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Developing indicators of public open space to promote health and wellbeing in communities

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Introduction

Evidence supporting associations between the built environment and health behaviors and outcomes continues to accumulate (Koohsari, Badland, & Giles-Corti, 2013). Along with other built environment attributes (e.g., public transport infrastructure, walkability), public open space (POS) confers physical and social benefits including encouraging physical activity (B Giles-Corti et al., 2005), and fostering neighborhood social cohesion (Kaźmierczak, 2013; Peters, Elands, & Buijs, 2010). Studies have linked POS with chronic conditions such as obesity (Lachowycz & Jones, 2011), cardiovascular disease (Pereira et al., 2012), diabetes (Maas, Verheij, et al., 2009), respiratory health (Maas, Verheij, et al., 2009), and mental health (e.g., stress, anxiety, depression, attention deficit disorders) (Francis, Wood, Knuiman, & Giles-Corti, 2012). Furthermore, the provision of POS is important for mitigating health consequences (e.g., heat stress and heat-related illness) resulting from extreme ambient temperatures such as those potentially caused by climate change (Tan et al., 2007), and reducing urban heat island effects (Aniello, Morgan, Busbey, & Newland, 1995; Jonsson, 2004).

POS is defined as "all open space of public value, including areas of water such as rivers, canals, lakes and reservoirs (not just land) which offer important opportunities for sport and recreation and also act as visual amenity" (Alexander, 1977). POS, such as freely-accessible parks or green spaces, have received the most attention in urban planning and public health fields, with much of the research exploring the association between POS and health and wellbeing outcomes (Bedimo-Rung, Mowen, & Cohen, 2005; B Giles-Corti et al., 2005; Koohsari, Karakiewicz, & Kaczynski, 2013).

Consistent with this body of research, for the purposes of this paper, POS refers to green spaces.

Local access to green POS encourages walking for recreation (Sugiyama, Francis, Middleton, Owen, & Giles-Corti, 2010), walking for transport (Sugiyama & Thompson, 2008), and leisure (recreational) physical activity (Kaczynski, Potwarka, & Saelens, 2008; Lackey & Kaczynski, 2009). POS also provides a venue for people to socialise, interact, and gather; this contributes to social inclusion, and community social capital (Maas, Van Dillen, Verheij, & Groenewegen, 2009; Wood, Frank, & Giles-Corti, 2010). While access to POS within walking distance is necessary to facilitate physical activity, a growing body of literature suggests that proximity alone may be insufficient to entice use. Other elements such as POS quality or attractiveness (B Giles-Corti et al., 2005; Sugiyama et al., 2010) including its attributes (Cohen et al., 2006; B Giles-Corti et al., 2005; Potwarka, Kaczynski, & Flack, 2008), as well as its size (Paquet et al., 2013; Schipperijn, Bentsen, Troelsen, Toftager, & Stigsdotter, 2013), are also important determinants for POS use, physical activity, and mental health outcomes.

Since urban POS plays such an important role in providing space for enhancing health, the provision and access to POS is increasingly being recognised as an environmental justice issue, which aims for a fair distribution of resources to ensure vulnerable groups are not exposed to undue harm to health and wellbeing (Cutts, Darby, Boone, & Brewis, 2009). Thus, POS viewed through an environmental justice lens ensures the democratic provision and equitable access to POS for sectors of the community from different ethnic and socio-economic backgrounds (Low, Taplin, &

Scheld, 2009; Wolch, Wilson, & Fehrenbach, 2005). Although the evidence remains mixed (HM Badland, Keam, Witten, Kearns, & Mavoa, 2010), some studies show that the availability of POS disproportionately benefits more affluent communities; while others have shown more socioeconomically deprived areas and areas with high ethnic minority populations may have poorer quality POS (Crawford et al., 2008; Pearce, Witten, Hiscock, & Blakely, 2007; Timperio, Ball, Salmon, Roberts, & Crawford, 2007), which may in turn, amplify social inequalities.

The provision of POS is an important (and potentially modifiable) social determinant of health and wellbeing, and contributes to the liveability of a region. Liveability has been conceptualized as 'safe, attractive, socially cohesive and inclusive, and environmentally sustainable; with affordable and diverse housing linked to employment, education, public open space, local shops, health and community services, and leisure and cultural opportunities; via convenient public transport, walking and cycling infrastructure' (Lowe et al., 2013). This concept is closely aligned with the social determinants of health (SDH), 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). In addition to influencing people's health and community wellbeing, POS has broader relevance to regional and national policies, including: biodiversity protection (Sadler, Bates, Hale, & James, 2010), environmental sustainability and regeneration (Chiesura, 2004); climate change adaptation; and water management (Young, 2010).

The amount and spatial distribution of POS throughout cities is determined by state and local government urban planning policies, practices, and standards for open space

75 planning. In the context of POS planning, three types of ‘standards’ or ‘guidelines’
76 are generally used: 1) Area-percentages: a specified percentage of land to be reserved
77 for POS; 2) Population-ratios: a prescribed level of provision of POS related to the
78 level of population (typically, per 1000 population); and 3) Catchment area:
79 specifications for various categories of POS (typically based on size) of the ‘service
80 area’ or maximum distances which residents should have to travel to gain access
81 (Veal, 2013).
82
83 In Australia for example, the Victorian Planning Provision states that 95% of
84 dwellings should have access to a local park ≤ 400m from home (Victorian Planning
85 Commission, 2006). The Western Australian Liveable Neighbourhood Guidelines, on
86 the other hand, requires a minimum of 8-10% of gross subdivisible land area as POS
87 as well as catchment (distance) specifications for different sized parks (Western
88 Australian Planning Commission, Jaunary 2009 Update 02). Queensland POS
89 guidance is different again, based on population-ratios for recreational (2.0–2.6 ha per
90 1000 population) and sporting space (1.8–2.4 ha per 1000 population) within
91 specified distances, based on size, and 90% of dwellings.
92
93 Although urban design and planning literature provides a number of policy
94 recommendations for the provision of POS, they are not necessarily spatially
95 quantifiable and measurable. For example, an Australian review into the historical
96 origins of POS planning guidelines revealed most of the standards are not evidence-
97 driven, but rather derived from British or American standards, often with little
98 rationale for their application within the Australian context (Veal, 2013). Indeed,
99 internationally, there appears to be few evidence-based approaches to developing

100 urban design and planning standards for the provision of POS (La Rosa, 2014).
101 Similarly, there is no evidence about how different guidelines and recommendations
102 impact the health and wellbeing outcomes.
103
104 To optimize health and community wellbeing outcomes, there is a need to test
105 different policy standards and metrics to understand which measures are impactful.
106 Identification of the best POS indicators would be useful tools to measure and
107 monitor progress towards achieving a range of policy and health and wellbeing
108 outcomes, as well as reducing social and health inequalities (State Government
109 Victoria, 2014). This would further refine and inform evidence-driven planning policy
110 standards for POS provision.
111
112 The current study aims to: 1) develop a framework conceptualizing the pathways in
113 which POS influences health and wellbeing outcomes; 2) use this conceptual
114 framework as a guide to identify upstream policy-relevant indicators of POS that are
115 evidence-based, specific, quantifiable, and measurable across regions; and 3)
116 highlight methodological issues and challenges in developing these indicators. This
117 study will use major urban regions and capital cities across Australia as a case study
118 for the development of POS indicators, underpinned by the Australian planning policy
119 context. However, these methods may be relevant and applicable to other developed
120 countries, and could be modified for use in developing countries.
121
122 **Material and Methods**
123
124 *Development of a conceptual framework*

In a review of urban liveability indicators (H Badland et al., 2014) POS was identified as one aspect of liveability, and contributing to the SDH pathway. For each of the domains of liveability (e.g., housing, employment, transport, and social infrastructure), conceptual frameworks have been developed to inform the creation of indicators (H Badland et al., in press).

The POS conceptual framework was developed considering adult human health and wellbeing outcomes using a SDH lens. We identified how both upstream determinants (e.g., neighborhood attributes) and downstream determinants (e.g., behaviors) might influence health and wellbeing outcomes (Figure 1). Associations drawn from previous studies were used to guide the development of our framework. In turn, the conceptual framework was used to identify spatial measures of POS that may be associated with selected behavioral, intermediate, and longer-term health and wellbeing outcomes.

Indicator selection

A review of Australian policy documents, grey literature, and journal articles (Australian and international) helped identify a list of the most promising policy-relevant POS indicators using the following inclusion criteria (H Badland et al., 2014).

1) Is the indicator related to liveability and/or the SDH in urban areas?
2) Is the indicator specific, quantifiable and able to be spatially applied within a defined spatial area?
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?

A list of POS indicators based on these criteria were compiled, along with available relevant datasets (Table 1). When measures were identified as being important based on the conceptual framework but were not available through the policy and grey literature, the authors created fit-for-purpose measures based on the current academic research.

The subgroup responsible for selecting the final inclusion of indicators spanned multiple disciplines including: public health, urban design and planning, psychology, health policy, and transport engineering. When generating and applying these criteria, we continually liaised and collaborated with other researchers, policy-makers and practitioners. Using the process outlined, we attempted to include the most promising policy-relevant indicators associated with health and wellbeing outcomes, which were measurable across different geographic regions.

Operationalizing and computing spatial indicators

When selecting the most promising indicators for use, POS measures were required to be spatially attributable (i.e., the unit of measurement had to be within a spatially defined boundary). Spatially defined boundaries enable comparison and contrast of different areas to understand what POS are available within a defined spatial unit.

In this study, POS indicators were calculated for Statistical Area Level 1 (SA1) boundaries. SA1s are defined by The Australian Bureau of Statistics (ABS) Australian Statistical Geography Standard (ASGS) (Australian Bureau of Statistics, 2013) as

equivalent to an area of approximately 400 persons (Australian Bureau of Statistics, 2013). We chose to use these small scale SA1 boundaries because they are more likely to isolate neighborhood effects (rather than larger spatial units) (Learnihan, Van Niel, Giles-Corti, & Knuiman, 2011). By way of example, living in in a disadvantaged 'pocket' of a suburb with few (if any) or poor quality local parks, may impact on residents' health and wellbeing outcomes, compared with other residents living in the same suburb but in a 'pocket' with more parks. Hence, measuring POS at a smaller scale is preferable.

Testing with health and wellbeing outcomes

The measures in Table 1 will be created using Geographic Information Systems (GIS) (ESRI ArcGIS v10.2.1; (ESRI (Environmental Systems Resource Institute), 2010)). Once developed, the measures will be linked with existing population health and survey datasets (Department of Health Preventative Health Survey (Department of Health & State Government Victoria, 2014), VicHealth Indicators Survey (VicHealth & State Government of Victoria, 2014), and the Victorian Integrated Survey of Travel and Activity (Department of Transport Planning and Local Infrastructure & State Government of Victoria, 2014)) to explore associations between POS and health and wellbeing (Figure 1)). These datasets contain information about the lifestyles, and health and wellbeing of Victorians. In this way, we are able to further understand how urban design planning and policy decisions for POS affect health and wellbeing outcomes.

Results

Conceptual framework

The 'upstream' POS determinants of health and wellbeing outcomes (left side of Figure 1) focus on built environment attributes, and are informed by available evidence (B Giles-Corti et al., 2005; Paquet et al., 2013). The 'downstream' determinants of the framework (moving to the right of Figure 1) are the more behavioral measures of health and wellbeing, which in turn influence intermediate and long-term health and wellbeing outcomes (to the far right of Figure 1). For example, the quantity of POS (an upstream measure of POS access) may influence whether people use parks for recreational physical activity (behavioral outcome) (Kaczynski & Henderson, 2007). In turn this influences their physical activity levels (intermediate outcome) (Roux et al., 2007), which are protective against chronic conditions such as cardiovascular disease (long-term outcome) (Anderssen et al., 2007).

The 'grey' boxes (e.g., POS quantity and distance) represent the indicators that can more readily be derived spatially because data are available. The 'white boxes' (e.g., quality of POS and POS amenities) are more difficult to measure spatially because of limited objectively available data. These indicators are included in the framework for completeness, and the feasibility of their inclusion as indicators may increase as technology advances. Moreover, 'walkability and neighborhood features surrounding POS' were included because they facilitate accessing POS since people are more likely to walk to destinations in more 'walkable' environments (e.g., with more direct routes, fewer major roads to cross) (Frank et al., 2010). There is extensive research available on walkability (Frank et al., 2010; Müller-Riemenschneider et al., 2013), hence walkability indicators are not considered in detail in this paper as they would require a separate investigation of their own.

Insert Figure 1 here

Spatial indicators

Overall, 17 POS indicators were identified, but only 11 met our criteria. The final indicators used to populate the conceptual framework are listed in Table 1. The final selection spans POS quantity (amount), access (e.g., proximity), and purpose. The most consistent indicators were those for the amount and proximity of POS. The majority of these indicators could be operationalised at the SA1 level. The final selection of indicators are also appropriate for implementation in large metropolitan (e.g., Melbourne) and regional areas (e.g., large regional centres across Victoria), and in future, could be expanded to generate national-level measures comparable across states. Six potential indicators were not selected for inclusion in our final suite of indicators. These addressed more subjective indicators of POS, such as quality and frequency of use (H Badland et al., 2014), and can be difficult to measure spatially as valid and reliable data at an appropriate scale are rarely available and require intensive resources to develop.

Insert Table 1 here

Discussion

Urban design and planning policies have the capacity to shape people's health and wellbeing, and influence social and health inequities. To date an evidence-based approach to developing recommendations for the provision of POS has rarely been adopted in urban design and planning practice and literature. Moreover, the use of

POS indicators for the specific purpose of informing and monitoring urban planning policy and practice, is lacking. This may, in part, be due to limited understanding of which POS indicators are most meaningful for health and wellbeing.

To that end we have utilised a novel approach to identify policy-relevant POS indicators by using an evidence-based conceptual framework purposefully linking indicators to health and wellbeing outcomes. We reviewed relevant policy as well as research to develop indicators that can be spatially applied. The indicators are therefore evidence-based, specific, quantifiable, and measurable within cities and across regions. Furthermore, most indicators are easily developed and analysed using GIS and spatial data.

In this way, once developed and implemented, these indicators have the potential to inform urban design policy and practice to quantify and (re)design POS provision at the neighborhood-level, and in turn influence a variety of health and wellbeing outcomes. The next stages of this research are to source appropriate spatial data for the measures, develop the measures, and test them against health and wellbeing outcomes in existing population health datasets. The final step will be developing appropriate indicators based on these findings. Indicators may be 'grouped' into a composite index, if appropriate.

However, there are a number of key methodological challenges and limitations when developing and applying indicators, including spatial data availability, spatial applications, data harmonization, generalizability to other contexts, and reliance on cross-sectional study designs. These challenges are discussed below.

Developing and using spatial indicators

Spatial data availability

Some measures are difficult to measure spatially. For example, research has shown that quality of POS and availability of amenities are important in determining its use, and have been linked to health outcomes (B Giles-Corti et al., 2005). POS quality has been measured by assigning a score for quality or attractiveness based on attributes and amenities within the POS (e.g., sporting facilities, shade along paths, water features, and lighting) (B Giles-Corti et al., 2005). However, spatial measures of quality are: rarely readily available; are inconsistently collected and collated across local government authorities; are extremely difficult to source both regionally and nationally; and are more prone to temporality issues (i.e., the time point at which data were collected). Various audit tools for collecting POS attributes have been developed in Australia using physical (actual visits to assess POS), and desktop auditing techniques (e.g., Google Earth, Near Map imagery) (Edwards et al., 2013), but these are resource-intensive and time consuming (Edwards et al., 2013), making it expensive to acquire for large geographical areas (e.g., cities, states, countries). As such, these are less appealing options for indicators to be used across large-scale and multiple geographical areas and over time. The lack of available data to compute spatial measures of POS quality is a key limitation, but it is envisaged that end-users interested in these indicators (e.g., local government authorities) could develop their own spatial data using readily available tools (Edwards et al., 2013).

Geographic scale

Associations between POS and health and wellbeing outcomes have been reported in many studies, however the geographic scales at which POS needs to measured and the magnitude (how much) of POS is required to support health and wellbeing are not clear (Koohsari, Badland, et al., 2013) . The importance of choosing the most appropriate neighborhood boundary (geographic scale) is a key methodological challenge in linking spatial data to health and behavioral data, and is commonly referred to as the 'Modifiable Unit Area Problem' (MAUP) (Openshaw, 1984). MAUP is concerned with: 1) 'scale or aggregation effect' (i.e., aggregating smaller units to larger units, with each aggregation providing variations in data), and 2) 'grouping or zoning effect' (i.e., the variability in results due to aggregating different areal unit shapes) (Gotway & Young, 2002). For example, a measure such as shortest distance to a POS may be calculated as the road network distance from the population-weighted centroid (PWC) of the administrative spatial unit (e.g., SA1) to the POS. The PWC represents the 'centre' of the unit based on the dispersion of the population (Thornton, Pearce, & Kavanagh, 2011). If a larger administrative spatial unit is used (e.g., SA2), different results may contribute to measurement error and attenuate associations with health and wellbeing outcomes (Learnihan et al., 2011). However, selection of a neighborhood boundary should be meaningful (e.g., recognize natural boundaries, such as busy roads and rivers) and relevant for policy and practitioners.

Harmonizing data to create national POS indicators

Ideally, *national* POS datasets (e.g., with details on geocoded location, type, and size) are preferable for country-level analysis because any systematic errors present will be consistent across states/regions, and minimises the time taken to 'clean' data.

However, spatial layers of this type are unlikely to be available. Using individual state or regional datasets to compute spatial measures can be problematic when trying to harmonize data with other states because different methods are used to create the data, which are attributed in different ways. For example, POS datasets may have different naming conventions, classification schemas, and even vary in methods used to digitize POS (i.e., cadastre or mesh-block) across regions. Some measures may capture park access from the digitized centroid of the park (i.e., point at the centre of the park), while others may digitize a park at set intervals around the park perimeter (e.g., at 10 m intervals around the perimeter of the park) to better reflect the true access points to the park. Variation in digitizing approaches may result in differences in proximity estimates (e.g., closest distance to park), thereby introducing measurement error in analyses. Furthermore, if the accompanying metadata is not thorough, the differences in POS spatial calculations may be disguised. Thus, to ensure consistency in the spatial measures, spatial data should first be checked, validated for quality assurance, and cleaned. This may prove time consuming when using multiple data sources. Another issue is that each state/region may have different urban planning policies. As mentioned, the feasibility of this work will be informed by stakeholder consultation with policy-makers and practitioners across Australia.

Testing with health and wellbeing outcomes

Different populations

Although the conceptual framework presented focused on adults, it is important to note that the magnitude and direction of associations between POS and health and wellbeing may vary depending on the sub-population or life stage being investigated

(e.g., children, adolescents, older adults) (Giles-Corti & King, 2009; Giles-Corti, Timperio, Bull, & Pikora, 2005). For example, different POS amenities (e.g., local facilities and equipment) such as playgrounds are recognized as being important for supporting children's physical activity levels and independent play (Cohen et al., 2006), while others (e.g., toilets, park benches) have been associated with older adults' park use (Alves et al., 2008). It is also important to consider the availability of culturally-relevant amenities that meet community-based needs, and foster equitable opportunities for people of different ethnic and cultural backgrounds (Northridge & Freeman, 2011). Moreover, proximity to POS may be more meaningful for some groups than others. Children and older adults for example, are more likely to use destinations located within walking distance of their home (Christian et al., 2011; McDonald & Alborg, 2009; Page, Cooper, Griew, & Jago, 2010; Timperio et al., 2006; Transportation Research Board, 2005), but POS located further away may be less of a barrier for adolescents and adults (Sugiyama et al., 2010). Thus, taking into account associations between POS indicators and health and wellbeing data for different life stages to ensure that liveable neighborhoods cater for all its residents across the life course, and are designed and managed without 'unintended consequences' (Giles-Corti & King, 2009).

Cross-sectional data

A key limitation of the majority of built environment and health research is the use of cross-sectional data (rather than longitudinal) to examine associations. In this way, causal inferences (cause and effect) cannot be confirmed; this is essential to develop more effect interventions to modify built environments for achieving better health and wellbeing. For example, neighborhood self-selection has rarely been addressed e.g.,

do physically active people choose to live in neighborhoods with more parks? Although one study found little evidence of self-selection for recreational walking, more longitudinal evidence is required (Giles-Corti et al., 2013). Nevertheless, the development of evidence-based, policy-relevant indicators for the purpose of 'benchmarking', monitoring and designing better environments across regions is among the first step in addressing an important gap, and in future these can be applied and tested using longitudinal datasets.

Conclusions

With over 50% of the global population living in urban environments (United Nations Development Program, 2011), it is not surprising there is increasing research and policy interest in creating indicators for liveable and healthy cities to support our rapidly growing urban population (H Badland et al., 2014; State Government Victoria, 2014). POS is important for urban liveability, and has been associated with health and wellbeing. Despite key methodological challenges and our focus on the developed world, we have proposed an important first step to providing an evidence-based, policy-relevant, and best-practice 'benchmark measures' of POS in relation to health and wellbeing outcomes. Indicators will help provide a better guide to communities, policy-makers and practitioners to assess equity of provision, distribution and access, that need improvement. A key challenge as cities grow in the developing world is to create relevant indicators in these contexts. In this way, resources can be utilised more effectively for POS and amenity provision and benchmarks to compare within and between cities, which can be used to monitor progress towards achieving POS policy

goals. Research translation and assistance with understanding the indicator results is extremely important for the uptake of these indicators within a policy and planning context. The indicators can also be used to inform the development of web-based tools to measure progress towards (re)designing urban environments that reduce inequalities and support health and wellbeing.

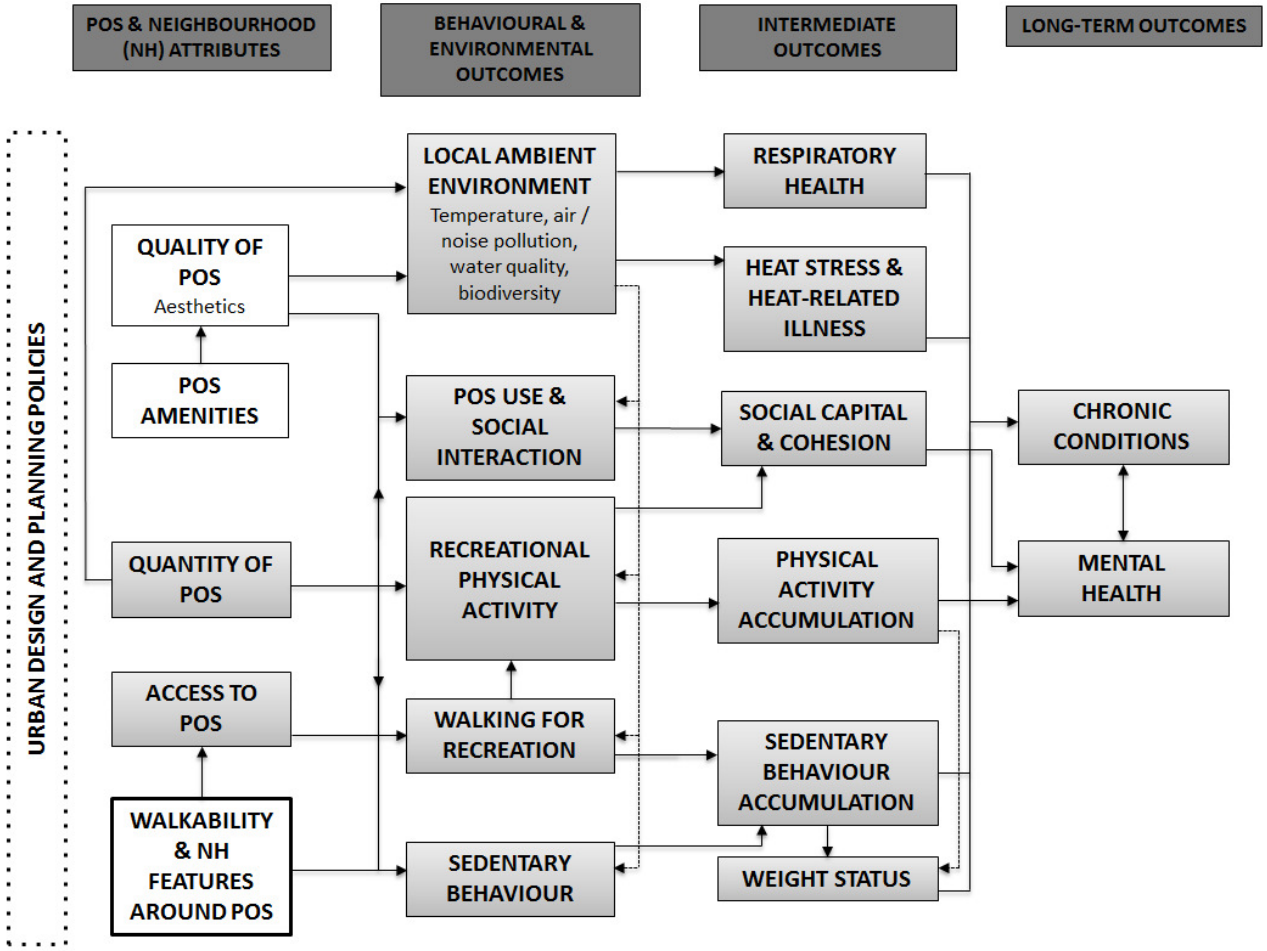

Figure 1. The role of Public Open Space in health and wellbeing: a conceptual framework

Mental health: e.g., psychological distress, anxiety, stress, depression, perceived quality of life. *Chronic conditions:* e.g., obesity, cardiovascular disease, diabetes, asthma.

Table 1. Proposed selection of spatially attributable Public Open Space indicators

	Measure	Policy guideline	Comments
	POS quantity		
1	% POS area within SA1	No guidelines available[1]	A measure of the total area of POS within a SA1/gross land area of the SA1.
2	% POS area of subdivisible SA1 land area	WA Liveable Neighbourhoods (Western Australian Planning Commission, 2000)	WA planning policy requires 10% of the subdivisible land area of all new developments to be POS.
3	# of POS available within SA1	No guidelines available[1]	
4	# POS by size/type within SA1	No guidelines available[1]	
	POS access		
5	Road network distance from SA1 population-weighted centroid to nearest POS border	No guidelines available[1]	Suggested by sub-group as a raw measure of access. Calculate PWCs of SA1s.
6	95% of dwellings have access to a local (≤0.3ha) park POS $\leq$ 400m	VPP Clause 56.05 [34]	Local park POS sizes based on WA policy recommendations (Western Australian Planning Commission, 2000).
7	95% of dwellings have access to a small (>0.3 to ≤0.5ha) neighborhood park POS $\leq$ 400m	VPP Clause 56.05 [34]	Small neighborhood POS sizes based on WA policy recommendations.
8	95% of dwellings have access to a medium (>0.5 to ≤1.5ha) neighborhood[1] park POS $\leq$ 400m	VPP Clause 56.05 [34]	The WA Liveable Neighbourhood Guidelines are currently being updated with the following size cut-offs: Pocket <0.4ha; Local = 0.4-1ha; Neighborhood – 1-5ha; District = 5-20ha; Regional >20ha. The Medium neighborhood POS sizes are being considered for inclusion in the update of WA policy recommendations (Western Australian Planning Commission, 2000).

9	95% of dwellings have access to a large (>1.5 to ≤2.5ha) neighborhood park POS ≤ 800m	No guidelines available[1]	There are no policy guidelines for this, but we want to include an 800m buffer as people may travel further to access a better quality/larger POS.
10	95% of dwellings have access to a district (>2.5 to ≤4.0ha) park POS ≤ 800m	No guidelines available[1]	There are no policy guidelines for this, but we want to include an 800m buffer as people may travel further to access a better quality / larger POS.
11	95% of dwellings have access to a regional (>4.0ha) park POS 5km or 10km	No guidelines available[1]	There are no policy guidelines for this. Discussions with WA DSR have suggested the use of a 5km buffer. Work on a POS strategy with a Local Government Association has used a 10km buffer around regional POS.
	POS quality		
12	A quality (attractiveness) score is assigned to each POS based on its attributes and amenities	No guidelines available[1]	POS quality or attractiveness is assessed by summing the weighted scores for a number of POS attributes audited using remote sensing methods (e.g., sporting facilities, shade along paths, water features, and lighting). See (B Giles-Corti et al., 2005); (Edwards et al., 2013).

POS: Public Open Space; GIS: Geographic Information System; SA1: Statistical Area Level 1; VPP: Victorian Planning Provision; WA: Western Australia; DSR: Department of Sport and Recreation; PWC: population-weighted centroid.
No guidelines available: Policy and grey literature were reviewed to identify policy-relevant measures. In cases where no policy guidelines existed, fit-for-purpose measures were created based on academic evidence.

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