The impact of green spaces on mental health in urban settings: a scoping review

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The impact of green spaces on mental health in urban settings: a scoping review

A. Callaghan, G. McCombe, A. Harrold, C. McMeel, G. Mills, N. Moore-Cherry and W. Cullen

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ABSTRACT

Background: Our planet is currently experiencing the largest wave of urban growth in history, with 55% of the world’s population (4.2 billion people) currently living in urban areas, a figure set to rise to 70% by 2050. Primary care is the first point of treatment for most mental health disorders. Since the urban environment and health are intrinsically linked, it is useful to examine the effectiveness of Nature-Based Solutions in addressing mental health.

Aims: The aim of this scoping review was to examine “How urban green spaces can improve mental health and wellbeing among patients attending general practice and primary care?”

Methods: The scoping review framework comprised a five-stage process developed by Arksey and O’Malley.

Results: Twenty-five studies were included in the review, mostly cross-sectional studies. A wide range of mental health outcomes were identified. Out of the 25 included studies, 23 showed positive associations between mental health and green space characteristics.

Conclusion: Our findings suggest that while green spaces are associated with positive mental health outcomes, most studies were cross-sectional in nature and provided limited evidence for association. Furthermore, the population samples used in most of the studies were taken from national survey data and were not specifically primary care patients. Further studies that assess primary care patients specifically are warranted.

Introduction

Our planet is currently experiencing the largest wave of urban growth in history, with 55% of the world’s population (4.2 billion people) currently living in urban areas, a figure set to rise to 70% by 2050 (United Nations, 2014).

As populations urbanise, access to natural environments such as green spaces can be diminished and where higher density fails to be accompanied by compensatory public space this is particularly the case. Previous research has demonstrated benefits of green spaces to urban communities, including improved physical health (Dempsey et al., 2018), increased physical activity (Ambrey, 2016) and social cohesion (Maas, Van Dillen, et al., 2009).

Recently, there has been greater recognition of the importance of urban green spaces for mental health, as well as physical health. This has led to a body of research that has provided limited, but significant, evidence for the mental health benefits of green spaces (McEachan et al., 2018; Sarkar et al., 2018). There have been a number of theories proposed to explain the positive impact urban green spaces can have on mental health and wellbeing. An early theory by Kaplan & Kaplan proposed that access to green spaces in urban environments allows the mental fatigue of modern life to be countered by “psychological restoration” (Kaplan & Kaplan, 1989). Proximity to green space has been found to improve psychological health through: decreasing cortisol levels (Roe et al., 2013), buffering the negative effects of stressful life events, (Van den Berg et al., 2010), decreasing maternal depression (R. McEachan et al., 2016), increasing social cohesion (Gonzalez & Kirkevold, 2016; Hartig et al., 2014), and increasing general psychological well-being (Annerstedt et al., 2012; Triguero-Mas et al., 2015).

The World Health Organisation (WHO) has stated that urban green spaces are a “necessary component for delivering healthy, sustainable, liveable conditions” and have highlighted the need for evidence to support more effective urban planning (World Health Organization, 2016). Driven in many cases by the European urban agenda and recognition that urban development needs to be founded on more sustainable principles, only recently have green spaces become recognised in Europe for their positive potential contribution to urban development.

A recent European survey found that primary care was the main entry point to mental health services for the majority of patients (Barbato et al., 2016). Most patients with mental disorders are managed in primary care (McDaid, 2013). As there are no large geographic or social differences in access to general practice, morbidity presented in general practice can be regarded as a close approximation of morbidity present in the general population (Maas, Verheij, et al., 2009). This means that primary care settings...
are well placed to conduct research in the area of mental health. Given the high prevalence of mental health issues in patients attending primary care, research examining factors which promote resilience and well-being in primary care patients is particularly important.

With this in mind, we conducted a scoping review of the current literature on urban green spaces, with the aim of identifying their impact on mental health outcomes, particularly in primary care populations. Our aim was to identify what is currently known about the impact of urban green spaces on mental health and explore areas for future research and policy development.

Methods
A scoping review methodology was chosen, in order to gain a comprehensive overview of the literature on the topic of urban green spaces and mental health. Unlike a systematic review, a scoping review does not include an assessment of study quality, as the focus is on covering the range of work that informs the topic rather than limiting the work to studies that meet particular standards of scientific rigour. A five-stage methodology was adopted (Arksey & O’Malley, 2005), in order to produce a comprehensive review of the literature:

i. Identifying the research question

Given the recent focus of both research and government policy on urban green space, as well as the importance of mental health as a public health issue, this review focused on the impact of green spaces on mental health within the urban environment. Due to the important role of primary care in the treatment of common mental health disorders, and the importance of promoting mental wellbeing in patients, there was a focus on studies conducted in primary care settings. This resulted in the research question “How can urban green spaces improve mental health and wellbeing among patients attending general practice and primary care and how might this influence future urban planning and policy-making?” For purposes of relative comparability, we were mostly interested in studies that focused on residents living in urban areas within Europe, however, a small number of non-European studies were also included due to the significance of their findings. For the purpose of the review, the term “green space” was given a relatively broad definition of a natural or semi-natural area partially or completely covered by vegetation that occur in or near urban areas. These include spaces such as parks, sports fields, protected areas, public gardens, natural meadows and woodlands. Private gardens and other private spaces were not included as these spaces are not accessible to all residents.

ii. Identifying relevant studies

A general search was carried out using multiple search terms and a short reading list was generated which contained the most recent studies on the subject. Search terms were then generated using the keywords that were identified from the initial reading list. The electronic databases that were used in the searches were “PUBMED”/“MEDLINE”, “Google Scholar” and the “Cochrane Library”. Despite the limitations associated with the use of “Google Scholar” as a search engine (Bates et al., 2017), it was used as recommended by Bates et al, in conjunction with other databases, in order to provide a comprehensive overview of all types of literature in the area. The search terms were grouped (see Figure 1) and the results required mention of at least one search term in each of the following groups: Europe, green spaces, mental health and urban areas and primary care/general practice. Further relevant studies were identified and added through hand-searching reference lists of key studies, resulting in the identification of the small number of non-European studies.

iii. Selecting studies

The initial search and short reading list identified 86 studies with an additional seven studies added from hand-searching references from key literature. Abstracts of studies returned by the search engine were first read by the reviewers and those which were deemed as relevant were selected for full text review. The first author conducted the primary screening of the findings. Findings were then reviewed by the second and last authors to ensure a comprehensive screening was completed. The “Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)” flow diagram (Figure 2) outlines how papers were selected for the review. The inclusion criteria were broad and both peer-reviewed literature and grey literature were included in the search. Once the initial search was performed, 19 duplicates

PUBMED/MEDLINE and COCHRANE Search

((“Europe” OR “European” OR “EU”) AND (“green spaces” OR “greenspaces” OR “natural environment” OR “nature”) AND (“mental health” OR “mental wellbeing” OR “wellbeing” OR “mental disorder”) AND (“urban area” OR “urban environment” OR “urban communities”) AND (“primary care” OR “general practice”))

Results: PUMED/MEDLINE 85, COCHRANE 1

Figure 1. Search terms used.
were removed. Endnote X8 software was used to assist with the screening process and to remove duplicates. Studies were then selected by a pre-determined inclusion criteria and de-selected by exclusion criteria.

- Not in English
- Not published between 2000–2019
- Did not examine green spaces
- Did not examine mental health outcomes
- Did not involve urban communities
- Review articles

iv. Charting the data

Only studies published from the year 2000 onwards were included in order to focus the findings of the review on recently published data. Once all exclusion criteria were applied the data from the remaining studies ($n=25$) were charted under the following headings: Author, Year; Name of Location; Study Design; Population; Intervention, Control; Health Outcome Measures; Green Space Measures and Evidence for Positive Impact on Mental Health (see Table 1).

v. Collating, summarising and reporting results

The data from each selected study was collated, presented and reported in the results section of the review. The significance of the data was examined in the discussion under five major themes:

- Mental health outcome measures
- Characteristics of green spaces
- The mechanisms behind the positive association of green spaces and mental health
- The effect of green spaces on mental health outcomes of general practice populations
- The effects of ethnicity and socioeconomic factors

Results

The initial search of the “PubMed” and “Cochrane Library” databases yielded 86 records, of which 19 were identified to be relevant to the impact of green spaces on mental health in urban residents. The search, identification and selection process are summarised in the PRISMA diagram (Figure 2). A total of 25 records were included.

Among these, four were randomised control trials (RCTs) (Bratman et al., 2015; Hartig et al., 2003; McAllister et al., 2017; Vujcic et al., 2017), five were cohort studies
Mental health outcome measures

Seventeen studies used only one measure of mental health (Alcock et al., 2014; Annerstedt et al., 2012; Beyer et al., 2014; Dzhambov, Hartig, et al., 2018; Dzhambov, Markevych, et al., 2018; Houlden et al., 2017; McEachan et al., 2018; Mitchell et al., 2015; Pope et al., 2015; Roe et al., 2013; Sarkar et al., 2018; Stigsdotter et al., 2010; Sugiyama et al., 2008; Van Herzele & de Vries, 2012; White et al., 2017) and eight used two or more (Ambrey, 2016; Bratman et al., 2014; Cohen-Cline et al., 2015; Hartig et al., 2003; Maas, Verheij, et al., 2009; Mitchell et al., 2017; McAllister et al., 2017; Mitchell et al., 2015; Pope et al., 2015; Pretty et al., 2007; Sarkar et al., 2018; Stigsdotter et al., 2010; Sugiyama et al., 2008; Van Herzele & de Vries, 2012; White et al., 2017) and used solely self-reported data in the form of questionnaires (Alcock et al., 2014; Annerstedt et al., 2012; Beyer et al., 2014; Cohen-Cline et al., 2015; Dzhambov, Hartig, et al., 2018; Dzhambov, Markevych, et al., 2018; Houlden et al., 2019; Houlden et al., 2017; McEachan et al., 2018; Mitchell et al., 2015; Pope et al., 2015; Roe et al., 2013; Sarkar et al., 2018; Stigsdotter et al., 2010; Sugiyama et al., 2008; Vujcic et al., 2017; White et al., 2017; Wood et al., 2017) and used a combination of both self-reported measures and physiological measures to measure mental health (Ambrey, 2016; Bratman et al., 2015; Hartig et al., 2003; Roe et al., 2013). One study used mental health data derived from electronic medical records of general practices (Maas, Verheij, et al., 2009).

Self-reported measures of mental health

General health. The most commonly used self-reported measure of mental health was the General Health Questionnaire (GHQ), employed by six studies (Alcock et al., 2014; Annerstedt et al., 2012; Dzhambov, Hartig, et al., 2018; Dzhambov, Markevych, et al., 2018; Pope et al., 2015; Pretty et al., 2007). All six studies used the shortened 12-item version of the questionnaire (GHQ-12) and defined the presence of a mental health issue as reporting a problem in three or more of the items. The mental health status of children was measured using the “Strengths and Difficulties Questionnaire” (SDQ) in one study (McEachan et al., 2018).

Subjective wellbeing. Subjective wellbeing was a common measure of mental health used in eight studies (Ambrey, 2016; Hartig et al., 2003; Houlden et al., 2019; Houlden et al., 2017; Mitchell et al., 2015; Stigsdotter et al., 2010; White et al., 2017; Wood et al., 2017). The “Warwick-Edinburgh Mental Wellbeing Scale” (WEMWBS) was employed by two studies (Houlden et al., 2017; Wood et al., 2017) as a measure of hedonic (life satisfaction, happiness) and eudemonic (worth) mental wellbeing in the general population. One study measured self-reported hedonic and eudemonic wellbeing using questions developed by the Office of National Statistics (Houlden et al., 2019). The WHO Wellbeing Index was used to measure subjective wellbeing in one study (Mitchell et al., 2015). The validated 36-item Short Form Health Survey was used in two studies to measure eight dimensions of health including mental wellbeing (Ambrey, 2016; Stigsdotter et al., 2010). A shortened 12-item version was used in one study (Sugiyama et al., 2008). One study (White et al., 2017) used a “Self-reported Subjective Wellbeing” survey.

Depression. Self-reported depression was measured as a negative mental health outcome in four studies (Beyer et al., 2014; Cohen-Cline et al., 2015; Sarkar et al., 2018; Vujcic et al., 2017). The longer 42-item Depression, Anxiety and Stress Survey (DASS-4) was used to measure depression in one study (Beyer et al., 2014) and the shorter DASS-21 was used to measure incidence of depression in another (Vujcic et al., 2017). The Patient Health Questionnaire (PHQ-2) was also used to measure depression in one study (Cohen-Cline et al., 2015). One study used specific diagnostic criteria using a combination of items from the PHQ-2, lifetime experience of depression and presence of social supports for mental health (Sarkar et al., 2018). One study used prevalence of depression derived from electronic medical records of general practices over a 12 month period (Maas, Verheij, et al., 2009).

Anxiety. Self-reported anxiety was measured as a mental health outcome in three studies (Beyer et al., 2014; Cohen-
Cline et al., 2015; Vujcic et al., 2017). One study used the 21-item DASS (Vujcic et al., 2017), one used the 42-item DASS (Beyer et al., 2014) and another used the Brief Symptom Inventory (Cohen-Cline et al., 2015). One study used prevalence of anxiety disorder derived from electronic medical records of general practices over a 12 month period (Maas, Verheij, et al., 2009).

**Stress.** Self-reported stress levels were measured as an indirect measure of mental health outcomes in four studies (Beyer et al., 2014; Cohen-Cline et al., 2015; Roe et al., 2013; Vujcic et al., 2017). One study used the DASS-21 survey (Vujcic et al., 2017) one used the DASS-24 survey (Beyer et al., 2014) and two used the Perceived Stress Scale which measures perceived stress over the preceding month (Cohen-Cline et al., 2015; Roe et al., 2013).

**Psychological distress.** Self-reported psychological distress was measured as a negative mental health outcome in two studies (Ambrey, 2016; Pope et al., 2015). One study used the GHQ to measure mental health (Pope et al., 2015). The other study used the Kessler Psychological Distress Scale (Ambrey, 2016).

**Happiness.** Self-reported happiness was measured as a positive mental health outcome in one study using the Overall Happiness Scale (Hartig et al., 2003).

**General mood.** Self-reported general mood was measured in three studies (Hartig et al., 2003; McAllister et al., 2017; Pretty et al., 2007). The Positive and Negative Affect Schedule was used in one study (McAllister et al., 2017), the Profile of Mood States questionnaire was used in another (Pretty et al., 2007) and another used the Zuckerman’s Inventory of Personal Reactions (Hartig et al., 2003).

**Rumination.** In one study self-reported rumination was measured as an indirect negative mental health outcome using the Reflection and Rumination Questionnaire (Bratman et al., 2012).

**Self-esteem.** Self-esteem was measured as an indirect positive mental health outcome in one study (Pretty et al., 2007) using the Rosenberg Self-Esteem Scale.

One study did not specify the measures used for mental health outcomes and only stated that it used a Health Survey in Belgium and other self-reported measures derived from previously published studies (Van Herzele & de Vries, 2012).

**Physiological measures of mental health**

Four studies used a combination of self-reported and physiological measures to either directly or indirectly measure mental health (Ambrey, 2016; Bratman et al., 2015; Hartig et al., 2003; Roe et al., 2013). One study measured regional cerebral blood flow to the sub-genual prefrontal cortex associated with rumination and sadness after an environmental intervention in both the subjects and control group (Bratman et al., 2015). One study measured blood systolic and diastolic blood pressure at 10 min intervals during an environmental treatment (Hartig et al., 2003). One study measured the cortisol concentration of saliva as an indirect measure of mental health via stress levels (Roe et al., 2013).

**Green Space Measures**

The definition of “urban green space” was relatively consistent across all studies. The definition included parks, sports fields, community gardens, cemeteries, natural meadows, protected areas woodlands and shrublands. Private gardens and other private spaces were not included as these spaces are not accessible to all residents. Although private spaces were not included explicitly, studies which used the Normalised Difference Vegetation Index (NDVI) method, which employ satellite/aerial imagery, may have included private green space, unless researchers knew these spaces and specifically excluded them. Characteristics of green spaces that were measured included quantity, quality, exposure (usage) and accessibility. Twelve studies used a single measure of green space (Alcock et al., 2014; Annerstedt et al., 2012; Beyer et al., 2014; Cohen-Cline et al., 2015; Houlden et al., 2019; Houlden et al., 2017; Maas, Verheij, et al., 2009; Mitchell et al., 2015; Pretty et al., 2007; Roe et al., 2013; Sarkar et al., 2018; Sugiyama et al., 2008), eight used two or more measures of green space (Dzhambov, Hartig, et al., 2018; Dzhambov, Markevych, et al., 2018; McEachan et al., 2018; Pope et al., 2015; Stigsdotter et al., 2010; Van Herzele & de Vries, 2012; White et al., 2017; Wood et al., 2017), one study did not specify the type of measure used (Ambrey, 2016) and four studies were trials using controlled environments (Bratman et al., 2015; Hartig et al., 2003; McAllister et al., 2017; Vujcic et al., 2017).

**Objective measures of green space characteristics**

**Quantity of green space.** Of the included studies, 11 examined associations between the quantities of green space and mental health (Alcock et al., 2014; Ambrey, 2016; Beyer et al., 2014; Cohen-Cline et al., 2015; Dzhambov, Hartig, et al., 2018; Dzhambov, Markevych, et al., 2018; Houlden et al., 2019; Houlden et al., 2017; McEachan et al., 2018; Wood et al., 2017; Wroe et al., 2015). The proportion of green space was calculated for either each lower-Layer Super Output Area (an area that is generated with consistent population sizes with a minimum of 1000 and mean of 1500), Census District or within a defined radius of residents. The most commonly used instrument in the
quantitative measurement of green spaces was the NDVI and was used in five studies (Beyer et al., 2014; Cohen-Cline et al., 2015; Dzhambov, Hartig, et al., 2018; Dzhambov, Markkevych, et al., 2018; McEachan et al., 2018). The NDVI quantifies vegetation by measuring the difference between the near-infrared light reflected by vegetation and red light which is absorbed by vegetation. The Generalised Land Use Database for England was used as a quantitative measure of greenspace is two studies in the UK (Alcock et al., 2014; Houlden et al., 2017). A digital spatial (polygon) database was used to quantify green spaces in one study (Wood et al., 2017) and unspecified Geographical Information Systems (GIS) were used in two studies to quantify green space (Ambrey, 2016; Roe et al., 2013). One study used the GIS tools ArcGIS and R to calculate the total amount (m²) of public greenspace within a 300 m of each individual's home (Houlden et al., 2019).

**Accessibility to green spaces.** Associations between accessibility of green spaces and mental health were examined in three studies (Cohen-Cline et al., 2015; Dzhambov, Hartig, et al., 2018; Wood et al., 2017). In all three studies accessibility was measured as the level of green spaces within a specified distance from residents. Two studies used the NDVI (Cohen-Cline et al., 2015; Dzhambov, Hartig, et al., 2018) and one study used a digital spatial (polygon) database (Wood et al., 2017).

**Exposure to green spaces.** Exposure vs non-exposure to green spaces was the intervention used in all four trial studies to examine the association between green spaces and mental health (Bratman et al., 2015; Hartig et al., 2003; McAllister et al., 2017; Vujcic et al., 2017). All four were RCTs whereby the subject group were exposed to some level of natural environmental conditions and a control group were exposed to either a built urban environment or lack of natural environmental conditions. Specific interventions included a nature-based horticultural therapy (Vujcic et al., 2017), a 90 min nature walk (Bratman et al., 2015), a virtual "wild" nature experience (McAllister et al., 2017) and sitting in a room with tree views, then walking in a nature reserve (Hartig et al., 2003). Specific controls were no nature-based horticultural therapy, a 90 min walk in a built-up urban area, a virtual "wild" urban experience and sitting in a room without views, then walking in an urban area, respectively.

**Self-reported measures of green space characteristics**

Characteristics of green spaces were also measured using questionnaires to assess perceived quantity, quality and accessibility, as well as different types of exposures. A total of 11 studies used self-reported data with only three of these using a combination of both self-reported data and objective measures of green space (Dzhambov, Hartig, et al., 2018; McEachan et al., 2018; White et al., 2017). The remaining eight studies used only self-reported data to assess the characteristics of green spaces (Annerstedt et al., 2012; Dzhambov, Hartig, et al., 2018; McEachan et al., 2018; Mitchell et al., 2015; Pope et al., 2015; Pretty et al., 2007; Stigsdotter et al., 2010; White et al., 2017).

One study assessed perceived green space qualities using terms chosen from previous studies such as "serene", "wild" and "lush" (Annerstedt et al., 2012), three studies assessed self-reported access to green spaces (Mitchell et al., 2015; Pretty et al., 2007; Stigsdotter et al., 2010) and one study assessed self-reported frequency of exposure to green spaces (White et al., 2017). One study assessed both self-reported quality and access to green spaces (Pope et al., 2015), one study assessed both self-reported quality and types of exposure (McEachan et al., 2018) and one study assessed self-reported quality, access and types of exposure (Dzhambov, Hartig, et al., 2018) (see Table 1).

**Measures of mental health in primary care populations**

Of the included studies, only two examined the effect of urban green spaces on mental health outcomes in patients derived from general practice populations. One study examined whether there was a significant association between green space and self-reported general indicators of physical and mental health, including depression and anxiety disorder, in a general practice population (Maas, Verheij, et al., 2009). This study found that the annual prevalence rate of anxiety disorder and depression was lower in living environments with more green space in a 1 km radius. This relation was stronger for anxiety and depression than any of the other disease clusters examined, demonstrating the importance of green spaces for mental health outcomes in clinical populations.

Another study collected data from a general practice registry in an urban area in the UK, however, a stratified (age and sex) sample was randomly selected, rather than a sample of patients with a particular mental health disorder (Pope et al., 2015). The results of this study demonstrated the importance of not only having access to green space but being able to feel comfortable in and use those green spaces to improve mental well-being. The majority of studies examined the effects of urban green spaces on mental health using statistically based, rather than patient focussed data.

**The effects of ethnicity and socioeconomic factors**

Quality of green spaces and accessibility to those spaces tend to be lower in deprived and lower-income communities, which may also suffer from a lower level of private urban greenspace (Brennan et al., 2017). One cross-sectional study found that socioeconomic health inequality was 40% narrower among respondents reporting good accessibility to green spaces, compared with those with poorer access (Mitchell & Popham, 2008). No other neighbourhood characteristics were associated with narrower health inequality. This suggests that accessibility to greenspace is one of the major factors associated with improved mental health.

Moderation by ethnicity was apparent in one cohort study (McEachan et al., 2018). The study found a significant
<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Name of study</th>
<th>Location</th>
<th>Study design</th>
<th>Population</th>
<th>Method of recruitment</th>
<th>Intervention/ Control</th>
<th>Health outcome measures</th>
<th>Green space measures</th>
<th>Interaction effects between green spaces and mental health</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Alcock et al. (2014)</td>
<td>Longitudinal effects on mental health of moving to greener and less green urban areas</td>
<td>England</td>
<td>Cohort study</td>
<td>Residents ($n = 1064$)</td>
<td>Adult samples were drawn from the British Household Panel Survey from 1991–2008</td>
<td>N.A.</td>
<td>Self-reported mental health using General Health Questionnaire (GHQ)</td>
<td>Quantity using Generalized Land Use Database for England</td>
<td>Positive</td>
</tr>
<tr>
<td>2. Ambrey (2016)</td>
<td>Greenspace, physical activity and well-being in Australian capital cities: how does population size moderate the relationship?</td>
<td>Australia</td>
<td>Cross-sectional</td>
<td>Collection Districts ($n = 1819$), Residents ($n = 6077$)</td>
<td>Residentitis were obtained from wave 13 (2013) of the Household, Income and Labour Dynamics in Australia (HILDA) survey.</td>
<td>N.A.</td>
<td>Self-reported mental health using SF-36 Mental Component Summary (MCS)</td>
<td>Unspecified</td>
<td>Limited association – effect may depend on population size</td>
</tr>
<tr>
<td>3. Annerstedt et al. (2012)</td>
<td>Green qualities in the neighbourhood and mental health – results from a longitudinal cohort study in Southern Sweden</td>
<td>Sweden</td>
<td>Longitudinal Cohort Study</td>
<td>Participants ($n = 24,945$)</td>
<td>A survey was distributed as a mailed questionnaire in 33 municipalities in the Scania region of Sweden. Swedish register data was used for geo-coding of each individual.</td>
<td>N.A.</td>
<td>Self-reported mental health using the General Health Questionnaire (GHQ-12)</td>
<td>“Green qualities” based on previous studies</td>
<td>Positive</td>
</tr>
<tr>
<td>4. Beyer et al. (2014)</td>
<td>Exposure to neighbourhood green space and mental health: evidence from the survey of the health of Wisconsin</td>
<td>Wisconsin, USA</td>
<td>Cross-sectional study</td>
<td>Participants ($n = 2479$), Census Block Groups ($n = 229$)</td>
<td>Data was taken from the Survey of the Health of Wisconsin (SHOW) database from a representative sample of Wisconsin residents.</td>
<td>N.A.</td>
<td>Self-reported mental health using Depression Anxiety and Stress Scales (DASS)</td>
<td>Green space quantity using NDVI which corresponds to level of healthy vegetation</td>
<td>Positive</td>
</tr>
<tr>
<td>5. Bratman et al. (2015)</td>
<td>Nature experience reduces rumination and subgenual prefrontal cortex activation</td>
<td>USA</td>
<td>Randomised Control Trial</td>
<td>Participants ($n = 38$)</td>
<td>Participants with no current or past diagnosis of neurologic or psychiatric disorder and who lived and worked in urban parts of the San Francisco Bay Area were invited to take part.</td>
<td>Participants were assigned either a 90min nature walk or control (urban walk)</td>
<td>Self-reported rumination using Rumination and Reflection Questionnaire</td>
<td>N.A.</td>
<td>Positive</td>
</tr>
</tbody>
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<tr>
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</tr>
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<tbody>
<tr>
<td>Cohen-Cline et al. (2015)</td>
<td>Access to green space, physical activity and mental health: a twin study</td>
<td>Washington, USA</td>
<td>Cross-sectional analysis</td>
<td>Participants ($n=4,338$)</td>
<td>Same-sex twin pairs were selected from the University of Washington Twin Registry (UWTR), 2008–2014.</td>
<td>N.A.</td>
<td>Self-reported depression using 2-item Patient Health Questionnaire (PHQ-2)</td>
<td>Accessibility using NDVI</td>
<td>Positive, significant for depression</td>
</tr>
<tr>
<td>Dzhambov et al. (2018)</td>
<td>Multiple pathways link urban green-and bluespace to mental health in young adults</td>
<td>Plovdiv, Bulgaria</td>
<td>Cross-sectional analysis</td>
<td>Students ($n=720$)</td>
<td>Students age 18–35yrs were recruited from the Medical University in Plovdiv</td>
<td>N.A.</td>
<td>Self-reported mental health using 12-item form of the General Health Questionnaire (GHQ-12)</td>
<td>Quantity using NDVI and tree cover density for</td>
<td>Positive</td>
</tr>
<tr>
<td>Dzhambov et al. (2018)</td>
<td>Urban residential greenspace and mental health in youth: Different approaches to testing multiple pathways yield different conclusions</td>
<td>Plovdiv, Bulgaria</td>
<td>Cross-sectional analysis</td>
<td>Participants ($n=399$)</td>
<td>Students age 15–25 were recruited from educational institutions distributed across Plovdiv</td>
<td>N.A.</td>
<td>Self-reported mental health using General Health Questionnaire (GHQ)</td>
<td>Accessibility, quality and exposure using objective and self-reported measures</td>
<td>Positive</td>
</tr>
<tr>
<td>Hartig et al. (2003)</td>
<td>Tracking restoration in natural and urban field settings</td>
<td>USA</td>
<td>Randomised Control Trial</td>
<td>Participants ($n=112$)</td>
<td>Students were recruited from the University of California</td>
<td>N.A.</td>
<td>Systolic and diastolic blood pressure</td>
<td>Environmental restorativeness using Zuckerman’s Inventory of Personal Reactions</td>
<td>Positive</td>
</tr>
<tr>
<td>Houlden et al. (2017)</td>
<td>A cross-sectional analysis of green space prevalence and mental wellbeing in England</td>
<td>England</td>
<td>Cross-sectional analysis</td>
<td>Participants ($n=30,900$)</td>
<td>Data were drawn from the first wave of the UK Longitudinal Household Panel Study (UKLHS), which ran from 2009 to 2010. Only residents of England were included.</td>
<td>N.A.</td>
<td>Self-reported wellbeing using WEMWBS scale</td>
<td>Quantity using General Land Use Database</td>
<td>Failed to find association</td>
</tr>
<tr>
<td>Author, Year</td>
<td>Name of study</td>
<td>Location</td>
<td>Study design</td>
<td>Population</td>
<td>Method of recruitment</td>
<td>Intervention/ Control</td>
<td>Health outcome measures</td>
<td>Green space measures</td>
<td>Interaction effects between green spaces and mental health</td>
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</tr>
<tr>
<td>11. Houlden et al. (2019)</td>
<td>A spatial analysis of proximate greenspace and mental wellbeing in London</td>
<td>England</td>
<td>Cross-sectional analysis</td>
<td>Residents ($n = 25,518$)</td>
<td>Individual and Household-level data were drawn from the Annual Population Survey at postcode level (APS, Pooled Dataset 2012–2015), Greenspace data were obtained from Greenspace Information for Greater London Group (GiGL),</td>
<td>N.A.</td>
<td>Self-reported hedonic and eudemonic wellbeing was measured using three questions developed by the Office of National Statistics (ONS)</td>
<td>GIS used to calculate amount ($m^2$) of greenspace within a 300 mile radius of individuals homes</td>
<td>Positive</td>
</tr>
<tr>
<td>12. Maas et al. (2009)</td>
<td>Morbidity is related to a green living environment</td>
<td>The Netherlands</td>
<td>Cross-sectional analysis</td>
<td>Patients ($n = 345,143$)</td>
<td>Data were collected within the framework of the second Dutch National Survey in General Practice (DNSGP-2), which included a nationwide, representative sample of 104 general practices with 195 GPs</td>
<td>N.A</td>
<td>Data on prevalence of depression and anxiety were extracted from electronic medical records at GP practice over 12 month period</td>
<td>The percentage of green space within a 1km and 3km radius around the postal code</td>
<td>Positive</td>
</tr>
<tr>
<td>13. McAllister et al. (2017)</td>
<td>Into the woods or a stroll in the park: how virtual contact with nature impacts positive and negative affect</td>
<td>Australia</td>
<td>Randomised Control Trial</td>
<td>Participants ($n = 220$)</td>
<td>Participants were recruited by email from the general population.</td>
<td>Participants were assigned either a virtual “wild” nature experience, virtual “urban” nature experience or control (non-nature experience)</td>
<td>Self-reported restorativeness using 26-item perceived restorativeness scale (PRS)</td>
<td>N.A.</td>
<td>Positive</td>
</tr>
<tr>
<td>14. McEachan et al. (2018)</td>
<td>Availability, use of, and satisfaction with green space, and children’s mental wellbeing at age 4 years in a multicultural, deprived, urban area: results from the Born in Bradford cohort study</td>
<td>Bradford, UK</td>
<td>Cohort Study</td>
<td>Mothers ($n = 2,594$)</td>
<td>Mothers were recruited during pregnancy at the City’s main maternity unit between 2007 and 2011.</td>
<td>N.A.</td>
<td>Self-reported mental health of children using Strengths and Difficulties Questionnaire (SDQ)</td>
<td>Quantity, quality, exposure and accessibility using NDVI and self-reported measures</td>
<td>Positive for South Asian Children only</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Author, Year</th>
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<th>Green space measures</th>
<th>Interaction effects between green spaces and mental health</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. Mitchell et al. (2015)</td>
<td>Neighbourhood environments and socioeconomic inequalities in mental well-being</td>
<td>Europe</td>
<td>Cross-sectional survey</td>
<td>Participants ($n = 21,294$)</td>
<td>Data were extracted from the 2012 European Quality of Life Survey (EQLS) of people age 18 or over living in urban areas of 34 European nations. A stratified sample of 1680 adults was randomly selected from a general practice population register and questionnaires mailed to each sampled individual.</td>
<td>N.A.</td>
<td>Self-reported mental wellbeing using WHO-5 questionnaire</td>
<td>Self-reported access to recreational/ green areas</td>
<td>Positive</td>
</tr>
<tr>
<td>16. Pope et al. (2015)</td>
<td>Quality of and access to green space in relation to psychological distress: results from a population-based cross-sectional study as part of the EURO-URHIS 2 project</td>
<td>Sandwell, UK</td>
<td>Cross-sectional Survey</td>
<td>Participants ($n = 1,680$)</td>
<td>A stratified sample of 1680 adults was randomly selected from a general practice population register and questionnaires mailed to each sampled individual.</td>
<td>N.A.</td>
<td>Self-reported psychological distress using 12-item General Health Questionnaire (GHQ)</td>
<td>Self-reported accessibility and quality of green spaces</td>
<td>Positive</td>
</tr>
<tr>
<td>17. Pretty et al. (2007)</td>
<td>Green exercise in the UK countryside: Effects on health and psychological well-being, and implications for policy and planning</td>
<td>UK</td>
<td>Cross-sectional survey</td>
<td>Participants ($n = 263$)</td>
<td>Participants were accessed by using a stratified cluster sampling technique. Cluster sampling was used to select a random sample of case studies to represent the total population.</td>
<td>All participated in organised “green exercise” activity</td>
<td>Self-reported psychological health using General Health Questionnaire (GHQ) Self-reported self-esteem pre- and post-activity using the Rosenberg Self-Esteem Scale Mood status pre- and post-activity using the Profile of Mood States test questionnaire</td>
<td>Quality using self-reported measures</td>
<td>Positive</td>
</tr>
<tr>
<td>18. Roe et al. (2013)</td>
<td>Green space and stress: evidence from cortisol measures in deprived urban communities</td>
<td>Scotland</td>
<td>Cohort Study</td>
<td>Participants ($n = 106$)</td>
<td>Specified postcode areas in the city of Dundee were selected on the basis of Carstairs indices of 5–7. Within these areas door-to-door recruitment was undertaken over a period of five weeks, from May to June 2010.</td>
<td>N.A.</td>
<td>Salivary cortisol concentration Self-reported stress using PSS</td>
<td>Exposure using GIS</td>
<td>Positive</td>
</tr>
<tr>
<td>Author, Year</td>
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<td>Interaction effects</td>
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<tr>
<td>Stigsdotter et al. (2010)</td>
<td>Health promoting outdoor environments-Associations between green space, and health, health-related quality of life and stress based on a Danish national representativesurvey</td>
<td>Denmark</td>
<td>Cross-sectional Survey</td>
<td>Participants ($n = 11,238$)</td>
<td>The study sample was drawn from the Danish Civil Registration System.</td>
<td>N.A.</td>
<td>Self-reported stress using SF-36 Questionnaire</td>
<td>Accessibility and frequency of exposure using self-reported measures</td>
<td>Positive</td>
</tr>
<tr>
<td>Sugiyama et al. (2008)</td>
<td>Associations of neighbourhood greenness with physical and mental health: do walking, social coherence and local social interaction explain the relationships?</td>
<td>Australia</td>
<td>Cross-sectional Survey</td>
<td>Participants ($n = 1,895$)</td>
<td>The study sample was drawn from residential addresses within 32 neighbourhoods, 250 addresses were randomly selected and those who met the eligibility criteria and agreed to participate were included.</td>
<td>N.A.</td>
<td>Self-reported physical and mental health using SF-12 Health Survey</td>
<td>Quantity and accessibility using GIS</td>
<td>Positive</td>
</tr>
<tr>
<td>Van Herzele and de Vries (2012)</td>
<td>Linking green space to health: A comparative study of two urban neighbourhoods in Ghent, Belgium</td>
<td>Ghent, Belgium</td>
<td>Cross-sectional Analysis</td>
<td>Residents ($n = 190$)</td>
<td>Three hundred residential households per neighbourhood were randomly selected to participate in the study. A self-completion questionnaire was distributed in June 2004.</td>
<td>N.A.</td>
<td>Self-reported health using Belgian Health Interview Survey and other self-reported health measures derived from previously published studies</td>
<td>N.A.</td>
<td>Positive</td>
</tr>
<tr>
<td>Vujcic et al. (2017)</td>
<td>Nature based solution for improving mental health and well-being in urban areas</td>
<td>Serbia</td>
<td>Randomised Control Trial</td>
<td>Psychiatric patients ($n = 30$)</td>
<td>Participants were recruited from the Institute of Mental Health if they had a primary diagnosis of anxiety or depression disorders being treated with pharmacotherapy and psychotherapy</td>
<td>N.A.</td>
<td>Self-reported mental health using DASS21</td>
<td>N.A.</td>
<td>Positive</td>
</tr>
</tbody>
</table>
association between access to green spaces and behavioural difficulties among south Asian children living in a deprived urban area in the UK, but not among young white British children in the same area. Satisfaction with green space was independently predictive of south Asian children’s mental wellbeing after controlling for demographics, socioeconomic status, maternal health behaviours, and maternal mental wellbeing. This is an important finding, suggesting that the quality, in addition to quantity, of green space is important for health.

One study found that four attributes of green spaces (i.e. if green spaces were accessible, you could relax in them, they could be used for recreation and they were sufficient) were significantly associated with a reduced risk of psychological distress (Pope et al., 2015), suggesting that the ability to feel comfortable within the environment is an important consideration for the development of green spaces. An increased number of positive green space attributes were associated with a significant reduction in psychological distress, suggesting that quality and accessibility, may be more important than quantity in determining mental health. Another study found that the association between green spaces and well-being appeared higher towards the outskirts of London, with weaker associations observed towards the centre. These results imply that the association between greenspace and mental wellbeing, although overall positive, the strength and direction may further depend on the individual people and places and the characteristics of the greenspaces in the area.

**Discussion**

The aim of this scoping review was to examine the impact of urban green spaces on mental health outcomes and well-being among patients attending general practice and primary care. Our findings suggest positive associations between mental health and green space characteristics. Of 25 included studies, 23 showed positive associations, one study found a limited association and one failed to find any associations. There was a paucity of research found that examined mental health outcomes in general practice populations.

A systematic review conducted in 2015 found limited evidence of long-term beneficial mental health effects of surrounding greenness (Gascon et al., 2015). The authors attributed this finding to a lack of research and highlighted the need for detailed information on the characteristics of the green spaces that promote better mental health. In recent years there has been an increase in research which examines the impact of green spaces on mental health outcomes. With over half the studies in this review published since 2015, the difference in our findings and those of Gascon et al, may be due to the rapid increase of research in this area in recent years.

Various mechanisms have been proposed to explain the positive association between mental health and green spaces. These mechanisms include (a) the restoration theory which postulates that psychological restoration occurs through
viewing and observing green spaces (Hartig et al., 2003) (b) the synergistic relationship between physical activity and green spaces on mental health (Ambrey, 2016) and (c) the ability of green spaces to enhance social cohesion (Brennan et al., 2017). Urban green space has shown to have social benefits that may impact on mental health, including increased social support and sense of community in urban populations (Kim & Kaplan, 2004). These benefits of urban green space may explain the mechanisms through which green spaces lead to improved mental health outcomes in urban populations.

This review aimed to examine patients attending general practice and primary care, however only two studies were found which examined the effect of urban green spaces on mental health outcomes of general practice populations. This demonstrates an evident gap in the literature that should be addressed in future research. Of the included studies which examined general practice populations, results indicated that higher levels of surrounding urban green space were associated with a reduced prevalence of mental health disorders, particularly anxiety and depression (Maas, Verheij, et al., 2009), and demonstrated the importance of specific characteristics of such urban green spaces in improving mental health outcomes of primary care populations (Pope et al., 2015). The results of these studies indicate that urban green spaces may impact on mental health outcomes of primary care patients, with or without a diagnosed mental health disorder.

**Limitations**

The majority of studies that investigated the relationship between green spaces and mental health were cross-sectional meaning it was not possible to distinguish between reverse causality and associations which may be causal in nature. Observational studies are prone to bias and confounding factors. For example, it may be that those with better mental health tend to spend more time in green spaces and would report increased exposure and accessibility.

Measures of green space were often vague and varied across the included studies, making accurate comparisons difficult. Further studies which utilise similar measures of green space as well as those examining the potential role of private urban green infrastructure within the city, are required in order to examine their impact on well-being within the urban environment.

The diversity of mental health measures used across the included studies is problematic as it makes accurate comparisons of the effect of green spaces on mental health outcomes difficult. As the majority of studies used self-reported measures of mental health, findings may be subject to response bias. Furthermore, as the majority of included studies were cross-sectional, it is impossible to infer causation. Further longitudinal studies would provide more robust evidence for causation.

This review adopted a scoping review methodology, in order to gain a comprehensive overview of the literature. Unlike a systematic review, a scoping review does not include an assessment of study quality, as the focus is on covering the range of work that informs the topic rather than limiting the work to studies that meet particular standards of scientific rigour. This may give rise to some limitations, as it was not possible to determine the quality of the included studies. While we aimed to be comprehensive in our approach, there is a possibility that not all publications relevant to the inclusion criteria were identified by the searches or databases used. Furthermore, while the main focus of the review was on European literature, eight non-European studies were also included due to the significance of their findings. However notwithstanding these limitations the 25 studies included in the review allowed us to gain a comprehensive overview of the current research in the area of urban green spaces and mental health, identifying gaps in the literature and informing our future research on this topic.

**Implications for future research and policy-making**

The majority of studies found a positive association between green space and mental health, suggesting that policies to increase urban green space may have sustainable public health benefits. The current evidence suggests the potential for environmental initiatives which aim to increase urban green spaces, to address the public health issue of poor mental health in urban communities and provide lasting public health benefits. However, there was a paucity of studies that examined links between underlying socio-economic factors and inequalities, and access to green spaces and mental health. Therefore future research should also consider the relevant socio-economic and/or environmental determinants of health.

The findings of this review demonstrate the importance of urban green spaces in European countries. Ireland is one country in which such environmental initiatives may lead to improvements in the mental health and wellbeing of urban populations. Ireland underwent a rapid transition from a predominantly rural to a majority urban population during the “boom years” of the late 1990s to the mid 2000s. As this placed significant pressure on planners to deliver basic housing and transport infrastructure, limited attention was given to the provision of green spaces. The Environmental Protection Agency was the first in Ireland to carry out a cross-sectional “health-led” study on green spaces. Their subsequent report emphasised the importance of green and blue spaces for the physical and mental health and wellbeing of the Irish population (Foley et al., 2016). Further research conducted in an Irish context may be useful in determining how urban green spaces might influence mental health outcomes in the Irish urban population.

There is an evident lack of research in this area conducted in primary care. Conducting studies in primary care settings will add to the current research on this topic and provide valuable information regarding how urban green spaces might influence mental health outcomes. Furthermore, social prescribing is now commonly used by GPs to promote physical activity in patients and link them
with sources of support and social activities within their community. As such, research examining how the availability of green spaces within a community mediates the success of social prescribing is also warranted.

Such research can inform policy-makers in this area by providing robust evidence for urban planning-based mental health interventions and allow for the development of coherent and evidence-based policies and governance solutions capable of addressing mental health issues within communities.

Disclosure statement

There are no conflicts of interest to declare.

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References


