of Parramatta, it is useful to recognise that children living in high-density housing are not homogenous. Pre-existing risks, for example due to socioeconomic status, can increase vulnerability and magnify the effects of certain environmental exposures. Children living in high-density housing can be subdivided into two broad categories for heuristic purposes (Sherry 2012, Randolph 2006, Whitzman & Mizrachi 2009). The first group are the children of higher SES owner-occupier parents. They tend to live in the inner city, in areas of good amenity, although they may be relatively isolated from other children. The second group are from lower SES backgrounds, are renting, and may have a very low family income. They may be recent migrants or from culturally and linguistically diverse (CALD) backgrounds. They often reside in the outer suburbs, in older buildings with fewer nearby amenities. Children in this latter group are more vulnerable to issues of overcrowding, poorer building safety features, and worse building location (e.g. next to busy roads). Although there is likely to be a gradient between such groups, it is nonetheless useful to recognise that many of Parramatta’s children are likely to fall closer to the latter group and as a result may face particular vulnerabilities.

1.1.4 The City of Parramatta Council local context

There is evidence from housing developments within the CoP LGA that families with children are increasingly living in high-density housing. For example, in their case study of the brownfield development of apartment buildings at Wentworth Point (approximately 10km east of Parramatta CBD and within the CoP LGA), Easthope and Tice (2011) demonstrate that families with children made up 31% of household types in that area in 2006, which had

doubled since 2001. Furthermore, between 2001 and 2006 they also note a doubling in the proportion of households with a lower income (less than \$650 per week) and observe that the “vast majority” of people moving into the new developments were from nearby Auburn and surrounding suburbs. They argue that “such population shifts suggest that the needs of families with children must be seriously considered if new developments are to meet the ends of their future residents”. In other words, high-density housing must be “built *with children in mind*” (Easthope & Tice 2011, p. 427, emphasis in original).

1.1.5 New South Wales: a leader in healthy urban development for children

New South Wales has recognised the importance of healthy built environments for children over the last decade, with a 2005-6 NSW Parliamentary Inquiry and a follow-up Inquiry in 2011 into “Children, Young People and the Built Environment” making recommendations which were fully supported by the state Government (New South Wales Parliament 2006 and New South Wales Government 2011). A key resource arising from these Inquiries was *built4kids*, a “good practice guide to creating child-friendly built environments” (NSW Commission for Children and Young People 2009). However, *built4kids* does not specifically consider high-density housing. In 2009 the NSW Department of Health also published the *Healthy Urban Development Checklist* (NSW Government Department of Health 2009). This considers some of the evidence regarding the health of children in certain residential environments, for example concluding that “unsafe pedestrian environments” discourage active school transport (NSW Government Department of Health 2009). It also notes a number of child health indicators of poor quality housing, including “respiratory diseases such as asthma”, exposure to pests such as rodents, and safety issues (NSW Government Department of Health 2009). Although the *Checklist* is not focussed on high-density housing, it does contain a number of useful considerations during the preparation of development proposals, including supporting parental surveillance of child play, integrating public open spaces with other facilities, and encouraging active school transport and healthy food environments (NSW Government Department of Health 2009). The *Checklist* is a tool to help Local Health Districts and NSW Health to provide feedback to local councils, however it is non-binding. As a result there remains community and expert concern that governments and developers are “child-blind, with the new higher density centres being built essentially for the childless in mind” (Woolcock et al. 2010).

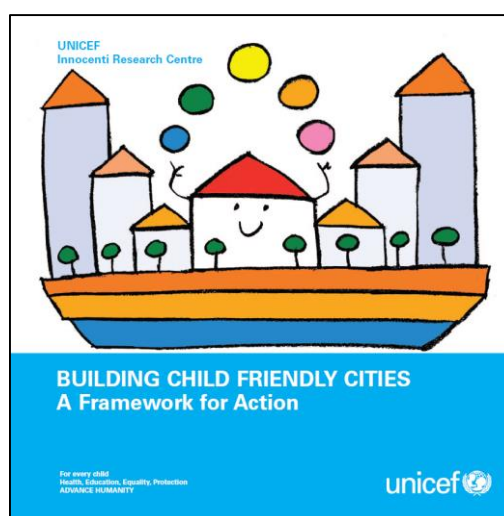
1.1.6 Growing international emphasis on child friendly built environments

Internationally, UNICEF’s *Child Friendly Cities* initiative is creating momentum for local governments to strengthen and promote the rights of children through thoughtful urban environments, with a particular focus on the most vulnerable children (Figure 4, UNICEF Australia 2016). This initiative has already been supported by a number of Australian communities, with Penrith City Council, for example, releasing a *Child Friendly City Strategy* (Penrith City Council 2012). Child-friendly urban development is increasingly prominent on the global agenda, with the *Quito Declaration on Sustainable Cities and Human Settlements for All* advocating engaging children in participatory decision-making about urban environments. The *Declaration* prioritises a “safe and healthy journey to school for every

child”, and commits to “safe, healthy, inclusive” cities for children (United Nations Conference on Housing and Sustainable Urban Development 2016). This aligns with the United Nation’s *Sustainable Development Goals*, in which Goal 11 is to “make cities inclusive, safe, resilient and sustainable”, with a target to “provide universal access to safe, inclusive and accessible, green and public spaces, in particular for...children” by 2030 (United Nations n.d.).

Therefore, momentum exists at local, national and international levels to support a focus on children’s health in the urban environment.

FIGURE 4: UNICEF’S CHILD FRIENDLY CITIES FRAMEWORK



Source: (UNICEF Innocenti Research Centre 2004)

1.1.7 Housing and the surrounding environment can support optimal child health and development

Housing is recognised as an important social determinant of health for all ages (Wilkinson & Marmot 2003). An Australian study estimates that, all else being equal, housing accounts for between 2% and 8% of the variation in children’s health and development outcomes, based on data from the *Longitudinal Study of Australian Children* and the *Longitudinal Study of Indigenous Children* (Dockery et al. 2013). Meanwhile, Leventhal and Brooks-Gunn (2000) attribute approximately 5-10% of variation in child health and development outcomes to the effect of the neighbourhood, all other things being equal. These figures highlight the importance of ensuring optimal built environment conditions for children.

At a population level, optimising early childhood outcomes can have significant impacts on a society’s future productivity and wellbeing. The period from birth to 24 months is particularly crucial for the development of the young brain, meaning that exposures during this time may have a magnified effect, whether positive or negative (Aboud & Yousafzai 2016). A focus on children within the high-density housing discussion is also warranted because children have particular needs. These needs change over time as the child grows and develops new skills, although this developmental trajectory is often not well understood or considered by adults

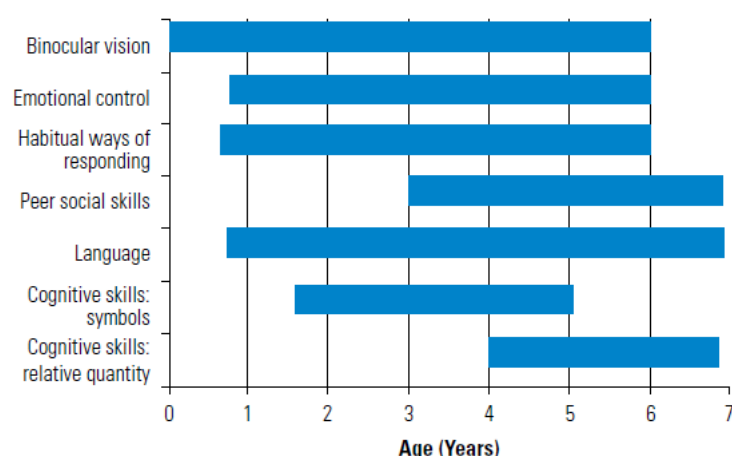
(Churchman 2003). Creating an environment where a child's development can flourish represents an opportunity to help them reach their potential. Generally, a child's development can be considered across a number of domains, which include:

- Motor, including gross and fine (examples include walking and drawing)
- Language, including receptive and expressive (examples include listening and talking)
- Cognitive (examples include problem solving, memory)
- Behavioural (examples include sitting still for a task)
- Socio-emotional (examples include playing with other children)

There are a series of stages of usual child development, through which children progress at different speeds and in different sequences within a 'normal' range (figure 5). These domains interact with and influence each other. The health and development impacts of high-density living on children will be analysed based on these (simplified) domains of development:

1. Physical health and development
2. Psychosocial wellbeing and mental health
3. Language, cognitive and communication skills

FIGURE 5: SENSITIVE PERIODS FOR VARIOUS DOMAINS OF HEALTHY CHILD DEVELOPMENT



Source: (Dunn 2012)

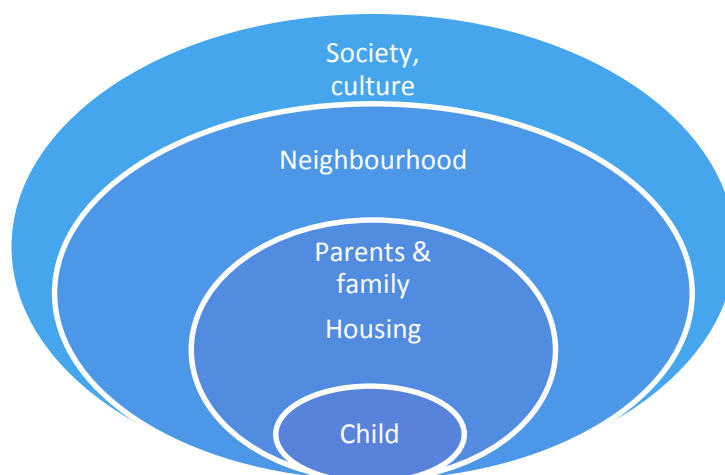
A child's development is influenced by a 'back-and-forth' model of interaction between the child and external factors, including their social and physical environments (figure 6). Child development is therefore an active and ongoing process, and children need to be challenged in order to develop skills. One important external support is a family who love the child, interact with them frequently, and attend to their basic needs. In particular, the primary caregiver's (often the mother's) psychological wellbeing is an important determinant of the

child's health and development, and itself may be strongly influenced by the environment (World Health Organization 2016). For younger children in particular, the way the environment is experienced is often mediated through the parental relationship, as the child is almost completely dependent on the parent during those early years (Churchman 2003).

Other developmental influences include physical factors such as housing and neighbourhood features. It is biologically plausible, for example, that a child who is learning to run (often around 15-18 months of age) may be slower to do so if they do not have space to learn and practice regularly. It is also plausible that children living in apartments may be given more “quiet time” and screen time to avoid disruption to neighbours from noisy play. This may hinder the boisterous, social and creative play that is also important for children's development (figure 7), which may in turn potentially affect their adult social competence. Sydney researchers have also found that children living in apartments may be more likely to be shortsighted, with environmental factors being a recognised influence on the development of vision (Ip et al. 2008). Given that different developmental domains mature at different ages (figure 5), it follows that high-density living may affect the development of different skills to varying degrees, depending on when the period of high-density living occurs in a child's life.

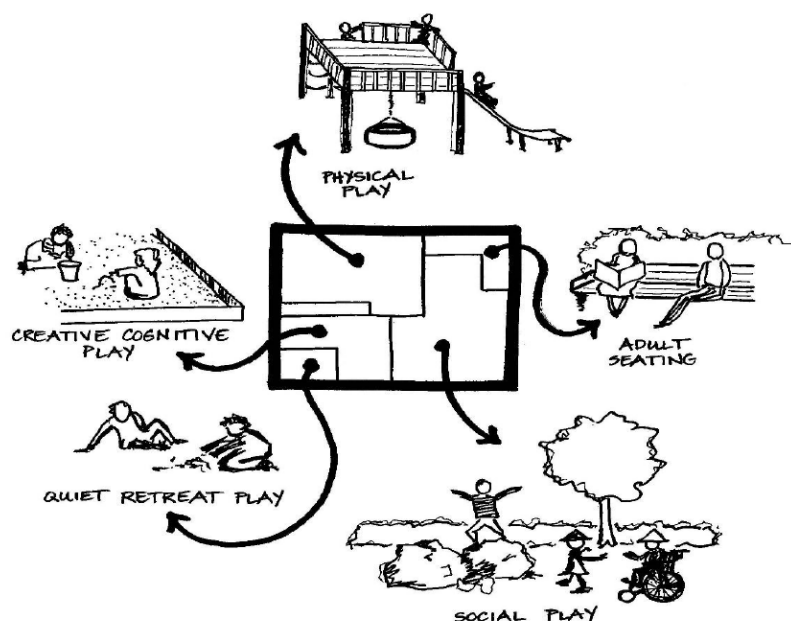
In early childhood, the home may be particularly influential because children spend a greater amount of time there (Cheng et al. 2016). It is important to have a clear understanding of the potential risks and benefits of high-density living across early childhood in order to make and implement appropriate recommendations to optimise the health and development of children living in these environments. Investment in the health and development of Australia's young children today ensures that the nation will continue to prosper through collectively reaping economic and social dividends into the future (Bales & Kendall-Taylor 2014).

FIGURE 6: THE ECOLOGICAL MODEL: CHILDREN INTERACT WITH AND ARE INFLUENCED BY MANY ASPECTS OF THEIR ENVIRONMENT



Source: Adapted from Bronfenbrenner 1994

FIGURE 6: A VARIETY OF PLAY SPACES ENCOURAGE HEALTHY CHILD DEVELOPMENT



Source: (Sarkissian et al. 2003)

Snapshot: the health status of Parramatta's children

The predominant health issues affecting the children of Parramatta are strongly tied to the quality of the built environment, particularly in the areas of physical activity, obesity, and nutrition. Although data is not available at the level of the local government area, 34% of children in Western Sydney Local Health District (WSLHD, which encompasses CoP LGA) aged 2-15 years are classified as being either overweight or obese, which is similar to 29.5% in NSW as a whole (Western Sydney Local Health District 2012). The NSW Premier has specified a 'priority target' of "reducing overweight and obesity rates of children by 5% over 10 years", indicating that policy and action in this area is of particular political interest (Centre for Population Health 2016). WSLHD has also been found to deviate from the NSW norm in a number of areas, with one-third fewer children reaching physical activity targets and fewer children eating the recommended amount of vegetables (Western Sydney Local Health District 2012).

In addition, the proportion of preschool children in the City of Parramatta LGA who are developmentally vulnerable in one or more domains on the Australian Early Development Census (AEDC) has increased between 2012 and 2015 from 21.5% to 24%, a statistically significant change (AEDC 2015). The specific developmental domains of social competence and emotional maturity have also seen an increased proportion of vulnerable children over this time (AEDC 2015). Parramatta's children remain more developmentally vulnerable than NSW children as a whole, and within Parramatta LGA particular pockets of vulnerability are evident at the 'local community' (suburb) level (AEDC 2015).

2. Methods

We undertook a rapid review of reviews (Peters et al. 2015, Grant & Booth 2009). Given that a number of reviews considering this topic have already been published, this method allows us to combine a broad range of different exposures, outcomes and age ranges into a single overview with policy relevance (Smith et al. 2011). This overview aims to provide a summary of the relevant evidence in a timely manner which can be used to inform local government and other stakeholder's policy making and activities. Search terms were informed by previous reviews and refined over multiple searches to ensure an optimal balance between sensitivity and specificity. Search terms included variations of:

1. "child", "infant", "young person", AND
2. "high-rise", "housing density", "population density", "apartment", "flat", "housing", AND
3. "health", "child development".

The search was limited to reviews, non-English language articles were excluded, and was not limited by publication date. See [Appendix A](#) for detailed search methodology. Databases searched included: PubMed, ProQuest, Cochrane Database of Systematic Reviews, and Ovid (MEDLINE). Grey literature search strategies were also employed, using snowball searching from the reference lists of identified articles, website searching, and contacting experts in the field. It was deemed necessary to include grey literature in this report given that much relevant literature on this topic is produced by governments and civil society organisations rather than published in academic journals. Population data was retrieved from .id Consulting's analysis of Australian Bureau of Statistics Census data (.id n.d. a). At the time of publication, data is largely from the 2011 Census – this report will be updated when all 2016 Census data becomes available.

For the guidelines review, we utilized a grey literature search strategy to identify relevant guidelines documents for inclusion, from 1990 onwards, using keyword search terms from the black literature review. Databases searched included: 1/ Google search and 2/ Grey Literature report, New York Academy of Medicine. Experts in the field were consulted and asked to contribute relevant guidelines documents. Reference lists of identified documents were searched for additional potential inclusions. Guidelines were included if they provided recommendations which aimed to improve quality of life or health of children in high-density or apartment housing. Key themes were identified and synthesised.

3. Results

The rapid review identified 444 systematic reviews, reviews or meta-analyses which met the search criteria. The titles and abstracts of these articles were reviewed for relevance, and of these 40 were considered for full-text review. Full-text article access was gained through Westmead Hospital library if available, and 10 articles were retained after full-text review. An additional eight articles retrieved from a grey literature search were included. 18 articles

were therefore deemed eligible for inclusion in the final review ([Appendix B: Studies included in review](#)). Of these, six were systematic reviews and the remaining 12 were narrative or scoping reviews. Key results from each article were tabulated, analysed for their relevance to the Western Sydney context, and the results synthesised.

In general, evidence regarding the effects of medium and high-density housing on the health of children is limited and often conflicting. Most previous studies have been cross-sectional in design, making it difficult to establish causality (Villanueva et al. 2016). The evidence relating specifically to children is minimal, except in the area of children's independent mobility which tends to focus on the 8-12 year old age group. Additionally, the strength and direction of associations often vary depending on other variables, particularly age, gender and socioeconomic status.

Overall, the evidence suggests that high-density housing is not intrinsically “good” or “bad” for health, but that its health effects are likely to differ depending on **who** is living within it, **how** such housing is designed, and **what** are the features of the wider urban environment within which it is situated (Carroll et al. 2011, Easthope and Tice 2011).

The review of the literature revealed a number of associations between high-density housing and the health and development of children, which are presented within the three predetermined domains of: 1. Physical health and development, 2. Psychosocial wellbeing and mental health, and 3. Language, cognitive and communication skills.

3.1 Physical health and development

3.1.1 Active transport, outdoor play and obesity

There has been a clear decline in children's active transport over the last 50 years, with many children now being driven to school where they previously would have walked or biked (Tranter 2006, Mackett et al. 2007). This increasing reliance on car travel may be a contributing factor to the 25% prevalence of obesity and overweight in Australian children (ABS 2013, Victoria Parliament, Legislative Council, Environment and Planning References Committee 2012). Nonetheless, the evidence regarding the effects of high-density housing on physical activity in children cannot be categorised as a simple correlation. Haigh et al. (2011) found that children living in higher density areas are likely to be more physically active than those living in lower density. It may, however, depend on the nature of the physical activity, with some reviews finding a possible increase in active school transport in higher density areas (Wong et al. 2011, Fraser and Lock 2010), while others found a reduction in outdoor play (Evans 2006, Evans 2003, Ferguson et al. 2013). Children living in higher density may also have lower levels of overweight and obesity than children living in low density suburbs, although the evidence for this is weak and seems to vary according to gender and age (Haigh et al. 2011, Dunton et al. 2013, Giles-Corti et al. 2012). For example, girls (but not boys) living in high-density housing seem more likely to be overweight and have more restricted independent mobility compared to their peers living in separate dwellings (Giles-Corti et al. 2012). Another review suggested that there may be a density “tipping point”, observing that high-density buildings up to six stories seem to promote

children's physical activity, but buildings taller than that inhibit it (Giles-Corti et al. 2012). It is likely that the relationships are complex, varying by demographic factors and influenced by context (Kent et al. 2011).

3.1.2 Traffic

Aside from the effects of high-density housing itself, there are also potential effects which relate to neighbourhood features which are often, but not invariably, associated with high-density dwelling types. For example, an increase in traffic or traffic danger (resulting from higher traffic volume and speed, or fewer pedestrian crossings) has been associated with restricted outdoor play (Villanueva et al. 2016, Ferguson et al. 2013, Evans 2006, Haigh et al. 2011), weaker motor skill development (Ferguson et al. 2013, Evans 2006), an increase in injuries (Evans 2006), and more frequent respiratory illness attributed to vehicle exhaust fumes (Haigh et al. 2011). However, the extent to which housing densification results in traffic intensification or attenuation is dependent on other factors such as parking provision, public transport access, and traffic calming measures (figure 8). Thus, the effects of housing densification on active transport cannot be understood as a simple exposure-outcome relationship, because the relationship is also influenced by a number of other factors, both in the environment and within the individual child (Haigh et al. 2011).

FIGURE 7: THE DUTCH "WOONERF" (LIVING STREET) PRIORITISES CHILDREN'S PLAY BY USING TRAFFIC-CALMING LANDSCAPING



Source: (Steinberg 2015)

3.1.3 Walkability

Another important urban design feature which may mediate the relationship between high density and health is the “walkability” of neighbourhoods. Improved walkability means improved proximity of destinations, mixed land-use, street connectivity, pedestrian amenity and aesthetics (Haigh et al 2011, Villanueva et al. 2016). Fraser and Lock (2010) found that neighbourhoods with mixed land-use increased rates of children cycling to school. “Smart growth”, with an emphasis on walkable connectivity, was also associated with greater community social capital, although this was not specific to children (Lindberg et al. 2010).

3.1.4 Falls and injuries

High-rise housing seems to be associated with an increased likelihood of falls (Meadows-Oliver 2014), although not all reviews found increases in injury rates for children in higher density (Haigh et al. 2011). In 2012, after an alarming rise in children presenting to the Emergency Department with injuries resulting from falls from buildings, the Children's Hospital Westmead launched the 'Kids Can't Fly' campaign (Sherry 2012, figure 9), which was strongly supported by the City of Parramatta Council. The NSW Government has since mandated the installation of child safety devices on all above ground strata building windows to try and minimise these injuries, which must be fitted by 13 March 2018 (NSW Government Fair Trading 2016). Similar regulatory changes in New York City in the 1970s reduced child deaths from falls by 96% (Committee on Injury and Poison Prevention 2001). Given that falls are "the leading cause of hospitalised injury" in children aged 0-14 years, it will be important to monitor the effectiveness of this new legislation on the rates of child falls from windows (Australian Institute for Health and Welfare 2016).

FIGURE 8: FALLS FROM WINDOWS AND BALCONIES ARE A SIGNIFICANT RISK TO CHILDREN'S HEALTH IF APPROPRIATE SAFETY DEVICES ARE NOT INSTALLED



Source: Kids Health at the Children's Hospital Westmead 2016 [CC]

3.1.5 Crowding

Crowding within residential environments is more common in high-density housing, but it can also be found in other dwelling types and as such is not a focus of this report. Crowding has been associated with negative outcomes across all domains of child health and development, including mental health (Ferguson et al. 2013, Evans 2006, Evans 2003) and physical development (Ferguson et al. 2013, Evans 2006), although in the European context the evidence has been described as weak with many associations being non-significant (Pillas et al. 2014). Children living in crowded conditions display increased aggressive and withdrawn behaviour (Ferguson et al. 2013, Dockery et al. 2010, Evans 2006, Evans 2003), and language and cognitive skills may also be affected (Evans 2006). However, the negative effects of crowding may be offset by provision of a separate play or study space (Dockery et al. 2010) or compounded by crowding in the classroom (Giles-Corti et al. 2012).

3.2 Psychosocial wellbeing and mental health

The effect of high density (especially high-rise) living on mental health has been much explored over the last 50 years, although often not specifically in children. Fanning's oft-cited *Families in Flats* study (1967) was one of the earliest to draw a link between high-density living and psychological distress, finding that mothers living in higher density housing (which they were allocated to randomly) had worse mental health than controls. Poorer mental health in mothers was more marked the higher the floor of residence, and this link between high-rises and poorer adult mental health has been supported by subsequent reviews and may be related to a paucity of social networks (Villanueva et al. 2016, Evans 2003). The reviews suggest that socially supportive neighbourhood relationships seem to be less common in high-rise buildings, although reverse causation may be a factor here (Evans 2003, Evans 2006).

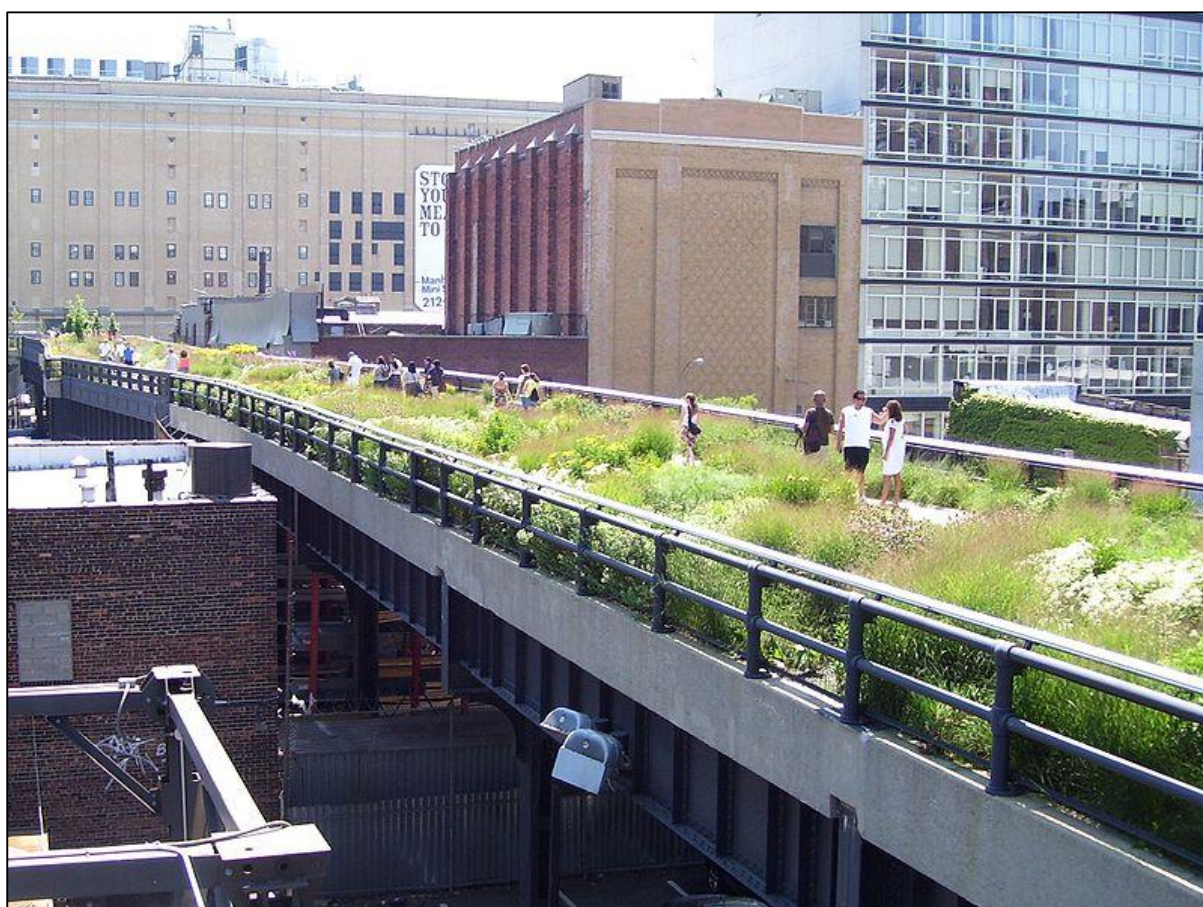
The evidence regarding children's mental health is less established, but there is a possible association between higher floor of residence and worse mental health (Evans 2003). Additionally, numerous reviews found an increase in behavioural problems in children living in high-rise buildings (Haigh 2011, Ferguson et al. 2013, Dockery et al. 2010), with the association seeming stronger for younger children (Evans 2006, Dockery et al. 2010). Villanueva et al. (2016) found increased social withdrawal and behavioural problems in children in high-density settings, however they describe the evidence as "indicative rather than conclusive". Numerous mechanisms have been postulated for this potential association. One possibility is that behavioural problems may be mediated by a third factor, such as chronic noise exposure or reduced social interactions (Haigh et al. 2011). It is critical to uncover such mediating factors where they exist, as this allows us to intervene instead of simply dismissing densification as inherently unhealthy.

3.2.1 Green space

Access to open, green spaces has been associated with an increase in children's physical activity (Ferguson et al. 2013, Giles-Corti et al. 2012, figure 10), as well as improved gross

motor skills (Villanueva et al. 2016, Evans 2006). Furthermore, access to green spaces is consistently correlated with a positive effect on emotional regulation and psychological wellbeing in children. Multiple reviews found that the effect of such spaces on children was “restorative”, resulting in improved affect and less impulsive behaviour (Villanueva et al. 2016, Ferguson et al. 2013, Evans 2006, Evans 2003). Conversely, children with less proximity to green space have been found to have more behavioural problems, including hyperactivity and inattention (Villanueva et al. 2016). The quality of the green space is also key. “Over-designing” spaces for children – by eliminating the “wildness” or “nature” of a play space – may diminish the essential developmental opportunities for children to take risks, be creative and test their skills through play (Chadha 2014, Whitzman and Mizrachi 2009).

FIGURE 9: MANHATTAN'S HIGH LINE: REVITALISED URBAN GREEN SPACE IN A HIGH DENSITY MIXED-USE AREA



Source: Beyond My Ken, Wikimedia Commons [CC]

3.3 Language, cognitive and communication skills

Cognitive development in early childhood has been found to be delayed in children living in high-density housing (Ferguson et al. 2013), however some reviews have found inconsistency of the evidence between high-rise residence and a reduction in academic achievement (Ferguson et al. 2013, Evans 2006). One environmental feature that is often,

but not invariably, related to high-density living is that of chronic noise exposure. The effects of a noisy environment on children's development and health has been relatively frequently studied, although a number of the studies have been undertaken in the school rather than home environment.

A number of reviews noted an association between chronic moderate-high levels of noise exposure (for example, living near an airport or freeway) and biological markers of stress in children, including increased blood pressure and higher levels of stress hormones such as cortisol (Evans 2006, Ferguson et al. 2013, Stansfeld et al. 2000). Chronic noise exposure has also been found to reduce children's language and cognitive skills, with worsened reading skills, long-term memory, and attention; and increased learned helplessness behaviour (Ferguson et al. 2013, Evans 2006, Evans 2003). Furthermore, noise has been negatively associated with social development and behaviour, specifically with an increased risk of oppositional disorders (Ferguson et al. 2013). Finally, while a number of reviews found that noise is associated with worse mental health (Evans 2003, Ferguson et al. 2013), others found mixed or inconsistent evidence (Evans 2006, Stansfeld et al. 2000).

FIGURE 10: REVIEW OF GUIDELINES ON HEALTHY HIGH-DENSITY HOUSING FOR CHILDREN

Given this report's aim to provide guidance to local government regarding the health effects of high-density housing on children, it is useful to consider what guidelines already exist on this topic. A keyword-based search found a general paucity of relevant guidelines, with a total of five documents being included for analysis (see [Appendix C](#) for tabulated results). Guidelines were considered relevant for inclusion if their focus was on providing recommendations regarding improving the health, development and/or wellbeing of **children** living in high density or apartment-type housing. Of these guidelines, 3/5 were from Australia, with one document each from Canada and New Zealand. All the guidelines were non-statutory in nature. Some, such as Sarkissian's (2003) recommendations, were prepared on behalf of a private property developer, however the majority were prepared by the public sector. All the guidelines gave recommendations aimed predominantly at new, rather than existing, housing developments. The guidelines varied considerably in the level of depth and breadth covered of their recommendations. Only one of the guidelines (City of Vancouver 1992) covered three "levels" within high-density development, namely: 1. individual dwelling, 2. building and 3. neighbourhood. Two of the five guidelines made recommendations relating to two of these "levels", and a further two made recommendations regarding one level only. One guideline made a recommendation to engage children in the design process of the built environment (Holliday 2006). Interestingly, none of the guidelines made recommendations regarding "who" should live within high density (for example: recommending that a certain number of dwellings be reserved for low-income families). Finally, none of the guidelines referenced an explicit evidence base for their recommendations.

For analysis, each guideline's recommendations were mapped against our three simplified child health and development domains: 1. Physical health and development, 2. Psychosocial wellbeing and mental health, and 3. Language, cognitive and communication skills. This revealed that all five documents made recommendations which broadly related to the first domain of children's physical health. The majority of these recommendations related to one of: safety issues, play spaces (both indoor and outdoor), and enabling active travel. In addition, two documents made recommendations relating to supermarkets/grocery stores, acknowledging the important contribution of food environments to the obesogenicity of the built environment (Whitzman et al. n.d., City of Vancouver 1992). In the second domain of psychosocial wellbeing and mental health, 4/5 guidelines made recommendations regarding built environment features that broadly support social and emotional wellbeing and development, in particular relating to community spaces or 'hubs', but also to spaces within dwellings where children can socialise with peers (Whitzman et al. n.d., Holliday 2006, City of Vancouver 1992, Sarkissian 2003). Recommendations regarding the third domain were not commonly included in the guidelines, although 2/5 did include recommendations regarding access to facilities which support cognitive and language development, such as schools and libraries (Whitzman et al. n.d., City of Vancouver 1992). In addition, 2/5 guidelines made recommendations relating to the minimisation of noise exposure in high-density housing (City of Vancouver 1992, Sarkissian 2003). None of the reviewed guidelines explicitly use the term "health", although their chosen terms align with the World Health Organization's (1948) definition of health, which incorporates "complete physical, mental and social well-being". Two documents use the term "child-friendly" (Holliday 2006, Shephard & Matthews 2016), a further two use "the needs of children and families" (Whitzman et al. n.d., Sarkissian 2003) and one uses "liveability" (City of Vancouver 1992).

This highlights the importance of considering the framing and language used around this topic. Advocates, particularly health professionals who may be less familiar with such language, might want to use terms that will have meaning to other stakeholders. However, this might also present an opportunity to adopt an explicit health lens in advocacy efforts, thus including a wider group of advocates who had not previously been active in the field, as well as potentially creating a greater sense of urgency regarding the problem.

FIGURE 11: PERCEIVED OPPORTUNITIES AND RISKS OF HIGHER DENSITY IN THE CITY OF PARRAMATTA: KEY STAKEHOLDER INTERVIEWS

Key stakeholder interviews were undertaken with staff from a number of teams within Western Sydney Local Health District (n=10) and City of Parramatta (n=19). These informal consultations revealed a number of key themes regarding the health opportunities and risks of higher density living for resident children and families specific to the City of Parramatta LGA. The preliminary themes are discussed here, and will be reported in more detail as part of an ongoing project that will include interviews with parents of young children living in high density.

Apartments: Safety was often cited as a key concern regarding children living in apartments, with risks from falls mentioned frequently. Traffic safety was also a recurrent theme, with participants stressing the need to improve traffic calming measures in higher density areas, particularly in areas that may be used by children to play. Health providers mentioned they frequently encountered significant crowding within residences, often due to multigenerational or multiple families living within one apartment. This creates difficulties for health provider's ability to perform in-home visits, due to a lack of privacy for the client. This was linked to the theme of the lack of housing affordability, which reduces choices for young families and particularly affects those from less affluent backgrounds. Culturally and linguistically diverse groups were mentioned as being particularly affected by this affordability challenge.

Buildings: The participants also commented on higher density buildings, with a strong focus on parking. Health service providers frequently remarked about the difficulties accessing parking in and around higher density buildings, with a lack of visitor parking and security restrictions making home visits difficult. Emphasis was placed on the need to site families closer to the ground in higher density developments, to allow children access to ground-level play spaces as well as facilitating parental surveillance of children's play. Concerns were also raised about the liveability of very tall buildings, particularly at heights where wind speed precludes the building of balconies, limiting private outdoor space for residents.

Neighbourhoods: The most frequent comments during these interviews related to higher density neighbourhoods, in particular open, green and play spaces for children. There was a broad consensus about the need to provide child friendly spaces within both higher density buildings and neighbourhoods, but also general agreement that this was not yet done well or consistently. The ramifications of a lack of open spaces were outlined by health providers, who described their concerns across a wide range of potential impacts. For example, paediatric allied health professionals were concerned about children in higher density having impaired gross motor skill development and increased obesity due to spending more time indoors and sedentary. A City of Parramatta employee expressed concerns about some high-density child-care centres in Sydney having 'simulated' outdoor play areas, which are substantially enclosed. They also noted that open spaces such as sports fields or school playgrounds are increasingly subject to conflicting user groups and crowding. In contrast, however, participants also noted the opportunity for higher density to create more open space, remarking that open space can be created within neighbourhoods by building upwards for housing.

The interviews also generated rich discussion about the impact of higher density housing on the social environment and interactions of residents. Some participants noted the opportunity afforded by such proximity to encourage interactions between neighbours, allowing diverse communities to flourish. However, a number of others noted that strata rules might inhibit neighbours' interactions, functioning effectively like a 'vertical cul-de-sac'. Furthermore, a "vacuum" was noted in regard to community spaces within buildings and neighbourhoods, and suggestions for improvement supported planning for resident diversity and mixed use, including music rooms, children's play rooms, better noise insulation, and improving resourcing of community services such as libraries to better cater for evolving uses and clients.

4. Discussion

In the case of urban development, what is good for children is often good for everyone. As the former Mayor of Bogota, Colombia, Enrique Peñalosa (2004) said: “Children are a kind of indicator species. If we can build a successful city for children, we will have a successful city for all people.” Older people, people with disabilities, and even childless adults are likely to benefit from many of the changes that would support a child-friendly high density urban environment. For example, making a neighbourhood more walkable is likely to improve active transport for adults as well as children. Behavioural economists argue that improving neighbourhood walkability can “nudge” people of all ages into increased physical activity, by making walking the easiest option (Roberto & Kawachi 2016). This recognises that people’s behaviour is highly dependent on their surrounding ‘choice architecture’, and that changing such architecture can reduce car dependent behaviour.

Furthermore, child-friendly high-density housing might also be considered from a human rights perspective. Such an approach should ensure the needs of the child through all stages of development are met, ensuring that the *Convention on the Rights of the Child* (UNOHCHR 1990) is upheld under Australia’s obligations. Such perspectives support a standard practice of designing housing and neighbourhoods with “children in mind” (Easthope & Tice 2011).

There is evidence to suggest that all medium and high-density housing is not equal. For example, certain design characteristics may improve the acceptability of housing to parents (for example, windows facing onto a play area allowing easy surveillance) while maintaining a given level of higher density (Villanueva et al. 2016). Giles-Corti et al. (2012) suggest that families often prefer low- or medium-rise housing which allow informal surveillance and more opportunities for socialisation (forms A and B in Figure 1), rather than high-rise living. Furthermore, engaging residents – including children – in the design of projects can itself improve residents’ health, happiness and satisfaction through the process of participation itself (Haigh et al. 2011, Nightingale Housing 2016).

As children progress through childhood, different aspects of high-density living are likely to affect children of different ages in different ways. For example, younger children (<10 years) are likely to be more at risk from high traffic situations than older children, whose cognitive maturity allows them to negotiate a higher degree of traffic complexity (Villanueva et al. 2016). Older children may benefit more from the proximity of destinations in higher density areas, affording them better independent mobility and the potential to learn important way-finding skills, compared to younger children whose parents must accompany them regardless of destination proximity. Again, the emphasis on equity should be applied here, as research has shown that areas of socioeconomic deprivation tend to have fewer “destinations” of interest to children, and those that exist are of poorer quality (Villaneuva et al. 2016).

The growth of high-density development should prompt parents, communities, and local governments to rethink their mode of interaction with the built environment, which in Australia will mean a density-aware adaptation of the traditional “Quarter Acre dream”. High-

rise housing has long been considered inappropriate for children, at least in part due to the “ghettoization” of marginalised populations in public housing during 1960s Australia. A modern reframing does not mean acceptance of all high-density developments without question, but rather should support efforts to provide in public spaces what once would have been in the backyard. One example of such a strategy is the ‘Playing Out’ initiative in the United Kingdom, which is a resident-driven movement of regular street closures with the aim of allowing children to play in car-free streets (Playing Out n.d.)(figure 13). Such an initiative could help to neutralise any effects of high-density housing in reducing outdoor play, while also building informal social networks among residents who have less-traditional social interactions resulting from apartment living.

FIGURE 12: CHILDREN PLAY IN THE STREET, UNITED KINGDOM



Source: Fair Play for Children, n.d.

A number of cities internationally have specific policies or guidelines addressing the health of children living in high density, with Canada taking the lead (figure 14). Over 25 years ago, the City of Vancouver Council adopted *High-density housing for families with children guidelines* (1992), which provide guidance across the spectrum of development: from project siting and neighbourhood, to the building and grounds, and finally the apartment itself. Closer to home, the *Auckland Design Manual* (Shephard & Matthews 2016) incorporates a more informal ‘Child-Friendly Checklist’ for consideration when developing high-density housing. Although these guidelines and checklists do not take an explicit health lens, many of their recommendations relate to features which will directly or indirectly influence child health and development, including children’s play areas, open space, passive surveillance, traffic, and safety features of apartments.

FIGURE 13: HIGH-RISES DOMINATE THE VANCOUVER CITY SKYLINE



Source: Thom Quine, Wikimedia Commons [CC]

4.1.1 Research in progress

An in-progress, longitudinal study called the *Kids in Communities study*, pairs population-level data from the *Australian Early Development Census* with community-level determinants of health (including housing density) in order to determine how the neighbourhood might influence early childhood development (Villanueva et al. 2015). This study is collecting data from 25 communities across the country, and the results are likely to be highly informative for City of Parramatta.

In addition, the City of Toronto is currently undertaking the *Growing Up: Planning for children in new vertical communities* project. This project aims to examine “how new multi-unit housing in high-density communities can better accommodate the needs of households with children and youth” through public consultation, case studies, and design jams for solutions. The City has engaged a large range of stakeholders, from children to developers. A draft handbook of policy options is scheduled for release in 2017 (City of Toronto 2016).

4.1.2 Gaps

There are a number of opportunities to strengthen the evidence base regarding children’s health in high-density built environments. Firstly, although overall evidence is limited, the evidence about how high-density living might affect the health and development of children who have certain risk factors or pre-existing vulnerabilities is particularly lacking. For example, if an individual child already has a gross motor delay, to what extent would it be beneficial for them to live in a standalone dwelling instead of an apartment? This question is particularly salient for City of Parramatta, where 20% more preschool children have been found to be developmentally vulnerable compared to their state peers (AEDC 2015). Additionally, up to half the population of CoP speak a language other than English at home,

and it is important to consider the effect of such cultural and linguistic diversity on the health and development effects of high-density living. Thus, given the multifaceted potential for vulnerability, it will be critical to apply an equity lens to this question, with the intention of using our findings to optimise the health of Parramatta's children going forward.

Furthermore, it will be important to consider the potential for gentrification with increasing densification, with displacement of disadvantaged populations out of new higher density areas due to reduced affordability (Williams 2016). Will there be adequate provision of social or affordable housing to enable a diversity of demographic groups to live in the city centre, close to employment and other amenities? Finally, the child-friendliness (of lack thereof) of older high-density housing should not be neglected, and the feasibility of retrofitting should be considered to ensure that those who benefit from new child-friendly strategies are not simply the wealthiest group who can afford to live in new developments.

Finally, there are a number of important child health and development issues that could plausibly be impacted by high density and high-rise housing, but for which minimal or no evidence arose in our rapid review. These issues have been identified in discussion with managers and health service providers within City of Parramatta and Western Sydney Local Health District as areas for possible future focus. These issues include:

- **Vitamin D deficiency** and the risk of bone disease (rickets). This may result from limited sunlight exposure in children (especially those with deeply pigmented skin) who spend minimal time outdoors or where there is significant overshadowing of play spaces by tall buildings (noting however that City of Parramatta has regulations in place to minimise this). There is also a concern that children in early learning centres are increasingly spending time in 'simulated' outdoor play environments, in lieu of outdoors (C. Isaac-Dean 2016, personal communication, 10th October).
- **Food environments.** There are three key aspects to the food environment that may impact upon children, namely: food security, food advertising, and nearby food outlet options. Kent et al. (2011) note the strong evidence regarding the effects of "co-location and advertising of unhealthy food options near schools". Haigh et al's 2011 review of health impact assessments found that both medium- and low-density housing should require exclusion zones within 300m of children's institutions such as schools, which restrict advertising unhealthy foods. However, this recommendation did not include exclusion zones surrounding high-density housing, perhaps thought to be impractical due to frequent colocation with retail areas. Lindberg et al. (2010) show that food insecurity is more common in "predominantly minority neighbourhoods" due to fewer supermarkets in these areas, and food insecurity was associated with child malnutrition. However, they found that the impact of such food insecurity on children may be mitigated to an extent by housing subsidies. Although they did not link the food environment to higher density, there are likely to be complementary effects of improving food environments and other elements of the built environment, where density could play a supportive role. For example, nearby fresh, healthy food retail outlets can serve as "destinations", making pedestrian exploration of the neighbourhood more appealing and in turn increasing physical activity.

4.1.3 Limitations

The studies reviewed have a number of methodological limitations, which in turn limits the validity and generalizability of the findings of this report. In particular, the large majority of studies which are included in the reviews collated here are observational rather than interventional. Cross-sectional studies are the most common design for our research question, and this study design makes it difficult to determine causality (O'Campo 2003, Villaneuva et al. 2016). Although interventional studies in the area of housing as a social determinant of health are uncommon due to the expense and impracticability of relocating people (especially at random), one notable exception is the *Moving to Opportunity* study (Sanbonmatsu et al. 2011). Sponsored by the United States Department of Housing and Urban Development, *Moving to Opportunity* used randomised subsidies to investigate the impact of moving from high-poverty to low-poverty neighbourhoods for families living in public housing in a number of large U.S. cities. Although this study did not investigate the effects of high-density housing, *Moving to Opportunity* is notable as one of the only examples of a randomised intervention trial in this field. Its results highlight the complexity of causal interactions between housing exposures and health outcomes. For example, the important role of gender was noted, with mental health outcomes improving among girls and worsening in boys who moved to low-poverty neighbourhoods, while no significant improvements in physical health were seen (Sanbonmatsu et al. 2011). Such findings support our findings that the relationships between neighbourhoods and health are complex, and this is likely to be true of housing as well.

Another limitation of this work is that a rapid review methodology was used. Although this allows us to conduct a broad review and cover all areas of interest, it lacks depth in a specific area. Due to resource limitations, only one researcher undertook the review process, which may limit the validity of the research, and increases the risk of bias. In addition, although a number of Australian researchers lead the field in this area of study, most evidence still derives from international studies. This limits the generalisability of this evidence to the Parramatta context, particularly given some of the unique features of Western Sydney's population. The restriction of our search to papers in English is another limitation, given that a number of the world's highest-density cities – including Tokyo, Seoul and Manila – are in non-English-speaking countries and may be the subject of relevant research. Similarly, the use of a hospital-based license to retrieve articles may also have contributed to a bias, by limiting which articles could be reviewed in full text. This is an important consideration given the interdisciplinary nature of the topic, and given more time it would be ideal to contact authors directly to ask for papers that were not available in full text through our database.

FIGURE 14: CASE STUDY: CHILD-FRIENDLY HIGH-DENSITY HOUSING AT PEABODY TERRACE



Peabody Terrace is a residential development of Harvard University, situated on the banks of the Charles River in Cambridge, Massachusetts, United States. The development was constructed in 1964, and consists of three high-rise buildings (23 floors each), as well as approximately 8 medium-rise buildings (7 floors each). The complex houses a total of 480 apartments, of which 5% are 3-bedroom, and 32% are 2-bedroom. The apartments offer affordable housing to postgraduate students at Harvard University. The apartments and the complex have a number of child-friendly features, including:

- Multiple playgrounds and green spaces, catering to children at different ages and developmental stages
- Onsite family playrooms, with places for adults to sit and socialise while supervising children
- Easily accessible pram storage rooms in the lobby of each building
- Onsite pre-school/childcare centre
- Primary school within 100 metres
- Family-oriented social events (e.g. movie nights on the lawn) organised by the body corporate
- Study rooms for students
- Closure to traffic of a major adjacent road every Sunday for family recreation along the river
- Encouragement of active transport: limited parking, ample bicycle storage, bicycle-share hubs, car-share program, and location on major bike/walking path along the river
- Located within 500 metres of all amenities, including cafes, shops and public transport hub
- Balconies in most apartments, with lower levels allowing supervision of children playing in courtyards and on lawns
- Security patrols after-hours to improve safety
- Cul-de-sac driveway connects to pedestrian-only thoroughfare, improving walkability and connectivity



Source: Harvard University Housing 2015

5. Recommendations

5.1 Five guiding principles

This review supports consideration of the following five principles, in order to optimise the health of children in high-density residential development:

1. **Keep children's needs in mind when developing high-density housing:** Acknowledge that children are likely to live in high-density buildings, and plan public and private spaces to accommodate them and their play.
2. **Engage children in the housing design process:** Encourage child and parent consultation throughout the development process, at both the 'micro' level of individual developments, and at the 'macro' level of precinct or larger-scale urban planning.
3. **Prioritise walkable design:** Walkability contributes to the broader healthiness and liveability of buildings and neighbourhoods. Improving walkability for children means creating a hierarchy of spaces supporting gradual independent mobility, better traffic safety, more mixed-used destinations, and more interesting and close-by green and play spaces.
4. **Design the built environment to optimise the social environment:** High-density housing will be most successful if it balances clustering of families together (e.g. all on lower levels of the building) so children have peers for play and parents have social support and interaction.
5. **Don't forget older high-density housing:** It is particularly important from an equity perspective to consider the needs of children and families residing in older high-density buildings, as they are more at risk of pre-existing vulnerability due to relative socioeconomic disadvantage.

5.2 Child friendly high density checklist

A child friendly high-density housing checklist ([table 2](#)) has been developed based on the evidence and guidelines reviewed in this report. It is intended as a concise, simple reference tool for town planners, architects, property developers, and public health practitioners to use while designing or commenting on specific plans or policies regarding high-density housing. A mixed-methods research project currently underway within the City of Parramatta LGA will also add to the local evidence base, allowing further refinement of the checklist over time.

This checklist should be considered as building upon the NSW *Apartment Design Guidelines* (NSW Government Department of Planning and Environment 2015), which already include a number of features promoting children's health and development (e.g. minimum apartment sizes, storage requirements, private space requirements). Nonetheless, some elements of the *Guidelines* are repeated here, to emphasise and explain their specific relevance to child health and development.

For this checklist to be useful, it is crucial that it is revised by stakeholders including parents and children themselves, to ensure that its suggestions are feasible, pragmatic and maximally effective. Unfortunately such consultations could not be undertaken prior to the preparation of this report. Such an engagement process will enhance the effectiveness of the checklist, and create an opportunity to encourage buy-in from stakeholders around the importance of children's health in the urban environment, which may be a relatively novel consideration for some.

Items have been included in the checklist on the basis of potential for impact against the following criteria:

- Potential to 'shift the curve', by having an impact on the health of all of the population, with the aim of achieving maximum total health benefit (Rose 1985)
- Potential to 'level the playing field', that is, reduce inequity within the population
- Feasibility (including political and financial)

TABLE 2: CHECKLIST FOR OPTIMISING CHILD HEALTH AND DEVELOPMENT IN HIGHER-DENSITY HOUSING

Level of action	Checklist item & examples	Objective	Agent/s responsible	Supporting evidence, guidelines or case study
1. Unit/ Apartment	1.1. Safety: Design for child safety (e.g. windows and balconies designed to minimise falls risk, safety devices fitted as standard to windows, good lighting in common areas)	<ul style="list-style-type: none"> Reduce injury risk 	<ul style="list-style-type: none"> Architect Builder Property developer 	<ul style="list-style-type: none"> Working Party for the Prevention of Children Falling from Residential Buildings 2011
	1.2. Size: Apartments for families are minimum two bedrooms (parents generally prefer three bedroom apartments with two full bathrooms). Each room has sufficient floor space for a single bed, floor play (e.g. 1.4m x 2.5m), a dresser, and desk. → NSW Apartment Design Criteria apply here	<ul style="list-style-type: none"> Reduce health risks of crowding; Improve mental health and cognitive skill development 	<ul style="list-style-type: none"> State government Local government Property developer 	<ul style="list-style-type: none"> Keane 2016 Shephard & Matthews 2016 Sarkissian & Kerr 2003 City of Vancouver 1992 NSW Government Department of Planning and Environment 2015
	1.3. Private space: Each unit has private outdoor space (e.g. safe balcony or small yard), which is large enough for children to play within, facilitating a hierarchy of spaces. → NSW Apartment Design Criteria apply here	<ul style="list-style-type: none"> Enable gross motor skill development (especially in preschool children) 	<ul style="list-style-type: none"> Architect Property developer Local government 	<ul style="list-style-type: none"> Furlong & Cunningham 2007 Edmonton Federation of Community Leagues 2011 City of Vancouver 1992 NSW Government Department of Planning and Environment 2015
	1.4. Surveillance: Design to maximise adult surveillance of child play areas (e.g. place family units on ground or lower levels (<3 rd floor), with windows facing out onto shared courtyards or play spaces)	<ul style="list-style-type: none"> Enable gross motor skill development 	<ul style="list-style-type: none"> Architect Property developer 	<ul style="list-style-type: none"> Easthope and Tice 2011 Shephard & Matthews 2016 Easthope H. & Judd S. 2010

	<p>1.5. Noise: Ensure good noise control (e.g. site family apartments away from roads, and site playground areas nearer to family sections of buildings)</p> <p>➔ NSW Apartment Design Criteria apply here</p>	<ul style="list-style-type: none"> ■ Reduce conflict (and thus enable social, gross & fine motor, and cognitive skill development through unrestricted play) ■ Enable language skill development (through reduced road noise) 	<ul style="list-style-type: none"> ■ Architect ■ Property developer 	<ul style="list-style-type: none"> ■ Furlong & Cunningham 2007 ■ NSW Government Department of Planning and Environment 2015
	<p>1.6. Flexible and accessible floor plan: Ensure unit layout can be adapted to different life stages and family circumstances, incorporating universal design principles</p>	<ul style="list-style-type: none"> ■ Improve social capital (as families need to move less frequently, fostering a sense of community) 	<ul style="list-style-type: none"> ■ Architect 	<ul style="list-style-type: none"> ■ Easthope & Judd 2010
2. Building	<p>2.1 Family-sized dwellings: Encourage a higher proportion of larger, family-sized dwellings in high-density developments (while maintaining a mix of apartment sizes overall), to encourage social interaction and provide greater accommodation choice for families</p>	<ul style="list-style-type: none"> ■ Enable social skill development 	<ul style="list-style-type: none"> ■ State government ■ Local government ■ Property developer 	<ul style="list-style-type: none"> ■ Keane 2016 ■ City of Vancouver 1992
	<p>2.2 Play and social spaces: Incorporate child-friendly spaces for different ages into building design (e.g. playrooms, playgrounds, gathering spaces for teens, and common/multipurpose rooms)</p>	<ul style="list-style-type: none"> ■ Enable social skill development ■ Facilitates safe skill development across all ages 	<ul style="list-style-type: none"> ■ Architect ■ Property developer 	<ul style="list-style-type: none"> ■ Harvard University Housing 2015 ■ Whitzman et al. n.d. ■ Easthope & Judd 2010 ■ City of Emeryville 2015
	<p>2.3 Co-location of family dwellings: Provide family-sized units closer to the ground floor, and clustered nearer each other (to facilitate play among children), preferably in low- and mid-rise buildings ('human scale')</p>	<ul style="list-style-type: none"> ■ Enable social skill development ■ Improved maternal mental health 	<ul style="list-style-type: none"> ■ Architect 	<ul style="list-style-type: none"> ■ City of Vancouver 1992

	<p>2.4 Storage: Provide in-building and in-unit secure storage spaces, including easily accessible bike and pram storage (e.g. adjacent to lobby)</p> <p>➔ NSW Apartment Design Criteria apply here</p>	<ul style="list-style-type: none"> ■ Enable gross & fine motor skill development (through clearing more in-unit space for play and also allowing families to own outdoor play equipment e.g. bicycles) 	<ul style="list-style-type: none"> ■ Architect ■ Property developer 	<ul style="list-style-type: none"> ■ Shephard & Matthews 2016 ■ Harvard University Housing 2015 ■ City of Vancouver 1992 ■ NSW Government Department of Planning and Environment 2015
3. Neighbourhood	<p>3.1 Mixed-use: Encourage mixed-use neighbourhoods in areas of high-density housing</p>	<ul style="list-style-type: none"> ■ Reduce obesity risk ■ Enable cognitive development (through exposure to a variety of experiences in the neighbourhood) 	<ul style="list-style-type: none"> ■ State government ■ Local government ■ Property developer ■ 	<ul style="list-style-type: none"> ■ Committee for Sydney 2017
	<p>3.2 Traffic safety: Implement effective traffic calming measures (e.g. reduced speed limits, shared streets, landscaping and temporary street closures)</p>	<ul style="list-style-type: none"> ■ Reduce injury risk ■ Enable gross motor skill development 	<ul style="list-style-type: none"> ■ State government ■ Local government ■ Property developer ■ Parents 	<ul style="list-style-type: none"> ■ Villanueva et al. 2016 ■ Whitzman et al. n.d. ■ Furlong & Cunningham 2007
	<p>3.3 Play and green spaces: Ensure these are</p> <ul style="list-style-type: none"> • Nearby to facilitate child independent mobility (e.g. onsite or within 300m) • Safe and clean • Equipped with play equipment and natural features of interest for children of varying ages, incorporating challenge while maintaining safety 	<ul style="list-style-type: none"> ■ Enable gross motor skill development ■ Improve mental health 	<ul style="list-style-type: none"> ■ Local government ■ Property developer 	<ul style="list-style-type: none"> ■ Villanueva et al. 2016 ■ Sarkissian et al. 2003 ■ Whitzman et al. n.d. ■ Whitzman & Mizrachi 2009 ■ City of Vancouver 1992
	<p>3.4 Primary schools: Locate schools within 800m (safe) walking distance (to facilitate active travel to school)</p>	<ul style="list-style-type: none"> ■ Reduce obesity risk ■ Enable gross motor skill development ■ Enable socialisation ■ Reduce traffic injury risk 	<ul style="list-style-type: none"> ■ State government ■ Property developer 	<ul style="list-style-type: none"> ■ Whitzman & Mizrachi 2009 ■ City of Vancouver 1992

	3.5 Walkability: Ensure walking for transport is a favoured option resulting from <ul style="list-style-type: none"> • Consistent footpaths and traffic safety • Proximity to amenities such as public transport, stores, child care • Personal security and sense of community 	<ul style="list-style-type: none"> ■ Reduce obesity risk and increased physical activity ■ Improve crime prevention ■ Improve social capital 	<ul style="list-style-type: none"> ■ Local government ■ 	<ul style="list-style-type: none"> ■ Edmonton Federation of Community Leagues 2011 ■ Committee for Sydney 2017
	3.6 Food security: Ensure fresh food/supermarkets are available within walking distance (especially in areas of lower socioeconomic status)	<ul style="list-style-type: none"> ■ Reduce obesity risk 	<ul style="list-style-type: none"> ■ Property developer ■ Local government 	<ul style="list-style-type: none"> ■ Kent et al. 2011
4. Governance	4.1 Engagement: Engage children and families in building and precinct design	<ul style="list-style-type: none"> ■ Encourage cognitive development 	<ul style="list-style-type: none"> ■ Architects ■ Property developer ■ Local government 	<ul style="list-style-type: none"> ■ Haigh et al. 2011 ■ NSW Commission for Children and Young People 2009
	4.2 Strata by-laws: Ensure these do not restrict or ban children from safe, age-appropriate common area play, but instead support children's use of common areas. A building's child-friendly status should be clear to incoming tenants and prospective buyers	<ul style="list-style-type: none"> ■ Encourage gross motor skill development ■ Encourage social skill development 	<ul style="list-style-type: none"> ■ Owners corporation ■ Property developer ■ State government ■ Local government 	<ul style="list-style-type: none"> ■ Gleeson 2007 ■ Easthope & Judd 2010
	4.3 Continuous improvement: Use key indicators to monitor progress and inform change (see section 5.3)	<ul style="list-style-type: none"> ■ N/A 	<ul style="list-style-type: none"> ■ Local government ■ Public Health Practitioner 	<ul style="list-style-type: none"> ■ Lowe et al. 2013

5.3 Indicators of healthy higher density for children

Indicators are a useful tool to help public health practitioners and local government to measure progress towards child-friendly higher density, especially given the context of rapid ongoing high-density development in the City of Parramatta.

The following indicators ([table 3](#)) represent a recommended starting point for discussion, adapted from Lowe et al.'s (2013) evaluation of potential liveability indicators for Melbourne neighbourhoods. Further work is needed on this topic, to ensure indicator selection is undertaken with stakeholder collaboration, ensuring chosen indicators are valid for the studied population and are sufficient to measure the intended outcome (Sandhu-Rojon n.d.).

TABLE 3: SUGGESTED INDICATORS

Indicator area	Specific measure(s)	Checklist item(s) tracked	Potential data source(s)	Suggested target(s) & comments	Reference
Housing stock diversity	<ul style="list-style-type: none"> Average proportion of apartments in approved residential developments that are family-sized (disaggregated to 2 AND ≥3-bedroom apartments) 	2.1	<ul style="list-style-type: none"> Local government 	<ul style="list-style-type: none"> Adapted from <i>Healthy Urban Development Checklist (H2: Encourage dwelling diversity)</i>. The Hills Shire (NSW) has received State Government approval to offer a “bonus” (incentivised) floor space ratio in buildings where a “family friendly dwelling mix” is provided (minimum 20% of dwellings are ≥3 bedrooms) in addition to a “diversity of housing” (including larger-sized apartments). City of Vancouver suggests a minimum of twenty family units in a single project. 	NSW Government Department of Health 2009 Keane 2016 City of Vancouver 1992
Residential population density	<ul style="list-style-type: none"> Persons resident per hectare, AND Net site dwelling density (of new development) OR Building density (Floor Space Ratio (FSR)) 	1.2, 1.3	<ul style="list-style-type: none"> ABS Census Local government (Development applications) 	<ul style="list-style-type: none"> The Parramatta Local Environmental Plan (LEP) 2011 and the “Floor Space Ratio Map” specify maximum FSR for all land, with the maximum FSR being 19:1 and the majority of the LGA ranging from 0.5:1 to 1:1. Example international maximum building densities, for comparison: <ul style="list-style-type: none"> Vancouver: 3:1 as-of-right (bonus possible with Community Amenity Contribution) New York City: 10:1 as-of-right (up to 12:1 with creation of affordable housing or plaza) Hong Kong: 9:1 as-of-right (9.9:1 with environmental sustainability bonus) 	NSW Government 2016 Hodyl 2015
Primary school walkability	<ul style="list-style-type: none"> Average walking distance (km) to nearest government primary school from new higher density building 	3.4	<ul style="list-style-type: none"> GIS mapping AURIN portal 	<ul style="list-style-type: none"> <i>Vertical Living Kids</i> study (Melbourne) found improved child independent mobility to primary school when school located within 800m of apartment 	Whitzman & Mizrachi 2009

Access to play areas	<ul style="list-style-type: none"> Average walking distance to nearest useable green open space (park) or playground (km) 	3.3	<ul style="list-style-type: none"> GIS mapping AURIN portal 	<ul style="list-style-type: none"> Vertical Living Kids study found improved child independent mobility when green spaces within 300m of apartment 	Whitzman & Mizrahi 2009
Onsite open and/or play space	<ul style="list-style-type: none"> Amount of ground- or roof-level open space on the development site (can be public access or resident-only access) (m²/resident) 	1.3, 2.2	<ul style="list-style-type: none"> Local government Development applications 	<ul style="list-style-type: none"> Data would likely need to be collected prospectively. The NSW Apartment Design Guidelines recommend communal open space comprises a minimum area of 25% of the site. <ul style="list-style-type: none"> In comparison, Vancouver requires 4.6m²/apartment of communal open space (on-site), while Hong Kong requires 1m²/person of public open space (on-site) City of Vancouver recommends: <ul style="list-style-type: none"> Total outdoor play area: from 130m² to 280m² Preschool play area: 1.0m² per non-master bedroom; minimum 50m² overall Primary and adolescent play area: 1.5m² per non-master bedroom; minimum 85m² overall 	NSW Government Department of Planning and Environment 2015 Hodyl 2015 City of Vancouver 1992
Child development	<ul style="list-style-type: none"> Australian Early Development Census <ul style="list-style-type: none"> Percentage vulnerable on one or more domains Percentage vulnerable on two or more domains 	Tracks overarching outcome of child development	<ul style="list-style-type: none"> Australian Early Development Census (triennial) 	<ul style="list-style-type: none"> This is a long-term indicator that tracks child health and development outcomes, with results available specific to the City of Parramatta. Although the built environment is only one of many factors influencing the AEDC results, it is nonetheless important for stakeholders to continue to monitor child development across the LGA as they consider built environment factors. 	AEDC 2015

6. Conclusion

This report finds that the effect of high-density housing on children is not uniform.

The effect depends on the particular combination of outcome domain (physical, social and emotional, or cognitive and language), demographic factors (such as gender, age, cultural and linguistic background), the quality of the surrounding built environment, and the quality of the building itself.

Noting the paucity of high quality evidence (and therefore the absence of robust statistical correlations), the strongest positive correlation was between walkability of the neighbourhood and better physical outcomes, however evidence was still weak. The strongest negative correlation was between ambient noise and poorer language outcomes. There is insufficient evidence to comment on whether interactions and effects are additive.

In planning further high-density developments in the City of Parramatta, stakeholders should carefully consider the expected resident demographics, and the quality of the surrounding built environment. In so far as is possible, development decisions should also take advantage of, or compensate for, the qualities or deficits in the surrounding built environment. The clearest evidence is for encouraging developments in areas of high walkability, while discouraging development in areas of high noise pollution. Acknowledging that these two factors often coincide in urban environments, a pragmatic approach may be to focus on measures to reduce the harms associated with negative aspects of density, such as high noise pollution.

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Appendix A: Detailed Search Methodology

Black literature:

Stage 1: PubMed search

("Child" OR "Children" OR infan* OR "young person" OR "young people") AND ("high-rise" OR "high-rise" OR "housing density" OR "population density" OR "apartment" OR "flat" OR "housing" OR housing[Mesh]) AND (Health OR "child development" OR "childhood development" OR "infant development") AND ("review"[Publication Type] OR "meta analysis"[Publication Type])

- Search performed 26th September – all studies in database up to that date
- Limited to English language
- Total results = 300
- Reviewed titles and abstracts for relevance. Inclusion criteria:
 - Articles where the main focus was high density/high-rise housing/living (or if the focus was on housing or built environments more broadly, a substantial component related to high-density living or high-rise housing) AND the focus was on children under 12 years (or a substantial component within the article was related to children)
 - Article takes a public health rather than an individual/clinical focus. Health outcomes, developmental outcomes, and health behaviours or risks were all included.
- Excluded:
 - Articles which focus on aspects of housing that were not explicitly linked in the article to high-rise or high-density housing (for example: mould, air quality, lead contamination, crowding).
- Results after review of titles and abstracts = 16
- Of these 16, able to access 12 full-text articles for review
- After full-text review of 12 articles above, 8 were deemed relevant for inclusion

Stage 2: ProQuest search (Health and Medicine database)

all(("Child" OR "Children" OR infan* OR "young person" OR "young people") AND ("high-rise" OR "high-rise" OR "housing density" OR "population density" OR "apartment" OR "flat" OR "housing") AND (Health OR "child development" OR "childhood development" OR "infant development"))

Search performed 29th September 2016 – all studies in database up to that date

- Limited to English language
- Limited to "review" and "literature review"

- Total results: 24
- Reviewed titles and abstracts for relevance. Inclusion criteria:
 - Articles where the main focus was high density/high-rise housing/living (or if the focus was on housing or built environments more broadly, a substantial component related to high-density living or high-rise housing) AND the focus was on children under 12 years (or a substantial component within the article was related to children)
 - Article takes a public health rather than an individual/clinical focus. Health outcomes, developmental outcomes, and health behaviours or risks were all included.
- Excluded:
 - Articles which focus on aspects of housing that were not explicitly linked in the article to high-rise or high-density housing (for example: mould, air quality, lead contamination, crowding).
- Results after review of titles and abstracts for relevance: 4
- Of these 4, able to access 4 full-text articles for review
- After full-text review of 4 articles above, 1 was deemed relevant for inclusion in our review

Stage 3: Cochrane Database of Systematic Reviews search

("Child" OR "Children" OR infan* OR "young person" OR "young people") AND ("high-rise" OR "high-rise" OR "housing density" OR "population density" OR "apartment" OR "flat" OR "housing") AND (Health OR "child development" OR "childhood development" OR "infant development")

Search performed 29th September 2016 – all studies in database up to that date

- Total results: 21
- Reviewed titles and abstracts for relevance. Inclusion criteria:
 - Review or systematic review
 - Articles where the main focus was high density/high-rise housing/living (or if the focus was on housing or built environments more broadly, a substantial component related to high-density living or high-rise housing) AND the focus was on children under 12 years (or a substantial component within the article was related to children)
 - Article takes a public health rather than an individual/clinical focus. Health outcomes, developmental outcomes, and health behaviours or risks were all included.
- Excluded:
 - Articles which focus on aspects of housing that were not explicitly linked in the article to high-rise or high-density housing (for example: mould, air quality, lead contamination, crowding).
- Results after review of titles and abstracts for relevance: 0

Stage 4: Ovid (MEDLINE) Search

1. Child/
2. Infant/
3. (child\$ or pediater\$ or paediatric\$ or minor? or girl\$ or boy\$ or young people or young person or schoolchild\$ or school child\$ or preschool* or primary education or infant* or kid or kindergarten*).tw.
4. 1 or 2 or 3
5. city planning/ or environment design/ or urban renewal/
6. Housing/
7. Public Housing/
8. (physical environment or urban environment or built environment).tw.
9. (population density or street connectivity or neighborhood or residence characteristics).tw.
10. (urban design or urban population).tw.
11. ("high-rise" or "high-rise" or "apartment" or "flat").tw.
12. 5 or 6 or 7 or 8 or 9 or 10 or 11
13. exp Health/ or exp Child Health/
14. human development/ or exp child development/ or language development/
15. "Early Intervention (Education)"/ or Developmental Disabilities/
16. 13 or 14 or 15
17. 4 and 12 and 16
18. limit 17 to english language
19. limit 18 to (meta analysis or "review" or systematic reviews)

Search performed 29th September 2016 – all studies in database up to that date

- (Link to search:
<http://acs.hcn.com.au?acc=36422&url=http://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=titles&SEARCHNAME=WIP&SEARCHTYPE=ps&SEARCHLEVEL=pin&D=mesz>)
- Total results: 99
- Reviewed titles and abstracts for relevance. Inclusion criteria:

- Review or systematic review
- Articles where the main focus was high density/high-rise housing/living (or if the focus was on housing or built environments more broadly, a substantial component related to high-density living or high-rise housing) AND the focus was on children under 12 years (or a substantial component within the article was related to children)
- Article takes a public health rather than an individual/clinical focus. Health outcomes, developmental outcomes, and health behaviours or risks were all included.
- Excluded:
 - Articles which focus on aspects of housing that were not explicitly linked in the article to high-rise or high-density housing (for example: mould, air quality, lead contamination, crowding).
 - Literature related specifically to high-density living in “slums” was also excluded, as this was not relevant to our context
- Results after review of titles and abstracts for relevance: 28
- Of these 28, 8 were duplicates and were thus removed, leaving 20
- Of these 20, we were able to access 13 full-text articles for review
- After full-text review of 13 articles above, 1 was deemed relevant for inclusion in our review

Databases which were unavailable for searching due to licensing/Athens restrictions:

- ISI Web of Science
- Other ProQuest databases

Appendix B: Studies included in review

From peer-reviewed literature review

1. Villanueva K., Badland H., Kvalsvig A., O'Connor M., Christian H., Woolcock G., Giles-Corti B. & Goldfeld S. (2016) Can the Neighbourhood Built Environment Make a Difference in Children's Development? Building the Research Agenda to Create Evidence for Place-Based Children's Policy. *Academic Pediatrics* 16(1):10-19.
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Appendix C: Existing guidelines relating to healthy high-density housing for children

Guidelines name	Scope	Categories of recommendations	Key recommendations
Comments			
City of Vancouver (1992) <i>High-density housing for families with children guidelines.</i>	<ul style="list-style-type: none"> ■ New residential developments of 75 or more units per hectare in density ■ The standards are guidelines rather than “absolute requirements” ■ Developers are encouraged to “consider creative approaches” to achieving the guidelines’ objectives 	<ol style="list-style-type: none"> 1. Project planning - site <ol style="list-style-type: none"> a. Site selection b. Surrounding land uses c. Neighbourhood compatibility d. Number of family units e. Household mix 2. Project design - building <ol style="list-style-type: none"> a. Hierarchy of spaces b. Common open space c. Outdoor play areas for children d. Supervision of children’s play e. Children’s safety f. Pedestrian circulation routes g. Common indoor amenity space 	<ul style="list-style-type: none"> ■ 2.1 “Families with children should have reasonable and effective access to essential community services and recreational amenities...sites selected for family housing development should be within...0.4km walking distance to a playground and a public transit stop.” ■ 2.4 “There should be a sufficient number of family units in a project in order to give children peers to play with...Twenty family units in a single project is the suggested minimum.” ■ 2.5 “Family units should be grouped together in the most appropriate parts of the building or site...” ■ 3.2 “There should be appropriate open space to meet the on-site needs of children and adults...children will play everywhere; the entire site should be designed to withstand use by children.” ■ 3.3 “Children of all ages should have easy access to appropriately located, designed and landscaped outdoor play areas suited to their developmental and play needs...situated to maximise sunlight access...” Continues by specifying minimum play areas by age group per bedroom. ■ 3.4 “The design of a family development should maximise the potential for adults to supervise children at play.” ■ 3.7 “Provide appropriate common indoor amenity space for families with children where individual units are not suited to desired indoor activities...” “The potential role of common indoor space in creating community interaction and safety should be fostered...Consider including a day care or after-school care facility.” ■ 4.1 “Spaces [within units] should be designed to accommodate a variety of family activities...[with] separation of conflicting uses... Consider the layouts of

		<ul style="list-style-type: none"> h. Resident's parking 3. Unit design <ul style="list-style-type: none"> a. Unit size and interior layout b. Privacy c. Private open space d. Storage 	<p>adjacent units to ensure that "sleeping" areas are not affected adversely by proximity to neighbouring "living" areas."</p> <ul style="list-style-type: none"> ■ 4.3 "Ensure that each household has a private open space adjacent to its unit for its exclusive use." ■ 4.4 "Bicycle storage is critical...A special room for children's bicycles, wheeled toys and strollers adjacent to the common outdoor space is desirable."
			<ul style="list-style-type: none"> ■ <i>Provides depth and breadth of guidance across three categories (unit, building, and neighbourhood)</i> ■ <i>Guidelines are almost 25 years old and thus some recommendations may be out of date</i> ■ <i>Does not reference evidence used for recommendations</i>
<p>Sarkissian W. & Kerr A. (2003) <i>Working paper 11: High-density dwelling Design for Children.</i> Mirvac Fini</p>	<ul style="list-style-type: none"> ■ Developed specifically for Mirvac "Burswood Lakes" higher density estate in Perth 	<ul style="list-style-type: none"> ■ Guidelines for children aged 5-12 years ■ Guidelines to help the developer (Mircvac Fini) in preparation for the site master plan ■ Working paper 11 focusses on unit-level features and interior design, categorised into specific rooms and spaces, e.g. kitchen, dining room, bedrooms etc. ■ NB: A further working paper in the series (Working Paper 6) focuses on neighbourhood and outdoor amenity, but is not specific to high density thus has been excluded from review 	<p>Working paper 11:</p> <ul style="list-style-type: none"> ■ Approach to the design process: ■ "Affinity: What activities/spaces is this space related to?" ■ Proximity: What does it need to be next to? ■ Separation: What does it need to be separated from and how? (e.g. visually, acoustically, spatially?) ■ Communication: Which other spaces must users of this space communicate with? ■ Surveillance: What spaces should users of this space be able to watch over?" ■ "Recommended spatial arrangements include: avoidance of formality, especially with regard to common interior space; attention to the relationships between spaces, as well as size, e.g. the need for a direct connection between living room and kitchen space; the need for a large kitchen and the need to locate the children's room next to and opening into the family space." P.2 ■ Gives a number of specific recommendations for each room type, which includes safety considerations of particular importance to high density (e.g. balconies)
			<ul style="list-style-type: none"> ■ <i>Working paper 11 focuses mainly on safety; working paper 6 doesn't seem to be specific to high density</i>

			<ul style="list-style-type: none"> ■ <i>Australian-specific</i>
<p>Shephard T. & Matthews T. (2016) <i>Auckland Design Manual: High density Family Housing.</i></p>	<ul style="list-style-type: none"> ■ Non-statutory, guidelines for Auckland high density family housing 	<ul style="list-style-type: none"> ■ N/A 	<ul style="list-style-type: none"> ■ “The total and per-room floor space of a given house is the primary consideration for a child-friendly apartment design...” ■ “Families struggle to compete financially for larger city-centre units and are often pushed out to the suburbs, where detached housing is less expensive.” ■ “‘Child-friendly’ checklist: ■ Site design, building orientation, access and street frontage. ■ Car parks off the street, preferably behind the building, with child-gates between car park and child-play areas. ■ Lighting, security and passive surveillance of communal space. ■ Indoor and outdoor storage. ■ Waste and recycling. ■ Indoor and outdoor play areas for children. ■ Clothes drying facilities. ■ Shared open space at ground level. The space should be open, easily accessible and visible from the ground floor – where the family-orientated housing units should be concentrated”
			<ul style="list-style-type: none"> ■ <i>Very brief, broad categories only (i.e. no detail).</i> ■ <i>Focuses on unit and building levels, not neighbourhood.</i> ■ <i>Takes more of a discussion paper format, rather than guidelines</i>
<p>Whitzman C., Birch A., Mizrahi D., Woodcock I. & Perkovic J. (n.d.) <i>Vertical Living Kids and the Southbank Structure Plan: Considering the needs of children and families</i></p>	<ul style="list-style-type: none"> ■ Response to a draft precinct plan of the high density Melbourne area of Southbank ■ Includes recommendations to 	<ul style="list-style-type: none"> ■ Open and play spaces ■ Childcare and education facilities ■ Community and social spaces ■ Food environments ■ Active living & walkability 	<p>“Recommendations:</p> <ul style="list-style-type: none"> ■ The City of Melbourne should include a requirement of 5% public park space for all new residential, commercial, and office development within the Southbank Structure Plan... ■ The City of Melbourne should require a multi-purpose room in every new residential development for the use of both workers and residents... ■ The location of at least one future supermarket should be indicated in the Southbank Structure Plan... ■ The City of Melbourne and the State government should set a 30kph limit for all streets that are being promoted as walking or cycling arteries, consistent with international best practice on promoting active travel.”

	improve the plan's consideration of children and families		<ul style="list-style-type: none"> ■ <i>Focuses on neighbourhood features (which is aligned with goal of paper, i.e. to comment on the Southbank Structure Plan), rather than apartment features or population features</i> ■ <i>Many recommendations generally follow the SMART criteria (specific, measurable, attainable, relevant, and timely)</i>
<p>Holliday S. (2006) <i>Creating child friendly communities – challenges for the planning profession.</i> Reprinted in: Haigh F., Ng Chok H. & Harris P. (2011) <i>Housing density and health: a review of the literature and health impact assessments.</i></p>	<ul style="list-style-type: none"> ■ Literature review 	<ul style="list-style-type: none"> ■ Walking and cycling routes ■ Pedestrian-friendly streets ■ Parklands ■ Public transport ■ Fostering community spirit (including child engagement) ■ Shopping centres designed with child “in mind” 	<p>“Child friendly design recommendations: Well planned networks of walking and cycling routes include:</p> <ul style="list-style-type: none"> ■ Safe and accessible footpaths ■ Connections to local destinations <p>Local streets with direct, safe and convenient access such as:</p> <ul style="list-style-type: none"> ■ Safe places to cross streets ■ Slow traffic for safe streets...” <p>■ <i>Focuses on recommendations about neighbourhood</i> ■ <i>No recommendations at level of building or unit</i> ■ <i>Unclear whether recommendations are based on evidence</i></p>