

# The Influence of Green Space on Mental Health & Well-being

A Scoping Review of Reviews

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The Wellesley Institute is a research and policy institute that works to improve health equity in the GTA through action on the social determinants of health.

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# 1. Introduction And Background

In 2015, Toronto Public Health published the Green City report, an evidence-based review on how nature and green space impacts physical and mental health and well-being (Toronto Public Health [TPH], 2015). They found that frequent access to green space, such as parks, is important for mental health and that nearby public outdoor space may provide additional benefits in the case of low-income neighbourhoods. Neighbourhoods in a city like Toronto vary depending on available assets, like good parks and ravines. Low-income neighbourhoods have less access to open parks and high-quality green spaces (Floyd, Taylor & Whitt-Glover, 2009; Francis, Wood, Knuiman, & Giles-Corti, 2012). Therefore, it is important to understand the beneficial aspects of green space as it relates to the social determinants of health, in order to offer evidence-based models for city planning.

Toronto is undergoing dramatic changes. These changes are well documented. The *Three Cities* report found that Toronto's neighbourhoods are increasingly polarized by income (Hulchanski, 2010). There is an increasing disparity between high and low-income neighbourhoods, with the latter including more newcomers and racialized populations (Hulchanski, 2010). This growing disparity is compounded by the fact that newcomers and racialized populations in Toronto often face barriers to income security (Toronto Public Health and Access Alliance Multicultural Health and Community Services, 2011). In the City of Toronto, 18 percent of the population has been in Canada for ten years or less. About 49 percent of the population has a mother tongue that is not English or French (City of Toronto, 2013).

In recognition of shifting conditions in urban centres, health researchers have sought to better document health inequalities. The World Health Organization (WHO) has led an international initiative called the Urban Health Equity Assessment and Response Tool (Urban HEART) to address urban inequities. The City of Toronto analyzed data on its 140 neighbourhoods using the same framework (Centre for Research on Inner City Health [CRICH], 2014; WHO, 2010). This information was then used to identify 31 Neighbourhood Improvement Areas (NIAs), which had the lowest Neighbourhood Equity Scores. The Neighbourhood Equity Score is a “single number designed to capture the total weight of unnecessary, unfair and unjust differences faced by neighbourhood residents in five key areas: economic opportunities, social development, healthy lives, participation and decision-making and physical surroundings” (City of Toronto, 2014, p.1).

There is a body of research that indicates green space provides those living in urban spaces with access to the natural environment and its related benefits. For the purposes of this paper, green space includes any designated urban area of grass, trees, or other vegetation, used for recreational or aesthetic reasons. Urban planning focused on greening initiatives comes in many forms, from street-tree planting and designing pocket-parks (small-scale park areas, e.g. parkettes) to planning for larger parks (Kondo, South, & Branas, 2015). There is a

substantial body of literature that identifies the benefits of green spaces for mental health and well-being (Haluza, Schönbauer, & Cervinka et al., 2014; Maller, Townsend, Pryor, Brown & St. Leger, 2006; Shanahan, Fuller, Bush, Lin & Gaston, 2015).

The aim of this scoping review of reviews is to examine the evidence that exists about green space and mental health and provide a comprehensive scan of the vast amount of literature that exists in this area of study. Numerous studies investigate the effect of nature and green spaces on physical health and mental health (Hartig, Mitchell, de Vries, & Frumkin, 2014; O'Brien, 2006; Thompson Coon, Boddy, Stein, Whear, Barton, & Depledge, 2011). This scoping review of reviews offers a broad assessment of the peer reviewed literature published in this area, from 2005 to 2015, and identifies trends and patterns that have been observed (Goertzen et al., 2015). The research questions are:

- a) What are the aspects of green space associated with mental health and well-being?
- b) What are the mediating and moderating factors influencing the relationship between aspects of green space and mental health and well-being?

In addition, in recognizing the need to assess and plan green spaces for mental health promotion, a sub-analysis of the reviews was conducted to identify indicators that could be used to evaluate and measure green spaces.

## 2. Methods

### 2.1 Search Strategy

A scoping review was conducted in January 2016 using the six-step methodology outlined by Arksey & O'Malley (2005). The following databases were searched for peer-reviewed articles: MEDLINE, PsycINFO, EMBASE, Scopus, Environmental Science and Pollution Management, and Allied and Complementary Medicine (AMED). The search strategy was developed in consultation with a librarian at the University of Toronto. Where relevant, search strings were iteratively developed using MeSH headings, synonyms, Boolean operators, and limits to encompass the breadth of literature in this area.

For instance, the MEDLINE search was: exp City Planning/ OR exp Environment Design/ ]AND [ exp Mental Health/ OR greenspace or "green space\*" OR "green adj3 space\*" or "natural environment\*" or "urban design" or "built environment\*" or playground\* or "public park\*" or garden\* or "community garden\*" or "green path\*" or "living wall\*" or "green roof\*" or "open space\*" or "green corridor\*" or ravine\* or "city plan\*" or "urban plan\*" or "environment design\*" OR ("mental health" or "emotional well-being" or "psychological well-being" or "social well-being" or "well-being" or "stress" or "emotional health" or "mental wellness" or "social health" or "psychosocial health" or "community mental health").

This search was adapted accordingly for other databases (for other searches, see Table 1). To be included in the scoping review, articles needed to be written in English, published from 2005 onwards, in an urban setting (including peri-urban, suburban, inner city, high rise, vertical community, and towers). To be eligible, the articles were required to be review papers, including scoping reviews, systematic reviews, evidence reviews, and meta-analyses. Because the aim was to understand the relationships between green space and mental health, rather than measure the strength of these relationships, all types of reviews were included. The search was further limited geographically to include high-income countries such as Canada, the United States, the United Kingdom, Australia, and New Zealand. The rationale for this inclusion was to consider mental health-promoting green spaces that are comparable to the Greater Toronto Area (GTA) in Canada.

To define the search parameters it was important to first to establish how both “green space” and “mental health” are defined within this study and the literature that provides its foundation. Green space includes urban areas with grass, trees, or other vegetation, that are designated for recreational or aesthetic purposes. These spaces are public, outdoor spaces including parks, community gardens, open public space, green path/trail, ravines, green roofs, living walls and green corridors (Toronto Public Health, 2015).

In this review, mental health is defined as “a state of being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively, and is able to make a contribution to his or her community” (World Health Organization, 2015). This procedural definition provides a basis for understanding the how mental health and well-being refer to self-reported and objectively recorded mental health that incorporates mental and emotional well-being and wellness. For this review, mental illnesses (such as a diagnosis of schizophrenia, Alzheimer’s, dementia, depression, anxiety, and mood disorders) are excluded. Furthermore, this review focuses on emotional, mental health and well-being and excludes cognitive, social, and behavioural processes.

Reviews on green space were excluded if they focused on: rural environments, indoor, private or workplace-related green space, non-green public areas (e.g. asphalt, digital versions of green space, housing, road traffic, climate change or conservation, disaster resilience, transport planning, or environmental factors such as heat, humidity, air quality, or heat vulnerability index [HVI]). Articles on health were excluded if they focused on only physical health outcomes (such as asthma, obesity, and diabetes), mental illness (such as schizophrenia, Alzheimer’s/dementia, depression, and anxiety), ecotherapy, herbal medicine, or cognitive, social, or behavioural processes.

A second reviewer assessed randomly selected articles to ensure that they met inclusion and exclusion criteria and that the inclusion/exclusion criteria were applied consistently. In the case of uncertainty, the article was initially included for the full-text screening. Four additional articles were identified by checking reference lists; however, only one of these

was eligible in the final scoping review. No quality assessment of the articles was conducted. Given the range of methodologies in the included reviews, it would not have been possible to compare them. In line with the Arksey and O'Malley (2005) methodology, select researchers and practitioners in the field were consulted to identify any remaining publications that may have been missed through the review. However, the publications that were suggested were either grey literature reports or did not meet inclusion criteria.

## 2.2 Data Extraction

The articles that were selected for inclusion in the scoping review underwent a detailed data extraction process. If the article focused on multiple components of the built environment (e.g. housing, streets, and green space) or health (e.g. cardiovascular disease, diabetes, mental health) components relevant to the research question were extracted.

The following items were iteratively developed and data were extracted for each of the articles by the primary reviewer (NH) as per step 4 of Arksey and O'Malley (2005):

- Charting the data): Author, Year of Publication, Country, Review Design, Aim of the article, Definition of Green Space (and related components)
- Definition of Mental Health and Well-Being (and associated components)
- Number of final articles included in review
- Conceptual Model and Main Findings

The second reviewer also contributed to the development of the extraction table and any concerns regarding articles were resolved through discussion. No methodological quality assessment of the selected studies was conducted (as per Arksey & O'Malley, 2005). However, if a review did not report a methodology it was excluded from consideration.

## 2.3. Sub-analysis Methodology

As part of this scoping review of reviews, a sub-analysis was conducted to identify measures or indicators of green space from the specific findings within each of the individual articles included in the reviews. The research question for this sub-analysis asked, what are the indicators of green space that are associated with mental health and well-being? Indicators are considered measures or metrics that indicate the state of something—in this case, of green space. This sub-analysis was conducted by extracting the findings from the summary tables of articles included in each of the reviews. If a review had no summary table of articles, each article cited in the results section was individually included. In each of the studies, the independent variable that was measured was interpreted as an indicator. For instance, while the quality of green space is considered an aspect of green space, one particular indicator of the quality of green space is species richness. Other variables that modified the relationship between green space and mental health and well-being were categorized as mediating or

moderating factors. Mediating factors are variables that are involved directly in the pathway of how green space influences mental health and well-being. Moderating factors are variables that can increase or reduce the influence of green space on mental health and well-being (Baron & Kenny, 1986).

### 3. Results

The database search returned 1430 articles. After deduplication in EndNote, there was a total of 1252 articles. Subsequently, inclusion and exclusion criteria were applied to the abstracts and titles and 140 articles remained for full-text inclusion. In the final delimiting step inclusion and exclusion criteria were applied to the full-text articles, leaving 16 articles for inclusion in the review (see Figure 1).

The remaining 16 reviews ranged from scoping reviews (e.g. Abraham, Sommerhalder, & Abel, 2010) to systematic reviews (e.g. van den Berg, Wendel-Vos, van Poppel, & Maas, 2015), and semi-systematic reviews (e.g. Hunter & Luck, 2015). There was no consistent definition of green space within the literature. Green space definitions ranged from landscape (“a zone or area as perceived by local people or visitors, whose visual features and character are the result of the action of natural and/or cultural human factors” [European Landscape Convention-Council of Europe, 2000]) to nature (“areas containing elements of living systems that include plants and non-human animals across a range of scales and degrees of human management—from a small urban park to ‘pristine wilderness’” [Bratman et al., 2012]) For a complete list of definitions by review please see Table 2 in the Appendices.

The reviews developed different descriptions of mental health, reflecting a spectrum of definitions of well-being. These ranged from broad understandings of mental health, which framed psychological well-being as “positive effect on mental processes” (e.g. Keniger, Gaston, Irvine, & Fuller, 2013), to specific categorizations of mental health that defined stress as “the psychophysiological phenomenon caused when environmental demands reach or exceed an organism’s capacity to address those demands” (Bratman et al., 2012). There was no consistent definition of mental health that was used across the included reviews.

Three aspects of green space were identified through this scoping review of reviews: quantity of green space, access to green space, and quality of green space. The quantity of green space refers to the amount of land dedicated to green space and is often measured in units of area. Access to green space describes the ease of accessing the space (whether by walking, cycling, or other means of transport) as well as the consideration of mobility once inside the green space for specific populations (e.g. seniors, those with disabilities, infants). Finally, the quality of green space refers to the standards or degree of the condition of green space ranging from aesthetics, safety, facilities available, cultural context, and community need. These three aspects of green space are discussed below.



Mediating and moderating factors were extracted into the following categories: user demographics, exposure, type of interaction, social connection, the level of satisfaction, setting/location, and perception of safety.

### **3.1. Quantity of Green Space and Mental Health and Well-being**

Of the 16 reviews included, 50 percent (8 of 16) discussed quantity of green space in relation to mental health and well-being (Di Nardo, Saulle, & La Torre, 2010; Gascon, Triguero-Mas, Martinez, & Nieuwenhuijsen, 2015; Hunter & Luck, 2015; Lachowycz & Jones, 2013; Lee & Maheswaran, 2010; van den Berg et al., 2015; Velarde, Fry, & Tveit, 2007; Villanueva et al., 2015).

Three reviews found a positive association between quantity of green space and mental health and well-being (Lee & Maheswaran, 2010; van den Berg et al., 2015; Velarde et al., 2007). The reviews that report evidence of positive associations with mental health and well-being looked at objectively measured amounts of green space as well as perceived amounts of green space. They also found that views of nature and availability of green space were positively associated with mental health and well-being. Two reviews found limited evidence and varied or unpredictable evidence that the quantity of available green space influenced mental health and well-being (Di Nardo et al., 2010; Gascon et al., 2015). Three reviews did not report conclusions regarding the relationship between the quantity of green space and mental health and well-being, although they discussed quantity of green space indicators in relation to mental health and well-being (Hunter & Luck, 2015; Lachowycz & Jones, 2013; Villanueva et al., 2015). These reviews looked at the number of green spaces within a specified area as well as the percentage of green space within said area.

The reviews suggest that although the quantity of green space may be associated with mental health and well-being, the evidence is not conclusive. However, it appears to be important to have at least a small amount of green space available (Bowler, Buyung-Ali, Knight & Pullin, 2010; Villanueva et al., 2015).

#### **3.1.1. Indicators of Quantity of Green Space Associated with Mental Health and Well-being**

In the sub-analysis, there was a total of 27 indicators identified for the quantity of green space, distinct in either measurement or population (see Table 3 in Appendices for the complete list). The indicators for the quantity of green space, as found through this scoping review of reviews, fall into three categories: the amount of green space (eight articles), the number of green spaces (two articles), and the perception of green space (two articles).

## **Amount of Green Space**

Eight articles measured the quantity of green space based on the percentage of green space within a specific area, usually at a Census Area Unit (CAU) (Alcock et al., 2014; Astell-Burt, Feng & Kolt 2013; Flouri, Midouhas & Joshi, 2014; Maas, Verheij, Groenewegen, de Vries & Spreeuwenberg, 2006; 2014; Richardson, Pearce, Mitchell & Kingham, 2013; Roe et al., 2013; van den Berg et al., 2010; White, Alcock, Wheeler & Depledge, 2013). For instance, Beyer et al. (2014) found that an increase in tree canopy coverage at a CAU had a positive effect on mental health and well-being in those 21 to 74 years of age; however, the review does not elaborate on how this occurs. An increase in the amount of green space was found to have a positive effect on mental health and well-being in all articles except two, for which no association was found (Chong et al., 2013; van den Berg et al., 2010).

In other articles, the quantity of green space was determined by measuring the green space around a residence in a circular perimeter, at a set radius from the residence (Alcock et al., 2014; Astell-Burt, Mitchell & Hartig, 2014; Maas, Van Dillen, Verheig, Groenewegen, 2009a; Paquet et al., 2013; van Dillen, de Vries, Groenewegen & Spreeuwenberg, 2012). For instance, Triguero-Mas et al. (2015) measured green space in 100 meter, 300 meter, 500 meter, and one kilometer radii, for those between 34 and 64 years of age and found that as greenery increased, there was decreased risk of poor mental health after stratifying for physical activity, gender, socioeconomic status, and social support. Fan et al. (2011), however, reported no association between park acreage (within an 800 meter circular buffer) and mental health and well-being. More generally, van Dillen et al. (2012) found that the amount of streetscape greenery was positively associated with mental health and well-being in the general population.

## **Number of Public Green Space Options Available**

In a review by Villanueva et al. (2015), one of the indicators identified was the number of green spaces that are available within a specific area. Another indicator is the number of green spaces available based on size and type of green space, also within a specific area. The latter allows for more nuanced comparison based on the potential use of the green space. The authors note that green space needs to be measured with the same spatially defined boundaries, in order to make comparisons between different studies. It is not clear in the review whether these indicators are associated with mental health and well-being specifically or general health overall. In comparison, an article by Annerstedt et al. (2012) found that the number of green spaces had no effect on mental health and well-being. Balseviciene et al. (2014) found that the distance to the nearest park (of greater than 1 hectare in area and with 65 percent of the land covered by trees) to have no association with mental health and well-being.

## **Perception of Quantity of Green Space**

Sugiyama, Leslie, Giles-Corti and Owen (2008) found that the higher the subjective perception of greenness in a neighbourhood, the more positive the self-reports of mental health and well-being were. This correlation demonstrates that objectively recorded quantity of green space may not be the only way to assess the impact of green space on mental health and well-being. Leslie, Sugiyama, Lerodiaconou and Kremer (2010) found that both subjective and objective measures of neighbourhood greenness were positively associated with mental health and well-being.

In summary, 10 review papers used a total of 28 distinct indicators to measure quantity of green space. There were 21 indicators of the quantity of green space that had a positive association with mental health and well-being (such as the percentage of green space at Census Area Unit [CAU] or subjective perception of greenness). There were seven indicators for the quantity of green space, which were found to have no association with mental health and well-being (such as total park acreage or amount of green space). (See Table 3 in the Appendices for a full list of indicators of the quantity of green space).

## **3.2. Access to Green Space and Mental Health and Well-being**

Roughly 56 percent of the reviews (9 of 16) discussed access to green space in relation to mental health and well-being (Abraham et al., 2010; Badland et al., (2014); Bratman et al., 2012; Di Nardo et al., 2010; Gascon et al., 2015; Lachowycz & Jones, 2013; Lee & Maheswaran, 2010; Tzoulas, Korpela, Venn, & James, 2007; Villanueva et al., 2015).

Four reviews found a positive association between access to green space and mental health and well-being (Abraham et al., 2010; Bratman et al., 2012; Lee & Maheswaran, 2010; Tzoulas et al., 2007). These reviews looked at residential proximity to green space as well as visibility of green space from within a building. Two reviews found limited causal evidence between access to green space and mental health and well-being (Di Nardo et al., 2010; Gascon et al., 2015). There is, however, limited availability of longitudinal studies to support these observations. Three reviews did not report conclusions regarding the relationship between access to green space and mental health and well-being, although they discussed access to green space indicators in relation to mental health and well-being (Badland et al. (2014); Lachowycz & Jones, 2013; Villanueva et al., 2015). These indicators of access to green space included measures of distances to neighbourhood parks (e.g. access to a neighbourhood park POS <\_ 400m).

The reviews suggest that there is limited causal evidence between access to green space and mental health and well-being. However, positive associations have been found between access to green space and mental health and well-being.

### **3.2.1. Indicators of Access to Green Space Associated with Mental Health and Well-being**

In the sub-analysis, there was a total of 17 indicators identified for access to green space, distinct in either measurement or population (see Table 4 in Appendices for the complete list). The indicators for access to green space found through this scoping review of reviews fall into two categories: objective measures and subjective measures (from a total of four articles). Of the four articles, two examined both objective and subjective measures within the same study.

#### **Objective and Subjective Measures**

Residential proximity to green spaces was the most common indicator that demonstrated a positive association with mental health and well-being. Sturm & Cohen (2014) studied four categories of proximity to green spaces (<400 meters, 400-800 meters, 800 meters-1.6 kilometers, >1.6 kilometers) and found a positive association with mental health and well-being for all except distances greater than 1.6 kilometers. Similarly, Stigsdotter et al. (2010) found that residing within 300 km of green space is beneficial, whereas living further than one kilometer away from green space has a higher probability of stress. Proximity to the nearest green space influences mental health and well-being, regardless of whether it is objective or self-reported (Reklaitiene et al., 2014; Sturm & Cohen, 2014).

In summary, seven review papers used a total of 13 distinct indicators to measure access to green space. There were 10 indicators of access to green space that had a positive association with mental health and well-being (such as green space within 1.6 kilometers of a home). Three indicators of access to green space were found to have no association with mental health and well-being (such as distance to the nearest park).

### **3.3. Quality of Green Space and Mental Health and Well-being**

Of the 16 reviews included, 75 percent (12 of 16) discussed quality of green space in relation to mental health and well-being (Abraham et al., 2010; Badland et al., 2014; Gascon et al., 2015; Hunter & Luck, 2015; Lachowycz & Jones, 2013; Lee & Maheswaran, 2010; Lovell, Wheeler, Higgins & Depledge, 2014; Sandifer, Sutton-Grier & Ward, 2015; Tzoulas et al., 2007; van den Berg, et al., 2015; Velarde et al., 2007; Villanueva et al., 2015).

Four reviews found a positive association between quality of green space and mental health and well-being (Abraham et al., 2010; Gascon et al., 2015, Hunter & Luck, 2015; Tzoulas et al., 2007). These reviews focused on attractiveness and aesthetics of green spaces, sound levels, and biodiverse environments for mental health and well-being. Six reviews found mixed or conflicting evidence linking quality of green space and mental health and well-being (Hunter & Luck, 2015; Lachowycz & Jones, 2013; Lovell et al., 2014; Sandifer et al., 2015; van den Berg et

al., 2015; Velarde et al., 2007). These mixed findings appeared to be independent of whether or not biodiverse environments (either subjectively or objectively measured) promoted mental health and well-being. Three reviews did not report conclusions regarding the relationship between quality of green space and mental health and well-being, although they discussed the quality of green space indicators in relation to mental health and well-being (Badland et al., 2014; Lee & Maheswaran, 2010; Villanueva et al., 2015). For instance, these reviews assessed and discussed the importance of public facilities such as toilets, benches, and playgrounds without determining the nature of the relationship with mental health and well-being.

The reviews suggest that there is some evidence of the quality of green space being an important factor influencing the relationship between green space and mental health and well-being.

### **3.3.1. Indicators of Quality of Green Space Associated with Mental Health and Well-being**

In the sub-analysis, there was a total of 28 indicators identified measuring the quality of green space. These were distinctive in either measurement or population (see Table 5 in the Appendices for the complete list). The indicators for quality of green space found through this scoping review of reviews fall into six categories: biodiversity/species richness (eight articles), aesthetics of green space (four articles), sound levels/noise (five articles), availability and condition of facilities (four articles), safety (two articles), presence of blue space or water features (one article), and visual stimuli such as design or landscape style (seven articles).

#### **Biodiversity/Species Richness**

Eight studies concluded that biodiversity of both flora and fauna, whether objectively or subjectively measured, had a positive association with mental health and well-being (Annerstedt et al., 2012; Björk et al., 2008; Fuller et al., 2007; Grahn & Stigsdotter, 2010; Luck, Davidson, Boxall & Smallbone, 2011; Rishbeth & Finney, 2006; Wakefield et al., 2007; Waliczek, Zajicek & Lineberger, 2005). The richness of vegetation and perceived amount of vegetation were found to be beneficial for mental health and well-being (Milligan & Bingley, 2007; Rishbeth & Finney, 2006; Wakefield et al., 2007; Waliczek et al., 2005).

While Dallimer et al. (2012) found that perceived (subjective) species richness for bird, butterfly, plant, and habitat diversity was associated with mental health and well-being, objective species richness was not. However, one study found that butterfly diversity had no association with mental health and well-being among those 16 to 70+ years of age (Fuller et al., 2007). Similarly, Annerstedt et al. (2012) and Grahn and Stigsdotter (2010) found that more biodiverse environments had no effect on mental health and well-being among those 18 to 80 years of age and adults respectively.

## **Aesthetics of Green Space**

The maintenance of the green space—i.e. the absence of litter and a good general impression—is positively associated with mental health and well-being (de Vries, van Dillen, Groenewegen, & Spreeuwenberg, 2013). According to Özgüner, Eraslan and Yilmaz (2012), a derelict landscape has not been shown to be beneficial, whereas flowers and greenery in the landscape are preferred for their perceived effects (2012). The presence of flowering plants has also been documented as beneficial for mental health and well-being (Nordh et al., 2009). Additionally, the maintenance of public infrastructure associated with green spaces (e.g. public toilets) and upkeep of vegetation (e.g. no weeds) of green space has been shown to be important considerations for mental health and well-being (Annerstedt et al., 2012; De Vries et al., 2013).

## **Sound Levels/Noise**

The sounds of wind, water, birds, and insects in a “place of peace and silence” were found to be positively associated with mental health and well-being (Annerstedt et al., 2012). Noise (such as traffic, construction, or loud people) was found to be negatively associated with mental health and well-being (Annerstedt et al., 2012; Gidlöf-Gunnarsson & Öhrström, 2007; Guite, Clark & Ackrill, 2006).

## **Facilities: Availability and Condition**

The availability of green space for entertainment and sports was beneficial for mental health and well-being (Berto, 2005). However, it is also important that these spaces have appropriate facilities with adequate lighting and shade to enhance perceptions of safety (Broomhall et al., 2005; Edwards et al., 2013).

## **Safety**

The state of disrepair or lack of maintenance of a green space negatively impacts safety, which may impact the use of the green space (Bedimo-Rung, Mowen & Cohen, 2005; Law et al., 2006).

## **Presence of Blue Spaces/Water features**

White et al. (2010) found that the presence of blue spaces such as oceans, lakes, ponds or water views can have a positive effect on mental health and well-being.

## **Visual Stimuli/ Design/Landscape sSyle**

Seven articles examined the effect of visual complexity of the landscape or landscape style on mental health and well-being (Annerstedt et al., 2012; Jorgensen, Wilson & van den Berg,

2010; Milligan & Bingley, 2007; Özgüner and Kendle, 2006; Sharpe, 2005; Tzoulas & James, 2009; van Dillen et al., 2012). Özgüner and Kendle (2006) found that both formal (i.e. designed and planned) and naturalistic landscape styles were valued. Sharpe (2005) found that “wild” nature was found to be beneficial while Annersdtedt et al. (2012) found spaciousness important, defined as “a place offering a restful feeling of “entering another world,” like a beech forest.” Open, and accessible forests, as well as good quality open green spaces and streetscapes, have evidence linking these features to mental health and well-being (Milligan & Bingley, 2007; Tzoulas & James, 2009; van Dillen et al., 2012). Jorgensen et al. (2010) found that the complexity of the environment (i.e. where there are many different features) in a natural, undeveloped landscape had no association with mental health and well-being for students aged 17 to 40.

In summary, 11 review papers used a total of 31 distinct indicators to measure the quality of green space. There were 26 indicators of the quality of green space that had a positive association with mental health and well-being (such as the presence of blue spaces). Four indicators of the quality of green space were found to have no association with mental health and well-being (such as butterfly diversity). One indicator of the quality of green space was found to have a negative association with mental health and well-being (objectively measured species richness) (see Table 5 in the Appendices for a full list of indicators of quality of green space).

### **3.4. Potential Mediating, Moderating, and Other Factors**

Of the 16 reviews that were included, 81 percent (13 of 16) discussed mediating and moderating factors that affected the relationship between green space and mental health and well-being (Abraham et al., 2010; Badland et al., 2014; Di Nardo et al., 2010; Gascon et al., 2015; Hunter & Luck, 2015; Keniger et al., 2013; Lachowycz & Jones, 2013; Lee & Maheswaran, 2010; Russell et al., 2013; Sandifer et al., 2015; Tzoulas et al., 2007; van den Berg et al., 2015; Villanueva et al., 2015).

The mediating and moderating factors are not the focus of the included reviews. As a result, It was not possible to extract information on associations for mediating and moderating factors from the 16 review papers. However, these mediating and moderating factors were inferred as indicators, and the following sub-analysis allowed for an understanding of how various factors change the impact of green space on mental health and well-being. Given that the majority of the reviews (81 percent) highlighted the importance and dynamic nature of mediating and moderating factors in the relationship between green space and mental health and well-being, these factors warrant careful consideration when thinking about future research studies or planning green spaces for mental health promotion.

### 3.4.1. Mediating and Moderating Factors

In the sub-analysis, there were a total of 33 mediating and moderating factors, distinctive in either measurement or population (see Table 6 in Appendices for the complete list). The mediating and moderating factors found through this scoping review of reviews fall into the following categories:

- User demographics (six articles)
- Exposure (six articles)
- Type of interaction (18 articles)
- Social connection (three articles)
- Level of satisfaction (six articles)
- Setting/location (three articles)
- Perception of safety (one article)

#### User Demographics

Demographic variables (including age, gender, marriage, education, income, and ethnicity) were found to moderate the relationship between green space and mental health. For example, for people who identify as white, the association between green space and mental health was stronger than for non-white groups (Kerr, Frank, Sallis & Chapman, 2007; Scott et al., 2009). The reviews contained limited details on how these moderators changed the effect of green space on mental health and well-being; individual articles would have complete information, but were not extracted for the purposes of this scoping review of reviews.

#### Exposure

Exposure to green space (i.e. the amount of time spent in the natural environment) was found to increase the effect of green space on mental health and well-being (Barton, 2009; Nisbet & Zelenski, 2011; Stigsdotter et al., 2010). However, Pretty, Peacock, Sellens and Griffin (2005) and Barton and Pretty (2010) found that increased dose exposure to green space while exercising decreased the effect of green space on mental health and well-being. These inconsistencies may be due to differences in populations being studied, context, of study, or time points; however, the reviews did not provide sufficient detail on these factors to elaborate.

#### Type of Interaction

Pretty et al. (2005) discuss three levels of interacting with nature: viewing nature (e.g. from a window), passive use (e.g. reading in the park), and active involvement (e.g. running or gardening). There is evidence that interacting with nature has a positive association with mental health and well-being (Kamitsis & Francis, 2013; MacKerron & Mourato, 2013; Park et al., 2009). Pretty et al. (2005) and Barton and Pretty (2010) found that exercising in nature



(“green exercise”) was positively associated with mental health and well-being for men. None of the reviews had additional information on passive use or viewing nature for different population groups.

### **Social Connection**

Social connection, including the sense of community, knowledge of belonging to a community, and social interaction in green space, were all found to increase the effect of green space on mental health and well-being (Francis et al., 2012; Maas et al., 2008; Mayer, Frantz, Bruehlman-Senecal & Dolliver, 2008).

### **Level of Satisfaction**

If an individual was satisfied with a green space, whether through its availability, quality, or because it met the individual’s needs and purposes, an increased positive effect on mental health and well-being was reported (Bedimo-Rung et al., 2005; Bowler et al., 2010; Guite et al., 2006; Han, 2009; Putrik et al., 2015). Guite et al. (2006) also found that dissatisfaction with access to green space decreased the positive effect of green space on mental health and well-being.

### **Setting/Location**

The association between green space and health was stronger in urban areas compared to rural areas (Babey, Hastert & Brown, 2008; Maas et al., 2008; Nielsen & Hansen, 2007).

### **Perception of Safety**

Individuals may have varying perceptions in relation to how safe a green space is and, consequently, this may impact their use of the space (National Institute for Health and Clinical Excellence [NICE], 2006). Perceptions of safety and objective levels of safety were a concern, specifically for children, young people, and their parents (NICE, 2006). For instance, parental attitudes towards their children’s safety moderated the relationship between an environment and their children’s activities (Lachowycz & Jones, 2013). Women are also more influenced by safety concerns than compared to men (Lachowycz & Jones, 2013).

In summary, 11 review papers used a total of 33 distinct mediating and moderating factors. There are 29 factors that increase the influence of green space on mental health and well-being (such as race/ethnicity or contact with nature) and four factors that decrease the influence of green space on mental health and well-being (such as use of green space or the dose exposure to nature). (See Table 6 in the Appendices for the full list of mediating/moderating factors).

### 3.4.2. Other Factors

Table 7 describes other factors and trends found through the scoping review of reviews that change the association between green space and mental health and well-being. Cutt, Giles-Corti, Knuiiman and Burke, (2007) and Schipperijn et al. (2010) found that having a dog is affiliated with increased physical activity and more frequent use of green space. Living with children also influences the effect of green space on mental health and well-being (Kaczynski, Potwarka, Smale, & Havitz, 2009). Two other studies found that joggers prefer large space with quiet paths, whereas families with young children prefer areas with playgrounds, toilet access, and parking facilities (Cohen et al., 2010; McCormack, Rock, Toohey & Hignell, 2010). In contrast, individuals who uses green space as a means of commuting or getting to a destination prefer hard surfaces and well-lit paths (Cohen et al., 2010; McCormack et al., 2010).

## 4. Discussion

In total, the 16 review papers had a foundation comprised of 273 individual articles. The sub-analysis delves further into the individual studies that were included in the reviews to identify indicators of green space that are associated with mental health and well-being. Some of the studies were included in more than one review and are therefore counted more than once. Tables 2 to 7 highlight the entirety of the findings and also summarize the indicators by review and by study.

This scoping review of reviews found that three aspects of green space, namely quantity of, access to, and quality of green space, are largely positively associated with mental health and well-being. Although there is evidence of associations between green space and mental health and well-being, there is a lack of evidence on whether or not this relationship is causal.

Limited evidence of a causal relationship between the quantity of green space and mental health and well-being was reported in the reviews; however, there is evidence from cross-sectional studies indicating an association. Lee and Maheswaran (2010) state that it is unlikely that simply the presence of green space would enhance health and that there are likely complex mechanisms at play. The quantity of green space (and its link to mental health and well-being) may be measured using indicators on the amount of green space, the number of green spaces, or perception of the quantity of green space.

Access to green space was also not found to have a definitive causal relationship to mental health and well-being. There was limited evidence on the associations between access to green space and mental health and well-being. Because there are nuances that cannot be captured through only simple measures of distances to parks (Lachowycz & Jones, 2013), it is

not surprising that many studies do not find adequate evidence to form definite conclusions about the relationship between distance to green space and health. Access to green space and its link to mental health and well-being may be measured using objective or subjective indicators.

The quality of green space appears to be important in determining the effects on mental health and well-being, and there is more substantiated evidence of an association. The quality of green space (and the link to mental health and well-being) may be measured using indicators on biodiversity/species richness, aesthetics of green space, sound levels/noise, availability and condition of facilities, safety, presence of blue spaces or water features, and visual stimuli such as design or landscaping.

Most of the reviews (81 percent or 13 of 16) focused on mediating and moderating factors indicating the importance of understanding the potential pathways in how green space influences mental health and well-being. Mediating and moderating factors were grouped into the following categories: user demographics, exposure, type of interaction, social connection, the level of satisfaction, setting/location, and perception of safety.

Although there was no strong causal evidence for green space influencing mental health and well-being, there was evidence of associations, and these components of green space (quantity of, access to, and quality of) should be considered in urban planning. The quality of green space had the most evidence of association with mental health and well-being, and may have particular value in influencing mental health and well-being. Consequently, it is essential to include quality of green space, along with quantity and access, when assessing green spaces (Francis et al., 2012). Mediating and moderating factors are also important to understand in the context of mental health promotion through green spaces, given that they were incorporated and analyzed in most of the included reviews.

#### **4.1. Strengths and Limitations**

As there are a range of interpretations and definitions for green spaces and for mental health and well-being, other terms such as landscape, nature, and public open space were often used as synonyms of green space. Similarly, mental illness was often considered a part of mental health. The lack of clear and consistently used definitions of green space and mental health is problematic with respect to comparing studies and assessing mental health and well-being outcomes. Only findings that fit the predetermined definition were included and this allowed for a focused scope of this review of reviews. A scoping review of reviews approach may, in the interest of canvassing a wide body of literature, overlook specific pieces that offer value and insight in understanding the relationships between green space and mental health.

While there are different definitions and interpretations of mental health in the literature, this review focuses on particular understandings of mental health and well-being. As a result,

this review is limited to those aspects of mental health and well-being that operate more broadly than diagnostic conditions that fall under the umbrella of mental illness. Table 2 includes the terms and definitions used within each of the review articles.

Given the range of definitions and methodologies, it would not have been possible to compare studies for the purposes of evaluating the quality of the review. Due to the variability in methodological approaches in the measurement of green space and mental health, as well as review approach, no quality indicator was applied. Consequently, we could not identify the strength of the evidence for each aspect of green space and whether there was sufficient evidence for promoting mental health and well-being. The majority of reviews found that it was not possible to determine causal relationships. Only a couple of the reviews provided a synthesis of the articles in terms of categorizing the overall evidence as strong or weak and whether there was sufficient or inadequate evidence (Gascon et al., 2015; van den Berg et al., 2015). Moreover, the lack of longitudinal data means we are unable to consider relationships over time.

Only green spaces in developed countries were included in this review and, subsequently, there are limitations on the applicability of these findings to other settings. Future studies that focus on countries outside of these jurisdictions could provide insight into different contexts.

For the sub-analysis, only aspects of green space were extracted. Specific mental health and well-being outcomes were not extracted for each individual article, but articles were included as long as the mental health outcome met inclusion criteria. This was a limitation of the sub-analysis.

Since this sub-analysis focused on extracting the information from articles included in the reviews, and did not delve further into each article, there is some missing detail. Consequently, in some cases it was not possible to identify population groups or details on indicators. Any information that was not found in the reviews is indicated in Tables 3 to 7. Despite these limitations, this paper offers a starting point to understand what evidence exists regarding the relationships between green space and mental health.

## **4.2. Recommendations for Practice: Developing and Maintaining Mental Health-Promoting Urban Green Spaces in Toronto**

- Assess quality of green spaces (including parks, public school grounds, ravines and green corridors) in Toronto's 140 neighbourhoods using an appropriate tool
- Collect data on quality of Toronto's green spaces, which will enhance the data available through Urban HEART
- Include community residents and organizations in a meaningful way when it comes to development or revitalization initiatives that incorporate green spaces (e.g. the Regent Park revitalization)

- Develop a structured process for understanding community needs and uses of neighbourhood green space, by using the indicators in this paper as points for discussion
- Iteratively develop and create mental health-promoting spaces based on the available evidence

When it comes to promoting mental health through green spaces, it can be challenging to strike a balance between waiting to get the right evidence and having enough of it to inform ongoing revitalization efforts. There are not sufficient longitudinal studies to establish causality and guarantee that certain features of green spaces will improve mental health and well-being at a population level. However, there are rigorous research studies that have found associations between green space and mental health and well-being and which begin to understand the complexity of the potentially beneficial relationship between the two. While researchers work towards establishing a rigorous evidence base and understanding the causal pathways to mental health through green space, it is necessary to ensure that ongoing progressive change is taking place through implementing what we do know in urban planning and revitalization initiatives.

It should be noted that future studies should consider using standardized measures of mental health that are validated and have been used in previous studies to allow for comparison of results (Gascon et al., 2015). There are some options for mental health measures including the Kessler Psychological Distress Scale (K6) and the General Health Questionnaire (GHQ-12). Gascon et al. (2015) recommend the use of the GHQ in future studies to facilitate meta-analyses in this area.

## Conclusion

There is evidence that the quantity of, access to, and quality of green spaces are all important factors influencing mental health and well-being. Based on existing evidence of the three factors, the quality of green space appears to have the most impact on mental health and well-being. Access to green space is associated with mental health and well-being, but there is less evidence compared to the quality of green space. The quantity of green space had the least evidence of an association with mental health and well-being, although having green space available is still important. This review also identified key mediating and moderating factors in the relationship between green space and mental health and well-being; however, it was not possible to identify the extent to which factors impacted mental health. Indicators of green space for mental health promotion were identified through the sub-analysis of this paper and may be used in assessing green spaces.

## References

- Abraham, A., Sommerhalder, K., & Abel, T. (2010). Landscape and well-being: a scoping study on the health-promoting impact of outdoor environments. *International Journal of Public Health*, 55(1), 59-69.
- Alcock, I., White, M. P., Wheeler, B. W., Fleming, L. E., & Depledge, M. H. (2014). Longitudinal effects on mental health of moving to greener and less green urban areas. *Environmental Science & Technology*, 48(2), 1247-1255.
- Alvarsson, J. J., Wiens, S., & Nilsson, M. E. (2010). Stress recovery during exposure to nature sound and environmental noise. *International Journal of Environmental Research and Public Health*, 7(3), 1036-1046.
- Annerstedt, M., Östergren, P. O., Björk, J., Grahn, P., Skärbäck, E., & Währborg, P. (2012). Green qualities in the neighbourhood and mental health—results from a longitudinal cohort study in Southern Sweden. *BMC Public Health*, 12(1), 1.
- Arksey, H. & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology*, 8(1), 19-32.
- Astell-Burt, T., Feng, X., & Kolt, G. S. (2013). Mental health benefits of neighbourhood green space are stronger among physically active adults in middle-to-older age: evidence from 260,061 Australians. *Preventive Medicine*, 57(5), 601-606.
- Astell-Burt, T., Mitchell, R., & Hartig, T. (2014). The association between green space and mental health varies across the lifecourse. A longitudinal study. *Journal of Epidemiology and Community Health*, 68(6), 578-583.
- Babey, S. H., Hastert, T. A., & Brown, E. R. (2007). Teens living in disadvantaged neighborhoods lack access to parks and get less physical activity. *UCLA Center for Health Policy Research*.
- Badland, H., Whitzman, C., Lowe, M., Davern, M., Aye, L., Butterworth, I., Hes, D., & Giles-Corti, B. (2014). Urban liveability: Emerging lessons from Australia for exploring the potential for indicators to measure the social determinants of health. *Social Science and Medicine*, 111, 64-73.
- Balseviciene, B., Sinkariova, L., Grazuleviciene, R., Andrusaityte, S., Uzdanaviciute, I., Dedele, A., & Nieuwenhuijsen, M. J. (2014). Impact of residential greenness on preschool children's emotional and behavioral problems. *International Journal of Environmental Research and Public Health*, 11(7), 6757-6770.
- Barton, H. (2009). Land use planning and health and well-being. *Land Use Policy*, 26(SUPPL. 1), 115-123. <https://doi.org/10.1016/j.landusepol.2009.09.008>
- Barton, J., & Pretty, J. (2010). What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. *Environmental Science & Technology*, 44(10), 3947-3955.
- Bedimo-Rung, A. L., Mowen, A. J., & Cohen, D. A. (2005). The significance of parks to physical activity and public health: a conceptual model. *American Journal of Preventive Medicine*, 28(2), 159-168.

- Berto, R. (2005). Exposure to restorative environments helps restore attentional capacity. *Journal of Environmental Psychology*, 25(3), 249-259.
- Beyer, K. M., Kaltenbach, A., Szabo, A., Bogar, S., Nieto, F. J., & Malecki, K. M. (2014). Exposure to neighborhood green space and mental health: Evidence from the survey of the health of Wisconsin. *International Journal of Environmental Research and Public Health*, 11(3), 3453-3472.
- Björk, J., Albin, M., Grahn, P., Jacobsson, H., Ardö, J., Wadbro, J., ... & Skärbäck, E. (2008). Recreational values of the natural environment in relation to neighbourhood satisfaction, physical activity, obesity and wellbeing. *Journal of Epidemiology and Community Health*, 62(4), e2-e2.
- Bowler, D. E., Buyung-Ali, L. M., Knight, T. M., & Pullin, A. S. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health*, 10(1), 456.
- Bratman, G. N., Hamilton, J. P., & Daily, G. C. (2012). The impacts of nature experience on human cognitive function and mental health. *Annals of the New York Academy of Sciences*, 1249, 118-136.
- Centre for Research on Inner City Health. (2014). *Urban HEART @Toronto: Technical Report/User Guide*. Retrieved from [http://www.torontohealthprofiles.ca/urbanheartattoronto/UrbanHeartTechnicalReport\\_v1.pdf](http://www.torontohealthprofiles.ca/urbanheartattoronto/UrbanHeartTechnicalReport_v1.pdf)
- Chong, S., Lobb, E., Khan, R., Abu-Rayya, H., Byun, R., & Jalaludin, B. (2013). Neighbourhood safety and area deprivation modify the associations between parkland and psychological distress in Sydney, Australia. *BMC Public Health*, 13(1), 422. <https://doi.org/10.1186/1471-2458-13-422>
- Cohen, D. A., Ashwood, J. S., Scott, M. M., Overton, A., Evenson, K. R., Staten, L. K., ... & Catellier, D. (2006). Public parks and physical activity among adolescent girls. *Pediatrics*, 118(5), e1381-e1389.
- Cutt, H., Giles-Corti, B., Knuiaman, M., & Burke, V. (2007). Dog ownership, health and physical activity: A critical review of the literature. *Health & Place*, 13(1), 261-272.
- Dai, D. (2011). Racial/ethnic and socioeconomic disparities in urban green space accessibility: Where to intervene? *Landscape and Urban Planning*, 102(4), 234-244.
- Dallimer, M., Irvine, K. N., Skinner, A. M., Davies, Z. G., Rouquette, J. R., Maltby, L. L., ... & Gaston, K. J. (2012). Biodiversity and the feel-good factor: understanding associations between self-reported human well-being and species richness. *BioScience*, 62(1), 47-55.
- de Vries, S., van Dillen, S. M. E., Groenewegen, P., & Spreeuwenberg, P. (2013). Streetscape greenery and health: Stress, social cohesion and physical activity as mediators. *Social Science and Medicine*, 94, 26-33.
- Di Nardo, F., Saulle, R., & La Torre, G. (2010). Green areas and health outcomes: A systematic review of the scientific literature. *Italian Journal of Public Health*, 7(4), 402-413.
- Edwards, N., Hooper, P., Trapp, G. S., Bull, F., Boruff, B., & Giles-Corti, B. (2013). Development of a public open space desktop auditing tool (POSDAT): a remote sensing approach. *Applied Geography*, 38, 22-30.

- Flouri, E., Midouhas, E., & Joshi, H. (2014). The role of urban neighbourhood green space in children's emotional and behavioural resilience. *Journal of Environmental Psychology, 40*, 179-186.
- Francis, J., Wood, L. J., Knuiman, M., & Giles-Corti, B. (2012). Quality or quantity? Exploring the relationship between Public Open Space attributes and mental health in Perth, Western Australia. *Social Science & Medicine, 74*(10), 1570-1577.
- Gascon, M., Triguero-Mas, M., Martinez, D.V., & Nieuwenhuijsen, M.J. (2015). Mental Health Benefits of Long-Term Exposure to Residential Green and Blue Spaces: A Systematic Review. *International Journal of Environmental Research and Public Health, 12*(4), 4354.
- Gidlöf-Gunnarsson, A., & Öhrström, E. (2007). Noise and well-being in urban residential environments: The potential role of perceived availability to nearby green areas. *Landscape and Urban Planning, 83*(2), 115-126.
- Giles-Corti, B., Broomhall, M. H., Knuiman, M., Collins, C., Douglas, K., Ng, K., ... & Donovan, R. J. (2005). Increasing walking: how important is distance to, attractiveness, and size of public open space?. *American Journal of Preventive Medicine, 28*(2), 169-176.
- Goertzen, L. Halas, G., Rothney, J., Schultz, A. S. H., Wener, P., Enns, J. E., & Katz, A. (2015). Mapping a Decade of Physical Activity Interventions for Primary Prevention: A Protocol for a Scoping Review of Reviews. *JMIR Research Protocols, 4*(3) n.p.
- Grahn, P., & Stigsdotter, U. K. (2010). The relation between perceived sensory dimensions of urban green space and stress restoration. *Landscape and Urban Planning, 94*(3), 264-275.
- Guite, H. F., Clark, C., & Ackrill, G. (2006). The impact of the physical and urban environment on mental well-being. *Public Health, 120*(12), 1117-1126.
- Han, K. T. (2010). An exploration of relationships among the responses to natural scenes scenic beauty, preference, and restoration. *Environment and Behavior, 42*(2), 243-270.
- Haluza, D., Schönbauer, R., & Cervinka, R. (2014). Green perspectives for public health: a narrative review on the physiological effects of experiencing outdoor nature. *International Journal of Environmental Research and Public Health, 11*(5), 5445-5461.
- Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014). Nature and health. *Annual Review of Public Health, 35*, 207-228.
- Hunter, A. J., & Luck, G. W. (2015). Defining and measuring the social-ecological quality of urban greenspace: a semi-systematic review. *Urban Ecosystems, 18*(4), 1139-1163.
- Jorgensen, A., Wilson, E., & van den Berg, A. (2010). Evaluating stress relief in urban green and open space: does perceived naturalness make a difference. *Trees and Society*.
- Kaczynski, A. T., Potwarka, L. R., Smale, B. J., & Havitz, M. E. (2009). Association of parkland proximity with neighborhood and park-based physical activity: variations by gender and age. *Leisure Sciences, 31*(2), 174-191.
- Kamitsis, I., & Francis, A. J. (2013). Spirituality mediates the relationship between engagement with nature and psychological wellbeing. *Journal of Environmental Psychology, 36*, 136-143.



- Keniger, L. E., Gaston, K. J., Irvine, K. N., Fuller, R. A. (2013). What are the benefits of interacting with nature? *International Journal of Environmental Research & Public Health*, 10(3), 913-935.
- Kerr, J., Frank, L., Sallis, J. F., & Chapman, J. (2007). Urban form correlates of pedestrian travel in youth: Differences by gender, race-ethnicity and household attributes. *Transportation Research Part D: Transport and Environment*, 12(3), 177-182.
- Kondo, M. C., South, E. C., & Branas, C. C. (2015). Nature-Based Strategies for Improving Urban Health and Safety. *Journal of Urban Health*, 92(5), 800-814.
- Lachowycz, K. & Jones, A. P. (2013). Towards a better understanding of the relationship between greenspace and health: Development of a theoretical framework. *Landscape and Urban Planning*, 118, 62-69.
- Law, M., King, G., King, S., Kertoy, M., Hurley, P., Rosenbaum, P., & Hanna, S. (2006). Patterns of participation in recreational and leisure activities among children with complex physical disabilities. *Developmental Medicine & Child Neurology*, 48(05), 337-342.
- Lee, A. C. K. & Maheswaran, R. (2010). The health benefits of urban green spaces: A review of the evidence. *Journal of Public Health*, 33(2), 212-222.
- Leslie, E., Sugiyama, T., Lerodiaconou, D., & Kremer, P. (2010). Perceived and objectively measured greenness of neighbourhoods: Are they measuring the same thing?. *Landscape and Urban Planning*, 95(1), 28-33.
- Lorenc, T., Clayton, S., Neary, D., Whitehead, W., Petticrew, M., Thomson, H., Cummins, S., Sowden, A., & Renton, A. (2012). Crime, fear of crime, environment, and mental health and wellbeing: mapping review of theories and causal pathways. *Health & Place*, 18(4), 757-765.
- Lovell, R., Wheeler, B. W., Higgins, S. & Depledge, M. H. (2014). A systematic review of the health and well-being benefits of biodiverse environments. *Journal of Toxicology & Environmental Health Part B: Critical Reviews*, 17(1), 1-20.
- Luck, G. W., Davidson, P., Boxall, D., & Smallbone, L. (2011). Relations between Urban Bird and Plant Communities and Human Well-Being and Connection to Nature. *Conservation Biology*, 25(4), 816-826.
- MacKerron, G., & Mourato, S. (2013). Happiness is greater in natural environments. *Global Environmental Change*, 23(5), 992-1000.
- Maas, J., Verheij, R. A., Groenewegen, P. P., De Vries, S., & Spreeuwenberg, P. (2006). Green space, urbanity, and health: how strong is the relation? *Journal of Epidemiology and Community Health*, 60(7), 587-592.
- Maas, J., Verheij, R. A., Spreeuwenberg, P., & Groenewegen, P. P. (2008). Physical activity as a possible mechanism behind the relationship between green space and health: a multilevel analysis. *BMC Public Health*, 8(1), 1.
- Maas, J., Van Dillen, S. M., Verheij, R. A., & Groenewegen, P. P. (2009a). Social contacts as a possible mechanism behind the relation between green space and health. *Health & Place*, 15(2), 586-595.

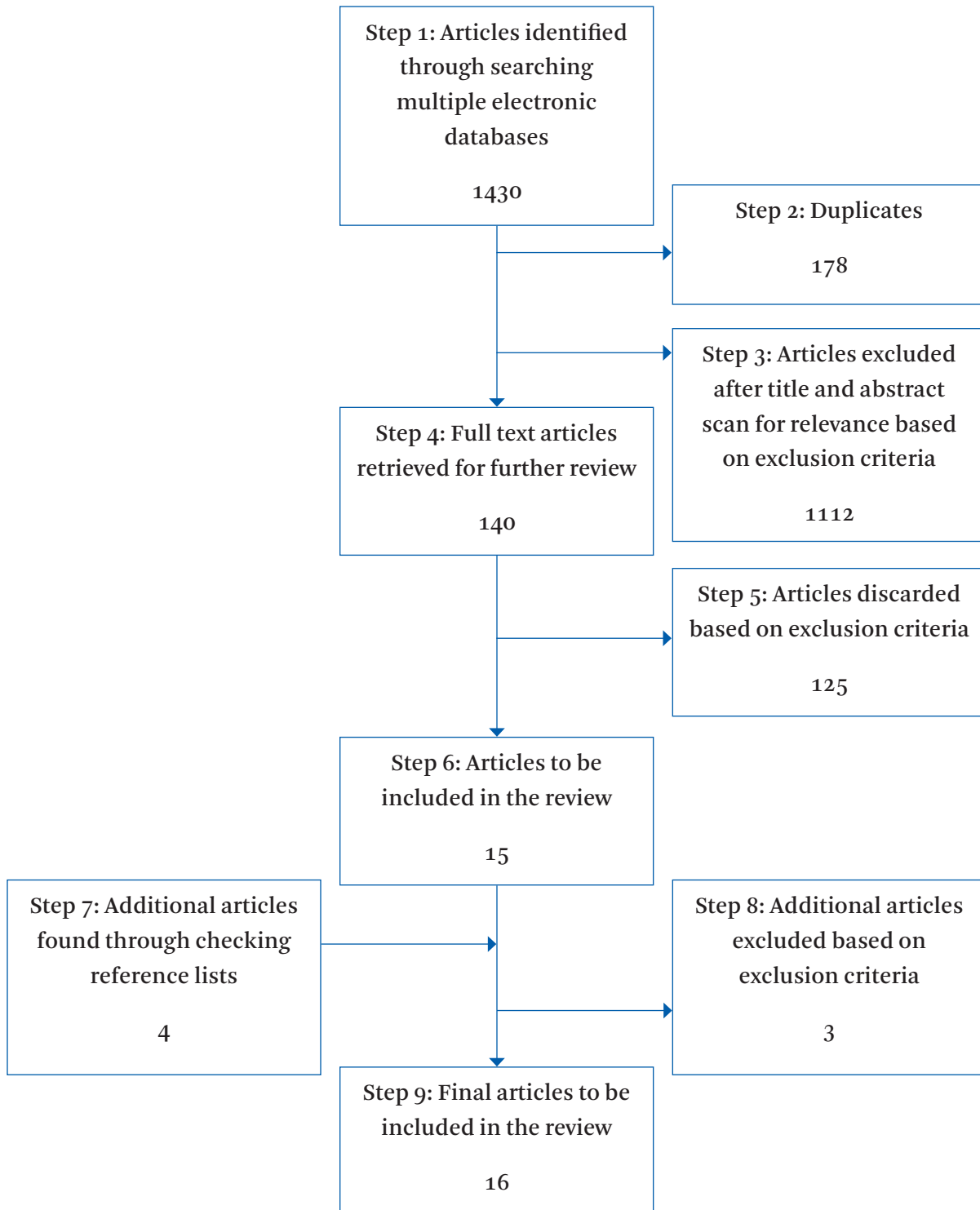
- Maas, J., Verheij, R. A., de Vries, S., Spreeuwenberg, P., Schellevis, F. G., & Groenewegen, P. P. (2009b). Morbidity is related to a green living environment. *Journal of Epidemiology and Community Health*, *63*(12), 967-973.
- Maller, C., Townsend, M., Pryor, A., Brown, P., & St Leger, L. (2006). Healthy nature healthy people: 'contact with nature' as an upstream health promotion intervention for populations. *Health Promotion International*, *21*(1), 45-54.
- Mayer, F. S., Frantz, C. M., Bruehlman-Senecal, E., & Dolliver, K. (2008). Why is nature beneficial? The role of connectedness to nature. *Environment and Behavior*, *41*, 607-643.
- McCormack, G. R., Rock, M., Toohey, A. M., & Hignell, D. (2010). Characteristics of urban parks associated with park use and physical activity: A review of qualitative research. *Health & Place*, *16*(4), 712-726.
- Milligan, C., & Bingley, A. (2007). Restorative places or scary spaces? The impact of woodland on the mental well-being of young adults. *Health and Place*, *13*(4), 799-811.  
<https://doi.org/10.1016/j.healthplace.2007.01.005>
- Nielsen, T. S., & Hansen, K. B. (2007). Do green areas affect health? Results from a Danish survey on the use of green areas and health indicators. *Health & Place*, *13*(4), 839-850.
- Nisbet, E. K., Zelenski, J. M., & Murphy, S. A. (2011). Happiness is in our nature: Exploring nature relatedness as a contributor to subjective well-being. *Journal of Happiness Studies*, *12*(2), 303-322.
- O'Brien, L. (2006). Strengthening heart and mind: Using woodlands to improve mental and physical well-being. *Unasylva*, *57*(224), 56-61
- O'Campo, P., Salmon, C., & Burke, J. (2009). Neighbourhoods and mental well-being: What are the pathways? *Health and Place*, *15*(1), 56-68.
- Özgüner, H., & Kendle, A. D. (2006). Public attitudes towards naturalistic versus designed landscapes in the city of Sheffield (UK). *Landscape and Urban Planning*, *74*(2), 139-157.
- Özgüner, H., Eraslan, ., & Yilmaz, S. (2012). Public perception of landscape restoration along a degraded urban streamside. *Land Degradation & Development*, *23*(1), 24-33.
- Park, B. J., Tsunetsugu, Y., Kasetani, T., Hirano, H., Kagawa, T., Sato, M., & Miyazaki, Y. (2007). Physiological effects of Shinrin-yoku (taking in the atmosphere of the forest)-using salivary cortisol and cerebral activity as indicators. *Journal of Physiological Anthropology*, *26*(2), 123-128.
- Peschardt, K. K., Schipperijn, J., & Stigsdotter, U. K. (2012). Use of Small Public Urban Green Spaces (SPUGS). *Urban Forestry and Urban Greening*, *11*(3), 235-244.
- Pretty, J., Peacock, J., Sellens, M., & Griffin, M. (2005). The mental and physical health outcomes of green exercise. *International Journal of Environmental Health Research*, *15*(5), 319-337.
- Putrik, P., de Vries, N. K., Mujakovic, S., van Amelsvoort, L., Kant, I., Kunst, A. E., ... & Jansen, M. (2015). Living environment matters: relationships between neighborhood characteristics and health of the residents in a Dutch municipality. *Journal of Community Health*, *40*(1), 47-56.

- Reklaitiene, R., Grazuleviciene, R., Dedele, A., Virviciute, D., Vensloviene, J., Tamosiunas, A., ... & Bernotiene, G. (2014). The relationship of green space, depressive symptoms and perceived general health in urban population. *Scandinavian Journal of Public Health*, 42(7), 669-676.
- Richardson, E. A., Pearce, J., Mitchell, R., & Kingham, S. (2013). Role of physical activity in the relationship between urban green space and health. *Public Health*, 127(4), 318-324.
- Rishbeth, C., & Finney, N. (2006). Novelty and nostalgia in urban greenspace: refugee perspectives. *Tijdschrift voor Economische en Sociale Geografie*, 97(3), 281-295.
- Roe, J. J., Thompson, C. W., Aspinall, P. A., Brewer, M. J., Duff, E. I., Miller, D., ... & Clow, A. (2013). Green space and stress: Evidence from cortisol measures in deprived urban communities. *International Journal of Environmental Research and Public Health*, 10(9), 4086-4103.
- Russell, R., Guerry, A.D., Balvanera, P., Gould, R. K., Basurto, X., Chan K. M. A., Kklain, S., Levine, J., & Tam, J. (2013). Humans and nature: How knowing and experiencing nature affect well-being. *Annual Review of Environment and Resources*, 38, 473-502.
- Sandifer, P. A., Sutton-Grier, A. E., & Ward, B. P. (2015). Exploring connections among nature, biodiversity, ecosystem services, and human health and well-being: Opportunities to enhance health and biodiversity conservation. *Ecosystem Services*, 12, 1-15.
- Schipperijn, J., Ekholm, O., Stigsdotter, U. K., Toftager, M., Bentsen, P., Kamper-Jørgensen, F., & Randrup, T. B. (2010). Factors influencing the use of green space: Results from a Danish national representative survey. *Landscape and Urban Planning*, 95(3), 130-137.
- Scott, D., & Jackson, E. L. (1996). Factors that limit and strategies that might encourage people's use of public parks. *Journal of Park and Recreation Administration*, 14(1), 1-17.
- Shanahan, D. F., Fuller, R. A., Bush, R., Lin, B. B., & Gaston, K. J. (2015). The health benefits of urban nature: how much do we need?. *BioScience*, 65(5), 476-485.
- Stigsdotter, U. K., Ekholm, O., Schipperijn, J., Toftager, M., Kamper-Jørgensen, F., & Randrup, T. B. (2010). Health promoting outdoor environments-Associations between green space, and health, health-related quality of life and stress based on a Danish national representative survey. *Scandinavian journal of public health*.
- Sturm, R., & Cohen, D. (2014). Proximity to urban parks and mental health. *The Journal of Mental Health Policy and Economics*, 17(1), 19.
- Sugiyama, T., Leslie, E., Giles-Corti, B., & Owen, N. (2008). Associations of neighbourhood greenness with physical and mental health: do walking, social coherence and local social interaction explain the relationships?. *Journal of Epidemiology and Community Health*, 62(5), e9-e9.
- Thompson Coon, J., Boddy, K., Stein, K., Whear, R., Barton, J., & Depledge, M. H. (2011). Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental wellbeing than physical activity indoors? A systematic review. *Environmental Science & Technology*, 45(5), 1761-1772.
- Toronto Public Health. (2015). Green City: Why nature matters to health – An Evidence Review. Toronto, Ontario.

- Tzoulas, K., Korpela, K., Venn, S., & James, P. (2007). Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. *Landscape and Urban Planning*, 81(3), 167-178.
- van den Berg, M., Wendel-Vos, W., van Poppel, M., & Maas, J. (2015). Health benefits of green spaces in the living environment: A systematic review of epidemiological studies. *Urban Forestry and Urban Greening*, 14(4), 806-816.
- Van Dillen, S. M., de Vries, S., Groenewegen, P. P., & Spreeuwenberg, P. (2012). Greenspace in urban neighbourhoods and residents' health: adding quality to quantity. *Journal of Epidemiology and Community Health*, 66(6), e8-e8.
- Velarde, M. D., Fry, G., & Tveit, M. (2007). Health effects of viewing landscapes - Landscape types in environmental psychology. *Urban Forestry and Urban Greening*, 6(4), 199-212.
- Villanueva, K., Badland, H., Hooper, P., Koohsari, M. J., Mavoa, S., Davern, D., Roberts, R., Goldfeld, S., & Giles-Corti, B. (2015). Developing indicators of public open space to promote health and wellbeing in communities. *Applied Geography*, 57, 112-119.
- Wakefield, S., Yeudall, F., Taron, C., Reynolds, J., & Skinner, A. (2007). Growing urban health: community gardening in South-East Toronto. *Health Promotion International*, 22(2), 92-101.
- Waliczek, T. M., Zajicek, J. M., & Lineberger, R. D. (2005). The influence of gardening activities on consumer perceptions of life satisfaction. *HortScience*, 40(5), 1360-1365.
- White, M. P., Alcock, I., Wheeler, B. W., & Depledge, M. H. (2013). Would you be happier living in a greener urban area? A fixed-effects analysis of panel data. *Psychological Science*, 0956797612464659.
- White, M., Smith, A., Humphries, K., Pahl, S., Snelling, D., & Depledge, M. (2010). Blue space: The importance of water for preference, affect, and restorativeness ratings of natural and built scenes. *Journal of Environmental Psychology*, 30(4), 482-493.

# Appendix

Figure 1. Flowchart of the Scoping Review Process (Stage 2 and 3 of Arksey and O'Malley (2005))



**Table 1. Table of Findings**

Author & Year	Country	Review Design	Aim of article	Definition of green space (and related components)	Definition of mental health and well-being (and related components)	# of final articles in review	Model (Yes or No)	Main Findings
Abraham et al. (2010)	Switzerland	Scoping Review (Arksey & O'Malley, 2005)	To systematically describe the potential of landscape as a resource for physical, mental and social well-being.	<b>Landscape:</b> "natural or designed environments in urban and rural areas. Landscape can be imagined as a continuum between 'wild' nature and designed environments such as urban and rural forests, green spaces, parks, gardens, waters, and neighbourhood areas." (p.59)	<b>Mental well-being</b> through attention restoration, stress reduction and evoking positive emotions	123	Yes	<ul style="list-style-type: none"> <li>Landscapes may provide a space for mental health promotion including recovery from stress and promoting positive emotions.</li> <li><u>Access to Green Space:</u> Easy access and availability of nearby public green spaces are key</li> <li><u>Quality of Green Space:</u> <ol style="list-style-type: none"> <li>perceived as pleasant and attractive for all senses</li> <li>safe (e.g. well-lit routes and presence of other people and sidewalks)</li> <li>general functionality to promote walkability</li> </ol> </li> <li>Health promoting landscapes are perceived and used differently by various social groups and are group specific.</li> </ul>
Badland et al. (2014)	Australia	Literature Review	<ol style="list-style-type: none"> <li>To bring together concepts of urban 'liveability' and social determinants of health 2)</li> <li>To synthesize various liveability indicators developed</li> <li>To assess their quality using a health and wellbeing lens</li> </ol>	<b>Liveable cities:</b> "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." (p.65)	Not defined explicitly	82	Yes	<ul style="list-style-type: none"> <li>Use a livability framework based on the social determinants of health to connect public health and urban planning. Relevant indicators can then be used to measure progress</li> <li>Public Open Spaces (POS) are important for mental health and wellbeing.</li> <li>Access to Green Space: indicator (Objective)</li> <li>Quantity of POS indicator (Objective)</li> <li>Quality of Green Space and Variety of POS (Subjective), Frequency of Use</li> <li>Some indicators were specific to types of spaces (e.g., playgrounds, green spaces) or populations (e.g., youth, older adults).</li> <li>Range of POS indicators exists with potential; all required further development</li> </ul>

Bratman et al. (2012)	USA	Snowball method from seminal work of Stephen & Rachel Kaplan.	To review the effects of nature experience on human cognitive function and mental health.	<p><b>Nature experience:</b> Time spent being physically present within, or viewing from afar, landscapes. The distinction between physical and visual contact with nature may be important.</p> <p><b>Nature/natural:</b> "Areas containing elements of living systems that include plants and non-human animals across a range of scales and degrees of human management—from a small urban park to "pristine wilderness." (p.120)</p>	<p><b>Mood:</b> "A sustained positive or negative affective state that can influence emotions occurring over a shorter time-span" (p.121)</p> <p><b>Stress:</b> "the psychophysiological phenomenon caused when environmental demands reach or exceed an organism's capacity to address those demands." (p.122)</p>	N/A	No	<ul style="list-style-type: none"> <li>• There are positive impacts of nature experience on mental health (mood and stress). • Support for "green exercise": nature benefits individuals over and above exercise itself. <b>Access to Green Space:</b></li> <li>• Natural areas viewed from inside or physically experienced important for mental health. • More research needed to determine the ideal amount of exposure to nature. • Useful if future research is able to attribute "psychological benefit values" reliably to different nature types (urban parks vs. forests) e.g. quantify marginal benefit of a single tree in an urban park • Natural environments provided quieter atmospheres and comparatively larger field of view than the urban environments</li> </ul>
Di Nardo et al. (2010)	Italy	Systematic Review	To examine the evidence of green areas on health outcomes	<p><b>Natural green space:</b> "our public parks, woodlands, countryside and even our tree-lined streets." (p.402)</p>	<p><b>Health:</b> "physical health and also mental health, social health, physical activity and well-being." (p.402)</p>	15	No	<p><b>Quantity of Green Space:</b></p> <ul style="list-style-type: none"> <li>• Availability of urban green spaces is key elements that influence perceived health in a measurable way</li> <li>• Population's response to urban design interventions is often unpredictable</li> </ul> <p><b>Access to Green Space:</b> • Ability to access green spaces positively affects stress and quality of life/ the longer the distance of the respondents' homes from the nearest green space, the more stress was reported • Lack of robust evidence for the link between mental health, well-being and green space • People who are stressed may actively seek green space</p>

Gascon et al. (2015)	Spain/ Norway	Systematic Review	To systematically review the available literature on the long-term mental health benefits of residential green and blue spaces.	Green spaces: refers to "vegetation (trees, grass, forests, parks, etc.)" (p.4355)	Mental health (Disorders including mood, dysthymic, depressive, bipolar, cyclothymic, anxiety, anxiety-panic, obsessive-compulsive, posttraumatic stress, stress, acute stress, body dysmorphic, factitious, mental, dissociative disorders and somatization, agoraphobia, phobia, somatoform hypochondriasis, depersonalization dissociative amnesia, mental health, mental hygiene, emotional well-being, psychological well-being, social well-being, well-being). (p.4356)	28	No	<p><b>Quantity of Green Space:</b> • Limited evidence of causal relationship between surrounding greenness and mental health in adults.</p> <p><b>Access to Green Space:</b> • Inadequate evidence of a causal relationship between access to green spaces and mental health in adults. Mainly measured as the distance to the nearest green space, park or public open space.</p> <p>Limited number of studies on access to green spaces and emotional problems in children. <b>Quality of Green Space:</b> • Two studies assessed the mental health benefits of the quality of green spaces and found positive benefits. • Need further research and more detailed information on the characteristics of the green spaces that promote better mental health (quantity, quality and distance) and the mechanisms, which are highly related to the use of these spaces.</p>
Hunter & Luck (2015)	New York, US	Semi-systematic review	To acknowledge the heterogeneity among different greenspace types, and to use suitable metrics of greenspace ecological and social quality	Greenspace: "open, unsealed land with some form of vegetation cover. When this greenspace occurs within the limits of urban settlements, it is often referred to as 'urban greenspace' (UGS)" (p.1139)	Psychological benefits: "Self-rated or objectively measured psychological health or other psychological measure including restoration and affective responses to landscapes." (p.1147)	50	Yes	<p>First known typology compiled based on the qualities of green spaces as opposed to the types of green spaces. <b>Quality of Green Space:</b> 14 qualities used to define urban green space and extent to which used in literature:</p> <ul style="list-style-type: none"> <li>• 'Physical' (72%) • 'Descriptive' (68%)</li> <li>• 'Biotic' (49%) • 'Planning concepts' (43%) • 'Socio-cultural' (38%) • 'Access' (36%) • 'Management' (32%) • 'Ownership' (26%) • 'Spatial' (19%) • 'Abiotic' (19%)</li> <li>• 'Temporal' (15%) • 'Designation' (8%)</li> <li>• 'Governance' (8%)</li> </ul>



Keniger et al. (2013)	Australia/ UK	Literature Review	<p>1) To explore the geographic distribution of studies on benefits of interacting with nature</p> <p>2) To examine the types of benefits studied to understand whether some have received more focus than others</p> <p>3) To review the evidence on each of the identified benefits of people-nature interactions</p>	<p><b>Green spaces and natural elements:</b> “public and private parks, gardens, landscaping and street trees.” (p.918)</p>	<p><b>Psychological well-being:</b> “positive effect on mental processes.”</p> <p>E.g: improved mood, reduced anger/frustration, psychological-well-being (note: stress reduction was considered a physiological effect in this paper) and mental fatigue considered cognitive. (p.917)</p>	57	No	<ul style="list-style-type: none"> <li>• Interaction with nature can improve self-esteem, mood, psychological well-being and reduce anger and stress.</li> <li>• Psychological well-being effects arising from exercising in a natural environment.</li> <li>• Some studies found little or no relationship between the setting in which exercise takes place and psychological well-being benefit.</li> <li>• Intentional interactions with nature (e.g. gardening and watching wildlife) promote psychological well-being.</li> <li>• Interacting with nature may have specific benefits for children, including positive impact on self-esteem and mental-well-being.</li> <li>• There is emerging evidence that childhood interactions with nature may influence attitudes towards nature in later life.</li> </ul>
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Lachowycz & Jones (2013)	UK	Literature Review	To develop a novel theoretical framework which summarizes current knowledge about hypothetical causal pathways between access to greenspace and health outcomes.	Green space: "broadly encompass publicly accessible areas with natural vegetation, such as grass, plants or trees" (p.62) They include built environment features, such as urban parks, as well as less managed areas, including woodland and nature reserves.	Psychological health benefits: "e.g. improved mental well-being, recovery from stress and attention fatigue, reduced aggression" (p.64)	N/A	Yes	<ul style="list-style-type: none"> <li>Physical and mental health outcomes are interacting states</li> <li>Psychological benefits gained from exposure to nature and social interactions.</li> <li>Moderation occurs by three broad mechanisms:             <ol style="list-style-type: none"> <li>1) Opportunity to use green space</li> <li>2) Personal motivation and reasons to use green space</li> <li>3) Ease of use.</li> </ol> </li> <li>Three broad groups of mediators:             <ol style="list-style-type: none"> <li>1) improved perceptions and satisfaction from "having the park there"</li> <li>2) aesthetic satisfaction and restoration from viewing natural features</li> <li>3) use of the space for relaxation, physical activities, socialization, and to interact with wildlife</li> </ol> </li> </ul> <p><b>Quality of Green Space:</b> • Information about quality and type of green space is rarely available. Key park characteristics are condition, safety, and aesthetics.</p> <ul style="list-style-type: none"> <li>Free use of public green space vision enables use by lower socioeconomic status (SES) groups.</li> <li>Ethnicity influences perceptions of natural environments, preferences for recreation and nature and frequency of use of green space.</li> </ul>
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Lee & Maheswaran (2010)	UK	Literature review (with quality assessment)	To broadly examine the evidence for the population health benefits of green spaces, and to provide a narrative summary for health policy-makers and urban planners.	'Green space' and 'public open space' were used interchangeably and presumed to be synonymous.	Not explicitly defined	35	No	<ul style="list-style-type: none"> <li>Weak evidence for link between physical, mental health and well-being, and urban green space.</li> <li>User determinants, such as age, gender, ethnicity, the perception of safety, are important.</li> </ul> <p><u>Quantity of Green Space:</u></p> <ul style="list-style-type: none"> <li>Availability of green space influences of the space.</li> </ul> <p><u>Access to Green Space:</u></p> <ul style="list-style-type: none"> <li>The provision and access to green space positively affects reported stress and quality of life.</li> </ul> <p><u>Quality of Green Space:</u></p> <ul style="list-style-type: none"> <li>Characteristics of green space (features, condition, accessibility, safety) affect the use of green space.</li> <li>State of disrepair of green space negatively affects its use by contributing to perception of lack of safety. Important for children, youth and their parents.</li> </ul>
Lovell et al. (2014)	UK	Systematic Review/ Narrative analysis	To systematically identify, summarize, and synthesize research that had examined whether biodiverse environments are health promoting.	<b>Biodiversity is not explicitly defined.</b> <b>Cultural ecosystem services:</b> "the 'nonmaterial' benefits that are derived from ecosystems and are related to factors such as promotion of well-being through aesthetics, leisure and recreation, and sense of place" (p.2)	Not explicitly defined	17	No	<p><u>Quality of Green Space:</u></p> <ul style="list-style-type: none"> <li>Evidence to suggest that biodiverse natural environments promote better health through exposure to pleasant environments or the encouragement of health-promoting behaviors.</li> <li>However, overall inconclusive evidence that fails to identify a specific role for biodiversity in the promotion of better health.</li> <li>Positive associations between subjective assessment of species (bird, butterfly, and plant) richness and self-report well-being.</li> </ul>

Russell et al. (2013)	British Columbia, Canada/ US	Literature Review	To identify facets of the relationship between well-being and differences in nature elements that have received substantive research attention and to highlight those that remain poorly captured.	<b>Natural/nature:</b> "all living and nonliving components of ecosystems described in an expansive though not exhaustive way, excluding nonliving human-built environments" (p.475) <b>Ecosystem services:</b> ecosystems' contributions to human well-being, e.g., provisioning services, regulating services, cultural services, and underpinning them all, supporting services (p.475)	Mental health and subjective (overall) well-being are 2 of the 10 constituents that span the spectrum of critical dimensions of human well-being. <b>Mental health:</b> "include cognitive performance, self-reported stress, and emotional well-being (focusing on change or difference in mental health resulting from or correlating with biophysical change or differences)" (p.480) <b>Subjective well-being:</b> "self-reported assessments of overall individual well-being." (p.490)	Not available	Yes	<ul style="list-style-type: none"> <li>Contributions of nature experiences to human well-being can be difficult and sometimes impossible to quantify.</li> <li>Generally, nature makes people happier and healthier via our nontangible connections to ecosystems. • The empirical literature explicitly identifies strong relationships between nature and mental health.</li> <li>Viewing, interacting with, and living in natural environments can reduce stress, increase patience, self-discipline, capacity for attention, recovery from mental fatigue or from crisis and from psychophysiological imbalance. • Evidence on subjective well-being is scarce.</li> </ul>
Sandifer et al. (2015)	USA	Review (No quality assessment)	To explore connections among nature, biodiversity, ecosystem services and human health and well-being, through biodiversity–ecosystem services linkages, associations of nature with human health	<b>Nature:</b> "the physical and biological world not manufactured or developed by people". (p.2) <b>Natural elements:</b> "plants and other living things, natural areas including coastlines and mountains, natural and semi-natural environments" (p.2) <b>Biodiversity:</b> "the variety of life, encompassing variation at all levels, from the genes within a species to biologically created habitat within ecosystems." (p.2) <b>Ecosystem services:</b> "the specific benefits people derive from nature" (p.2)	<b>Health, or health and well-being:</b> including a supportive environment, personal security, freedom of choice, social relationships, adequate employment and income, access to educational resources, and cultural identity (p.2)	Not available	Yes	<ul style="list-style-type: none"> <li>Interacting with nature has psychological reported health benefits including: psychological well-being, positive/improved mood, increased happiness, increased calmness, comfort and refreshment.</li> </ul> <p><b>Quality of Green Space:</b></p> <ul style="list-style-type: none"> <li>Diverse natural habitats and many different species, has important positive impacts for human health, including mental health. • Esthetic appreciation of biodiversity may contribute to the cultural and emotional components of human well-being. • Some exposure to wildlife also may provide health benefits. • Although the evidence is limited to date, taken together these studies suggest that contact with biodiverse environments, or those perceived to be biodiverse, result in positive benefits to human well-being.</li> </ul>

Tzoulas et al. (2007)	Finland/ UK	Literature Review	To formulate a conceptual framework of associations between urban green space, and ecosystem and human health.	<b>Green Infrastructure:</b> "comprised of all natural, semi-natural and artificial networks of multifunctional ecological systems within, around and between urban areas, at all spatial scales. Emphasizes the quality of urban as quantity of urban and peri-urban green spaces." (p.169)	<b>Health:</b> "a state of complete physical, mental and social well-being" (p.168) <b>Well-being:</b> "encompasses a wide array of biological, sociological, economical, environmental, cultural and political factors" <b>Well-being:</b> "includes material security, personal freedoms, good social relations and physical health" (p.169)	20	Yes	<ul style="list-style-type: none"> <li>Nearby trees and grass visible from apartment buildings have been shown to enhance residents' effectiveness in facing their major life issues and to lessen intra-family aggression by reducing mental fatigue</li> <li>Sufficient evidence that a Green Infrastructure is a significant public health factor <b>Quality of Green Space:</b></li> <li>Green spaces that are perceived to be overgrown or unmanaged may have a negative effect on peoples' well-being by increasing anxiety caused by fear of crime</li> <li>Passive viewing of natural environments produces stress-ameliorating effects</li> <li>Favourite places in natural settings provide emotional release and restorative experiences • Diversity of habitats and species in and around urban areas may have human well-being benefits</li> </ul>
van den Berg et al. (2015)	The Netherlands/ Austria	Systematic Review of epidemiological studies	To systematically review the literature examining the relationship between quantity and quality of green spaces and health outcomes.	<b>Green spaces:</b> "open spaces with natural elements such as parks, playgrounds and recreation areas" (p.806)	<b>Perceived mental health</b> was used but not explicitly defined.	30	No	<ul style="list-style-type: none"> <li>Studies suggested that associations depend on subgroups such as gender, age groups, social economic status, level of physical activity of people. However, findings were mixed and inconclusive.</li> <li><b>Quality of GS on MH:</b> • Strong evidence for significant positive associations between the quantity of green space (objectively measured around residence) and perceived mental health (based on five high quality studies with significant findings and one high-quality with null findings)</li> <li><b>Quality of GS on MH:</b></li> <li>Insufficient studies on the quality of green spaces to synthesize evidence.</li> </ul>

Velarde et al. (2007)	Spain/ Norway	Literature Review	To analyse the range of landscapes used in environmental psychology studies, and the evidence of health effects related to viewing these landscapes	<b>Landscape:</b> “a key element of individual and social well-being” The European Landscape Convention (p.199)	<b>Health:</b> “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (p.199) <b>Restoration:</b> “the process of renewing physical, psychological and social capabilities diminished in ongoing efforts to meet adaptive demands” (p.200)	31	Yes	<b>Quantity of Green Space:</b> • Generally, natural landscape had a stronger positive health effect compared to urban landscapes. • Main health effects: short-term recovery from stress or mental fatigue, and long-term overall improvement on people’s health and well-being • Little information about which landscape elements have contributed most to the reported health effects. <b>Quality of Green Space:</b> • Presence of water gives a positive health effect, but results are weak. No clear relationship was identified between openness and health effects. • The greener the environment the better. However, no information provided about what kind of greenery produces the greatest benefit, or whether all kinds of natural elements give similar effects.
Villanueva et al. (2015)	Australia	Literature review of Australian policy documents, grey literature, and journal articles (Australian and international)	To develop policy-relevant indicators of public open space (POS) to promote health and well-being in communities	Public Open Space (POS) refers to green spaces. POS is one component of “liveability”, should be “safe, attractive, socially cohesive, inclusive and environmentally sustainable ... via convenient public transport, walking and cycling infrastructure” (p.113)	Mental health: stress, anxiety, depression, and attention deficit disorders, psychological distress, perceived quality of life. (p.112)	N/A (12 POS indicators)	Yes	<b>Quantity of Green Space:</b> • Identified “liveability” indicators that are specific, quantifiable and spatially defined, scale appropriate <b>Quality of Green Space:</b> • POS quality or attractiveness is (e.g., sporting facilities, shade along paths, water features, and lighting). • Measuring POS at a smaller scale is preferable. • The conceptual framework differentiates between “upstream” POS determinants of health outcomes and “downstream” POS determinants, which are more behavioural.

**Table 2. Indicators of Quantity of Green Space**

Positive association (+) means that when the indicator is increased, there is a positive association with mental health and well-being (i.e. improved mental health and well-being).

Review	Article	Indicator/ Measure Definition	Population	Association with Mental Health and Well-Being
<b>Amount of Green Space (Percentage or circular buffer)</b>				
Gascon et al. (2015)	Flouri et al. (2014)	% GS at Census Area Unit (CAU)	Poor children 3 – 5 y	+
Gascon et al. (2015)	Alcock et al., (2014); White et al.(2013)	% GS at Census Area Unit (CAU)  (residence change in time)	Adults	+
Gascon et al. (2015)	Astell-Burt et al. (2013)	% GS in 1 km buffer	Physically active adults > 45 y	+
Gascon et al. (2015)	Beyer et al. (2014)	% tree canopy coverage at CAU	21 – 74 y	+
Gascon et al. (2015)	Roe et al. (2013)	% GS at CAU	33–55 y of socio-economically deprived areas	+
Gascon et al. (2015)	Richardson et al. (2013)	% GS of > = 0.02 ha at CAU	>15 y (physical activity)	+
Hunter & Luck (2015), Lovell et al. (2014), Sandifer et al. (2015)	Dallimer et al. (2012)	% canopy cover	16–70+ y, users of green spaces during sampling period	+
Di Nardo et al. (2010), Lee & Maheswaran (2010), Keniger et al. (2013)	Maas et al. (2006)	% of GS/ Amount of GS	Not specified in review. Association stronger for lower socioeconomic groups, youth, and the elderly	+

Villanueva et al. (2015)	Multiple documents and policy guidelines. Not specified'	1. % POS area within SA1 2. % POS area of subdivisible SA1 land area 3. # of POS available within SA1 4. # POS by size/type within SA1 Note: spatially defined boundaries are key for comparison	Not specified in review	+
van den Berg et al. (2015)	Maas et al. (2009a), Paquet et al. (2013) van Dillen et al. (2012)	Amount of GS around residence in circular buffer	General Population	+
van den Berg et al. (2015)	Alcock et al. (2014)	Amount of GS around residence in circular buffer	Movers to more green space	+
van den Berg et al. (2015)	Astell-Burt et al. (2014)	Amount of GS around residence in circular buffer	men early adulthood through middle age; women only middle age through old age	+
van den Berg et al. (2015)	Beyer et al. (2014), White et al. (2013), Richardson et al. (2013)	Amount of green space in small area/neighbourhood	General Population	+
van den Berg et al. (2015)	Astell-Burt et al. (2013)	Amount of green space in small area/neighbourhood	(middle/old-aged and only most physically active)	+
van den Berg et al. (2015)	van Dillen et al. (2012)	Amount of streetscape greenery	General Population	+
van den Berg et al. (2015)	Chong et al. (2013)	Amount of green space in small area/ neighbourhood	General Population	None



Gascon et al. (2015)	Triguero-Mas et al. (2015)	Increasing greenness (within 100 m, 300 m, 500 m and 1 km buffers)	34–64 y (physical activity, gender, degree of urbanization, socioeconomic status and social support)	+
Gascon et al. (2015)	Triguero-Mas et al. (2015)	Presence of a GS within 100 m, 300 m, 500 m and 1 km buffers	34–64 y (physical activity, gender, degree of urbanization, socioeconomic status, and social support)	None
Gascon et al. (2015)	Fan et al. (2011)	Total park acreage in an 800 m buffer	Adults 18 – 75 y	None
Gascon et al. (2015)	Sarkar et al. (2013)	500 m buffer	65 – 84 y	None
Gascon et al. (2015)	van den Berg et al. (2010)	% GS in 1 km & 3 km buffers	>18 y (stressful life events)	None
Gascon et al. (2015)	Balseviciene et al. (2014)	Distance to the nearest park of >1 ha and 65% of the land tree covered <sup>2</sup>	4–6 y (maternal education) Lower maternal education group	None
Hunter & Luck (2015)	Ward Thompson et al. (2012)	Not specified in review.	Not specified in review. 25 “deprived” adults (all of lower SES; 72% unemployed)	+
<b>Number of Green Spaces</b>				
van den Berg et al. (2015)	Annerstedt et al. (2012)	Presence/number of green spaces within distance (not specified in review)	Physically active women	+
van den Berg et al. (2015)	Annerstedt et al. (2012)	Presence/number of green spaces within distance (not specified in review)	General Population	None

<b>Perception of Green Spaces</b>				
Hunter & Luck (2015)	Leslie et al. (2010)	Greenness of neighbourhood: user-perceived and user-independent Note: User-perceived measures consider what is known and accessible	Not specified in review.	+
Di Nardo et al. (2010), Lee & Maheswaran (2010), van den Berg et al. (2015)	Sugiyama et al. (2008)	Perception of degree of neighbourhood greenness	Not specified in review/ General Population	+
Lee & Maheswaran (2010), Bratman et al. (2012)	van den Berg et al. (2010)	Higher levels of green space	Not specified in review	+

**Table 3. Indicators of Access to Green Space**

Positive association (+) means that when the indicator is increased, there is a positive association with mental health and well-being (i.e. improved mental health and well-being)

Review	Article	Indicator/ Measure Definition	Population (Stratifications/ Interactions)	Association with Mental Health and Well-Being
<b>Objective Access</b>				
Gascon et al. (2015)	Sturm & Cohen (2014)	Distance to the studied parks (<400 m, 400–800 m, 800 m-1.6 km, >1.6 km) Note: (no association beyond 1.6 km)	45–72 y (age, gender, park use)	+
Di Nardo et al. (2010), Lee & Maheswaran (2010)	Stigsdotter et al. (2010)	Residence within 300m from a green space (Note: if more than 1 km away, higher probability of stress)	Not specified in review	+
Di Nardo et al. (2010)	van den Berg et al. (2010)	GS within 3 km but not for GS within 1 km from home	Not specified in review	+ / None

Villanueva et al. (2015)	Multiple documents and policy guidelines. Not specified <sup>3</sup>	<ol style="list-style-type: none"> <li>1. Road network distance from SA1 population-weighted centroid to nearest POS border</li> <li>2. 95% of dwellings have access to a local (&lt;0.3ha) park POS &lt; 400 m</li> <li>3. 95% of dwellings have access to a small (&gt;0.3 to &lt;0.5 ha) neighbourhood park POS &lt; 400 m</li> <li>4. 95% of dwellings have access to a medium (&gt;0.5 to &lt;1.5 ha) neighbourhood park POS &lt; 400 m</li> <li>5. 95% of dwellings have access to a large (&gt;1.5 to &lt;2.5 ha) neighbourhood park POS &lt; 800 m</li> <li>6. 95% of dwellings have access to a district (&gt;2.5 to &lt;4.0 ha) park POS &lt; 800 m</li> <li>7. 95% of dwellings have access to a regional (&gt;4.0 ha) park POS 5 km or 10 km</li> </ol> <p>1. Note: spatially defined boundaries are key for comparison</p>	Not specified in review	+
Lee & Maheswaran (2010)	Maas et al. (2006)	Proximity to green space (not defined further in review)	Not specified in review.	+
van den Berg et al. (2015)	Sturm & Cohen (2014)	Distance to nearest green space (objective)	General Population	+
van den Berg et al. (2015)	Reklaitiene et al. (2014)	Distance to nearest green space (objective)	Female park users living close to park	+
van den Berg et al. (2015)	Carter & Horwitz (2014)	Proximity to nearby play and social spaces	Not specified in review	+
Gascon et al. (2015)	Fan et al. 2011,	Distance to the nearest park	Adults 18–75 y	None

<b>Subjective Access</b>				
Hunter & Luck (2015), Abraham et al. (2007)	Gidlöf-Gunnarsson and Öhrström (2007)	Subjective question: "Do you have access to green areas close to your dwelling?" 3 response categories	Not specified in review. 18-75y	None
van den Berg et al. (2015)	Sturm & Cohen (2014)	Distance to nearest green space (self-reported)	General Population	+
van den Berg et al. (2015)	Reklaitiene et al. (2014)	Distance to nearest green space (self-reported)	Female park users living close to park	+

**Table 4. Indicators of Quality of Green Space**

Positive association (+) means that when the indicator is increased, there is a positive association with mental health and well-being (i.e. improved mental health and well-being)

Review	Article	Indicator/ Measure Definition	Population	Association with Mental Health and Well-Being
<b>Biodiversity</b>				
Hunter & Luck (2015), Lovell et al. (2014), Russell et al. (2013), Sandifer et al. (2015), Lachowycz & Jones (2013)	Fuller et al. (2007)	Biodiversity: user-perceived and user-independent species richness (bird, plant, habitat diversity) Note: objectively measured species richness is positively associated	16-70+ y ,users of green spaces during sampling period	+
Lovell et al. (2014)	Björk et al. (2008)	Species diversity	18-80 y	+
Lovell et al. (2014)	Luck et al. (2011)	Species richness (weakly positive)	No age provided	+
Hunter & Luck (2015), Lovell et al. (2014), Sandifer et al. (2015)	Dallimer et al. (2012)	Perceived (subjective) species richness (bird, butterfly, plant, habitat diversity)	16-70+ y ,users of green spaces during sampling period	+
Lovell et al. (2014)	Annerstedt et al. (2012)	Presence of Environmental Qualities: More biodiverse environment	18-80 y	None
Lovell et al. (2014)	Grahn and Stigsdotter (2010)	Biodiverse environments	Adult	None
Sandifer et al. (2015)	Fuller et al. (2007)	Butterfly diversity	16-70+ y ,users of green spaces during sampling period	None
Hunter & Luck (2015)	Dallimer et al. (2012)	Objectively measured species richness	Not specified in review	-

Abraham et al. (2010)	Waliczek et al. (2005); Rishbeth & Finney (2006); Wakefield et al. (2007)	Rich in vegetation	Not specified in review	+
<b>Aesthetics</b>				
Gascon et al. (2015)	Annerstedt et al. (2012)	Presence of Environmental Qualities: Serene: a place of peace, silence, and care. Sounds of wind, water, birds, and insects. No rubbish, no weeds, no disturbing people. Spacious: a place offering a restful feeling of “entering another world”, a coherent whole, like a beech forest.	Physically active women	+
Gascon et al. (2015)	De Vries et al. (2013)	Five items: variation, maintenance, orderly arrangement, absence of litter, and general impression. 5 point scales	Not specified in review	+
Villanueva et al. (2015)	Francis et al. (2012)	High quality public open space. Note: residents may not need to use space to benefit	Not specified in review	+
Lee & Maheswaran (2010)	Tzoulas & James (2009)	Good quality open space	N/A because literature review	+
van den Berg et al. (2015)	van Dillen et al. (2012)	Quality of green areas/streetscape (objective or self-reported)	General Population	+
Hunter & Luck (2015)	Nordh et al. (2009)	Presence of flowering plants	Not specified in review	+
<b>Sound Levels/Noise</b>				
Hunter & Luck (2015), Abraham et al. (2010)	Gidlöf-Gunnarsson & Öhrström (2007)	No noise/ Low sound levels	Not specified in review. 18-75 y	+
Di Nardo et al. (2010)	Guite et al. (2006)	No noise	Not specified in review	+

<b>Presence of Blue Spaces/ Water Features</b>				
Hunter & Luck (2015)	White et al. (2010)	Presence of blue spaces (oceans, lakes, ponds or water views)	Not specified in review	+
Abraham et al. (2010)	Maller et al. (2006), Gidlöf-Gunnarsson & Öhrström (2007)	Contains visual richness of elements like waters	Not specified in review	+
<b>Facilities</b>				
Villanueva et al. (2015)	Giles-Corti, Broomhall, et al. (2005); Edwards et al. (2013) <sup>4</sup>	Quality or attractiveness score assigned to each POS based on attributes and amenities (e.g., sporting facilities, shade along paths, water features, and lighting).	Not specified in review	+
Abraham et al. (2010)	Berto (2005)	Availability of public open spaces for entertainment and sports	Not specified in review	+
<b>Safety</b>				
Lachowycz & Jones (2013)	Bedimo-Rung et al. (2005)	Safety of green space	Not specified in review	+
Lee & Maheswaran (2010)	Law et al. (2006)	Lack of disrepair	Children with complex physical disabilities	+
<b>Visual Stimuli/ Design/ Landscape Style</b>				
Abraham et al. (2010)	Maller et al. (2006), Gidlöf-Gunnarsson & Öhrström (2007)	Landscape perceived as pleasant (contains visual stimuli, moderate complexity, richness of elements like vegetation)	Not specified in review	+
Abraham et al. (2010)	Sharpe (2005)	“Wild” nature	Not specified in review	+
Bratman et al. (2012)	Cole & Hall (2010)	Prolonged exposure in wilderness areas	Not specified in review	+
Russell et al. (2013)	Nisbet et al. (2011)	Landscape design	Not specified in review	+
Abraham et al. (2010)	Milligan & Bingley (2007)	Open and accessible forests, perceived amount of open space and vegetation	Not specified in review	+



Lovell et al. (2014), Hunter & Luck (2015)	Jorgensen et al. (2010)	Complexity of environment: visual allocation of landscapes based on complexity	students (from single university) age 17-40 years,	None
Hunter & Luck (2015)	Özgüner et al. (2012)	Landscape style: derelict vs. restored Note: trees, flowers and greenery' as the most preferred  post-restoration landscape features	Not specified in review	+
Hunter & Luck (2015)	Özgüner and Kendle (2006)	Landscape style: naturalistic vs. formal Note: both were valued	Not specified in review	+

**Table 5. Mediating and Moderating Factors**

Review	Article	Factor/Measure Definition	Population	Effect of Green Space on Mental Health and Well-Being (Increase or Decrease)
<b>User demographics</b>				
Hunter & Luck (2015)	Luck et al. (2011)	Demographic variables such as age	Not specified in review	+
Lachowycz & Jones (2013)	Kerr et al. (2007), Scott et al. (2009), Wen et al., (2007)	Race/ethnicity	Association between green space exposure and improved health are stronger for Whites groups	+
Bratman et al. (2012)	Ottosson and Grahn (2008)	Those dealing with greater crisis/ increased level of stress experience greater benefits	Those with poorer mental health	+
Russell et al. (2013)	Mayer et al. (2008)	Demographic variables such as marriage, education, and income	Not specified in review	+
<b>Exposure</b>				
Lovell et al. (2014)	Barton et al. (2009)	Time spent in high natural environment	19–70 y	+
Bratman et al. (2012)	Nisbet & Zelenski (2011)	Duration: Even short exposure	Not specified in review	+
Lee & Maheswaran (2010)	Stigsdotter et al. (2010)	Greater use of green space	Not specified in review	+
Lachowycz & Jones (2013)	Nielsen & Hansen (2007)	Use of green space	Danish adults	-
Bratman et al. (2012)	Pretty et al. (2005), Barton & Pretty (2010)	Dose exposure to nature while exercising (green exercise)	Not specified in review	-
<b>Type of Interaction</b>				
Russell et al. (2013)	Hartig & Staats (2006)	Walking in nature	College students	+
Russell et al. (2013)	Bratman et al. (2012)	Experiencing nature	Not specified in review	+
Russell et al. (2013), Abraham et al. (2010)	Maller et al. (2006)	Contact with nature/ natural landscapes	Not specified in review	+

Russell et al. (2013)	Mayer et al. (2008)	Connectedness to nature	Not specified in review	+
Russell et al. (2013)	Matsuoka & Kaplan (2008)	Being in natural environments	Not specified in review	+
Lovell et al. (2014)	Lemieux et al. (2012)	Visiting protected areas	visitors to protected areas during sampling period, age 19-66+ y	+
Bratman et al. (2012)	Mayer et al. (2008)	Connection to nature through experience	Not specified in review	+
Sandifer et al. (2015)	MacKerron & Mourato, (2013), Park et al. (2009), Kamitsis & Francis (2013)	Interacting with nature	Not specified in review	+
Keniger et al. (2013)	Maller et al. (2009)	Contact with nature	Children	+
Keniger et al. (2013)	Moore et al. (2007)	Interacting with nature	Not specified in review	+
Keniger et al. (2013)	Van den Berg & Custers (2011)	Gardening	Not specified in review	+
Keniger et al. (2013)	Hansmann et al. (2007)	Green Exercise	Not specified in review	+
Lachowycz & Jones (2013)	Maas et al. (2008)	Physical activity as underlying mechanism	Not specified in review	-
Bratman et al. (2012), Sandifer et al. (2015), Keniger et al. (2013)	Pretty et al. (2005), Barton & Pretty (2010)	Green exercise: i.e. exercise in nature	Men	+
Lachowycz & Jones (2013)	Thompson Coon et al. (2011) <sup>5</sup>	Exercise in green environments	Not specified in review	+
<b>Social Connection</b>				
Villanueva et al. (2015)	Francis et al. (2012)	Social support/ sense of community	Not specified in review	+

Russell et al. (2013)	Mayer et al. (2008)	Knowledge of belonging to a community or something bigger through nature	Not specified in review	+
Lachowycz & Jones (2013)	Maas et al. (2008)	Social interactions in greenspace	Not specified in review	+
<b>Level of Satisfaction</b>				
Bratman et al. (2012)	Bowler et al. (2010), Han (2009)	Compatibility (a “match” between an individual’s intentions, inclinations, or purposes and the environment)	Not specified in review	+
Lachowycz & Jones (2013)	Bedimo-Rung et al. (2005)	Satisfaction with “having park there”	Not specified in review	+
van den Berg et al. (2015)	Putrik et al. (2015) Guite et al. (2006)	Satisfaction with green space Quality	General Population	+
Di Nardo et al. (2010)	Guite et al. (2006)	Dissatisfied with access to green open space	Not specified in review	-
<b>Setting/Location</b>				
Lachowycz & Jones (2013)	Nielsen & Hansen (2007), Maas et al. (2008), Babey et al. (2008)	Urban areas: association between GS and health stronger in urban areas compared to rural	Not specified in review	+
<b>Perception of Safety</b>				
Lee & Maheswaran (2010)	National Institute for Health and Clinical Excellence (NICE), 2006	Perceived safety	Children, youth and their parents	+

**Table 6. Other Trends/ Descriptions**

Review	Article	Factor / Measure	Population
Lee & Maheswaran (2010)	Mitchell & Popham (2008), Abercrombie et al. (2008)	Socio-economic factors: Gender, ethnicity, disability	Ethnic minorities and people with disabilities are less likely to use green space. Women are more likely to walk purposefully than for exercise.
Lachowycz & Jones (2013)	Bedimo-Rung et al. (2005)/ Kerr et al. (2007), Scott et al. (2009), Wen at el. (2007)/ Maas et al. (2006), Maas et al. (2009b), Babey et al. (2008)	Socio-economic factors: Gender, ethnicity, income	Women more influenced by safety concerns/ Whites have stronger association between greenspace exposure and improved health/ Lower income groups have stronger association between exposure and improved health
Lachowycz & Jones (2013)	Cutt et al (2007)/ Schipperijn et al. (2010)	Having a dog/dog walker	Dog ownership affiliated with increased physical activity/ Dog walkers are frequent users of greenspace
Lachowycz & Jones (2013)	Kaczynski et al. (2009)	Living with children	Living with children
Lachowycz & Jones (2013)	Babey et al. (2008)	Children living in an apartment	Children
Lachowycz & Jones (2013)	Tucker & Gilligand (2007)	Weather and day length	Especially for children
Lachowycz & Jones (2013)	Coombes et al. (2010)	Greenspace type	Different groups value differently (not specified in review)
Lachowycz & Jones (2013)	Cohen et al. (2010), McCormack et al. (2010)	Characteristics, activities and facilities within greenspace	Jogger: large space with quiet paths Family with young children: smaller areas with play, toilets and parking facilities People may traverse on route: hard surfaced paths and well lit
Lachowycz & Jones (2013)	Cohen et al. (2010)	Amenities	Different groups value differently (not specified in review)
Lachowycz & Jones (2013)	Giles-Corti et al. (2005)	Size and attractiveness	Different groups value differently (not specified in review)
Lachowycz & Jones (2013)	Kaczynski et al. (2009), Maas et al. (2009b)	Age	Younger and older groups are more sensitive to greenspace provision than middle aged adults (who more likely to be at work)
Lachowycz & Jones (2013)	Bedimo-Rung et al. (2005)	High crime rates (perceived or real) / Busy roads, derelict housing deter use of green space	Not specified in review

## Footnotes

- 1 It is unclear if indicator is linked specifically to mental health, but it may have an association and is included here for completeness.
- 2 Multifaceted indicators may include any combination of quantity of, access to, or quality of green space.
- 3 It is unclear if the indicator is linked specifically to mental health, but it may have an association and is therefore included here for completeness.
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