Accepted Manuscript

Urban liveability: Emerging lessons from Australia for exploring the potential for indicators to measure the social determinants of health

Hannah Badland, Carolyn Whitzman, Melanie Lowe, Melanie Davern, Lu Aye, Iain Butterworth, Dominique Hes, Billie Giles-Corti

Please cite this article as: Badland, H., Whitzman, C., Lowe, M., Davern, M., Aye, L., Butterworth, I., Hes, D., Giles-Corti, B., Urban liveability: Emerging lessons from Australia for exploring the potential for indicators to measure the social determinants of health, *Social Science & Medicine* (2014), doi: 10.1016/j.socscimed.2014.04.003.

Title pages

Urban liveability: Emerging lessons from Australia for exploring the potential for indicators to measure the social determinants of health

Hannah Badland[a], Carolyn Whitzman[b], Melanie Lowe[a], Melanie Davern[a], Lu Aye[c], Iain Butterworth[a,d], Dominique Hes[b], Billie Giles-Corti[a]

[a] McCaughey VicHealth Centre for Community Wellbeing, Melbourne School of Population and Global Health, The University of Melbourne, Level 5, 207 Bouverie Street, Carlton, Victoria 3010, Australia

[b] Faculty of Architecture, Building, and Planning, The University of Melbourne, 757 Swanston Street, Carlton, Victoria 3010, Australia

[c] Infrastructure Engineering, Melbourne School of Engineering, The University of Melbourne, Building 173, Grattan Street, Victoria 3010, Australia

[d] Victorian Department of Health, 145 Smith Street, Fitzroy, Victoria 3065, Australia

Email addresses

Hannah Badland: hannah.badland@unimelb.edu.au

Carolyn Whitzman: whitzman@unimelb.edu.au

Melanie Lowe: mdlowe@unimelb.edu.au

Melanie Davern: mdavern@unimelb.edu.au

Lu Aye: lua@unimelb.edu.au

Iain Butterworth: iain.butterworth@health.vic.gov.au

Dominique Hes: dhes@unimelb.edu.au

Billie Giles-Corti: b.giles-corti@unimelb.edu.au

Corresponding author

Dr Hannah Badland

Level 5, 207 Bouverie Street

Carlton, VIC 3010

Australia

Email: hannah.badland@unimelb.edu.au

Telephone: +61 3 8344 0943

Fax: +61 3 9348 2832

Running title: Liveability, health, and wellbeing

Abstract word count: 283 words

Main body word count (inclusive of references): 8,960 words

Number of Tables: 1 table

Number of Figures: 1 figure

Research highlights

- There is growing policy interest in urban liveability and how best to measure it

- The majority of liveability indicators are vague and require further development

- Liveability indicators can be used to monitor health and social outcomes

Abstract

It has long been recognised that urban form impacts on health outcomes and their determinants. There is growing interest in creating indicators of liveability to measure progress towards achieving a wide range of policy outcomes, including enhanced health and wellbeing, and reduced inequalities. This review aimed to: 1) bring together the concepts of urban 'liveability' and social determinants of health; 2) synthesise the various liveability indicators developed to date; and 3) assess their quality using a health and wellbeing lens. Between 2011 and 2013, the research team reviewed 114 international academic and policy documents, as well as reports related to urban liveability. Overall, 233 indicators were found. Of these, 61 indicators were regarded as promising, 57 indicators needed further development, and 115 indicators were not useful for our purposes. Eleven domains of liveability were identified that likely contribute to health and wellbeing through the social determinants of health. These were: crime and safety; education; employment and income; health and social services; housing; leisure and culture; local food and other goods; natural environment; public open space; transport; and social cohesion and local democracy. Many of the indicators came from Australian sources; however most remain relevant from a 'global north' perspective. Although many indicators were identified, there was inconsistency in how these domains were measured. Few have been validated to assess their association with health and wellbeing outcomes, and little information was provided for how they should be applied to guide urban policy and practice. There is a substantial opportunity to further develop these measures to create a series of robust and evidence-based liveability indices, which could be linked with existing health and wellbeing data to better inform urban planning policies within Australia and beyond.

Main text

Introduction

It has long been recognised that urban form impacts on health behaviours and outcomes (Snow, 1855), as well as the social fabric of communities (Jacobs, 1961). More recently, lower residential densities, reduced street connectivity, singular land uses, and poor access to public open space, public transport infrastructure, and shops and services have been negatively associated with diverse health outcomes (Department of Health Physical Activity Health Improvement and Promotion, 2004; Planning Institute of Australia, 2009; World Health Organization, 2004). These built environmental attributes are also related to a range of urban planning and transport policies, including: management and form of urban growth (United Nations Population Fund, 2007); traffic incidents, volume, and pollution (Dumbaugh & Rae, 2009); environmental sustainability (Woodcock et al., 2007); and social inclusion (Wood et al., 2008). Correspondingly, the role of urban form and service provision in supporting health and wellbeing is gaining attention in international and Australian urban policy discourse (Commission for Architecture and the Built Environment, 2008; Koohsari et al., 2013a; Major Cities Unit, 2011a; Western Australian Planning Commission & Department for Planning and Infrastructure, 2009). This is paralleled by growing public and health policy interest during the last decade in urban liveability and how best to measure it (Greenwood, 2008; United Nations Development Program, 2011). In the Australian context, this discourse has often been couched in terms of 'liveability' (Major Cities Unit, 2010).

Numerous definitions of liveability exist, ranging from 'desires related to contentment of life in a specific location' (de Chazal, 2010) to 'behaviour-related function of the interaction between environmental and personal characteristics' (Pacione, 1990). In this review, we began by adopting the Australian Major Cities Unit definition for urban liveability: 'Liveable cities are socially inclusive, affordable, accessible, healthy, safe and resilient to the impacts of climate change. They have attractive built and natural

environments. Liveable cities provide choice and opportunity for people to live their lives, and raise their families to their fullest potential' (Major Cities Unit, 2010).

This definition of liveability goes beyond the physical setting, extending to social interactions (Hankins & Powers, 2009). It is closely aligned with the social determinants of health, which encompass the 'circumstances in which people are born, grow up, live, work, and age, and the systems put in place to deal with illness' (World Health Organization, 2012). Liveability and the social determinants of health are further reflected in contemporary socioecological models of health, which seek to understand the various levels of influence that impact on health behaviours or outcomes (Sallis & Owen, 2002).

Epidemiological evidence examined from a socioecological perspective shows that those who are socioeconomically disadvantaged and/or live in socially- or resource-deprived neighbourhoods, experience higher levels of morbidity and premature mortality than those who are more advantaged (Strategic Review of Health Inequalities in England post-2010, 2010). This partially arises through the spatial patterning of contextual (area-level) exposures, including access to meaningful employment, education opportunities, goods and services, walkable communities, and public open space (Macintyre, 2007). As a result of these synergies, there has been a recent surge in interdisciplinary research that recognises the roles of the physical and social neighbourhood setting for supporting or hindering liveability and the social determinants of health, as well as impacting on specific health and wellbeing outcomes (Kent & Thompson, 2014).

By way of example, most 'affordable' new housing in Australasian and North American cities is located in urban fringe greenfield developments where land is cheaper to purchase (Major Cities Unit, 2011b). However, these developments typically include only low-density housing, with limited and delayed provision of employment, education, service and public transport infrastructure within walking and cycling distance (Giles-Corti et al., 2012). As a result, these urban fringe developments discourage active travel modes and

public transport use (Transportation Research Board & Institute of Medicine of the National Academies, 2005), and children's independent mobility (Badland & Oliver, 2012), and promotes private car use (Ewing & Cervero, 2001). Motor vehicle reliance increases community vulnerability to social isolation and socioeconomic disadvantage in the event of rising oil prices (Dodson & Sipe, 2008), as well as traffic-related injuries (Ewing et al., 2003). Compounded by rapid population growth in many Australian cities (Major Cities Unit, 2011a), it is now challenging to keep up with demand for essential services and infrastructure in greenfield developments (Outer Suburban Interface Services and Development Committee, 2012). Together, these factors are likely to affect health and wellbeing outcomes and increase inequalities at the society level.

By 2050, 70% of the global population will reside within cities (United Nations Population Fund, 2007). It is anticipated efforts to create liveable communities as cities grow will positively affect health outcomes. In 2012, the UN Rio De Janeiro Summit released a report focused on promoting equity and environmental sustainability at the community-through to the global-level (United Nations Development Program, 2011). In Australia, regional (Environmental Protection Act Victoria, 2006), state (Western Australian Planning Commission & Department for Planning and Infrastructure, 2009), and national bodies (Heart Foundation, 2009; National Prevention Health Taskforce, 2009) have also developed guidelines for creating more liveable environments that support better health behaviours and outcomes. As such, there is growing interest internationally in measuring progress towards achieving a wide range of policy outcomes related to creating more liveable cities, including reducing inequalities (Strategic Review of Health Inequalities in England post-2010, 2010; United Nations Development Program, 2011).

To optimise health and wellbeing outcomes, guidance is needed to advance this agenda. Accordingly, this review aimed to: 1) bring together the concepts of liveability and social determinants of health; 2) synthesise the various existing liveability indicators that

contribute to the social determinants of health; and 3) assess the quality of indicators using a health and wellbeing lens. Understanding the current state of evidence and existing gaps in liveability indicators will help inform the development of tools to measure progress towards creating urban environments that reduce inequalities and support health and wellbeing in Australia and beyond.

Methods

Review context

This review was undertaken as part of a larger project that seeks to inform urban planning and public health policies through best-practice evidence. The first step was to provide an overview of current academic and policy literature related to liveability. These findings were used to inform the Australian urban planning agenda by identifying policy-relevant indicators related to health and wellbeing, that are evidence-based, specific and quantifiable, measureable at the neighbourhood- and city-levels, and relevant to the Australian urban planning policy context. Accordingly, the Australian urban planning policy context underpinned the type of literature sourced and the methodology applied. Australia urban policy is fairly advanced in its consideration of liveability, with a series of federal and state government documents recognising the need to create liveable environments (Major Cities Unit, 2010, 2011a; Western Australian Planning Commission & Department for Planning and Infrastructure, 2009). However, many learnings presented in this paper are of relevance to other developed countries facing similar challenges associated with greenfield developments, the provision of affordable housing and infrastructure, and socio-spatial patterning of social inequalities.

Literature search

Between 2011 and 2013 the authors reviewed academic and policy documents, and other reports related to liveability. Initially, 56 electronic databases and Google were searched using appropriate combinations of the following terms: liveab*, livab*; index, indices, indicator; measure*, develop*. In addition, reference lists of sourced documents were examined and authors recommended other pertinent literature. The full report listing the databases searched and document references are available at: http://mccaugheycentre.unimelb.edu.au/__data/assets/pdf_file/0005/799592/Research_Paper_1_-_Liveability_Indicators_3.pdf. Sources spanned qualitative and quantitative studies, peer-reviewed and grey literature, with no country or date exclusion criteria applied. Literature was excluded if the document could not be located in English, the full text was unavailable, or indicators of liveability were not discussed in detail. Titles and abstracts of the identified literature were initially scanned for appropriateness. Overall, 114 documents containing indicators were reviewed, with 82 of these deemed eligible.

Inclusion criteria for indicators

The research team adopted an agreed indicator selection framework. Four criteria were used to assess the indicators, and determine their eligibility for inclusion:

1. Is the indicator significant to liveability and/or the social determinants of health and wellbeing in urban areas?

2. Is the indicator specific and quantifiable?

3. Can the indicator be measured at the appropriate level(s) and scale(s) so that intra- and inter-city comparisons can be made?

4. Is the indicator relevant to Australian urban planning policy?

Once identified, indicators were divided into three categories, based on these inclusion criteria:

1. The indicator is promising because it meets all or most of the criteria;

2. The indicator may be useful but requires further development to meet the above criteria; or

3. The indicator is not useful for our research purpose, either because it fails to meet the criteria of interest, or is redundant because of similar, but more promising measures.

The final selection of indicators was further divided into individual, social/built environment, or policy-level measures. There was an element of subjectivity when generating and applying these criteria; however earlier work suggests this approach is appropriate given that liveability is a subjective and relatively new construct (Cox et al., 2010). Further, liveability was considered from many perspectives in this study, given our multidisciplinary research team provided expertise spanning public health, urban planning and design, psychology, social policy, health policy, engineering, and sustainability.

Results

The review yielded 11 distinct domains considered to be important components of liveability, and likely to contribute to health and wellbeing through the social determinants of health pathway (Figure 1). The domains were: natural environment; crime and safety; education; employment and income; health and social services; housing; leisure and culture; local food and other goods; public open space; transport and social cohesion and local democracy.

INSERT FIGURE 1 ABOUT HERE

7

The purpose of this review was to synthesise the various liveability indicators that contribute to the social determinants of health. Therefore the 11 domains identified focussed on distal indicators of health and wellbeing (either directly or by proxy (e.g., crime rates)), rather than health and wellbeing outcomes *per se*. A vast number of indicators (n=233) were identified across the domains. The indicators were further categorised into 'promising' (n=61), 'requires further development' (n=57), or 'not useful for our purposes' (n=115). Table 1 presents a summary of the number of indicators in each category, and a full list of the indicators is available at:

http://mccaugheycentre.unimelb.edu.au/__data/assets/pdf_file/0005/799592/Research_Paper_1_-_Liveability_Indicators_3.pdf. Below we discuss how each domain relates to the social determinants of health, along with a summary of the indicators.

INSERT TABLE 1 ABOUT HERE

Natural environment

The natural environment is a pre-requisite for health, and hence an overarching or fundamental contributor to liveability. The world is rapidly urbanising (World Health Organization, 2010), and this brings many challenges, including: loss of green space and natural habitat; increased air, water, soil, and noise pollution; traffic congestion; sub-standard housing; and high energy consumption and associated greenhouse gas emissions (Newman, 2006). Moreover, reliance on fossil fuels contributes to climate change (Woodcock et al., 2007), which in turn increases the frequency of natural disasters, extreme weather events, and the risk of disease (Stern, 2007). The ability of communities to respond effectively to these challenges depends on the resilience and vulnerability of the population and setting (United Nations Population Fund, 2007). The impacts of climate change and health inequalities are linked; as both have the most severe consequences for the poor and

disadvantaged (Strategic Review of Health Inequalities in England post-2010, 2010). Indeed, solutions that address climate change, such as increasing active travel, providing access to local food, and building energy efficient housing, will likely bring health benefits for those most vulnerable (United Nations Population Fund, 2007). Hence, the natural environment is represented in Figure 1 as an overarching construct that impacts on the other domains of liveability.

The 30 indicators identified spanned water and air quality, water quantity and conservation, precipitation, climate, biodiversity, and energy consumption. Promising measures included: air quality, greenhouse gas emissions, household electricity use, household waste and recycling generation, and renewable energy and natural gas use (Community Indicators Victoria, 2013). Measures requiring further refinement were: preservation of agricultural land (New South Wales Department of Health, 2009); biodiversity (Hashimoto & Kodama, 1997); climate (Findlay et al., 1988; Newman, 2006); water conservation and quality (Newman, 2006); and precipitation (Money Magazine, 2011). Notably, measures of soil contamination, weeds, and pests were not identified through this review, despite having an important role in local biodiversity and, in some cases, a direct impact on health (e.g., soil contamination).

Crime and safety

Considering the upstream determinants of crime, an earlier meta-analysis revealed communities with higher levels of income inequalities tended to have higher levels of violent crime and lower social cohesion overall (Hsieh & Pugh, 1993). Moreover, a negative relationship exists between crime rates, educational opportunities, and neighbourhood advantage (Heckman et al., 2006). More downstream, crime rates (actual) and fear of crime (perceived) have established causal relationships with a multitude of health and wellbeing

outcomes, including mental health (Stafford et al., 2007a), self-rated health (Chandola, 2001), and physical functioning (Ross & Mirowsky, 2001).

In our review, 12 indicators of crime and safety were found. Indicators included safety for the general population and for specific sub-groups (e.g., children, women). Objectively measured crime indicators comprised of crimes against property (Community Indicators Victoria, 2013) and the person (Community Indicators Victoria, 2013). Perceived measures included safety while walking alone (Community Indicators Victoria, 2013) and provision of safe public spaces for people to meet (Honey-Ray & Enns, 2009). Promising indicators of crime and safety included: perceptions of personal safety (Community Indicators Victoria, 2013); perceptions of safety in public spaces (Honey-Ray & Enns, 2009); crime against person rates (Community Indicators Victoria, 2013); crime against property rates (Community Indicators Victoria, 2013); and family violence rates (Community Indicators Victoria, 2013). Although critical for health, in this project indicators of military or terrorist threats that were included in some liveability indices (e.g., Economist Intelligence Unit 2012) were not considered useful, as these measures would have limited applicability for informing regional and national built environment policy and planning.

Education

Education has consistently been found to be a strong predictor of mortality and morbidity across the life span (Strategic Review of Health Inequalities in England post-2010, 2010; Viner et al., 2012). Gaining an education, especially in childhood, is strongly associated with better employment, income, and physical and mental health trajectories over the life course, as well as reduced likelihood of committing crime (Heckman et al., 2006). Importantly, these associations hold across the social gradient (Heckman et al., 2006), with provision of good early years education having a disproportionate positive effect on disadvantaged children (Melhuish, 2004).

Many measures of formal education exist. Overall, 26 indicators were identified. These primarily focussed on access to education (i.e., distance), availability of formal educational opportunities, and rates of secondary-school student retention. Only three measures of educational quality were identified; student – teacher ratios (Findlay et al., 1988), school building design (San Francisco Department of Public Health, 2010), and internet access (Community Indicators Victoria, 2013). Although *quality* of education is an important social determinant of health (Melhuish, 2004), it is challenging to measure within an indicator framework. Moreover, our focus was to examine how urban planning and policies influence the social determinants of health. Notably, most indicators reviewed focussed on primary or secondary school educational opportunities, rather than early childhood, tertiary, or adult-education opportunities. However, this focus aligns with the evidence, which shows that completion of secondary schooling is the most predictive education measure for mortality and morbidity outcomes (Viner et al., 2012). Promising objective indicators were all related to the social/built environment. These included the: number and access to government primary and secondary schools (Community Indicators Victoria, 2013) and tertiary facilities (Money Magazine, 2011); and walkability of the built environment around schools (Community Indicators Victoria, 2013).

Employment and income

Being in good employment (i.e., having a decent living-wage, opportunities for in-work development, flexibility, and work-life balance) provides financial security, personal development, and social networks (Strategic Review of Health Inequalities in England post-2010, 2010), and much research demonstrates that it is protective of health (R. Wilkinson & Marmot, 2003). Conversely, unemployment or poor working conditions negatively affect physical and mental health. For example, those engaged in temporary employment (versus permanent workers) have higher levels of mortality and mental illness (Commission on

11

Social Determinants of Health, 2008); declines in physical functioning occur approximately 12 years earlier in those with lower compared with higher employment grades, and a positive linear relationship exists between a person's work status and sense of control (Chandola et al., 2007). Further, employment patterns mirror the social gradient, whereby unemployment rates are highest in those with the least skills and qualifications, people with disabilities and mental illnesses, some ethnic minorities, carers and single parents, and older and younger workers; thus contributing to a cycle of entrapment (Kasl & Jones, 2000). Our review identified 20 employment and income indicators. Promising objective urban planning indicators captured the location of employment (Litman & Burwell, 2007) and the number and types of jobs available locally (New South Wales Department of Health, 2009).

Health and social services

Health and social services is a broad domain, encompassing healthcare, childcare and youth services, maternal services, senior citizen organisations, community centres, and public amenities. This social infrastructure is required for communities to function adequately, and to ensure services and resources are in place to respond to disruptive or extreme events. Services promote health and wellbeing if they support independent living in the community; thereby minimising institutional or high-need care solutions and improving quality of life across the social gradient. They play a key role in capacity building and developing autonomy, through aids such as training and on-going educational opportunities, debt management, resolving housing issues, outreach programs, and relationship management (Strategic Review of Health Inequalities in England post-2010, 2010). Provision of these services supports the development and maintenance of life skills, enabling people to reach their full potential. Yet those who are more disadvantaged often have the greatest challenges accessing these amenities. Reasons include being: unable to afford the services (Marmot, 2004); incapable of accessing services by the modes of transport available

(Department for Transport, 2009); marginalised by stigmatising attitudes (Littlejohn, 2006); and unable to navigate the system (Littlejohn, 2006; Strategic Review of Health Inequalities in England post-2010, 2010; R. Wilkinson & Marmot, 2003).

There are complexities in selecting health and social service indicators, as their relevance differs depending upon demographics and community needs. From the 22 health and social indicators identified, only six were regarded as promising for our purposes, with the remainder requiring further development. Promising indicators included: objective measures of the distance to and number of general practices for a given population (Community Indicators Victoria, 2013; Findlay et al., 1988); access to various services for older adults (Community Indicators Victoria, 2013; Findlay et al., 1988); and provision of aged-care facilities (Findlay et al., 1988). Meaningful indicators requiring further development included the number of hospital beds available (Findlay et al., 1988) and access to public amenities (e.g., park benches, public toilets) (World Health Organization, 2007), child and youth services (Honey-Ray & Enns, 2009), and emergency centres (Doi et al., 2008). However, in many instances it is challenging to source local data for these measures, particularly data at the micro-scale (e.g., park benches).

Housing

Living in poorer-quality housing has been associated with poorer mental health and higher rates of infectious diseases, respiratory problems, and injuries (Howden-Chapman, 2002; Krieger & Higgins, 2002). Provision of affordable housing is a major health equity issue (Commission on Social Determinants of Health, 2008). Those who live in rented accommodation have worse physical and mental health than owner-occupiers, and some studies have shown housing tenure to be a better predictor of health compared with education measures (Macintyre et al., 2001). The development of low-density housing in greenfield sites is also problematic. Although initially cheaper to purchase, these

developments often incur higher 'hidden' on-going costs, as the lower residential densities are unable to support local services, employment, and public transport infrastructure (Giles-Corti et al., 2012), thereby increasing motor vehicle dependency.

We identified 20 housing indicators. These focussed on the quality and affordability of housing, housing density, land use mix, residential population, housing stock and tenure, and housing adaptability. Promising objective indicators were residential and population density (Cicerchia, 1999) and land use mix (Li et al., 2008). Promising subjective indicators included housing affordability (e.g., proportion of income spent on housing) (Community Indicators Victoria, 2013; Findlay et al., 1988; Money Magazine, 2011) and social and other non-profit housing provision (Community Indicators Victoria, 2013). Indicators requiring further development included housing stock diversity, including provision of age-friendly housing (World Health Organization, 2007) and acoustic insulation (World Health Organization, 2007). Despite its importance, (Krieger & Higgins, 2002), no measures of homelessness or fear of homelessness were identified, possibly due to the difficulty in adequately measuring these indicators.

Leisure and culture

Cultural resources include normative beliefs and behaviours, and interact with economic and social capital to influence behaviours. For example, values and knowledge of health outcomes and behaviours, such as nutrition and eating practices, are cultural resources that impact on choices. Thus cultural capital is a compositional measure that mediates the pathway for social and health inequalities (Abel, 2008). Literature has shown that participation in specific recreational activities, such as art, cultural activities, group singing, attending religious services, or socialising with work colleagues is positively associated with mental health and negatively associated with mortality and morbidity (Khawaja & Mowafi,

14

2006; Veenstra, 2000). These relationships hold when individual-level socio-economic status is accounted for.

Ten indicators were identified. The majority of these focussed on access to and the presence of appropriate cultural and leisure activities measured both objectively and subjectively (Findlay et al., 1988; Honey-Ray & Enns, 2009). Indicators of leisure and cultural activity participation were also identified (Community Indicators Victoria, 2013). However, all of these require further development. Although not identified through this review, measures of gambling and electronic gaming machine access and density should be considered within the scope of this domain. They have been included in other indicator projects (e.g., Community Indicators Victoria) and have been shown to be negatively associated with the social determinants of health (Korn et al., 2003).

Local food and other goods

Neighbourhood access to food is somewhat socio-spatially patterned. Areas of higher disadvantage tend to have less access to fresh foods (Dowler & Dobson, 1997) and more access to fast-food outlets and convenience stores (Pearce et al., 2007). However, the literature regarding siting of supermarkets (selling both healthy and non-healthy foods) by area-level advantage remains equivocal (Pearce et al., 2007; Powell et al., 2007; Smith et al., 2010).

Local access to other goods has received less attention in the literature. Of the few studies available, access to local high street facilities mediates the association between area-level disadvantage and self-rated health (Wen et al., 2003), and has been negatively associated with obesity and waist-to-hip ratio (Stafford et al., 2007b). Having various types of shops within walking distance is also likely to support active travel behaviours when purchasing everyday goods and services (Stafford et al., 2007b).

The 11 indicators identified for this domain included access to different types of food and shops, food prices, food security, and local retail activity. Promising indicators were measures of food security (measured subjectively) (Community Indicators Victoria, 2013) and the density of fast food outlets (objective measures) (Li et al., 2008). Objective indicators that required further development included: proximity to different types of shops (Design for Health, 2008; Li et al., 2008; New South Wales Department of Health, 2009), access to 'big-box' retailing (Findlay et al., 1988), retail area per population (Cicerchia, 1999), urban agriculture availability (New South Wales Department of Health, 2009), and land available for business development (San Francisco Department of Public Health, 2010). No indicators of alcohol outlets and licensed premises were observed, yet the density of these destinations has been shown to be associated with excess alcohol consumption (Chikritzhs et al., 2007; C. Wilkinson & Livingston, 2012), which can have substantial effects on domestic violence, physical and mental health, and broader negative social impacts (Commission on Social Determinants of Health, 2008).

Public open space

Public open spaces are important for health and wellbeing, as they promote physical activity, mental health, and reduce blood pressure and stress levels (Frumkin, 2003; Hartig et al., 2003). Consequently, the importance of public open space provision has received much attention in the built environment and public health field (Koohsari et al., 2013b; Paquet et al., in press; Sugiyama et al., in press). A smaller body of work has looked at the association between disadvantage and public open space access. Mitchell and Popham (2008) showed that inequality gradients were flatter in populations with higher levels of green space, potentially because there are more settings for vertical and horizontal social interactions.

We identified 17 public open space indicators. Objective measures included measures of access (Honey-Ray & Enns, 2009) and the quantity of public open space

available (Community Indicators Victoria, 2013; Li et al., 2008; World Health Organization, 2007). Subjective indicators included public open space variety (New South Wales Department of Health, 2009) and quality (Community Indicators Victoria, 2013; Li et al., 2008; World Health Organization, 2007), as well as frequency of use (VicHealth, 2012). Some indicators were specific to types of spaces (e.g., playgrounds, green spaces) or populations (e.g., youth, older adults). Although a range of indicators of public open space exists and many have potential, all required further development based on our criteria.

Social cohesion and local democracy

Local governments play an important role in shaping local environments and the lives of the people within them. They are directly responsible for the planning, implementation, and delivery of a broad range of services, infrastructure, and policies. Local government also has the task of bringing various partners, providers, and sectors together (Butterworth, 2007; Campbell, 2010). The interface between local government and local democracy is important for reducing social and health inequalities, as community engagement and consensus are important levers to influence service provision (Campbell, 2010). Ongoing community participation in planning can lead to greater confidence and competence among individual citizens, and empower whole communities (Schuller et al., 2004). Successful models of local democracy and community engagement are those that provide opportunities to engage local people, increase social capital and generate financial benefits associated with co-location of services (Platt et al., 2007).

Twenty-three indicators were identified, but only five (two individual, three social/built environment) were useful for our purposes based on the aforementioned criteria. These included opportunities to contribute to important issues, membership of community organisations, feeling part of the community, accessing social support, and community volunteering (Community Indicators Victoria, 2013). Other indicators that

appeared to have potential but required further development included: community

acceptance of diversity (Community Indicators Victoria, 2013), opportunities for community

input in planning and governance (Honey-Ray & Enns, 2009), community pride and

attachment (Baker & Palmer, 2006; Honey-Ray & Enns, 2009), and social and community

connectedness (Honey-Ray & Enns, 2009; New South Wales Department of Health, 2009).

These last four indicators are proxy measures that reflect planning decisions, such as

provision of shared spaces to promote encounters that foster tolerance (Fincher & Iveson,

2008).

Transport

The transport domain had the largest body of indicators available (n=42). This is potentially a

reflection of the importance transport plays in day-to-day life. Transportation is necessary

for a functioning society as it enables people to access employment, education, food, health

and social services, and meet with family and friends. However, in order to be effective

transport planning needs to be integrated with land use planning, housing, environmental,

and health planning (Strategic Review of Health Inequalities in England post-2010, 2010).

Providing 'walkable' environments that support active and public transport modes to

meaningful destinations can help reduce inequalities by providing inexpensive and

proximate access (Department for the Environment, 2004). There is considerable evidence

in this area, especially showing associations between walkability and health outcomes

(Christian et al., 2011; Frank et al., 2010; Witten et al., 2012). Conversely, environments

designed primarily for private car use assume people can afford and maintain a vehicle. Poor

access to a motor vehicle and public transport, can result in social isolation, reduced

opportunities for meaningful employment and skill development and a cycle of debt

(Dodson & Sipe, 2008). Pedestrian-motor vehicle injuries are also higher in more

disadvantaged areas (Ewing et al., 2003; Grayling et al., 2002). Hence, the discussion of

transport indicators below separates the measures into active and public transport, car and freight transport, and general transport indicators.

Creating walkable environments encourages active travel (i.e., walking and cycling for transport purposes, public transport), providing opportunities to habitually engage in physical activity, which in turn protects against many non-communicable diseases and obesity (Beaglehole et al., 2011). Moreover, engaging in active travel provides environmental and social benefits through reduced reliance on fossil fuels and more frequent social interactions, respectively (Strategic Review of Health Inequalities in England post-2010, 2010). Twenty active and public transport indicators were identified. Promising indicators included: layout of street networks and access points (Community Indicators Victoria, 2013; Li et al., 2008; New South Wales Department of Health, 2009); travel times and distances (Honey-Ray & Enns, 2009) and rates of engagement in active and public transport modes (Community Indicators Victoria, 2013; Litman & Burwell, 2007). In turn, these impact on health and wellbeing outcomes.

The contribution of car transport and road freight to liveability is contestable. On the one hand, the literature argues reduced car reliance and disincentives for private motor vehicle use increases levels of active travel, which positively influences liveability (Ewing & Cervero, 2001). On the other hand, improving vehicle traffic movement enhances air quality and provides time and economic benefits to the community (Litman & Burwell, 2007). These perspectives may not be mutually exclusive; therefore indicators should seek to measure different facets of car and freight transport in relation to liveability. Furthermore, high levels of automobile congestion has been associated with higher stress from noise and air pollution, reduced sense of community, and decreased perceptions of control (Wilson & Baldassare, 1996). Overall nine car transport and road freight indicators were identified. Potential indicators identified (though requiring more refinement) include: perceptions of car parking (Balsas, 2004); car dependency and ownership separately (New South Wales

Department of Health, 2009) and in conjunction with mortgage stress and income (Dodson & Sipe, 2008); speed and affordability of freight transport (Litman & Burwell, 2007); motor vehicle mileage (Balsas, 2004); traffic speeds (Balsas, 2004); and car and freight commute times (Balsas, 2004).

General transport indicators were relevant to all transport modes, and could contribute both positively and negatively to liveability. In our review we identified 13 general transport indicators. Promising indicators included: travel mode to work/education (Australian Bureau of Statistics, 2006); modal share (Litman & Burwell, 2007); transport affordability (Litman & Burwell, 2007); connectivity across the transport network (Porta & Renne, 2005); transport safety (Litman & Burwell, 2007); and traffic noise (Litman & Burwell, 2007).

Discussion

As identified through this review, there is a large body of literature on liveability indicators arising from many disciplines. Liveability has been conceptualised in various ways with numerous subjective and objective indicators being applied at various levels from community (Community Indicators Victoria, 2013) through to entire cities (de Chazal, 2010). Major international studies such as the Mercer Quality of Living Survey (Mercer, 2011) and the Economist Intelligence Unit's Liveability Index (Economist Intelligence Unit, 2012) rank global cities on their current liveability in order to guide business investment and expatriate remuneration. Yet these high-level liveability indices mask intra-city differences in terms of differing physical and social structures (e.g., lack of infrastructure available within greenfield developments). Vulnerable populations may also be further marginalised as their needs are not be recognised when such broad comparisons are made (Woolcock et al., 2009).

Thus far little attention has also been paid to the validation of liveability indicators against specific health and wellbeing outcomes, or attempting to understand the pathways

through which liveability impacts on health and wellbeing and inequalities. Indeed, no measures of liveability to date use a health lens. Hence, this review was framed using a social determinants of health lens, where the evidence for each domain of liveability was considered from this perspective. Important measures of liveability, such as the density of gambling and alcohol outlets, and biodiversity, were notably absent from the literature reviewed highlighting the potential for further development.

To meet the challenge of 21st century cities, there have been calls for the disciplines of urban planning and public health to reconnect (Corburn, 2004). Combining liveability and social determinants of health frameworks go some way towards reconnecting these two fields. If planners use a liveability framework based on the social determinants of health, healthy and liveable communities will be developed, and relevant indicators can then be used to monitor progress. Moreover, future work should look to developing these measures to track health and social inequalities over time to enhance planning decisions.

While drawing on international research, this review was framed within an Australian urban planning policy context. Nevertheless, in all instances the indicators identified are consistent with social determinants of health applicable to other similarly developed countries (Macintyre & Ellaway, 2003), particularly those grappling with how best to plan for population growth demands and to manage urban sprawl. Furthermore, because of rapid urbanisation patterns occurring globally (United Nations Population Fund, 2007), it is also timely to consider liveability in the context of developing countries and whether the domains identified here are relevant for these settings. Nevertheless, while the domains identified may be relevant in many settings across the globe, as discussed in the following section, the relevance to local policy-makers is likely to be enhanced if indicators are tied to measuring the impact of local urban planning policy on health, liveability, and inequalities.

Measurement challenges

21

Although many indicators of liveability were identified in this review, the majority require further development before they can be operationalised and linked to health and wellbeing data. As long ago as 2003, it was noted that the domains discussed in this paper are vital for health and wellbeing, but were under-investigated (Macintyre & Ellaway, 2003). While progress is being made in some areas, there is still much work to be done. Hence, we suggest aligning and comparing future indicators against existing urban planning policies. This will assist in evaluating progress over time, and the effectiveness of policy in promoting health and wellbeing. The number and diversity of spatial indicators may be confusing to policy-makers and planners, therefore marrying to urban policies may also simplify the indicator selection process. In addition, where possible, indicators should be expressed as proportions and rates. This would facilitate comparisons within and between cities. Finally, in order to validate liveability indicators, consideration should also be given to testing associations between indicators and health and wellbeing outcomes. This could be achieved by linking indicators measured at an appropriate scale to existing health and wellbeing datasets (Villanueva et al., 2013).

A major challenge is having data available at scales that provide meaningful comparisons within and between regions, and at scales appropriate to examine associates with health and wellbeing outcomes (Villanueva et al., 2013). This is a persistent problem in urban health research, and is known as the Modifiable Areal Unit Problem (MAUP). MAUP results in statistical biases and uncertainty resulting from scale selection, and solutions to overcome this are in their infancy (Kwan, 2012). However, in some areas consensus is emerging. For example, the 'walkability' of environments usually incorporates measures of street connectivity, land use mix, and residential density. It has been commonly applied at the neighbourhood-level (Frank et al., 2010), and found to be associated with walking outcomes. Moreover, the walkability index has been successfully replicated at this scale in many countries thus far (Kerr et al., 2013).

Of note, many of the indicators reviewed are based on outcomes or perceptions of policy and relied on population survey data using area-based sampling. Implementation can be measured through routinely collected sources. An advantage of utilising routinely collected sources is that data are typically available regionally, and frequently nationally, and can be presented at aggregated or disaggregated scales. Further, available routine data sources can be used to generate time series measures, increasing efficiencies and reducing redundancies in the indicators collected. The utility of routine survey data sources not only applies to indicators of liveability, but also for monitoring health and wellbeing outcomes. Large-scale population surveys are increasingly being linked to spatial data (Villanueva et al., 2013). This enables examination of how the built environment is related to specific health and wellbeing outcomes. As noted earlier, linking policy-relevant indicators of liveability to population surveys will help provide guidance on how policies may enhance health and wellbeing.

Next stages

Communities and cities are complex systems. Pathways to health and wellbeing result from a combination of individual, household, and community factors that are in part influenced by neighbourhood features. It is these more distal determinants of health and wellbeing and their intermediate outcomes that liveability indicators seek to measure. While extensive, it is possible our search strategy and indicator selection criteria (including the Australian urban planning policy focus) omitted relevant sources and indicators; however promising indicators identified through this review are likely to be relevant for many developed countries, yet they require further refinement. This includes considering the appropriate spatial scales at which each indicator should be measured, and validation against population health and wellbeing datasets. There is a need to create liveability indices that are robust and evidence-driven, and link to urban planning policies. By creating such tools, policies can

be monitored, their impact on health and wellbeing outcomes better understood. As the

evidence-base grows, guidance provided about thresholds and scale can be used to inform

urban policies that enhance health and wellbeing outcomes.

References

Abel, T. (2008). Cultural capital and social inequality in health. *Journal of Epidemiology and Community Health,* 62, 1-5.

Australian Bureau of Statistics. (2006). Census - Household form. Canberra: Australian Bureau of Statistics.

Badland, H., & Oliver, M. (2012). Child independent mobility: Making the case, and understanding how the physical and social environments impact on the behaviour. In E. Turunen, & A. Koskinen (Eds.), *Urbanization and the Global Environment* pp. 51-79). New York: NOVA Publishers.

Baker, D., & Palmer, R. (2006). Examing the effect of perceptions of community and recreation participating on quality of life. *Social Indicators Research,* 75, 395-418.

Balsas, C. (2004). Measuring the livability of an urban centre: An exploratory study of key performance indicators. *Planning Practice & Research,* 19, 101-110.

Beaglehole, R., Bonita, R., Horton, R., Adams, C., Alleyne, G., Asaria, P., et al. (2011). Priority actions for the non-communicable disease crisis. *The Lancet,* 377, 1438-1447.

Butterworth, I. (2007). Municipal public health planning policy in Victoria. In S. Barraclough, & H. Gardner (Eds.), *Analysisng health policy: A problem-oriented approach* pp. 94-104). Melbourne: Churchill Livingston Elsevier.

Campbell, F. (2010). The social determinants of health and the role of local government. (p. 75). London: Improvement and Development Agency.

Chandola, T. (2001). The fear of crime and differences in health. *Health & Place,* 7, 105-116.

Chandola, T., Ferrie, J., Sacker, A., & Marmot, M. (2007). Social inequities in self-reported health in early old age: Follow-up of prospective cohort study. *BMJ,* 334, 990-994.

Chikritzhs, T., Catalano, P., Pascal, R., & Henrickson, N. (2007). Predicting alcohol-related harms from licensed outlet density: A feasibility study. Hobart: National Drug Law Enforcement Research Fund, Commonwealth of Australia.

Christian, H., Bull, F., Middleton, N., Knuiman, M., Divitini, M., Hooper, P., et al. (2011). How important is the land use mix measure in understanding walking behaviour? Results from the RESIDE study. *International Journal of Behavioral Nutrition and Physical Activity,* 8, doi:10.1186/1479-5868-1188-1155.

Cicerchia, A. (1999). Measures of optimal centrality: Indicators of city effect and urban overloading. *Social Indicators Research,* 46, 273-299.

Commission for Architecture and the Built Environment. (2008). Civilised spaces. London: Commission for Architecture and the Built Environment.

Commission on Social Determinants of Health. (2008). Closing the gap in a generation: Health equity through action on the social determinants of health. Final report of the Commission on Social Determinants of Health. Geneva: World Health Organization.

Community Indicators Victoria. (2013). Data Framework. Melbourne: University of Melbourne.

Corburn, J. (2004). Confronting the challenges in reconnecting urban planning and public health. *American Journal of Public Health,* 94, 541-546.

Cox, D., Frere, M., West, S., & Wiseman, J. (2010). Developing and using local community wellbeing indicators: Learning from the experience of Community Indicators Victoria. *Australian Journal of Social Issues,* 45, 71-88.

de Chazal, J. (2010). A systems approach to livability and sustainability: Defining terms and mapping relationships to link desires with ecological opportunities and constraints. *Systems Research and Behavioral Science,* 27, 585-597.

Department for the Environment, Transport, and the Regions. (2004). Social exclusion and the provision of public transport. London: Department for the Environment, Transport, and the Regions.

Department for Transport. (2009). National travel survey: 2008. Transport statistical bulletin.

London: Department for Transport.

Department of Health Physical Activity Health Improvement and Promotion. (2004). At least

five a week: Evidence on the impact of physical activity and its relationship to

health. A report from the Chief Medical Officer. London: Department of Health.

Design for Health. (2008). Health impact assessment: Threshold analysis workbook.

Minnesota: University of Minnesota.

Dodson, J., & Sipe, N. (2008). Unsettling suburbia: The new landscape of oil and mortgage

vulnerability in Australian cities. Urban Research Program: Griffith University.

Doi, K., Kii, M., & Nakanishi, H. (2008). An integrated evaluation method of accessibility,

quality of life, and social interaction. *Environment and Planning B: Planning and

Design,* 35, 1098-1116.

Dowler, E., & Dobson, B. (1997). Nutrition and poverty in Europe: An overview. Nutrition

Society pp. 51-62).

Dumbaugh, E., & Rae, R. (2009). Safe urban form: Revisiting the relationship between

community design and traffic safety. *Journal of the American Planning Association,*

75, 309-329.

Economist Intelligence Unit. (2012). A summary of the liveability ranking and overview.

London: Economist Intelligence Unit.

Environmental Protection Act Victoria. (2006). Sustainable Neighbourhoods Clause 56 –

Residential Subdivisions of the Victoria Planning Provision. Melbourne: Government

of Victoria.

Ewing, R., & Cervero, R. (2001). Travel and the built environment: A synthesis.

Transportation Research Record, 1780, 87-114.

Ewing, R., Schieber, R., & Zegeer, C. (2003). Urban sprawl as a risk factor in motor vehicle occupant and pedestrian fatalities. *American Journal of Public Health,* 93, 1541-1545.

Fincher, R., & Iveson, K. (2008). *Planning and diversity in the city: Redistribution, recognition, and encounter*. New York: Palgrave Macmillan.

Findlay, A., Morris, A., & Rogerson, R. (1988). Where to live in Britain in 1988: Quality of life in British cities. *Cities,* 5, 268-276.

Frank, L., Sallis, J., Saelens, B., Leary, L., Cain, K., Conway, T., et al. (2010). The development of a walkability index: Application to the Neighborhood Quality of Life Study. *British Journal of Sports Medicine,* 44, 924-933.

Frumkin, H. (2003). Healthy places: Exploring the evidence. *American Journal of Public Health,* 93, 1451-1456.

Giles-Corti, B., Ryan, K., & Foster, S. (2012). Increasing density in Australia: Maximising the health benefits and minimising harm. Canberra: National Heart Foundation.

Grayling, T., Hallam, K., Graham, D., Anderson, R., & Glaister, S. (2002). Streets ahead: Safe and liveable streets for London. London: Institute for Public Policy Research.

Greenwood, T. (2008). Bridging the divide between community indicators and government performance measurement. *National Civic Review,* 97, 55-59.

Hankins, K., & Powers, E. (2009). The Disappearance of the State from 'Livable' Urban Spaces. *Antipode,* 41, 845-866.

Hartig, T., Evans, G., Jamner, L., Davis, D., & Gärling, T. (2003). Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology,* 23, 109-123.

Hashimoto, A., & Kodama, M. (1997). Has livability of Japan gotten better for 1956-1990? A DEA approach. *Social Indicators Research,* 40, 359-373.

Heart Foundation. (2009). Position statement: The built environment and walking. Melbourne: National Heart Foundation of Australia.

28

Heckman, J., Stixrud, J., & Urzua, S. (2006). The effects of cognitive and non-cognitive abilities on labor market outcomes and social behavior. *Journal of Labor Economics, 24,* 411-482.

Honey-Ray, L., & Enns, C. (2009). Child and youth friendly Abbotsford: Community Strategy. In City of Abbotsford, & Union of British Columbia Municipalities (Eds.). Abbotsford, BC: City of Abbotsford.

Howden-Chapman, P. (2002). Housing and inequalities in health. *Journal of Epidemiology and Community Health,* 56, 645-646.

Hsieh, C., & Pugh, M. (1993). Poverty, income inequality, and violent crime: A meta-analysis of recent aggregate data studies. *Criminal Justice Review,* 18, 182-202.

Jacobs, J. (1961). *The death and life of great American cities*. New York: Random House.

Kasl, S., & Jones, A. (2000). The impact of job loss and retirement on health. In L. Berkman, & I. Kawachi (Eds.), *Social epidemiology* pp. 118-136). Oxford: Oxford University.

Kent, J., & Thompson, S. (2014). The three domains of urban planning for health and well-being. *Journal of Planning Literature*, 1-18.

Kerr, J., Sallis, J., Owen, N., De Bourdeaudhuij, I., Cerin, E., Reis, R., et al. (2013). Advancing science and policy through a coordinated international study of physical environments: IPEN methods. *Journal of Physical Activity & Health,* 10, 581-601.

Khawaja, M., & Mowafi, M. (2006). Cultural capital and self-rated health in low income women: Evidence from the Urban Health Study. *Journal of Urban Health,* 83, 444-458.

Koohsari, M., Badland, H., & Giles-Corti, B. (2013a). (Re)Designing the built environment to support physical activity: Bringing public health back into urban design and planning. *Cities,* 35, 294-298.

Koohsari, M., Kaczynski, A., Giles-Corti, B., & Karakiewicz, J. (2013b). Effects of access to

public open spaces on walking: Is proximity enough? *Landscape and Urban Planning,*

117, 92-99.

Korn, D., Gibbins, R., & Azmier, J. (2003). Framing public policy towards a public health

paradigm for gambling. *Journal of Gambling Studies,* 19, 235-256.

Krieger, J., & Higgins, D. (2002). Housing and health: Time again for public health action.

American Journal of Public Health, 92, 758-768.

Kwan, M.-P. (2012). The uncertain geographic context problem. *Annals of the Association of

American Geographers,* 102, 958-968.

Li, F., Harmer, P., Cardinal, B., Bosworth, M., Acock, A., Johnson-Shelton, D., et al. (2008).

Built environment, adiposity, and physical activity in adults aged 50-75. *American

Journal of Preventive Medicine,* 35, 38-46.

Litman, T., & Burwell, D. (2007). Issues in sustainable transportation. *International Journal of

Global Environmental Issues,* 6, 331-347.

Littlejohn, C. (2006). Does socio-economic status influence the acceptability of, attendance

for, and outcome of, screening and brief interventions for alcohol misuse: A review.

Alcohol and Alcoholism, 41, 540-545.

Macintyre, S. (2007). Deprivation amplification revisited; or, is it always true that poorer

places have poorer access to resources for healthy diets and physical activity? .

International Journal of Behavioral Nutrition and Physical Activity, 4,

doi:10.1186/1479-5868-1184-1132.

Macintyre, S., & Ellaway, A. (2003). Neighborhoods and health: An overview. In I. Kawachi, &

L. Berkman (Eds.), *Neighborhoods and health* pp. 20-44). New York: Oxford

University Press.

Macintyre, S., Hiscock, R., Kearns, A., & Ellaway, A. (2001). Housing tenure and health

inequalities: A three-dimensional perspective on people, homes, and

neighbourhoods. In H. Graham (Ed.), *Understanding health inequalities* pp. 84-102).

Buckingham: Open University Press.

Major Cities Unit. (2010). State of Australian Cities 2010. Canberra: Infrastructure Australia.

Major Cities Unit. (2011a). Creating places for people: An urban design protocol for

Australian cities. Canberra: Department of Infrastructure and Transport,.

Major Cities Unit. (2011b). State of Australian Cities 2011. In D.o.I.a. Transport (Ed.).

Canberra: Commonwealth of Australia.

Marmot, M. (2004). Social causes of social inequalities in health. In S. Anand, P. Fabienne, &

A. Sen (Eds.), *Public health, ethics, and equity* pp. 37-62). Oxford: Oxford University

Press.

Melhuish, E. (2004). A literature review of the impact of early years provision on young

children, with emphasis given to children from disadvantaged backgrounds. London:

National Audit Office.

Mercer. (2011). Mercer 2011 quality of living survey highlights - defining 'quality of living'.

New York: Mercer.

Mitchell, R., & Popham, F. (2008). Effect exposure to natural environment on health

inequalities: An observational population study. *The Lancet,* 372, 1655-1660.

Money Magazine. (2011). Best places to live: Compare cities.

National Prevention Health Taskforce. (2009). Australia: The healthiest country by 2020.

National preventative health strategy - the roadmap for action. Canberra:

Commonwealth of Australia.

New South Wales Department of Health. (2009). Healthy urban development checklist.

Sydney: New South Wales Department of Health.

Newman, P. (2006). The environmental impact on cities. *Environment and Urbanization,* 18,

275-295.

Outer Suburban Interface Services and Development Committee. (2012). Inquiry into liveability options in outer suburban Melbourne. In Parliament of Victoria (Ed.). Melbourne.

Pacione, M. (1990). Urban liveability: A review. *Urban Geography,* 11, 1-30.

Paquet, C., Orschulok, T., Coffee, N., Howard, N., Hugo, G., Taylor, A., et al. (in press). Are accessibility and characteristics of public open spaces associated with a better cardiometabolic health? *Landscape and Urban Planning*.

Pearce, J., Blakely, T., Witten, K., & Bartie, P. (2007). Neighborhood deprivation and access to fast-food retailing. *American Journal of Preventive Medicine,* 32, 375-382.

Planning Institute of Australia. (2009). Healthy spaces and places: A national guide to designing places for healthy living. Canberra: Planning Institute of Australia.

Platt, S., Backett-Milburn, K., & Rankin, D. (2007). Evaluation of the Health Living Centre programme in Scotland. Phase 2 report. Scotland: NHS Health Scotland.

Porta, S., & Renne, J. (2005). Linking urban design to sustainability: Formal indicators of social urban sustainability field research in Perth, Western Australia. *Urban Design International,* 10, 51-64.

Powell, L., Slater, S., Mirtcheva, D., Bao, Y., & Chaloupka, F. (2007). Food store availability and neighborhood characteristics in the United States. *Preventive Medicine,* 44, 189-195.

Ross, C., & Mirowsky, J. (2001). Neighborhood disadvantage, disorder, and health. *Journal of Health and Social Behavior,* 42, 258-276.

Sallis, J., & Owen, N. (2002). Ecological models of health behavior. In K. Glanz, B. Rimer, & F. Lewis (Eds.), *Health behavior and health education: Theory, research, and practice* pp. 462-484). San Francisco: Jossey-Bass.

San Francisco Department of Public Health. (2010). Healthy development measurement tool development checklist version 3.02. San Francisco, CA: San Francisco Department of Public Health.

Schuller, T., Preston, J., Hammond, C., Bassett-Grundy, A., & Bynner, A. (2004). *The benefits of learning: The impact of learning on health, family life and social capital*. London: Routledge.

Smith, D., Cummins, S., Taylor, M., Dawson, J., Marshall, D., Sparks, L., et al. (2010). Neighbourhood food environment and area deprivation: Spatial accessibility to grocery stores selling fresh fruit and vegetables in urban and rural settings. *International Journal of Epidemiology,* 39, 277-284.

Snow, J. (1855). *Mode of communication of cholera*. London: John Churchill.

Stafford, M., Chandola, T., & Marmot, M. (2007a). Association between fear of crime and mental health and physical functioning. *American Journal of Public Health,* 97, 2076-2081.

Stafford, M., Cummins, S., Ellaway, A., Sacker, A., Wiggins, R., & Macintyre, S. (2007b). Pathways to obesity: Identifying local, modifiable determinants of physical activity and diet *Social Science & Medicine,* 65, 1882-1897.

Stern, N. (2007). *The economics of climate change: The Stern review*. New York: Cambridge University Press.

Strategic Review of Health Inequalities in England post-2010. (2010). Fair society, healthy lives. London: Department of Health.

Sugiyama, T., Giles-Corti, B., Summers, J., Du Toit, L., Leslie, E., & Owen, N. (in press). Initiating and maintaining recreational walking: A longitudinal study on the influence of neighborhood green space. *Preventive Medicine*.

Transportation Research Board, & Institute of Medicine of the National Academies. (2005). Does the built environment influence physical activity? Examining the evidence.

Washington D.C.: Transportation Research Board, Institute of Medicine of the

National Academies.

United Nations Development Program. (2011). Human development report 2011.

Sustainability and equity: A better future for all. In U.N.D. Program (Ed.). New York.

United Nations Population Fund. (2007). State of world population 2007: Unleashing the

potential of urban growth. New York: United Nations Population Fund.

Veenstra, G. (2000). Social captial, SES, and health: An individual-level analysis. *Social

Science & Medicine,* 50, 619-629.

VicHealth. (2012). VicHealth indicators survey 2011: Selected findings. Melbourne: Victorian

Health Promotion Foundation.

Villanueva, K., Pereira, G., Knuiman, M., Bull, F., Wood, L., Christian, H., et al. (2013). The

impact of the built environment on health across the life course: Design of a cross-

sectional data linkage study. *BMJ Open,* 3.

Viner, R., Orzer, E., Denny, S., Marmot, M., Resnick, M., Fatuis, A., et al. (2012). Adolescence

and the social determinants of health. *The Lancet,* 379, 1641-1652.

Wen, M., Browning, C., & Cagney, K. (2003). Poverty, affluence, and income inequality:

Neighborhood economic structure and its implications for health. *Social Science &

Medicine,* 57, 843-860.

Western Australian Planning Commission, & Department for Planning and Infrastructure.

(2009). Liveable neighbourhoods: A Western Australian Government sustainable

cities initiative. Perth: Western Australian Planning Commission.

Wilkinson, C., & Livingston, M. (2012). Distances to on- and off-premise alcohol outlets and

experiences of alcohol-related amenity problems. *Drug and Alcohol Review,* 31, 394-

401.

Wilkinson, R., & Marmot, M. (2003). Social determinants of health: The solid facts.

Copenhagen: World Health Organization.

Wilson, G., & Baldassare, M. (1996). Overall 'sense of community' in a suburban region: The effects of localism, privacy and urbanization. *Environment and Behavior,* 28, 27-43.

Witten, K., Blakely, T., Bagheri, N., Badland, H., Ivory, V., Pearce, J., et al. (2012). Neighbourhood built environment is associated with residents' transport and leisure physical activity: Findings from New Zealand using objective exposure and outcome measures. *Environmental Health Perspectives,* 120, 971-977.

Wood, L., Shannon, T., Bulsara, M., Pikora, T., McCormack, G., & Giles-Corti, B. (2008). The anatomy of the safe and social suburb: An exploratory study of the built environment, social capital and residents' perceptions of safety. *Health & Place,* 14, 15-31.

Woodcock, J., Banister, D., Edwards, D., Prentice, A., & Roberts, I. (2007). Energy and transport. *The Lancet,* 370, 1078-1088.

Woolcock, G., Maginn, P., & Jones, R. (2009). Measuring up? Assessing the liveability of Australian cities. State of Australian Cities: National Conference. Perth, Western Australia.

World Health Organization. (2004). Transport, environment and health. (p. 86). Austria: Regional Office for Europe of the World Health Organization.

World Health Organization. (2007). Global age-friendly cities: A guide. Geneva: World Health Organization.

World Health Organization (2010). Urbanization and health. *Bulletin of the World Health Organization,* 88, 245-246.

World Health Organization. (2012). Social determinants of health: Key concepts. Geneva: World Health Organization.

Table 1. Summary table presenting the measurement level of indicators identified and indicator usefulness by liveability domain

| Domain	Indicator usefulness	Total (n)	Individual (n)	Social / built environment (n)	Policy (n)
				Measurement scale	
Natural environment	Promising	7	-	7	-
	Needs further development	6	-	4	2
	Not useful for our purposes	17	-	14	3
Crime and safety	Promising	5	2	3	-
	Needs further development	-	-	-	-
	Not useful for our purposes	7	2	4	1
Education	Promising	15	-	15	-
	Needs further development	3	-	1	2
	Not useful for our purposes	8	2	5	1
Employment and income	Promising	5	-	5	-
	Needs further development	4	-	3	1
	Not useful for our purposes	11	-	10	1
Health and social services	Promising	6	2	4	-
	Needs further development	7	1	5	1
	Not useful for our purposes	9	1	5	3
Housing	Promising	6	-	6	-
	Needs further development	6	-	3	3
	Not useful for our purposes	8	-	6	2
Leisure and culture	Promising	-	-	-	-
	Needs further development	3	2	1	-
	Not useful for our purposes	7	2	5	-
Local food and other goods	Promising	2	1	1	-
	Needs further development	3	-	1	2
	Not useful for our purposes	6	-	3	3
Public open space	Promising	-	-	-	-
	Needs further development	14	5	7	2
	Not useful for our purposes	3	2	1	-
Social cohesion and local democracy	Promising	5	3	2	-
	Needs further development	3	1	2	-
	Not useful for our purposes	15	13	1	1
Transport	Promising	10	1	8	1
	Needs further development	8	3	5	-
	Not useful for our purposes	24	7	13	4
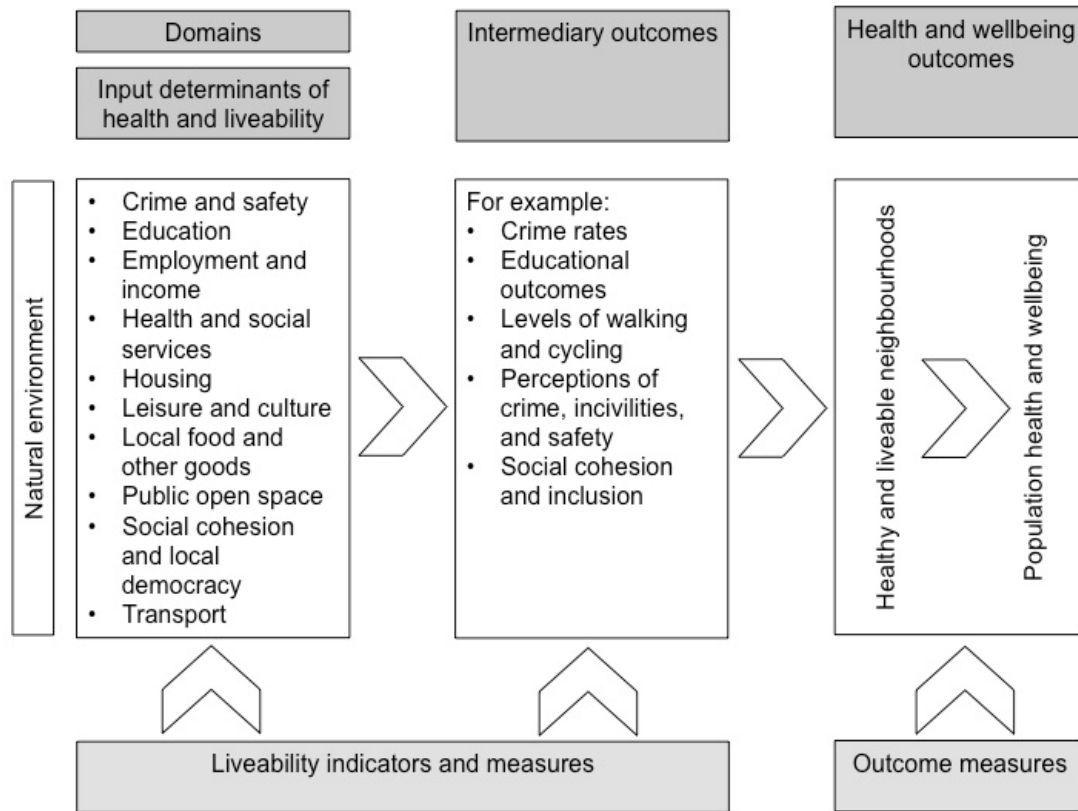
Figure 1 Causal pathway of liveability, encompassing determinants, intermediary outcomes, and final health and wellbeing outcomes