

Centre for Primary Health Care and Equity

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**Housing density and health:
A review of the literature and
health impact assessments**

August 2011

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Queensland Health



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Table of Contents

1	Executive Summary.....	1
2	Introduction	7
2.1	Purpose	7
2.2	Audiences.....	7
2.3	Scope and limitations.....	7
2.4	Definitions	9
3	Search strategy	10
4	Background- Urban form and health	12
5	Evidence from the literature: Housing density and health.....	16
5.1	Physical activity	16
5.1.1	Housing density and obesity	18
5.1.2	Traffic	19
5.1.3	Effects on Children	20
5.1.4	Effects on older people	21
5.2	Community safety	21
5.2.1	Effects on children	22
5.2.2	Older people	23
5.3	Mental health.....	23
5.3.1	Effects on children	24
5.3.2	Effects on older people	25
6	Impact of Housing density on health in Health Impact Assessments.....	26
6.1	Findings	27
6.2	Summary of Housing Density Recommendations	31
6.3	Discussion.....	36
7	Conclusions	38
	References	39
	Appendix 1: Built environment evidence	43
	Appendix 2:	44
	Case Study – The German Paradox (Minster 2010)	44

1 Executive Summary

Urban spaces have direct and indirect impacts on health and wellbeing. Direct impacts include air quality, climate, water quality, and noise. Indirect impacts affect more distal determinants of health, such as social connections, access to services and physical activity.

There are three main characteristics of an urban environment that influence health - place, space and people:

- Space: the physical nature of the area and the infrastructure that is available;
- Place: the historical and social relationships that exist within the community that shape values and norms; and
- People: the characteristics of the people and their ways of acting and interaction.

The literature on the impact of housing density on health outcomes is inconclusive. There is a large amount of heterogeneity between studies which makes it difficult to compare studies or investigate pooled effects. Results from studies are often contradictory – what works in one place doesn't necessarily work in another. This suggests that the impacts of housing density are context specific and the design of higher density housing needs to be fit for purpose. It is not clear whether objective or perceived environment has a greater impact on health outcomes. A combination of physical design and educative strategies may be needed to maximise any potential health benefits of higher density housing.

We found no evidence that clearly differentiated between moving from low to medium and low to high density housing. There are a range of different definitions of density used which also complicates comparisons between studies and applying findings to the Mackay context. The evidence is unclear on whether there is an ideal housing density. Some evidence indicates that there is a tendency to have more potential negative impacts on health at both ends of the housing density scale compared with medium density housing.

Impacts associated with higher density housing are related to features such as: access to greenspace, active transport, services and resources; environmental factors such as noise, light, air quality; economic factors such as housing affordability; and social factors such as fear of crime, social capital, privacy levels, social interaction, networks and sense of belonging. These impacts are often not the result of housing density itself but rather the urban environment within which the higher density housing is situated.

There is strong evidence that urban areas are often grouped by social class and ethnicity. Evidence suggests that the role of economic status, in particular poverty, in an area has a stronger impact on determinants of health such as physical exercise than the built environment.

Some potential impacts of higher density housing are also person or population group specific. For example, families with children particularly benefit from having outside space that can be easily monitored by caregivers. Poor people are more likely to live in low quality built environments and this contributes to poor health. Children and older people are particularly vulnerable not only because of a biological vulnerability but also because of the significant numbers of children and older people who are poor.

Our review of the consideration of housing density within Health Impact Assessments has demonstrated a lack of consideration for housing density impacts in HIA reports. Most HIAs cover broader urban environmental impacts and generalize, uncategorically, the nature of housing impact. Locating the evidence of differential housing density impacts and the impacts they have on each other proved difficult.

A predominant and recurring 'determinant of health' in the identified HIAs was the assessment of urban design. Its importance as a mediator of positive outcomes that flow from the built environment on to the community was highlighted in each HIA. These reports also describe the urban design of an environment to influence the population through its impact on other determinants of health which include; access to safety, access to public open space and services, air and water quality, employment, and housing to name a few.

These themes were also recurrent in the literature from the European context, however like the findings in this review, efforts to identify explicit guidance frameworks referring explicitly to 'housing density' proved difficult. However, most seemed to report the broader urban design and built environment impacts identified made in this review. These inextricable impacts and complexities linking housing density to other determinants of health may be a potential reason for the lack of evidence and report documentation.

The findings of the review highlight:

- the lack of information describing positive impacts associated with low and medium density housing type;
- the negative nature of impacts associated to low density housing;
- the relatively small impacts that differentiate medium density housing from low and high density housing;
- the potential for high density housing to affect residents both positively and negatively.

Physical activity

Evidence suggests that higher density housing can provide an environment that is supportive of higher levels of physical activity. Higher density combined with greater connectivity and having destinations within walking distance support walking. Residents of higher density areas tend to walk more than residents of less dense areas. They also tend to have lower obesity levels. However studies indicate that people who walk regularly choose neighbourhood environments that promote walkability and not vice versa.

In terms of car use there appears to be a 'paradox of intensification' whereby increased housing density resulting in increased population density will generally reduce overall vehicle use but increase levels in the higher density area resulting in local environmental and social problems. Studies suggest that in order stop this strong measures need to be utilised to deter car usage (e.g. car free areas, limiting parking, congestion charging).

In general, in children, higher density is also associated with increased physical activity and lower obesity levels than sprawling areas. The associations vary according to different physical environment variables, age, socio-economic status and gender. There is some limited evidence that

interventions to reduce perceived environmental barriers for physical activity are particularly needed for adolescent girls.

There is some qualitative literature documenting that older adults perceive local services (e.g. shopping, libraries), walking and traffic infrastructure (e.g., traffic volume and speed, the presence of footpaths), neighbourhood aesthetics (e.g., presence of parks and trees), and the availability of public transport to influence physical activity.

We could find no review level evidence about the impact of the high density buildings on physical activity. There are, however, some single descriptive studies that identify high density housing leading to an emphasis on activities that keep children quiet. It also appears often necessary for physical activity to take place outside the immediate household area (e.g. going to a local park or playground) which can also act as a barrier.

Community Safety – unintentional injury, healthy active ageing

There is limited evidence available about the relationship between higher density housing and community safety. Where there are perceived safety issues and traffic danger this may lead parents stopping children playing in the street or walking/cycling. Increased traffic density results in increased risk of road traffic accidents. However there is also evidence that increased density is associated with shorter trips and lower speeds. Children and older people are particularly vulnerable to road traffic accidents. When parents are asked what prevents their children from walking to school, the second most commonly mentioned factor is traffic danger (Binns, Forman et al. 2009).

High rise buildings can pose a risk particularly to young children from falling from windows or balconies. Evidence from the US shows that installation of window guards combined with education programmes is an effective measure to reduce accidents from falling (The Children's Hospital at Westmead Working Party for the Prevention of Children Falling from Residential Buildings 2011)

The relationship between the built environment/urban design and crime is widely recognised within the literature. Factors that influence safety and perception of safety (e.g. neighbourhood and housing design, accessibility and permeability of streets/areas; surveillance (natural and CCTV); street lighting; neighbourhood management and maintenance) are linked to the design of urban areas rather than the density of housing. The relationship between housing density and crime is unclear with contradictory evidence.

Mental health - social cohesion and connectedness

The architectural and urban design of a development may impact (positively or negatively) on levels of social inclusion, isolation and the ability of certain groups (disabled people, the elderly and families with young children) to access community and social networks and services. As with most of the potential impacts identified, research suggests that it is not necessarily high density that causes impacts on mental wellbeing (for example dissatisfaction) but related factors such as noise, traffic, community engagement and built environment aesthetics.

There is some evidence of lower levels of depression in older men in neighbourhoods with higher walkability but also contrasting evidence of older men living in areas of high availability of retail outlets and services being at a greater risk of depression.

There is mention in the literature of the ‘three Ps’ of high density housing that can lead to stress and dissatisfaction- “pets, parking and parties”. This suggests that it is important that higher density housing developments have clear guidelines for dealing with these issues.

Evidence from Health Impact Assessments indicate that the process of developing new housing can have significant impacts on mental wellbeing. For example, how communication with local residents is carried out by proponents and the opportunities for involvement for local residents impacts on determinants of mental wellbeing such as control, participation, inclusion, resilience and community assets.

Lessons from the literature review

- The physical environment shapes but does not determine well being. Apply good urban design principles to create an environment that supports healthy lifestyles and communities but be aware active steps are needed to ensure utilisation. Actions targeting utilisation of facilities will be required.
- The planning and design of higher residential density areas needs to be context specific and fit for purpose. Micro level design choices are important. Be careful in application of evidence from different countries. There is a need to move beyond traditional risk factor approach- urban environments are multi dimensional with multiple concurrent interrelated processes.
- As well as being context specific, planning processes should actively engage with residents in order to understand the needs of different population groups (e.g. families, singles, older people). Residential developments should be planned with the needs of specific population groups in mind. Consideration should be given to different stages within broader groupings. For example, the play needs of toddlers differ from primary school aged children and adolescents differ again.
- Higher densities developments should incorporate good connectivity and land-use mix to encourage walking.
- The process as well as outcome of implementing the residential density strategy will impact on health.
- Endogeneity – be aware that in planning neighbourhoods people who are more interested in physical activity/healthy lifestyles are more likely to select neighbourhoods that are conducive to this. This can potentially result in increasing inequalities as those that could benefit most from healthy urban design are least likely to benefit from it.
- Be aware of the different levels that impacts may occur on. For example, overall reduction in car usage may not result in local level benefits.
- Increased density/urbanisation is likely to increase urban related problems (noise, air quality, traffic etc); plan in ways that specifically address these potential issues
- Structural determinants of health such as poverty in neighbourhoods are likely to have a greater impact on health outcomes than urban design. If the planning of higher density residential areas is not linked to considerations of social disadvantage, then although there may be some overall improvements in health, health inequalities are likely to remain and may increase.

- Children and older people are particularly vulnerable to the potential health impacts of higher residential density. This is due not only to physical vulnerability but because of the significant numbers of children and elderly who experience poverty. These groups are particularly vulnerable to community safety related impacts such as accidents, crime and fear of crime but can also potentially benefit from good design that enables access to resources and services.

Table 1 outlines healthy urban planning principles that should be considered in planning processes.

Table 1 Healthy Urban Planning Principles (Grant 2009)

Spheres of the Health Map	Objectives for Healthy Urban Planning
1. People	<ul style="list-style-type: none"> • providing for the needs of all groups in the population • reducing health inequalities
2. Life-style	<ul style="list-style-type: none"> • promoting active travel • promoting physically active recreation • facilitating healthy food choices
3. Community	<ul style="list-style-type: none"> • facilitating social networks and social cohesion • supporting a sense of local pride and cultural identity • promoting a safe environment
4. Economy	<ul style="list-style-type: none"> • promoting accessible job opportunities for all sections of the population • encouraging a resilient and buoyant local economy
5. Activities	<ul style="list-style-type: none"> • ensuring retail, educational, leisure, cultural and health facilities are accessible to all • providing good quality facilities, responsive to local needs
6. Built environment	<ul style="list-style-type: none"> • ensuring good quality and supply of housing • promoting a green urban environment supporting mental well-being • planning an aesthetically stimulating environment, with acceptable noise levels
7. Natural environment	<ul style="list-style-type: none"> • promoting good air quality • ensuring security and quality of water supply and sanitation • ensuring soil conservation and quality • reducing risk of environmental disaster
8. Global ecosystems	<ul style="list-style-type: none"> • reducing transport-related greenhouse gas emissions • reducing building-related greenhouse gas emissions • promoting substitution of renewable energy for fossil fuel use • adapting of the environment to climate change

Lessons from HIA review

Evidence from HIAs suggests that the implementation of high density housing works best with planning that incorporates and embraces quality urban design. These include socially connected and purposefully built infrastructure that is equitably accessible to a wide range of people, promotes safety and active transport options to lower car dependence, provides opportunities for lower income earners to afford homes, limits leapfrog type development and places human health as a core feature. Implementation of HIA recommendations requires ongoing compliance and commitment from stakeholders. Box 1 outlines housing density related HIA recommendations

Box 1 HIA recommendations related to housing density

The higher density housing recommendations from the review require;

- Provisions are made for people that cover a range of ages e.g. children for their ‘free-will movement’ (Quigley and Ball 2007) with open play spaces (Jaime 2008).
- Seeking strategies to ensure the delivery of diverse housing types for the elderly, disabled and singles (Young, McKiernan et al. 2005)
- Access opportunities for recreation and open space (Quigley and Ball 2007)
- Restricting urban sprawl by monitoring land release and seek land development sites close to the town centre (GSAHS 2007)
- Active transport options and increased physical activity (Quigley and Ball 2007)
- Cycleways and walkways (Quigley and Ball 2007)
- Local retail and services (Tennant, Newman et al. 2010)
- Principles made to prevent crime and injury (Quigley and Ball 2007)
- Appropriate development and building standards to improve safety for children and residents (Ozanne-Smith, Guy et al. 2008)

The medium density housing recommendations from the review require;

- Seek measures to secure affordable housing for elderly, single people and people with disabilities (Young, McKiernan et al. 2005)
- Appropriate development and building standards to improve safety for children and residents (Ozanne-Smith, Guy et al. 2008)
- Regulation of signage of unhealthy foods (as defined by the Australian Guide to Healthy Eating) to be excluded no less than 300 metres from child serving institutions e.g. schools, pre-schools, hospitals, playgrounds etc (Tennant, Newman et al. 2010)
- Implementing plans that consider “social equity and housing affordability for residents” especially for vulnerable groups (Thornley 2008)
- Increased compliance and cooperation between stakeholders to limit urban sprawl (Quigley and Ball 2007)
- Monitoring demographic changes on a local government area basis (Young, McKiernan et al. 2005)

The lower density housing recommendations from the review require;

- Provision are made for vulnerable people e.g. elderly and disabled people with low mobility to gain access to transport facilities and services e.g. wheelchair access (Field, Arcus et al. 2009)
- Investment for age-friendly environments that reduce housing stress (Gordon and Van der Pas 2009)
- Regulation of signage of unhealthy foods (as defined by the Australian Guide to Healthy Eating) to be excluded no less than 300 metres from child serving institutions e.g. schools, pre-schools, hospitals, playgrounds etc (Tennant, Newman et al. 2010)

2 Introduction

2.1 Purpose

This review of literature and Health impact Assessments (HIA) was commissioned by Queensland Health's Tropical Population Health Services to inform a Health Impact Assessment (HIA) on the Mackay Regional Council's Residential Density Strategy. The strategy seeks to encourage the delivery of well-designed higher density residential development and, consequently increase the overall residential density of urban areas. The evidence presented may also provide information to guide future policy decisions, helping to ensure the health effects of housing density planning are positive for populations and communities.

The scoping process identified that the Strategy already had a clear commitment and understanding of healthy urban planning principles. Therefore the scope of this literature review is confined to health impacts directly relating to residential density. The purpose of the HIA is to identify the potential positive and negative health impacts that may result from increasing housing density from 'low' to 'medium' and 'high'. 'Higher' density collectively refers to low-medium density, medium density and high density and, therefore, means anything higher than low density. Although the focus was on increases in residential density the evidence gathered applies to density per se. The scoping process for the HIA determined three areas of focus— physical activity; community safety; mental health including social cohesion and connectedness. In addition particular emphasis will be given to potential impacts on two population groups: older people and children.

The question for the review were:

1. What are the impacts of higher housing density on health?
2. What are the potential health impacts of moving from low to medium and low to high density housing?
3. Are the impacts of housing density on health addressed by HIAs and, if yes, what have been the main findings and recommendations of these HIAs.

2.2 Audiences

Practitioners and policy-makers from sectors including but not limited to health, housing, planning, environment and conservation, and local government – and who may be using HIA to assist in decision-making on policies relevant to urban form and health. It may also be useful for others with a general interest in HIA or healthy urban and land-use planning.

2.3 Scope and limitations

The focus of this review is the association of higher housing density and health with a particular focus on:

- Physical activity
- Community Safety – unintentional injury, healthy active ageing
- Mental health - social cohesion and connectedness

Further focus will also be given to two population groups:

- Children
- Older people

This is not a general review of housing and health or the built environment and health. For reviews of the evidence in these broader areas see Appendix 1.

This is not a systematic review. Due to resource and time constraints the review focuses on literature reviews, systematic reviews, reviews of reviews, and meta-analyses rather than trying to conduct a comprehensive review of studies. In addition, recent studies, evaluations and evidence from the grey literature were included to supplement the information retrieved from the review of reviews (snowballing). HIAs that considered housing density were also identified and reviewed. A particular focus was given to HIAs carried out in Australian and New Zealand.

In terms of the evidence identified, there is a large amount of heterogeneity between studies which makes it difficult to draw conclusions and means it is not possible to look for pooled effects (Feng, Glass et al. 2010). Most studies that demonstrate these associations between housing density and health are cross sectional and causality cannot be inferred (Ewing 2005; Melia, Parkhurst et al. 2011). Recent research has shown there is very little direct evidence on the effects of urban intensification (Melia, Parkhurst et al. 2011).

A large amount of the literature is US based. Previous research has identified that the US differs from many other developed countries with respect to the size of urban areas and the residential segregation of socioeconomic and ethnic groups. This has raised the issue of whether the associations seen between environmental factors and behaviours in the USA are relevant to other developed countries (Giskes, van Lenthe et al. 2011).

The rapid review of Health Impact Assessments was done in a short timeframe and should not be perceived as an in-depth review. Efforts were made, where possible to search wide and identify conclusive evidence of housing density impacts on health explicitly outside of Australia and New Zealand towards the UK context. However due to the short time frame and the identified HIAs focus on urban design impact assessments rather than specific housing density, examples from outside of Australia and New Zealand have not been included in this review.

In addition, the strength and quality of evidence from most of HIAs reviewed is relatively weak and were not assessed for the quality of the evidence. Often statements are made within some of the HIAs with no indication of the evidence base supporting these statements and such findings should be treated with due caution.

2.4 Definitions

Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. (World Health Organization 1948).

Health Impact Assessment (HIA) is a combination of procedures, methods and tools by which a policy, programme or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population (WHO European Centre for Health Policy 1999).

Built environment refers to the man-made elements of the physical environment; buildings, infrastructure, and other physical elements created or modified by people and the functional use, arrangement in space, and aesthetic qualities of these elements (Macaulay, Jagosh et al. 2011).

Urban form refers to the quality of the built urban environment and is related to the density and intensity of land uses within urban areas. **Land use** refers to the location and grouping of activities within a geographical area such as residential, industrial, recreational and commercial. (Mead, Dodson et al. 2006).

Density is a measure of the amount of activity found in an area and can be defined in terms of population, housing unit, or employment density. Definitions of density vary and there is no consensus on which or when its many variants are appropriate (Feng, Glass et al. 2010).

Site density is the number of dwelling units per development site.

Net density is the number of dwelling units per area of land including development site, local roads, local parks and local drains.

The term **higher density** used within this document collectively refers to low-medium density, medium density and high density and, therefore, means anything higher than low density.

Table 2 Density definitions for Mackay Region

	Site dwelling Dwellings per ha	Net density Dwellings per ha	Lot size Based on lots occupied by 1 dwelling	Typical building form
Low density	Less than 20	Less than 16	Larger than 500m ²	- detached dwellings - semi detached dwellings - attached dwellings
Low-medium density	Between 20-34	Between 17-29	Between 500m ² - 290m ²	- detached dwellings - semi-detached dwellings - attached dwellings
Medium density	Between 35 - 99	Between 30-85	Smaller than 290m ²	- attached dwellings, - semi-detached dwellings - low-rise apartments - medium-rise apartments
High density	100 or more	86 or more	NA	- medium-rise apartments - high-rise apartments

3 Search strategy

The search was undertaken during May 2011 and terms used during searching included: (“housing density” OR “residential density” OR “urban consolidation” OR “smart growth” OR “urban intensification” OR “compact city” OR “transit orientated development”) AND (health OR wellbeing OR “well-being” OR “well being” “community safety” OR “physical activity” OR access OR exclusion OR participation)).

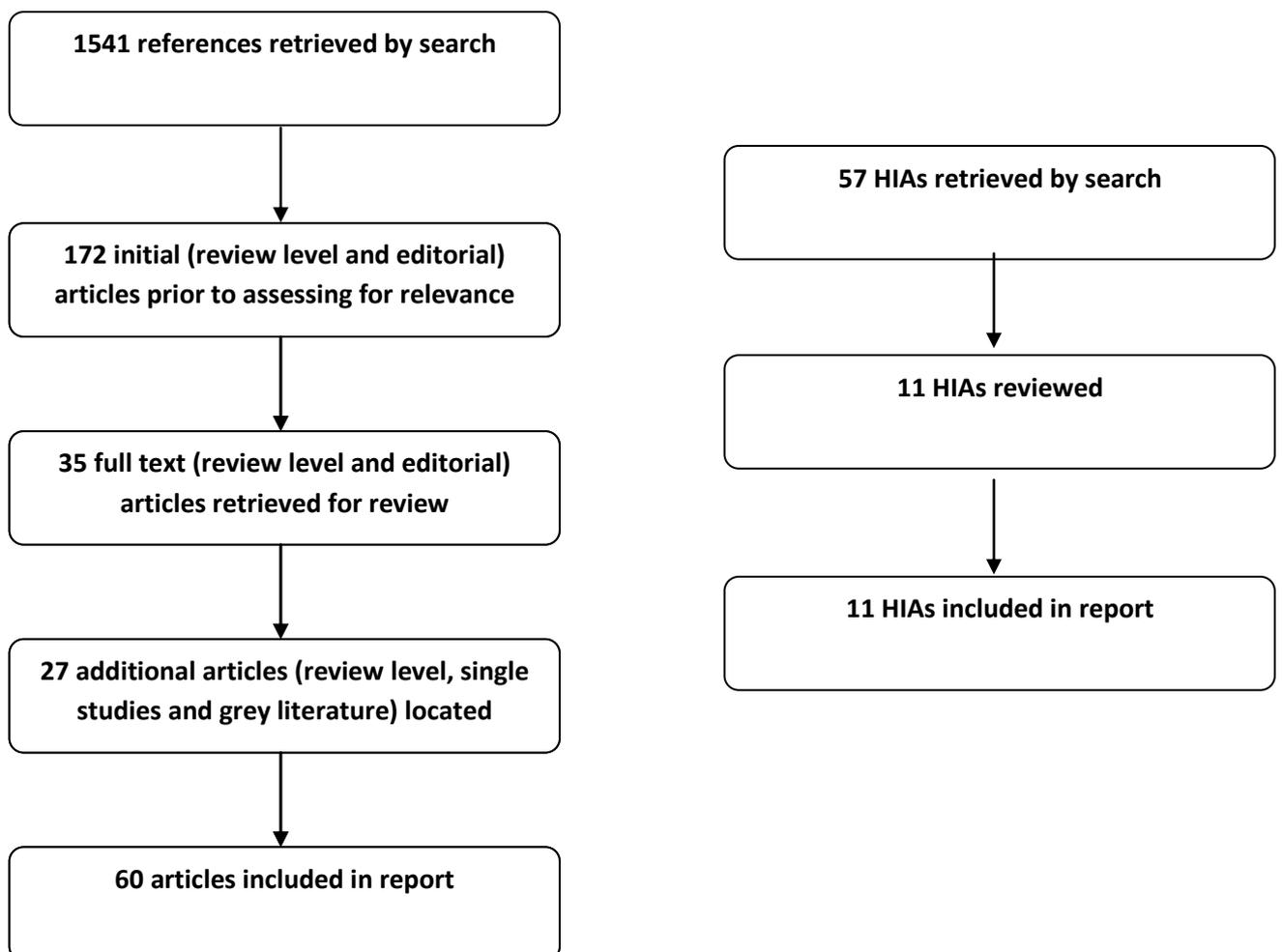
The initial search was limited to systematic reviews, other literature reviews, and selected expert opinion commentaries. Our main focus was review level evidence, however, where there was no review level evidence available we also identified relevant single studies and grey literature. Title and abstracts were assessed for relevance. Where recent reviews of the evidence included previous reviews, only the most recent reviews were included. In addition relevant single studies were identified through snowballing. Parameters were set for the time period 2000 – 2011, English language, and for articles which were electronically available either through UNSW library subscription or free download access from the internet.

Databases accessed via UNSW library were used for searching and included Scopus (which includes 100% of Medline coverage), Cinahl, Web of Science, PsychINFO, Embase and Cochrane. Selections of specific subject headings were made for Scopus (Medicine, Nursing, Social sciences, Health professions, Environmental science, Psychology and Engineering). In searching via Cinahl, the Medline option was excluded in order to minimise duplication as it had already been searched via Scopus, and the option “Apply related words” was selected.

In addition, key recent studies, evaluations and evidence from the grey literature were included to supplement the information retrieved from the review of reviews (snowballing). Where we could find no evidence additional searches were carried out with alternative search terms. For example (housing AND density AND injury).

An additional search was undertaken to identify Health Impact Assessments that were carried out between 2005 and 2010. Key words such as 'low-, medium-, and high- density housing' and 'urban sprawl' linked to positive and/or negative impacts on human health was included in this review. A search of HIA web sources such as HIA Connect, Health Impact Assessment Gateway, World Health Organization, International Health Impact Consortium and International Association for Impact Assessment was undertaken to identify Health Impact Assessments conducted between 2005 and 2010. Relevant evidence from reports was noted in the reference list. There was a focus on identifying examples from Australia and New Zealand, however, we also attempted to identify relevant international examples.

Figure 1 Housing density and health literature review search results



4 Background- Urban form and health

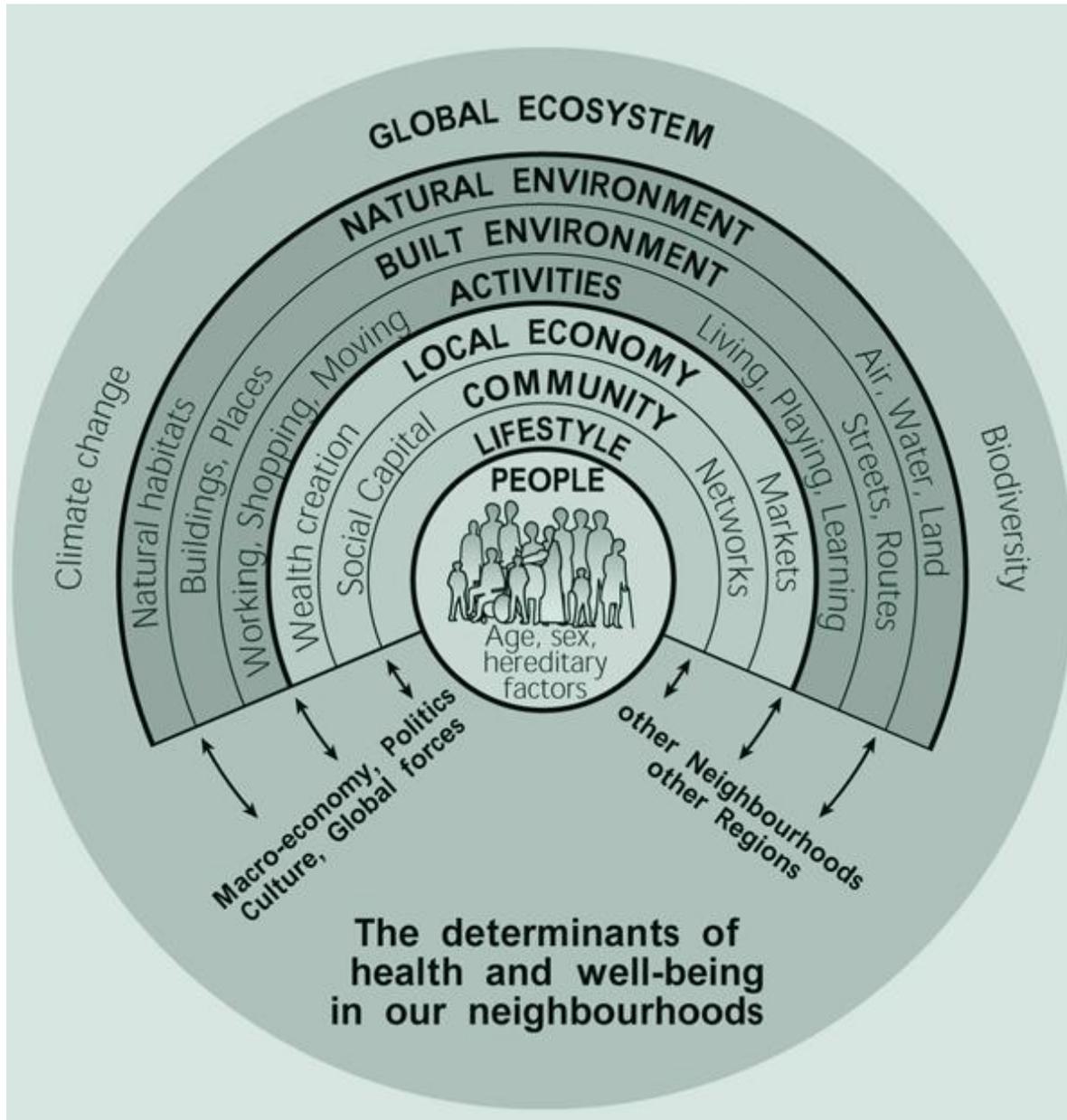
Urban spaces have direct and indirect impacts on health and wellbeing. Direct impacts include air quality, climate, water quality, and noise. Indirect impacts affect more distal determinants of health, such as social connections, access to services and physical activity. Decisions about factors such as density of communities, presence and size of parks, land-use mix, height and size of residential structures, food store location, and how roads are laid out affect people's physical health and psychological well-being (Wells, Evans et al. 2010).

Good physical structures and social conditions of 'place' contribute to individual and community empowerment that is fundamental to health equity and an enjoyable life (Tannerfeldt and Ljung 2006). There are three main characteristics of an urban environment that influence health - space, place and people:

- Space: the physical nature of the area and the infrastructure that is available;
- Place: the historical and social relationships that exist within the community that shape values and norms; and
- People: the characteristics of the people and their ways of acting and interaction (Travaglia, Harris et al. 2002).

Figure 2 illustrates determinants of health within the context of neighbourhoods. The layers represent different levels of determinants of health specifically focusing on the neighbourhood context.

Figure 2 The determinants of health and wellbeing in neighbourhoods (Barton & Grant, 2006)

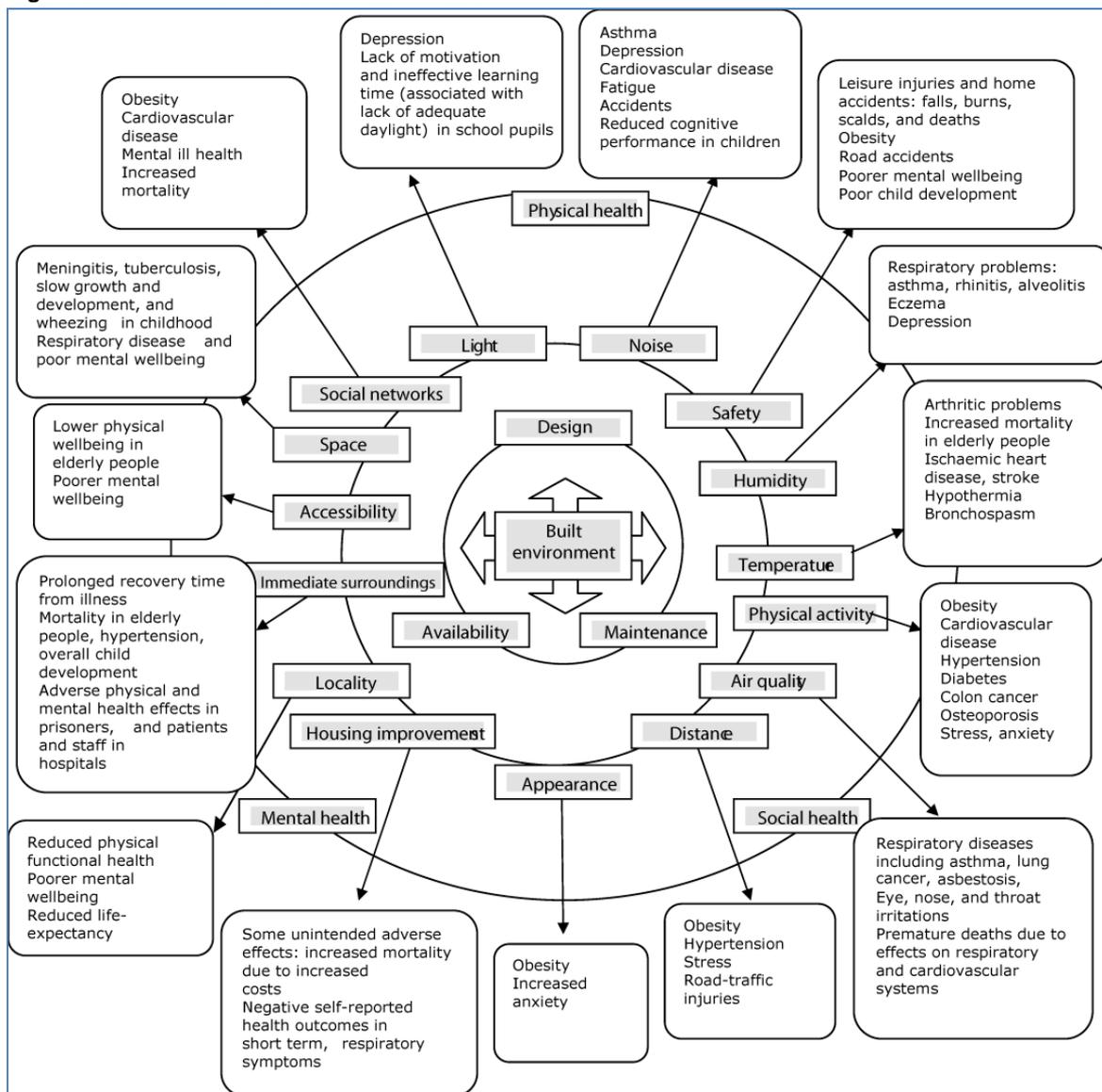


Barton, H & Grant, M, 2006, derived from Whitehead, M & Dahlgren, G, The determinants of health and well-being, 1991.

There is a growing body of research investigating the relationship between these characteristics of the built environment and health. The relationship is complex and often context specific (Feng, Glass et al. 2010).

Figure 3 shows a model of the associations between components of the built environment, health determinants and health outcomes with examples of the existing evidence. Higher density housing does not in itself usually result in changes in these determinants of health; however, the design of higher density housing can potentially affect these.

Figure 3 Built Environment and Health Model



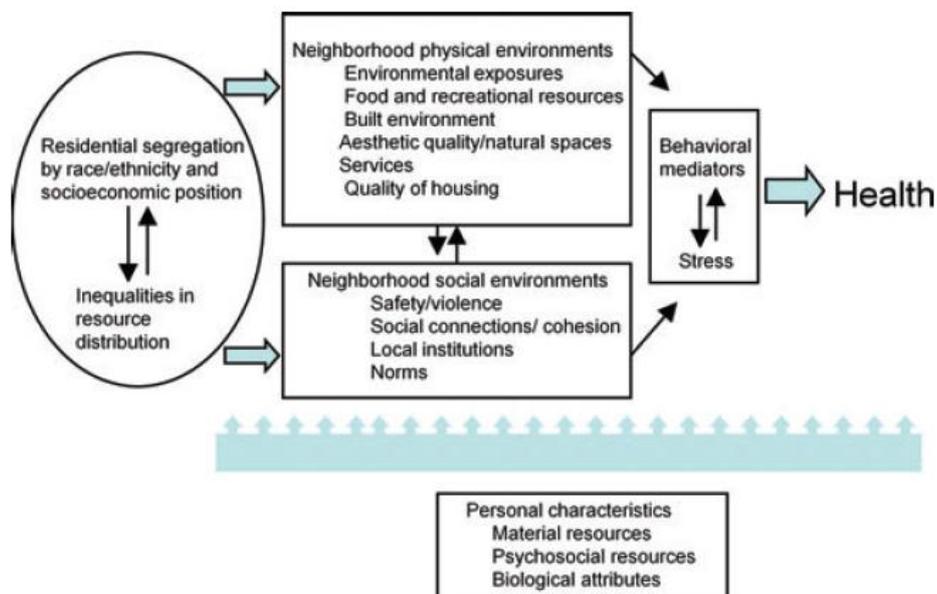
Source: Rao et al., 2007

Inequities exist between and within urban areas. Urban areas are often grouped by social class and ethnicity. Evidence suggests that the role of economic status, in particular poverty, in an area has a stronger impact on determinants of health such as physical exercise than the built environment (Bramley and Power 2009; Minster 2010). The Commission of the Social Determinants of Health reported that:

The systematic social patterning in health outcomes within and between cities suggests that there is something about urban living - urban physical and social environments and living conditions, and the ways of life they encourage - that cause these differences in health. These differences are by and large not explained by biological variation, which means that they can be avoided by reasonable societal-level action. That they are not [avoided] means they are unfair, unjust and, therefore, inequitable... This unequal distribution of health “is not in any sense a ‘natural’ phenomenon but is the result of a toxic combination of poor social policies and programmes, unfair economic arrangements, and bad politics (World Health Organisation 2008, p. 1).

Urban planning and design can potentially assist in reducing poverty and inequity through creating more compact and integrated cities in which all residents have more equitable access to the benefits of urban life such as livelihood opportunities, physical infrastructure and education (through walking/cycling or through affordable and effective public transport) (Smit 2010). However, some limited evidence suggests that changes in density (both increase and decrease) are often linked to increased income segregation (Pendall and Carruthers 2003). Figure 4 depicts how neighbourhood characteristics and inequalities contribute to outcomes.

Figure 4 Schematic representation of the contributions of neighbourhood environments and inequality (Diez Roux and Mair 2010)



5 Evidence from the literature: Housing density and health

The literature on the impact of housing density on health outcomes is inconclusive. There is a large amount of heterogeneity between studies which makes it difficult to compare studies or investigate pooled effects. Results from studies are often contradictory – what works in one place doesn't necessarily work in another. This suggests that the impacts of housing density are context specific and the design of higher density housing needs to be fit for purpose. It is not clear whether objective or perceived environment has a greater impact on health outcomes (Durand, Andalib et al. 2011). A combination of physical design and educative strategies may be needed to maximise any potential health benefits of higher density housing.

We found no evidence that clearly differentiated between moving from low to medium and low to high density housing. There are a range of different definitions of density used which also complicates comparisons between studies and applying findings to the Mackay context.

Impacts associated with higher density housing are related to features such as: access to greenspace, active transport, services and resources; environmental factors such as noise, light, air quality; economic factors such as housing affordability; and social factors such as fear of crime, social capital, privacy levels, social interaction, networks and sense of belonging. These impacts are often not the result of housing density itself but rather the urban environment within which the higher density housing is situated. Some studies have indicated that developments need to be fit for purpose and context specific (Bramley, Dempsey et al. 2009; Townshend and Lake 2009). A development may tick boxes in terms of factors that are related to potential health benefits but if the design is not appropriate then these benefits are unlikely to be realised.

There is strong evidence that urban areas are often grouped by social class and ethnicity (Diez Roux and Mair 2010). Evidence suggests that the role of economic status, in particular poverty, in an area has a stronger impact on determinants of health such as physical exercise than the built environment (Kashef 2011). For example there exists a “ ‘German paradox’ according to which cities are described as compact and thus seem to be anti-obesogenic, but where the obesity rate is high” (Minster 2010, p. 5)(see appendix 2). This is thought to be linked to socio-economic status and cultural factors.

Some potential impacts of higher density housing are also person or population group specific. For example, families with children particularly benefit from having outside space that can be easily monitored by caregivers. Poor people are more likely to live in low quality built environments and this contributes to poor health. Children and older people are particularly vulnerable not only because of a biological vulnerability but also because of the significant numbers of children and older people who are poor (Lavin 2006).

5.1 Physical activity

The strongest evidence of the impact of housing density on determinants of health is the relationship between density and walking. Residents of higher density areas tend to walk more than residents of less dense areas. In particular, higher density combined with greater connectivity and having destinations within walking distance support walking (Saelens and Handy 2008; Townshend and Lake 2009; Diez Roux and Mair 2010; Feng, Glass et al. 2010). Residents of higher density neighbourhoods also tend to have lower obesity levels. The evidence is not always consistent

however. For example a “methodologically robust study from the US concluded that increasing residential density while having potential for many positive impacts (such as efficient use of land and encouragement of lively streets), did not have an impact in the overall amount of exercise taken in the study areas” (Forsyth et al., 2007 cited inTownshend and Lake 2009, p. 911). A five year longitudinal study found no evidence that residents became more physically active in mixed-use neighborhoods than other types of estates and another US study found that employment density at work exerts more influence on mode choice for work trips than residential density at home (Kashef 2011). Diez Roux notes that most of the existing research is based on cross-sectional research (Diez Roux and Mair 2010).

A systematic review of built environment factors related to physical activity and obesity risk, with a focus on the implications for ‘smart growth’ urban planning (Durand, Andalib et al. 2011). The review found that communities which have diverse housing types, mixed land use, increased housing density, and development which is directed toward existing communities, coupled with increased levels of or access to natural space and critical environmental areas may show increases in walking and physical activity among residents exposed to these characteristics.

It appears that higher density housing can provide an environment that is supportive of higher levels of physical activity. However whether that actually results in increased physical activity is context and person specific. Studies indicate that endogeneity plays a role in this relationship; people who walk regularly choose neighbourhood environments that promote walkability and not vice versa (Feng, Glass et al. 2010; Kashef 2011). Table 3 illustrates selected processes the generate place specific difference in health behaviours.

Table 3 Selected processes that generate place specific difference in health behaviours and examples from study of neighbourhood patterning of physical activity (Diez Roux and Mair 2010)

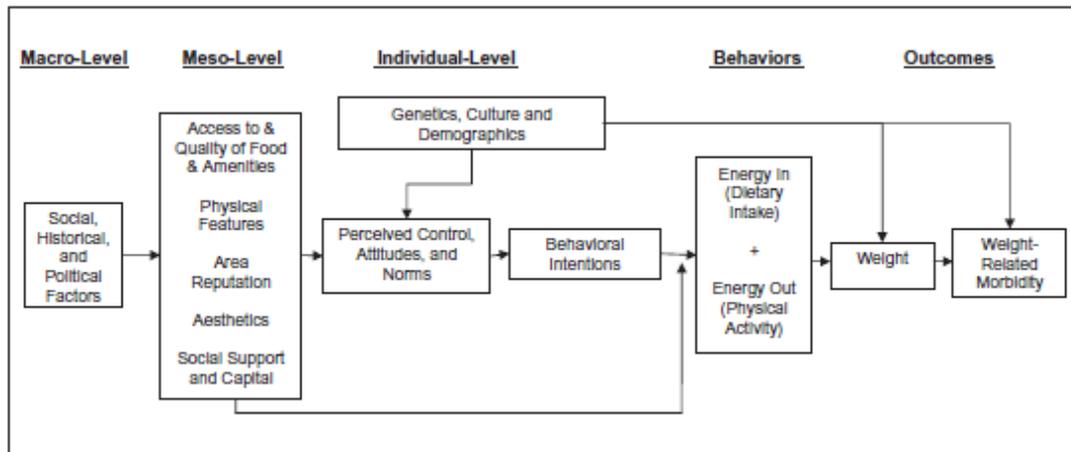
Processes generating place differences in health behaviours	Example for being physically active
1. Person level health is affected by features of the residential neighbourhood	Availability of places to be physically active promotes physical activity
2. Persons are selected into residential neighbourhoods based on their person/household characteristics	Individuals are sorted into neighbourhoods based on income and race/ethnicity. These characteristics are potentially related to being physically active
3. Persons select their residence based on their preferences for features of residential neighbourhoods	Neighbourhoods that have safe and aesthetically pleasing places to be physically active, attract persons who prefer to be physically active
4. Persons adapt their behaviours within their spatial (and social) network and wider geographic area	Seeing more bicycle riders may increase the likelihood of commuting to work via bike.
5. Neighbourhoods change in response to residents characteristics	Gyms are more likely to locate in areas where individuals are known to be physically active, or in wealthier areas where individuals have greater purchasing power, or in areas where physically active residents advocate for them.
6. Neighbourhoods adapt in response to features of other neighbourhoods or more distant places	Regional transport infrastructure affects the availability of public transport and automobile restrictions in neighbourhoods

We could find no review level evidence about the impact of the high density buildings (e.g. high rise apartments) on physical activity. In general there is very little research available investigating health impacts of high rise living (Gifford 2007). There are, however, some case studies that identify high density housing leading to an emphasis on activities that keep children quiet (Randolph 2006). It also appears often necessary for physical activity to take place outside the immediate household area (e.g. going to a local park or playground) which can also act as a barrier.

5.1.1 Housing density and obesity

In general studies have shown that people living in high density neighbourhoods with greater access to public transport with a greater mix of land use have lower BMIs. In a recent systematic review of the literature on environmental effects on cardiometabolic risk factors (obesity, hypertension, type 2 diabetes, dyslipidemias and the metabolic syndrome) found that environments with a high density of residential units, street intersections, and services are associated with decreased BMI (Leal and Chaix 2011). Figure 5 illustrates a framework for understanding how neighbourhoods influence obesity.

Figure 5 Proposed framework for understanding how neighborhoods influence body weight and obesity. (Black and Macinko 2008)



However the evidence is inconsistent. Another recent systematic review of the epidemiological evidence around the built environment and obesity found that there was as many or more studies investigating population density and sprawl that reported no evidence of association with obesity outcomes as there were that reported statistically significant associations (Feng, Glass et al. 2010).

In another systematic review of environmental factors and obesogenic dietary intakes among adults it was found that associations between the environment and weight status are more consistent than that seen between the environment and dietary behaviours (Giskes, van Lenthe et al. 2011). However this same review found that living in a socioeconomically-deprived area was the only environmental factor consistently associated with a number of obesogenic dietary behaviour.

A review of physical environmental correlates of childhood obesity found in contrast that *Meso-urban* characteristics, such as housing density and land use mix, were unrelated to BMI (Dunton, Kaplan et al. 2009). However this was based on a single study of preschool children included within the review.

Physical activity has been identified as a social justice issue (Lee and Cubbin 2009). Population groups with the lowest levels of physical activity tend to be those groups who experience inequities in terms of factors such as access to high-quality housing in safe neighborhoods, health care, education, and occupational opportunities (Lee and Cubbin 2009). This combined with evidence suggesting that people who are more likely to be physically active tend to select neighbourhoods that are conducive to physical activity suggests that when planning higher density developments consideration should be given to who are the residents who are likely to be interested in this housing and who is most likely to benefit it.

A systematic review of 131 papers investigating the influence of geographic life environments on cardio metabolic risk factors found that lower housing density was consistently associated with hypertension and obesity (Leal and Chaix 2011).

5.1.2 Traffic

In terms of car use there appears to be a ‘paradox of intensification’. On the one hand increased housing density resulting in increased population density will generally reduce overall vehicle use.

However, on the other hand increased levels in the higher density area result in local environmental and social problems. Studies suggest that in order stop this strong measures need to be utilised to deter car usage (e.g. car free areas, limiting parking, congestion charging) (Melia, Parkhurst et al. 2011).

In terms of land use pattern, the health impacts of air pollution are greater in urban areas with high density and tall buildings; these have higher levels of traffic and congestion, lower air dispersal characteristics and more people (Grant 2009).

Some studies have shown that increases in motor traffic on roads, forced residents to make major adjustments in their lives to protect against the nearly constant noise, pollution, dust and danger outside their front doors (Grant 2009).

5.1.3 Effects on Children

Compared with previous generations, children now spend less time playing outdoors and have lower participation rates in active transport (Carver, Timperio et al. 2008). For example, an Australian study found that between 1985 and 2001, the proportion of children aged 9–13 years who walked to school in areas of high socioeconomic status (SES) declined by around 50%, while the proportion of children who cycled to school at least once per week declined by 77% in areas of low SES (Salmon et al., 2005 cited in Carver, Timperio et al. 2008). A number of studies have focused on children and urban form “showing the direct correlation between the distance a child lives from school and the propensity to walk or cycle to it ” (Bricker et al., 2002 cited in Townshend and Lake 2009, p. 912). There is evidence that proximity to parks is also related to physical activity in children. (Binns, Forman et al. 2009)

In general, in children, higher density is also associated with increased physical activity and lower obesity levels than sprawling areas. The associations vary according to different physical environment variables, age, socio-economic status and gender. There is some limited evidence that interventions to reduce perceived environmental barriers for physical activity are particularly needed for adolescent girls (Yan, Voorhees et al. 2010).

Research in Australia has suggested that micro-urban design environments, such as the quality of pedestrian realm and public crossings can also be significant in whether parents allow their children to walk to school (Timperio et al., 2006 cited in Townshend and Lake 2009). Parental concern about traffic is a major barrier to children having opportunities for active free play (Binns, Forman et al. 2009).

In a systematic review of evidence on physical environment and childhood obesity the authors found that associations between physical environmental variables and obesity differed by gender, age, socioeconomic status, population density and whether reports were made by the parent or child (Dunton, Kaplan et al. 2009). They did find that urban sprawl was associated with obesity in adolescents. The authors conclude that:

Weak associations of community features, such as parks and recreational facilities, with childhood obesity outcomes suggest that it might be necessary to enhance the *use* of these resources through promotional strategies and messages, and targeted campaigns (Dunton, Kaplan et al. 2009).

We could find no review level evidence about the impact of the high density buildings (e.g. multiple occupancy buildings) on physical activity. There are, however, some single descriptive studies that identify high density housing leading to an emphasis on activities that keep children quiet. It also often appears necessary for physical activity to take place outside the immediate household area (e.g. going to a local park or playground) which can also act as a barrier (e.g. Randolph 2006).

Although higher density housing can facilitate higher levels of physical activity there is also risk that this can increase exposure to potential harms of vehicle exhaust and street traffic. In order to maximise health gains planning will need to promote physical activity while also addressing traffic and air pollution impacts (Binns, Forman et al. 2009).

5.1.4 Effects on older people

There is some qualitative research documenting that older adults perceive local services (e.g. shopping, libraries), walking and traffic infrastructure (e.g., traffic volume and speed, the presence of footpaths), neighbourhood aesthetics (e.g., presence of parks and trees), and the availability of public transport to influence physical activity.(Strath 2007)

5.2 Community safety

Urban land use patterns have been identified as having two major impacts on unintentional injury: flooding and the heat island effect (Grant 2009). Both of these are linked to climate change.

We found only limited evidence about the relationship between higher density housing and community safety. We found no evidence about the relationship between density and unintentional injuries. Unintentional injuries associated with urban design occur from several other sources. These can include poor street lighting, choice of materials for footpaths and walkways or injury resulting from poor maintenance of the built environment, poorly designed urban environments and poor maintenance of public open spaces, play areas, paths, rights of way, and canal towpaths (Grant 2009).Where there are perceived safety issues and traffic danger this may lead parents stopping children playing in the street or walking/cycling. Increased traffic density results in increased risk of road traffic accidents.

Interestingly dense urban areas appear to be safer in terms of traffic accidents (Ewing and Dumbaugh 2009). Fewer fatalities per capita occurred in areas with higher density, a greater mix of homes, shops and workplaces, and a more centered development pattern. This may be because less distance is driven on a per capita basis, and the driving that is done is at lower speeds that are less likely to produce fatal crashes. Also evidence suggests that where dense urban areas have less 'forgiving' design (narrow lanes, traffic calming measures, trees close to the road) this appears to enhance safety(Ewing and Dumbaugh 2009). This may be because the less-forgiving designs provide drivers with clear information on safe and appropriate operating speeds.

The relationship between the built environment/urban design and crime is widely recognised within the literature. Pease (1997) relates approaches to crime prevention to three different perspectives on the causes of crime – structural (via social and economic change), psychological (via control or reform of potential offenders) and circumstantial (via intervention in the social and physical settings of crime). Factors that influence safety and perception of safety (e.g. neighbourhood and housing design, accessibility and permeability of streets/areas; surveillance (natural and CCTV); street lighting; neighbourhood management and maintenance) are linked to the design of urban areas

rather than the density of housing. The relationship between housing density and crime is unclear and the common belief that high density housing causes higher crime levels does not appear to be supported by evidence (Roundtable 2002). Some evidence suggests that the higher crime rates experienced in some high density housing is correlated to socio-economic status rather than density (Li and Rainwater 1999). We could, however find no reviews that addressed this issue.

Urban designs that facilitate neighbourhood bonds and encourage supportive social networks (e.g. mixed use, pedestrian and cycling friendly) have been shown to be effective in reducing fear of crime (Lavin 2006).

5.2.1 Effects on children

Children are particularly vulnerable to accidents. In Australia the leading cause of death among young children (1-4) is accidents, poisoning and violence (external causes) which accounted for about 46% of all deaths among children (ABS). About a third of all child deaths from external causes were due to motor vehicle accidents and drowning. We found no review level evidence about higher density housing and accidents in children.

Children who live in neighbourhoods that they perceived as unsafe are at greater risk of developing behavioural problems such as hyperactivity, aggression and becoming withdrawn (Lavin 2006). Evidence suggests that low levels of active transport and physical activity among children in their neighbourhood are associated with lack of perceived neighbourhood safety (Carver, Timperio et al. 2008). Road safety and 'stranger danger' appear to be significant causes of parental anxiety in relation to their children's safety in the neighbourhood. When parents are asked what prevents their children from walking to school, the second most commonly mentioned factor is traffic danger (Binns, Forman et al. 2009). Children of parents who report anxiety about neighborhood safety get less physical activity.(Binns, Forman et al. 2009). There is some limited evidence that suggests that parents rather than children have a stronger influence on children's physical activity although adolescence has been identified as a time when there is potential negotiation between child and parent (Carver, Timperio et al. 2008). We found no evidence linking higher density housing, perception of crime and safety with children's activity.

Child friendly design recommendations

Well planned networks of walking and cycling routes include:

- Safe and accessible footpaths
- Connections to local destinations

Local streets with direct, safe and convenient access such as:

- Safe places to cross streets
- Slow traffic for safe streets

Local and regional parklands:

- Well located
- Places for activities and get togethers

Conveniently located public transport stops with:

- Facilities for comfort and convenience
- Safe visible stops
- Transport going direct to schools and shopping centres

Local neighbourhoods fostering community spirit by:

- Creating spaces for children's activity
- Involving children in planning activities

(adapted from "Healthy by Design"-Heart Foundation)

Shopping centres designed with children, teens and carers in mind:

- Pram friendly access
- Safe places for children to be left by parents while shopping
- Activities for children
- Gathering places for teens that minimize conflicts with other users

(Holliday 2006)

5.2.2 Older people

A large body of research has indentified older people as having relatively high levels of fear of crime. However older people are overwhelmingly *less* at risk of being victims of crime than other age groups (Criminology 2011). More recent studies have placed the status of older people as the group most fearful of crime in doubt (Pain 2000).

5.3 Mental health

The architectural and urban design of a development may impact (positively or negatively) on levels of social inclusion, isolation and the ability of certain groups (disabled people, the elderly and families with young children) to access community and social networks and services. As with most of the potential impacts identified, research suggests that it is not necessarily high density that causes impacts on mental wellbeing (for example dissatisfaction) but related factors such as environmental quality, noise, lack of community involvement, traffic and lack of services and facilities (Howley, Scott et al. 2009). The planning process is also important, as residents' participation in planning and design can itself enhance health and happiness (Smit 2010).

In a study of five British cities it was found that generally, social outcomes relating to attachment, satisfaction, safety, and environment are more positive at lower densities and in less central locations, while outcomes relating to use of local services display the opposite tendency (Bramley,

Dempsey et al. 2009; Bramley and Power 2009). The strongest negative relationships with density in the study were home satisfaction and safety.

There is mention in the literature of the ‘three Ps’ of high density housing that can lead to stress and dissatisfaction- “pets, parking and parties” (Easthope and Judd 2010). This suggests that it is important that higher density housing developments have clear guidelines for dealing with these issues. There are no systematic reviews yet available that provide evidence about higher density housing and noise related health risks.

One study showed that access to services is generally better in denser urban forms, and this effect is confirmed rather than weakened by taking account of other factors. Furthermore, in this case urban form is more important than socio-demographic composition (Bramley and Power 2009).

Some studies found that environmental noise problems are worse in areas of high density housing, rented accommodation (both social and private sectors), areas of deprivation and areas which are highly urbanised (Healthy urban planning, environment and health) (Grant 2009).

Table 4 Features of public space that promote social contact and cohesion

<p>Features of public spaces that best promote social contact and community cohesion include the following:</p> <ul style="list-style-type: none">• they allow for local involvement in planning, and are ‘co-produced’ rather than being planned top-down• they are accessible at most hours• they are available for a range of activities• they include places to sit down and places to eat or have coffee <p>Most importantly, these studies suggest that these features are likely to be more important than the formal design aspects. (Holliday 2006)</p>

5.3.1 Effects on children

Some studies have indicated that families living in high-rise housing, as opposed to single-family residences, have fewer relationships with neighbours, resulting in less social support. Wells, Evans et al discuss the following findings:

- High-rise housing is associated with psychological stress, particularly among low-income mothers of young children.
- Children who lived in 14-story public housing were found to have greater behavioral problems than children living in three-story public housing.
- Social isolation may be one reason for this, because parents are less likely to let their kids play outside if they live high up in a large building.
- Crowding has detrimental effects on both mental and physical health (Wells, Evans et al. 2010)

There is limited evidence of high density housing increasing pressure on parents to keep children quiet (Randolph 2006).

5.3.2 Effects on older people

There is some evidence of lower levels of depression in older men in neighbourhoods with higher walkability but also contrasting evidence of older men living in areas of high availability of retail outlets and services being at a greater risk of depression (Saarloos, Alfonso et al. 2011).

Having access to natural environments is good for well being and evidence suggests that older, urban residents who have places to walk and access to parks and tree-lined streets live longer (Wells, Evans et al. 2010).

6 Impact of Housing density on health in Health Impact Assessments

This section provides a brief overview of relevant previously conducted Health Impact Assessments (HIA) done in Australia and New Zealand between 2005 and 2010. In addition, searches were made of international HIA websites to identify HIAs that explicitly focused on housing density. Primary and secondary sources as well as the experience from HIA participants have also been reported, along with an overall summary of HIA recommendations. Reviewing HIAs provides an overview of the relevant context, the amount and variety of evidence identified in HIAs that address the different types of housing density impacts (both positive and negative) on health (Harris, Harris-Roxas et al. 2007).

Background

A Health Impact Assessment (HIA) is a widely acknowledged decision making tool that facilitates decision makers to consider more explicitly the social determinants of human health, wellbeing and equity prior to the implementation of a project, policy or plan (London Health Commission and Environment Committee of the Assembly 2002). The HIA process has been received as an engagement platform for stakeholders from different sectors to identify potential impacts and providing action-oriented recommendations that extenuate positive impacts and limit those impacts that threaten health (Harris, Harris et al. 2009).

The capacity and development of HIA has increased comparably over the past decade in Australia and New Zealand (Harris-Roxas and Simpson 2005). Most HIAs were conducted across different levels of government and covered a range of issues such as hospital redevelopments to waste management strategies. Several HIAs addressed the implementation of management plans for land-use and urban design in light of population growth. However the majority assess urban environmental impacts rather than specific impacts from housing density on health.

Evidence Base

A search of HIA web sources such as HIA Connect, Health Impact Assessment Gateway, World Health Organization, International Health Impact Consortium and International Association for Impact Assessment was undertaken to identify Health Impact Assessments conducted in Australia and New Zealand between 2005 and 2010 (Harris, Harris-Roxas et al. 2007). Key words such as low-, medium-, and high- density housing' and 'urban sprawl' linked to positive and/or negative impacts on human health was also done in these web sources to find any relevant secondary data included in this review. All secondary research evidence found in the review was also referenced to supplement the primary data from the HIA reports.

6.1 Findings

High Density Housing

Positive impacts of high density housing

In Australia, the Greater Western Sydney Urban Development Strategy Health Impact Assessment (2007) reported that high density housing potentially lowered the number of cars per household which increased the rates of incidental physical activity amongst resident (Gethin 2007). Both these impacts were also reported in two Health Impact Assessments (HIA) that respectively reported lowered car dependence in high density developments increased the usage of public transportation (Cervero and Radisch 1996) for commuters travelling shorter distances in the Auckland Regional Council Regional Land Transport Strategy Health Impact Assessment (2009). The Wellington Regional Form and Energy Draft Provisions Health Impact Assessment (2008) reported that residents of high density housing developments had higher rates of physical activity through walking and cycling (Saelens, Sallis et al. 2003).

The Greater Western Sydney Urban Development Strategy Health Impact Assessment (2007) also reported that increased housing developments for high density dwellings require increased service coordination and social connectivity infrastructure to consider disadvantaged groups (Gethin 2007). This was also reported in the Bungendore Health Impact Assessment (2007) and Keri-keri Waipapa Structure Plan Wellbeing Impact Assessment (WIA) (2007), both reported that increased investment in social connectivity infrastructure would likely improve the access of residents to social, community and health services. This was socially important for the inclusion of vulnerable groups by providing access and opportunities that support regional and local employment (Taske, Taylor et al. 2005).

The concept of improving connectivity was also reported in the Health Impact Assessment on the Ranui Concept Plan (Thornley 2008) which reported well-designed parks and open spaces provided amenity for in high density residents (Syme, McGregor et al. 2005). This was also found in the Keri-keri Waipapa Structure Plan WIA (2007). However, increasing the positive outcomes of amenity requires coupling building design with increasing the capacity of residents to govern their housing estate i.e. establishing residential committees to govern building regulations and set standards for noise limits, communal space, resolve waste disposal issues and maximise social connectivity (Quigley and Ball 2007).

The Keri-keri Waipapa Structure Plan WIA (2007) further reported that well-designed high density developments can improve the 'passive surveillance' of areas and further limit criminal activity while raising personal safety of residents. Safety was also reported with lowered reliance on motor vehicles associated to the reduction of various roadside accidents. This was particularly relevant in that roadside accidents predominantly involved children (especially indigenous children) in the area. The report also stated that well-designed play areas, networks for walking, cycling and driving are necessary to boost the level of safety (Quigley and Ball 2007).

Although out of scope for the Mackay HIA, environmental health outcomes were also reported in the Keri-keri Waipapa Structure Plan WIA (2007) describing the conflicting findings of high density housing on air and water quality. It was reported that air quality would improve as a result of

decreased dependence on cars and that enhanced monitoring of water management systems have the potential to improved water quality in high density areas (Quigley and Ball 2007).

Negative impacts of high density housing

There were two negative impacts from Australian Health Impact Assessments that impact on children. The Greater Western Sydney Urban Development Strategy HIA (2007) that reported a lack of open space and play areas for children in high density housing is associated with lower levels and development of cognitive skills in children (Randolph 2006). Child safety concerning risk of serious injury and death in children falling from windows and balconies of high rise dwellings (Ozanne-Smith, Guy et al. 2008) was reported in the Parramatta City Council's Draft Local Environment Plan Health Impact Assessment (2010).

In New Zealand, the Heretaunga Plains Urban Development Strategy Health Impact Assessment (2010) reported that centralized high density housing developments create social gradients that push middle income residents from the area to exterior less dense suburbs and predisposes lower income residents to the high density housing which form so-called 'ghettos'(Randolph 2004).

This inequity gradient was also reported to lower amenity of areas such as in the Greater Granville regeneration HIA (2006) that reported the extreme damage on the mental wellbeing of women in high density areas (Gabe and Williams 1993). In extreme cases it was reported that amenity and social capital decreased in very high density housing residents as they seek refuge and privacy away from a 'sensory overload' (GSAHS 2007).

The participants of the Manukau Built Form Health Impact Assessment (2009) also felt concerns of the potential for increased incidence of alcohol-related harm as a consequence of social gradient and increased availability of alcohol outlets in high density areas (Field, Arcus et al. 2009). The Flaxmere Town Centre Urban Design Framework Proposal Health Impact Assessment (2010) reported that crime and violence was reported in high density housing (Scribner, MacKinnon et al. 1995).

In terms of affordability, the Heretaunga Plains Urban Development Strategy HIA (2010) reported the findings of the review study by Syme et. al. in 2005 who conducted a review of surveys, media articles and literature to describe the affordability of housing based on density type. The study found that high density housing can potentially create socioeconomic gradients that meant housing costs were more affordable for some groups yet places disadvantage on others and further pushes low income earning groups to the periphery. (Syme, McGregor et al. 2005).

There were specific issues identified by the early Avondale Future Framework rapid Health Impact Assessment (2005) reporting high density housing impacts that related to poor design, governance, social connectivity and amenity i.e. 'poor ventilation, a lack of space (room size, storage and food preparation areas), and intrusive outside noise. Safety and security of car-parking, mail and access to apartment buildings, inadequate recycling facilities, poorly designed rubbish areas, inadequate balconies and the importance of building managers are further issues' (Auckland Uniservices Ltd 2004).

The positive environmental health impacts on air and water quality were described earlier. The Keri-keri Waipapa Structure Plan WIA (2007) reported the potential for high density housing to expose

residents to high concentrations of air pollutants as a consequence of car density (not car dependence) (Quigley and Ball 2007). Exposure of high density residents to older pre-existing non-sewered systems will also impact negatively on people. Delayed roadway construction and conflict between residential areas and motor vehicles are also negative short term impacts, (Quigley and Ball 2007) along with increased risk of disease spread (Young, McKiernan et al. 2005).

Medium Density Housing

Based on the reports from Australia and New Zealand there were relatively little positive impacts that explicitly looked at Medium-density housing. Most of which are covered generally by the positive and negative high housing impacts discussed above which incorporates general non-specific comments about 'increased' or 'increasing' housing density impacts.

Negative impacts of medium density housing

A comprehensive Health and Social Impact Assessment (HSIA) of the South East Queensland Regional Plan 2005-2026 (2005) discussed negative impacts of medium density housing being potentially counteractive to positive health impacts made from high density housing in regards to improved accessibility and availability of public transport and air quality. The report stated poor health outcomes were predominant in high-density areas peripheral to the town centre (Bayoumi, Hwnag et al. 2002).

The HSIA reported that medium density housing developers have been responsible for decreasing the affordability of land allocated for 'retirement villages and/or residential housing for older people'. This is a concern as the 'future needs of an ageing population' are not adequately met and compounding to this issue is the further relocation of services and facilities for this elderly group to proximal more available and affordable areas that are however, less accessible (Young, McKiernan et al. 2005).

The Greater Western Sydney Urban Development Strategy Health Impact Assessment (HIA) (2007) reported inequity gradients with increased low density type development promoted in outer suburbs which consist of exclusively large acreage type housing for more affluent people. This decreases the affordability of low density homes owned or rented by low income people in the same region and potentially drives investors away from improving the majority of older medium density type public housing (Gethin 2007). This finding was similar to the Ranui Concept Plan HIA (2008), from New Zealand, which described newly developed fringe areas suited the needs of investors rather than the majority of tenants occupying the medium to high density type housing.

Low Density Housing

There is little evidence from the search of HIAs reported in Australia and New Zealand that identify positive health impacts associated with low density housing development.

Negative impacts of low density housing

In New Zealand, the Wellbeing Impact Assessment done on the Keri-keri Waipapa Structure Plan (2007) reported that low density housing development potentially decreased the viability of local produce as land is lost to housing development (Quigley and Ball 2007). The report also highlighted that local employment will fall especially in indigenous youth and that negative impacts will be exacerbated by a decline in community service usage due to increased motor vehicle dependence.

The lowered attention to services will further impact on less mobile groups with poor access to motor vehicles e.g. children, elderly and disabled people (Quigley and Ball 2007).

Although increased priority for service provisions are recommended. The Australian Health Impact Assessment done on the Leopold Strategic Footpath Network (2008) reported that further development of low density housing in rural areas will facilitate inefficiency in terms of wasted infrastructure and place a burden on the quality and coordination of services (Boyce 2008).

The Flaxmere Town Centre Urban Design Framework Proposal Health Impact Assessment (2010) reported low density housing and increased car dependence were associated with poor physical activity levels. This association was also reported in the Wellington Regional Form and Energy Draft Provisions Health Impact Assessment (2008).

Social connectivity was identified in the Manukau Built Form and Spatial Structure Plan Health Impact Assessment (2009) which reported that residents from low density developments displayed characteristics that socially lacked the 'sense of community' as a consequence of motor vehicle dependence (Public Health Advisory Committee 2008). On the contrary, a low density housing community described in the Waihi Beach Age friendly communities Health Impact Assessment (2009) was reported to possess this sense of community pride. It also described a high dependency on motor vehicles and poorly built infrastructure for public transportation and access to services. These negative impacts affect the high risk less mobile elderly group who are highly represented in the population (Gordon and Van der Pas 2009).

The Greater Western Sydney Urban Development Strategy HIA (2007) reported inequity gradients with increased low density type development promoted in outer suburbs which consist of exclusively large acreage type housing for more affluent people. This decreases the affordability of low density homes owned or rented by low income people in the same region (Gethin 2007).

6.2 Summary of Housing Density Recommendations

There were many recommendations identified from this review of Health Impact Assessment reports that targeted the impacts of broader built urban environment. There were a few however, recurring recommendation themes that focus specifically on housing density. These cover: quality urban design, built infrastructure that promote social connectivity, health and social wellbeing, safety, equity and compliance from stakeholders.

The higher density housing recommendations from the review require;

- Provisions are made for people that cover a range of ages e.g. children for their ‘free-will movement’(Quigley and Ball 2007) with open play spaces (Jaine 2008).
- Seeking strategies to ensure the delivery of diverse housing types for the elderly, disabled and singles (Young, McKiernan et al. 2005)
- Access opportunities for recreation and open space (Quigley and Ball 2007)
- Restricting urban sprawl by monitoring land release and seek land development sites close to the town centre (GSAHS 2007)
- Active transport options and increased physical activity (Quigley and Ball 2007)
- Cycleways and walkways (Quigley and Ball 2007)
- Local retail and services (Tennant, Newman et al. 2010)
- Principles made to prevent crime and injury (Quigley and Ball 2007)
- Appropriate development and building standards to improve safety for children and residents (Ozanne-Smith, Guy et al. 2008)

The medium density housing recommendations from the review require;

- Seek measures to secure affordable housing for elderly, single people and people with disabilities (Young, McKiernan et al. 2005)
- Appropriate development and building standards to improve safety for children and residents (Ozanne-Smith, Guy et al. 2008)
- Regulation of signage of unhealthy foods (as defined by the Australian Guide to Healthy Eating) to be excluded no less than 300 metres from child serving institutions e.g. schools, pre-schools, hospitals, playgrounds etc (Tennant, Newman et al. 2010)
- Implementing plans that consider “social equity and housing affordability for residents” especially for vulnerable groups (Thornley 2008)
- Increased compliance and cooperation between stakeholders to limit urban sprawl (Quigley and Ball 2007)
- Monitoring demographic changes on a local government area basis (Young, McKiernan et al. 2005)

-

The lower density housing recommendations from the review require;

- Provision are made for vulnerable people e.g. elderly and disabled people with low mobility to gain access to transport facilities and services e.g. wheelchair access (Field, Arcus et al. 2009)
- Investment for age-friendly environments that reduce housing stress (Gordon and Van der Pas 2009)
- Regulation of signage of unhealthy foods (as defined by the Australian Guide to Healthy Eating) to be excluded no less than 300 metres from child serving institutions e.g. schools, pre-schools, hospitals, playgrounds etc (Tennant, Newman et al. 2010)
- Increased compliance and cooperation between stakeholders to limit urban sprawl (Quigley and Ball 2007)

Table 5. Health impacts explicitly linked to the density types identified from Australian and New Zealand Health Impact Assessment

Impacts	Low Density housing	Medium Density Housing	High Density Housing
Positive			<ul style="list-style-type: none"> • lowered number of cars per household • increased rates of incidental physical activity • increased usage of public transportation • increased connectivity • may improve access to services and coordination for disadvantaged groups • increased amenity through design and residential governance • may increase affordability of housing • passive surveillance • reduced crime • increased personal safety around roads and walkways and cycleways
Negative	<ul style="list-style-type: none"> • decreased viability of local production as land is lost to sprawl development • decreased local employment especially in indigenous youth • decline service usage due to increased car dependence. • lowered attention to services, impacting on less mobile groups e.g. children, elderly and disabled • decreased affordability for low income earners seeking to own a home • wasted infrastructure linking rural areas, burden quality and coordination of services 	<ul style="list-style-type: none"> • lack of play areas for children • loss of cognitive skills for children • counteract positive health impacts made in high density housing i.e. improved access, transport availability and air quality • competition from Medium density housing developers decreasing affordability and availability of land for elderly people. • poor serviceability to peripherally located facilities for elderly people 	<ul style="list-style-type: none"> • lack of play areas for children • loss of cognitive skills for children • risk of safety for children from windows and balconies • creation of inequity gradients in forming 'ghettos' • may damage mental health in women with children • increased alcohol-related harm • poor management of residence • loss of amenity depending on design • increased cost of living and intensification • increased safety and security concerns • increased pollution exposure • short term stress • increase risk of spreading disease

Table 6. Housing density types assessed in the Health Impact Assessments from the review

Health Impact Assessment	Housing Density type considered			
	Country	High	Med	Low
Ranui Urban Concept Plan (2008)	NZ	√	√	
Avondale's Future Framework (2005)	NZ	√		
Manukau Built Form and Spatial Structure Plan (2009)	NZ	√		√
Wellington Regional Form and Energy Draft Provisions (2008)	NZ	√		√
Heretaunga Plains Urban Development Strategy (2010)	NZ	√		
Greater Western Sydney Urban Development Strategy (2007)	AUS	√	√	√
*Draft far North District Council Keri-Keri Waipapa Structure Plan (2007)	NZ	√	√	√
Leopold Strategic Footpath Network (2008)	AUS			√

Greater Granville Regeneration Strategy(2006)	AUS	√		
Parramatta City Council's Draft Local Environment Plan (2010)	AUS	√	√	√
South East Queensland regional Plan 2005-2025 (2005)	AUS	√	√	√

*The housing density type definitions between the Mackay Hinterland criteria differed mostly with the Keri-keri Waipapa Structure Plan Wellbeing Impact Assessment (2007). It should be noted that the Mackay definition is relatively a step lower than the Keri-keri Waipapa definition of housing density, i.e. medium dense housing in Mackay is equivalent to high density housing in the Keri-keri Waipapa WIA (2007).

6.3 Discussion

A number of gaps are apparent in the Health Impact Assessment literature to describe the relationship and impact of housing density (including the different typologies) on human health and wellbeing. The search revealed a lack of consideration for housing density impacts in all HIA reports. Most HIAs cover broader urban environmental impacts and generalize, uncategorically, the nature of housing impact. Locating the evidence of differential housing density impacts and the impacts they have on each other proved difficult.

A predominant and recurring 'determinant of health' in the review was the assessment of urban design. Its importance as a mediator of positive outcomes that flow from the built environment on to the community was highlighted in each HIA. These reports also describe the urban design of an environment to influence the population through its impact on other determinants of health which include; access to safety, access to public open space and services, air and water quality, employment, and housing to name a few.

These themes were also recurrent in the literature from the European context, however like the findings in this review, efforts to identify explicit guidance frameworks referring explicitly to 'housing density' proved difficult. However, most seemed to report the broader urban design and built environment impacts identified made in this review. These inextricable impacts and complexities linking housing density to other determinants of health may be a potential reason for the lack of evidence and report documentation.

The findings of the review in Table 5 highlight:

- the lack of information to describe positive impacts associated to low and medium density housing type
- the negative nature of impacts associated to low density housing
- the relatively small impacts that differentiate medium density housing from low and high density housing
- the potential for high density housing to affect residents both positively and negatively

The high proportion of impacts identified for high density housing can be attributed to the fact that most of the HIAs reviewed, reported to have assessed mainly high density housing above all other types (see Table 6). This is true also for the lack of medium density housing impacts assessed. Despite the gradient between low and high density housing, it is of interest that there was a discrepancy identified between the two extremes in that medium density housing impacts were reported to counteract the positive health gains made from high density housing i.e. improved access, transport availability, air quality and also the report of medium-density housing developers decreasing the affordability and availability of land for elderly people.

Interestingly, the recommendations were similar amongst all HIAs and amongst all density types. The HIA recommendations reviewed concerning the necessity for ongoing compliance and commitment from stakeholders and equity considerations seemed to have transcended all density types i.e. access and affordability for residents from disadvantaged groups. Recommendations should also be assessed for equity related impacts. For example, a recommendation to prevent

signage of high dense non-core food 300 metres away from child accessible areas in medium and low density housing types was not recommended for implementation for high density housing types. In this example child residing in the high density housing areas will not benefit from this measure.

7 Conclusions

The relationship between housing density and health is complex and context specific. The evidence on the impacts of housing density on health outcomes is often inconclusive. There is a large amount of heterogeneity between studies which makes it difficult to make compare studies and draw conclusions. Our review of the consideration of housing density within Health Impact Assessments has also demonstrated a lack of consideration for housing density impacts in HIA. This suggests that in planning higher density housing and looking for examples of good practice to follow consideration should be given to 'what, worked for whom in what circumstances' and how that in turn relates to the MacKay context.

There is a substantial body of research around the built environment and health and approaches for maximising potential health gains and minimising negative impacts. The assessment of urban design impacts is also commonly prioritised in HIAs. Moving from low density to higher density housing will necessitate changes in urban form. We have seen from the literature and other HIAs that it is difficult to assess these in isolation and to do can potentially conflate issues and falsely underestimate the impacts from other determinants of health.

The evidence is unclear on whether there is an ideal housing density. Some evidence indicates that there is a tendency to have more potential negative impacts on health at both ends of the housing density scale compared with medium density housing. It is not clear whether objective or perceived environment has a greater impact on health outcomes. A combination of physical design and educative strategies may be needed to maximise any potential health benefits of higher density housing. Consideration should be given to *who* is likely to move into these developments. Designing high quality 'walkable' neighbourhoods can potentially result in increasing inequalities by benefiting those who are least in need.

This review has demonstrated the importance of considering differential impacts of housing density especially between each density housing type scenario. A comprehensive assessment of these differential impacts will contribute to the understanding of housing density impacts especially towards vulnerable groups such as children, elderly, and people living with disabilities. The review of HIAs suggests that recommendations should also be assessed for equity related impacts.

The amenity of residents is influenced by the housing density type and urban design form. These impacts the level of privacy, stress and the amount of social interaction i.e. 'sense of community' created. It is recommended that targeted consultation with population groups should be undertaken in the process of planning changes in housing density. Good process involving inclusive engagement that applies quality urban design principles, appropriate living measures by and for residents during implementation can potentially improve the health and wellbeing of residents.

It is important that stakeholders are aware of the implications these development types will have on health. Our review demonstrates that the implementation of high density housing will work best with planning that incorporates quality urban design. These include socially connected and purposefully built infrastructure that is equitably accessible to a wide range of people, promotes safety and active transport options to lower car dependence, provides opportunities for lower income earners to afford homes, limits leapfrog type development and places human health as a core feature.

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Appendix 1: Built environment evidence

- [Evidence Review on the Spatial Determinants of Health in Urban Settings](#)
- [Health Impacts of the Built Environment - A Review *Institute of Public Health in Ireland*](#)
- [The Health Impacts of the Urban Form: A Review of Reviews *CHETRE UNSW*](#)
- [The Health Impacts of Peri-Urban Natural Resource Development *Liverpool School of Tropical Medicine*](#)
- [Health Impact Assessment of Greenspace - A Guide *Health Scotland*](#)
- [The Health Impacts of the Design of Hospital Facilities on Patient Recovery and Wellbeing, and Staff Wellbeing: A Review of the Literature *CHETRE, University of New South Wales*](#)
- [Urban Environments and Health: Identifying Key Relationships and Policy Imperatives *Griffith University*](#)
- [Creating Healthy Environments: A review of links between the physical environment, physical activity and obesity *NSW Centre for Overweight and Obesity*](#)
- [The Relationship Between the Built Environment and Wellbeing: A Literature Review *Victorian Health Promotion Foundation*](#)
- [Understanding the Relationship Between Public Health and the Built Environment *LEED-ND*](#)
- [Creating A Healthy Environment: The Impact of the Built Environment on Public Health *Centers for Disease Control and Prevention*](#)
- [Healthy Cities and the Urban Planning Process: A background document on the links between health and urban planning *World Health Organization Regional Office for Europe*](#)
- [Our Cities, Our health, Our Future: Acting on social determinants for health equity in urban settings *WHO Commission on the Social Determinants of Health*](#)
- [Improving Park Performance - Public Space Lessons *CASESpace*](#)
- [Designing and Planning for Play - Public Space Lessons *CASESpace*](#)
- [The health impacts of place-based interventions in areas of concentrated disadvantaged: A review of the literature *CHETRE UNSW*](#)

Appendix 2:

Case Study – The German Paradox (Minster 2010)

Look at this table – which part of Bottrop do you think has higher levels of childhood obesity? Turn the page to find out.

South Bottrop	North Bottrop
Higher density	Lower density
More anti obesity design	Less anti obesity design
More physically active	Less physically active
Lower level car ownership	Higher level car ownership
High levels pedestrian security	High levels pedestrian security
More time spent outdoors	Less time spent outdoors
More physically active	Less physically active

Figure 6 Bottrop (Minster 2010 , p. 6)

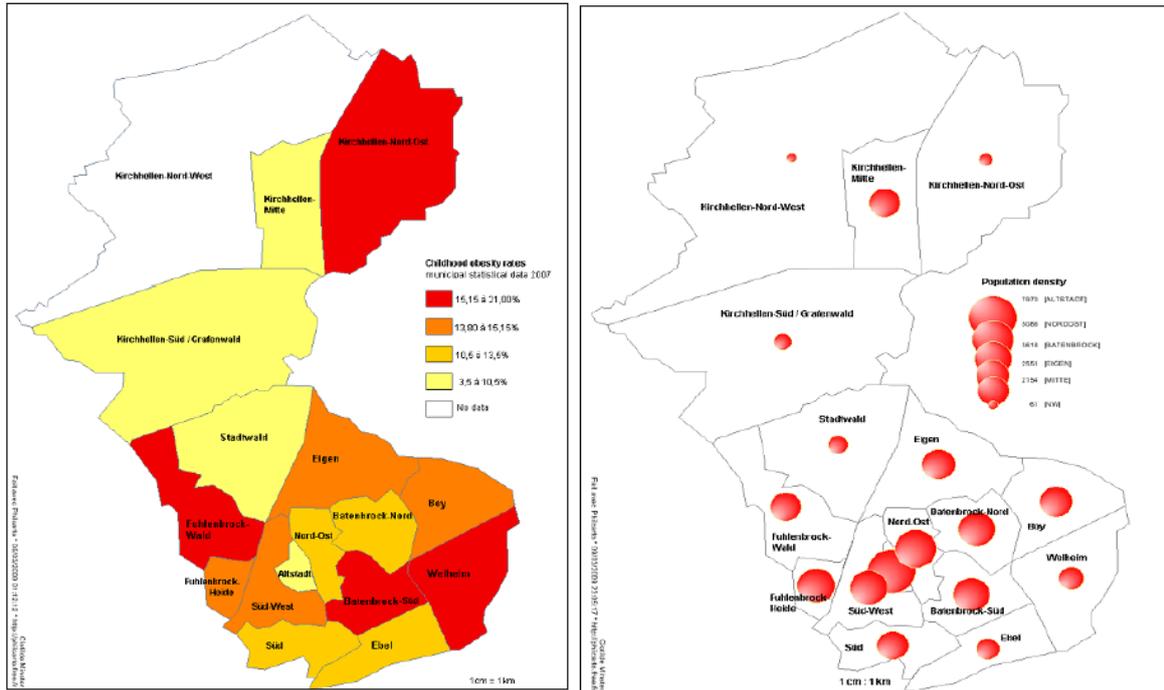


Figure 1: Childhood obesity rates³

Figure 2: Population density

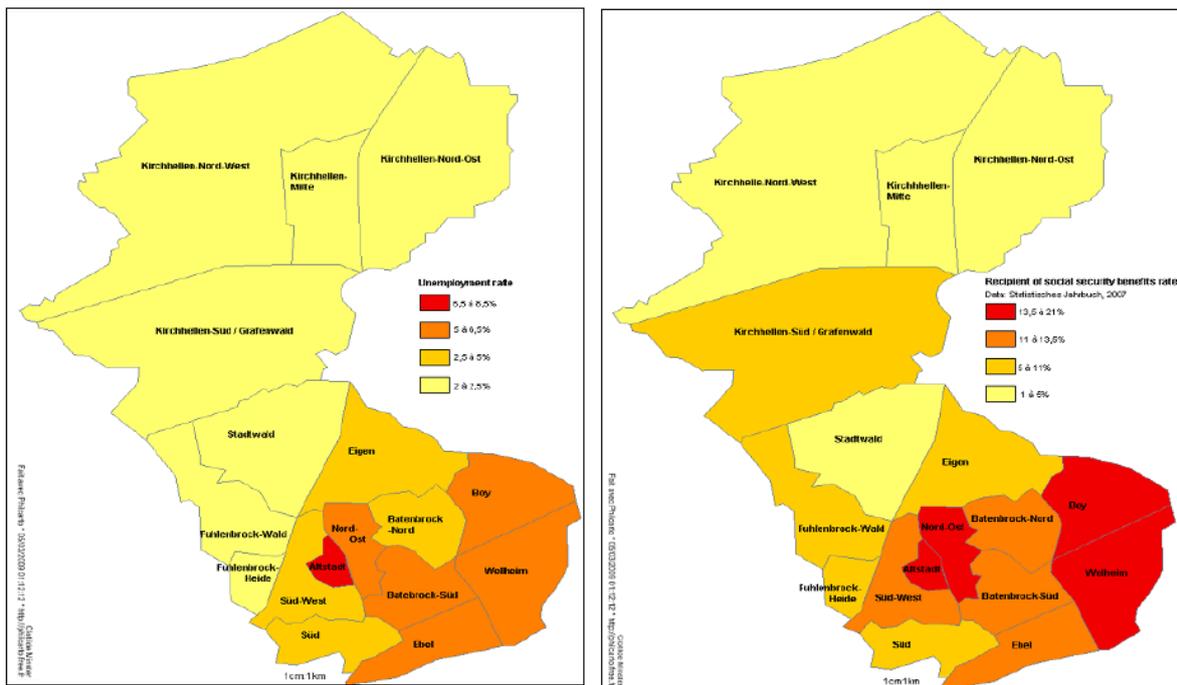


Figure 3: Areas of High Unemployment

Figure 4: Areas in Receipt of Social Security Benefits

³ Figure 1, the northern statistical district has a high obesity rate. Few children in that district had a medical examination (2007), but this result is probably the consequence of a statistical distortion due to the low number of people. We did not observe the same trend for the other years.

Bottrop is a medium sized town of approximately 120 000 inhabitants in northern Germany. Within the town density ranges from 61 to 7970 inhabitants per square kilometre. A cross sectional study investigating childhood obesity was carried out using a mix of existing population health data, self completion questionnaires, observations and interviews. For the purpose of the study Bottrop was split into two halves; the “denser historic city to the south and the more recent neighbourhood of Kirchhellen to the North”.

The study found that areas in Bottrop with higher density also had higher obesity levels even though the higher density areas were more ‘anti-obesity’ designed. These areas provide playing areas, green spaces, bicycles lanes and high levels of pedestrian security. Levels of car ownership are lower in the south- 50% of overweight children had no car compared to 13% of normal weight status children. The facilities are well used and people spend more time outside in the higher obesity areas. In fact, only one child did not do any sport. On average the overweight children did more sport than the children who had normal BMI. No link between mobility, urban design and obesity was found. There was however a positive relationship between obesity and unemployment rate. Non German children are more likely to be obese than German children. Non German children were almost all located in the denser South, but also ate more fattening food than German children. The findings of this study suggest that social factors rather than urban design have stronger influence on obesity.

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