



Characteristics of Natural Environments Associated with Mental Health and Well-being

Rapid Review
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Summary

This report describes the characteristics of natural environments that are associated with mental health and well-being. The 14 systematic reviews included in our rapid review had no consistent definition of natural environment, mental health or well-being. Many studies relied on self-reported health data and perceptions of natural environments, which may have a range of interpretations and made comparisons across studies difficult. However, we identified four main themes of natural environment characteristics that support mental health and well-being.

1. Proximity and access to natural environments

- The literature found that green spaces should be within a short distance of local residences, defined as a 'five-minute walk' or up to 300 m to less than one kilometre away

2. Quality of natural environments

- Biodiversity of flora and fauna had some positive associations with mental health/well-being whereas noise and poor maintenance/perceived safety hazards were found to be negatively associated with mental health and well-being

3. Quantity of natural environments

- There was a positive association between quantity of green space and perceived mental health/well-being, which is closely related to proximity and access
- Interventions such as improving parks and promoting the changes, greening of vacant lots and greening of urban streets had promising effects on mental health/well-being

4. Interactions with the natural environment

- Activities such as gardening in an allotment garden and forest therapy were found to benefit mental health and well-being

Most articles were limited to natural experiments; therefore, it was not possible to conclude causation. However, this type of research is likely the highest quality of evidence possible for this topic. The information from this report could support municipal governments to consider these features when building new residential communities or enhancing existing communities in order to support the mental well-being of residents.

Characteristics of Natural Environments Associated with Mental Health and Well-being

Background

Previous research suggests that access to nature and natural environments has a positive impact on the mental well-being of people of all ages.¹ Access to natural environments is particularly important because of increasing industrialization and the loss of natural space that is incurred with the increased residential development required to support a growing population. The presence and maintenance of natural environments within urban and rural communities can support residents to participate more often in nature, which may improve the mental health and well-being of the population. There are several pathways through which natural environments can impact mental health:

- Direct physiology: the innate connection between humans and nature (i.e., biophilia), creates relaxation and reduces stress (i.e., stress reduction theory) and supports focused attention (i.e., attention restoration theory)
- Physical activity: time spent in natural environments may involve physical activity, which has mental health benefits
- Social interaction and/or sense of contribution: natural environments can act as a space for social activities that connect people, encourage creative play and provide a sense of contribution or achievement
- Buffering effects: natural environments protect against stressors such as pollution, heat and noise, which can negatively impact mental health¹⁻⁶

Mental health and well-being is a priority issue at Southwestern Public Health (Public Health) because over a period of four months in 2016, there were 6 reported deaths by suicide among

Oxford County youth (16 to 20 years) compared to none reported the previous year.⁷⁻¹⁰ This alarmingly high number raised the urgency for community response and required suicide prevention measures to be strengthened. In 2017, a local needs assessment was completed and results were shared with the Suicide Prevention Oxford Leadership Coalition recommending preventative action be taken, including building communities with access to natural space to support residents to interact with nature more easily.¹¹ Although political will and community interest are crucial to make progress in city and land-use planning of this type, public health recognized a need (based on the needs assessment) to specifically identify which characteristics are most related to mental well-being to ensure the most beneficial use of developed spaces.

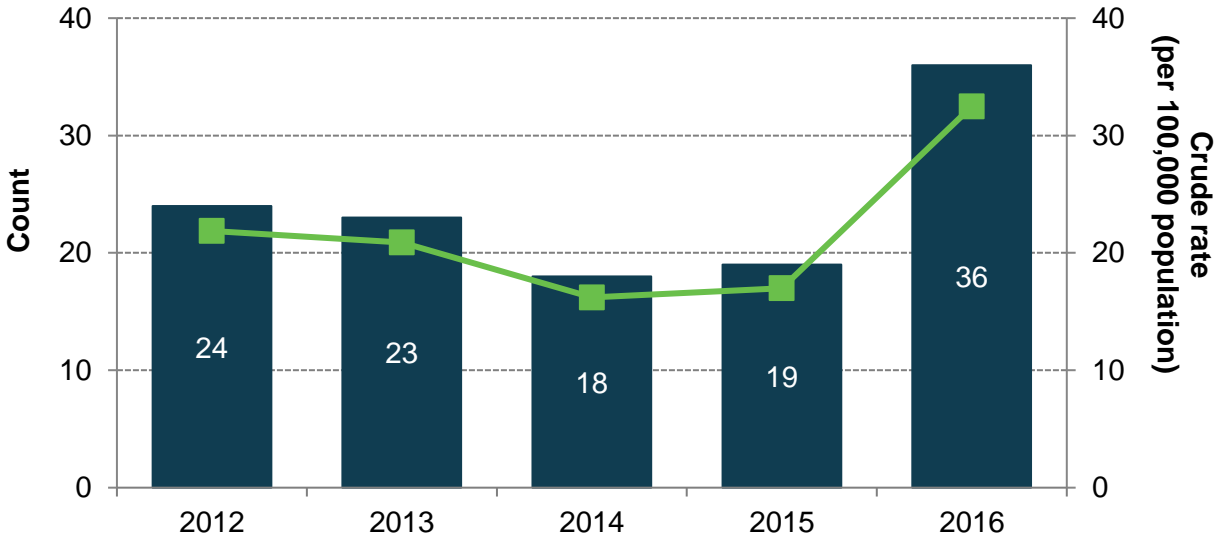
Within the large body of evidence describing the positive impact of natural environments on mental well-being, the specific characteristics of these spaces that support positive mental health are not well defined. For example, characteristics may include the presence of flower gardens, water fountains or streams, wooded areas or access to unpaved trails within the natural space. This lack of information about characteristics of natural environments makes it difficult to design these spaces appropriately to achieve the intended impact on mental health.

This rapid review explored which characteristics and/or features of natural environments are associated with mental health and well-being. Results may be used to support city and land-use planning and development teams, as well as encourage municipal governments to consider these features when building new residential communities or enhancing existing communities in order to support the mental well-being of the population.

Rationale

Mental health and well-being became a priority in Oxford County in 2016 due to an increase in youth suicides. However, over this time, there was also a notable increase in emergency department visits related to mental health and self-harm in the broader population. In 2016, there were 36 emergency department visits among Oxford County residents for mental health-related reasons (Figure 1), which could include schizophrenia, mood disorders, stress-related disorders, behavioural syndromes and disorders of personality. The crude rate of mental health-related ED visits among Oxford County residents from 2012 to 2015 fluctuated around 20 per 100,000 population but increased to 33 per 100,000 population in 2016.

Figure 1. Mental health-related emergency department visits by year, Oxford County, 2012-2016

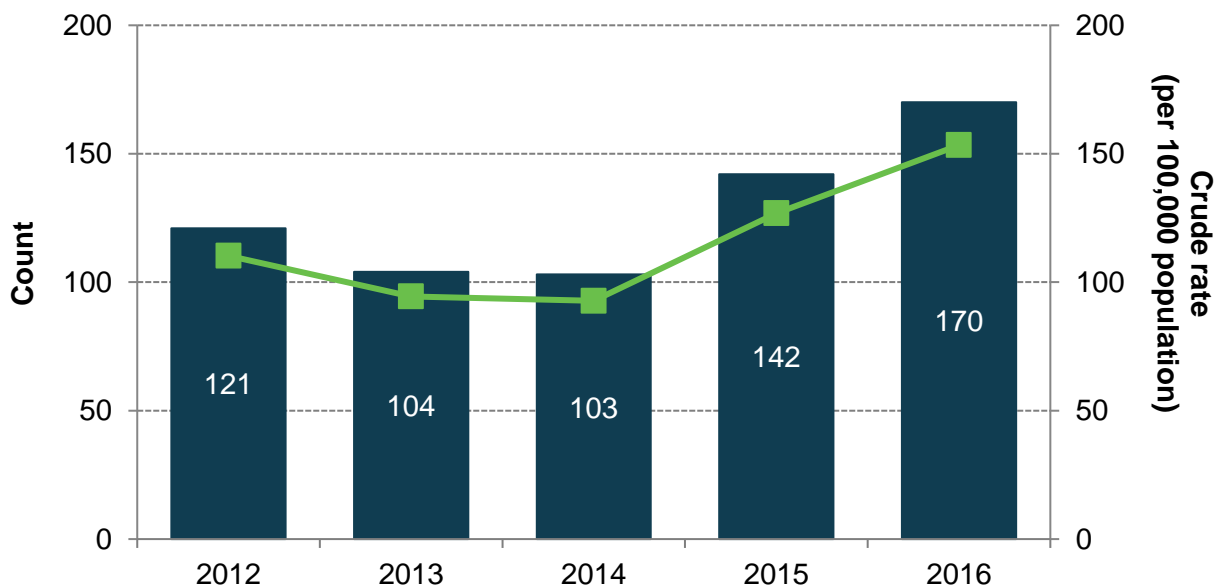


Note: These visits may or may not also include visits due to self-harm because self-harm is considered an external cause leading to an emergency department visit whereas mental health-related visits are considered main causes. Each visit has one main cause associated with it but can have multiple external causes. Therefore, visits could be counted more than once if the codes are combined.

Source: Ambulatory Emergency External Cause (2012-2016), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Date Extracted: October 6, 2017 & Population Estimates (2012-2015), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Date Extracted: January 17, 2017 & Statistics Canada, 2016 Census of Population, Statistics Canada Catalogue no. 98-400-X2016003. Date Accessed: July 14, 2017.

In 2016, there were 170 emergency department visits among Oxford County residents for self-harm (Figure 2). The crude rate of self-harm emergency department visits among Oxford County residents from 2012 to 2014 fluctuated around 95 per 100,000 population, but it increased in 2015 to 127 per 100,000 population and again in 2016 to 153 per 100,000 population.

Figure 2. Self-harm emergency department visits by year, Oxford County, 2012-2016



Source: Ambulatory Emergency External Cause (2012-2016), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Date Extracted: October 6, 2017 & Population Estimates (2012-2015), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Date Extracted: January 17, 2017 & Statistics Canada, 2016 Census of Population, Statistics Canada Catalogue no. 98-400-X2016003. Date Accessed: July 14, 2017.

Although this increase in emergency department visits is concerning, it only provides part of the picture of mental health and well-being in Oxford County because it only includes people who sought help at a hospital. In terms of service use more broadly, a situational assessment found that children, youth and families in Oxford County face barriers to good mental health because of limited access to services due to stigma and poor accuracy and consistency of service information.¹²

More generally, about two-thirds (65.3%) of Oxford County residents reported that their mental health was very good or excellent in 2016, whereas 6.5% felt that it was fair or poor.¹³ This proportion is similar to residents in the South West Local Health Integration Network (LHIN), where 5.1% reported fair or poor mental health from 2012-2015.¹⁴ Notably, a priority group with poorer self-reported mental health are secondary school students. In southwestern Ontario (i.e.,

Erie St. Clair and South West LHINs), 16.0% of grade 9-12 students reported fair or poor mental health in 2015.¹⁵

A smaller per cent of South West LHIN residents reported suicidal ideation in the past 12 months (1.6%).¹⁴ Similar to poor mental health, suicidal ideation was much higher among secondary school students; 12.8% of grade 9-12 southwestern Ontario students reported suicidal ideation in 2015.¹⁵ In addition, 30.7% of these students reported elevated stress in the past month and 32.2% reported moderate-to-serious psychological distress.¹⁵ When considering this current knowledge as a whole, adolescents and young adults are an important population for public health to target when aiming to improve mental health and well-being.

Rapid Review Question

This rapid review aims to answer the following public health question: *Which characteristics of natural environments are associated with mental health and well-being among adolescents (12 to 17 years) and young adults (18 to 24 years)?*

Public health practitioners support and advocate for healthy public policies and built environment features within a population health approach. They work with relevant partners, agencies and non-health sectors to enact change. However, activities such as raising awareness, bringing relevant research to the discussion, conducting research and supporting other sectors to make health-related improvements to communities and broader society are also part of public health practice.

For this rapid review, natural environments are considered distinct, but related to the built environment. Natural environments are defined as green spaces (e.g., parks, forests, meadows) and blue spaces (e.g., rivers, lakes, beaches) that stand in contrast to the concrete, glass and steel urban environment.¹⁶ Although some natural environments are long-standing (e.g., conservation areas), natural environments may also be built and maintained (e.g., walking paths, community gardens). In contrast, the built environment is focused more on land use patterns, transportation and design features such as neighbourhood walkability and street lighting.¹⁷

We limited our search to general mental health and well-being indicators such as self-perceived mental health, stress and the diagnoses of anxiety and/or depression because they are the most common mental health diagnoses. Research focusing on other diagnoses such as schizophrenia, dementia and attention deficit hyperactivity disorder (ADHD) were excluded. The methodology, including the search strategy, inclusion and exclusion criteria, search results, quality assessment and a detailed description of the included studies are provided in the appendices.

Synthesis of Findings

Our search of academic databases and grey literature returned 4,722 unique articles (Appendix C). For peer-reviewed articles (n=4,149), a title and abstract review was completed applying the inclusion and exclusion criteria outlined in Appendix B, Table 2, which left a total of 50 full-text peer-reviewed articles. The inclusion and exclusion criteria were subsequently applied to these 50 full-text articles and all grey literature (n=573). Articles remaining after the full-text review were critically appraised using the Health Evidence Quality Assessment Tool for review articles, a critical appraisal tool developed by Health Evidence (a partnership between McMaster University, the National Collaborating Centre for Methods and Tools and McMaster Optimal Aging Portal).¹⁸ Articles deemed to be of low quality were not included in the final synthesis, leaving a total of 14 systematic reviews for inclusion in the final review (see Appendix D for a detailed quality appraisal of each included study). Unfortunately, none of the included reviews focused on adolescents or young adults; therefore, our findings apply more generally to the population.

Within these 14 reviews, there was no consistent definition of natural environment, mental health or well-being (Table 1).¹⁹ Additionally, there was a broad range of measures used to assess exposure to natural environments and outcomes such as stress, depression, anxiety and well-being. Many studies relied on self-reported health data and perceptions of green space, which may have a range of interpretations and makes comparisons across studies difficult. Developing standardized objective measurements that can be applied across studies is important to advancing the understanding of the effects of natural environments on mental health and well-being.²⁰

Table 1. Examples of exposures and outcomes in the included systematic reviews

Exposures	Outcomes
Any vegetated land within an urban area, including parks, gardens, playing fields, children's play areas and school yards, woods and other natural areas, grassed areas and green corridors	Measured using validated scales such as the Warwick and Edinburgh Mental Well-being Scale, Rosenberg Self-Esteem Scale and Profile of Mood States Scale, Emotional States Scale
Urban space covered by vegetation of any kind, including smaller green space features such as street trees and roadside vegetation, green spaces not available for public access or recreational use such as green roofs and larger green spaces that provide various social and recreational functions such as parks and playgrounds	Any self-reported or objective measure of mental health or well-being, or secondary health-related outcomes (e.g., physical activity)
Outdoor blue space such as inland rivers, lakes, ponds, streams, rivulets, wetlands and fresh waters or non-inland coasts, beaches and salt waters	Psychological distress (common symptoms of depression and anxiety), but not psychiatric conditions classified as severe mental illness such as schizophrenia and schizoaffective disorder

Despite the inconsistencies between the included studies, we identified four main themes in our review of systematic reviews related to the characteristics of natural environments associated with mental health and well-being:

1. proximity and access to natural environments
2. quality of natural environments
3. quantity of natural environments
4. interactions with the natural environment

Proximity and Access to Natural Environments

Proximity from one's home to natural environments was identified as a main theme, often discussed as one's access to natural environments. For the purposes of this review, access refers to the distance or proximity to natural environments, as opposed to accessibility and quality (e.g., walkability, paths) which is more specific to the built environment. For instance, Gascon et al. defined access to green and blue spaces as the presence of green or blue spaces within a walkable distance from a residence.^{21,22} Of the 14 systematic reviews included in the analysis, 9 (64%) included analyses about access or distance to natural environments. The majority of the reviews discussed green space (e.g., public parks, backyard gardens) and two discussed blue spaces (e.g., lakes, rivers, coastal waters). Outdoor blue spaces are defined as outdoor environments, either natural or person-made, that prominently feature water and are accessible to humans.²²

The theme of access is closely connected to the theme of quantity, as green space quantity measurements generally include a measured distance or buffer around the residence. Many different tools and measurement indicators were used in the studies to measure proximity to green and blue spaces, such as geographic information system (GIS) techniques and land-use maps. Many of these indicators are linked with quantity, quality and type of interaction with the natural environment. Objective measures for proximity mainly included distances or buffers from/around participant's residences using GIS and Census Area Units (CAU's). Subjective measures were self-reported distances from one's residence and included descriptions such as "nearby" or "a five-minute walk". The presence or absence of green space within certain distances of a place of residence was also included. Similarly, a variety of tools were used to evaluate mental health and well-being, such as the General Health Questionnaire (GHQ) and Mental Health Inventory (MHI).²¹

Green space

Six systematic reviews looked specifically at the relationship between green space proximity and mental health and well-being. Gong et al. conducted a high quality systematic review which included one cross-sectional study that objectively measured the percentage of green space within a one kilometre and three kilometre radius around respondent's residence using GIS.²⁰

The authors found a greater amount of green space within a one kilometre radius around residents' homes was statistically significantly associated with a lower prevalence of anxiety (odds ratio (OR)=0.95, 95% confidence interval (CI): 0.94-0.97) and depression (OR=0.96, 95% CI: 0.95-0.98).²⁰

A scoping review of reviews by Hassen included 16 scoping and systematic reviews, nine of which discussed access or proximity to green space in relation to mental health and well-being.¹⁹ Four reviews found a positive association, two reviews found limited causal evidence and three reviews did not report conclusions regarding the relationship between access to green space and mental health and well-being. Proximity to green spaces (e.g., within two kilometres of a residence) demonstrated a positive association with mental health and well-being in several reviews. Overall, the authors concluded that there is a positive association between access to green space and mental health and well-being, but that there is limited causal evidence. Unfortunately, this review did not quantify the strength of the associations.

Rautio et al. conducted a high quality systematic review examining the living environment and its relationship to depressive mood.²³ Twelve of the 57 included studies specifically looked at green area proximity or quantity of green space within a particular radius of a participant's home and its relationship to depression. Nine studies showed statistically significant associations between green areas and depressive mood, but three studies showed no associations. For instance, in one study the total amount of green area (one-kilometre radius) was protective against depression (OR=0.86, 95% CI: 0.79-0.93). Another included study found that individuals living in areas where less than one-quarter of homes had private gardens had higher risk of depression than areas where greater than or equal to one-quarter of homes had private gardens (OR=1.29, 95% CI: 1.00-1.65).^a Finally, one study found that the presence of a local park in the neighbourhood reduced depressive symptoms (hazard ratio (HR)=0.80, 95% CI: 0.65-0.99)^b when adjusting for age and sex, but not when adjusting for other confounders. The authors

^a The odds ratio (OR) is the odds that an outcome will occur given an exposure compared to the odds than an outcome will occur in the absence of that exposure. It is used to measure associations when the outcome is dichotomous (i.e., has only two options), such as in logistic regressions. For example, people who live in areas where less than one-quarter of homes have private gardens were 1.29 times more likely to have depression compared to people who live in areas where at least one-quarter of homes have private gardens. ORs less than one are not as straightforward to interpret and can only be said to show negative associations.

^b The hazard ratio (HR) is used for survival analysis and measures how often an event happens in one group compared to how often it happens in another group over time. This measure can be calculated at any point in the study to demonstrate instantaneous risk. This differs from ORs which are cumulative over an entire study and use a defined endpoint.

noted that the heterogeneity between the studies and confounders make broad generalizations difficult.

Rugel conducted a moderate quality systematic review that included 46 studies that looked at green space.² One study found that the distance from the home to green areas was more closely associated with low levels of stress than actual use of green space. Another study found that the presence of large areas of green space within one kilometre of the home was linked to a lower prevalence of anxiety disorders and depression, particularly among children and individuals of lower socioeconomic status. Although the author noted positive associations, the results of these studies were not provided; therefore, the strength of the associations are unknown. The author concluded that even with cumulative evidence relating green space to improved mental health, the weight of evidence is still quite weak due to study designs (i.e., mostly cross-sectional), small sample sizes, short term follow-up and varying exposures and outcomes.

A meta-narrative systematic review completed by Toronto Public Health focused on the impact of urban green space on numerous health outcomes, including mental health and well-being.¹ The review included 106 studies, 47 of which focused on proximity or exposure to green space. The overall strength of the included studies was assessed as fair. The majority of studies (92%) that examined mental health outcomes found statistically significant associations between green space and positive mental health. Much of the research consists of epidemiological studies that examine health outcomes as they relate to the proximity of a green space to a resident's home. The authors did not provide numerical values for these associations; therefore, the strength of the associations is unknown. Included studies noted that closer proximity to green space is associated with reduced stress, and that living farther than one kilometre away from a green space is associated with decreased quality of life. Interestingly, one study reported that adults who lack green space in their neighbourhood do not compensate for the lack of green space by visiting green areas farther away. The main conclusions of the review were that green space improves mental health and well-being of urban residents and frequent access to nearby green space is especially important for children living in low income neighbourhoods.

A high quality systematic review by van den Berg et al. included 19 studies that examined the quantity of green space objectively measured as distance or proximity around a residence and its effect on perceived mental health.⁶ Based on six studies (five high quality with significant findings and one high quality study with null findings), the review concluded that there is strong

evidence for significant positive associations between proximity of green space and perceived mental health. The five high quality studies with significant findings had a range of results. For example, one study found that people who moved to places with more green space had better mental health three years after moving compared to the two years before moving ($\beta=0.431$, $p=0.008$). Another study found a negative association between poor self-rated mental health and the percentage of green space between a one kilometre to three-kilometre radius of one's residence ($\beta=-0.008$, $p\leq 0.05$) and the percentage of green space three kilometres around the centre of one's neighbourhood ($\beta=-0.010$, $p\leq 0.05$).^c

Most studies found that distances of green areas less than one kilometre from one's residence were associated with improved mental health outcomes, which were measured in several different ways and showed various levels of improvement. However, a World Health Organization evidence review recommends that green spaces should be within a short distance of local residences, defined as a "five-minute walk" or up to 300 m. This concurs with Hassen who found that a distance of 300 m was beneficial but greater than one kilometre away was associated with a higher probability of stress.

Blue space

Only two systematic reviews were found to include studies examining the effects of access or proximity to blue space on mental health and well-being.^{21,22} An initial high quality systematic review by Gascon et al. included only three studies that examined the relationship between blue spaces and mental health. One study found that the percentage of blue spaces in buffers of one kilometre and three kilometres were not associated with mental health outcomes.²¹ A second study found that living less than five kilometres from the coast improved mental health compared to living farther away, even after adjusting for percentage of green space and fresh water.²¹ However, the authors did not include enough information to assess the strength of the association. The final study did not find any associations between the presence of blue spaces

^c The *beta* coefficient (β) is the degree of change in the outcome variable for every one-unit of change in the predictor variable. It is a measure used in linear regressions (i.e., when the outcome is a continuous measure). For example, for every increase in the percentage of green space three kilometres around the centre of one's neighbourhood, poor self-rated mental health decreased by 0.01. This outcome value is based on a scale where higher scores indicate worse mental health. To interpret the clinical significance of the association, it is important to know the range of the scale. For example, a 0.01 decrease is more meaningful when the scale is small (such as from 0-5) than large (such as from 0-40). This would require the reader to retrieve the single study cited in the review article, which was not within the scope of this rapid review.

(within buffers ranging from 100 m to 1,000 m) and mental health. Overall, the authors could not draw any conclusions on the effects of blue space on health.

In a more recent high quality systematic review, Gascon et al. synthesized quantitative evidence of the benefits of outdoor blue spaces on well-being and health from 35 studies, of which 12 specifically looked at the effects of blue spaces on mental health and well-being.²² A positive association between greater exposure to blue spaces and benefits to mental health and well-being was found. For instance, one study reported that mental health was better when residing less than five kilometres from the coast compared to living more inland ($\beta=0.147$, $p\leq 0.05$), whereas another found that people reported greater life satisfaction when living less than two kilometres from the coast compared to those living greater than five kilometres away ($\beta=0.835$, $p\leq 0.05$). The authors concluded that the body of evidence suggests a positive association between exposure to blue spaces and mental health and well-being, but evidence of direct causation was limited. A meta-analysis was not possible due to the presence of significant heterogeneity in the study designs, blue space exposure assessments, outcomes assessed and tools to evaluate mental health outcomes. The prominence of cross-sectional designs further limited the ability to address causation. Overall, there is a lack of information on proximity or access to blue spaces and the potential effects it may have on mental health and well-being.

Theme summary

All included reviews concluded that positive associations have been found between proximity and access to green space and enhanced mental health and well-being. However, there is limited causal evidence and the strength of the associations were often unclear. The evidence of the effects of blue space on mental health and well-being is less clear, as much less research has been conducted in this area and the evidence is limited. A meta-analysis was not possible due to great heterogeneity in study designs, measures of the natural environment including proximity to green space, differing measures of mental health and well-being outcomes and differing adjustments for confounders.²³ Additionally, proximity to green space alone may not determine accessibility to the green space. For instance, some green space is privately owned and may not be accessible to the neighbourhood. It is important to look at both the total and usable amounts of green space in the future.²¹

Key message: There are positive associations between proximity of people's homes to natural environments and improved mental health and well-being.

Similarly, the safety of a natural environment (e.g., park) may influence one's use of the green space despite it being in close proximity. Much of the literature to date has not examined whether proximity to a green space alone is sufficient to improve mental health and well-being. More research is needed to measure actual exposure or use of green space, rather than just the distance from a person's residence.^{2,24} Almost all of the included studies measured access and proximity of a green space related to a person's residence or neighbourhood. Few studies discussed the total exposure or proximity to green space related to a person's work or school environment, which could arguably have a significant impact on a person's exposure to green space.²¹ This factor would be an important consideration based on the amount of time people spend away from their residence for work and school purposes.²⁰

Overall, there was limited evidence of a causal relationship between access to natural environments and mental health. However, many positive associations were observed in the studies reviewed between natural environments and proximity to a person's residence. This information should be incorporated into further evaluation and linked to quantity, quality and types of interactions with the natural environment that are found to be most beneficial in supporting mental health and well-being.

Quality of Natural Environments

Mental health and wellbeing, according to the literature reviewed, may be associated with the perceived quality of natural environments. These include green spaces and blue spaces in both positive and negative contexts. There are various features that are linked to the quality of natural environments and throughout. Of the 14 articles reviewed, 6 (43%) included discussion about the quality of natural environments.^{1,2,19,23-25} The studies within the reviews identified various features that affect mental health and well-being, but they were most often discussed in the context of green spaces. The articles identified these features attributes of green space such as safety, good maintenance, interesting features and inclusiveness. Examples of these attributes include wheelchair accessible paths, places to sit and places for groups to gather.¹ The quality of blue spaces was not discussed in the reviewed articles.

Despite these examples of attributes of quality in green spaces, the authors of the studies included in the reviews defined the attributes differently. The World Health Organization found that interventions to improve parks when coupled with advertising or marketing campaigns had a promising effect on mental health and well-being.²⁴ Within each study included in this review, park improvements could mean many different things. For example, one study found that creating a fenced leash-free area for dogs, an all-abilities playground, a walking track, a BBQ area, landscaping and a fenced area to prevent vehicle entrance into the park increased the number of park users over time (235 before improvements to 985 at 12 months after improvements) as well as the number of people engaged in physical activity. The indicators used to measure quality of natural environments are similarly varied. The articles in our review described the impact of quality on mental health and well-being in relation to biodiversity, sound levels and safety and maintenance.¹

Biodiversity

The impact of biodiversity on mental health and well-being is inconclusive in the articles we reviewed. According to Hassen, 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. Four studies found that the richness of vegetation and perceived amount of vegetation were beneficial for mental health and well-being as well as the presence of flowering plants. Unfortunately, the author did not include measures of association needed to evaluate the strength of the statistically significant relationships.¹⁹ Conversely, Lovell et al. found that there were conflicting conclusions among three studies looking at enhanced well-being related to increased plant species richness; two articles found a positive association and one article concluded that there was a decline in well-being.²¹ Hassen found there to be conflicting conclusions around whether or not species richness for bird, butterfly, plant and habitat diversity was associated with mental health. However, Lovell et al. found that bird species richness was positively associated with measures of well-being, but butterfly species richness was shown to have no association.^{19,25} Again, measures of association were not described in these studies.

Sound

The direct impact of sound on mental health is supported by one article included in this review. Hassen discovered that the sounds of wind, water, birds and insects in a “place of peace and silence” were positively associated with mental health and well-being.^{19, p. 11} Noise from traffic, construction and loud people was negatively associated with mental health and well-being.¹⁹ However, the strength of these associations is unknown. The ability for natural environments to act as a buffer against stressors, such as noise, is one of the proposed pathways for how natural environments can impact mental health and well-being.²

Safety and maintenance

Hassen’s review included three studies which concluded that the state of disrepair or lack of maintenance of a green space negatively impacts safety, which may impact the use of the green space. Although the availability of green spaces for entertainment and sports is beneficial for mental health and well-being, it is also important that these spaces have appropriate facilities with adequate lighting and shade to enhance perceptions of safety.¹⁹ In a different review by Toronto Public Health, four studies found that perceived safety and upkeep of green space may have the greatest influence on health outcomes.¹ However, neither of these reviews included the estimates of association; they only state that there were significant relationships.

Similarly, maintenance of green spaces including removal of litter, availability of public toilets and up keep of vegetation have all been shown to be important factors for mental health and well-being.¹⁹ Green space that is poorly maintained or perceived as unsafe or unsatisfactory has been shown to increase stress and negatively impact the health and well-being of residents.¹ Management and maintenance of urban green space is vital so that users perceive it as safe, clean and cared for.²⁴ This includes maintenance of vegetation so that it does not block the line of sight on pathways, ensuring that trash bins are provided and regularly maintained, controlling vandalism and fixing vandalism in a timely manner.²⁴ A perceived lack of care for green spaces is associated with poorer self-reported health, neighbourhood dissatisfaction, stress, social exclusion and poorer mental health among residents.¹ However, as with safety, the strength of these associations was not reported.

Theme summary

It is important to consider the size and distribution of natural environments, but it is also important to consider their quality when examining the impact of natural environments on mental health and well-being. Limited research on features associated with the quality of natural environments echoed the importance of good maintenance and cleanliness as well as features such as a diversity of play structures, water, shade, grass and large trees.¹ In particular, interventions to improve the quality of parks has been found to be a promising way to improve well-being when combined with marketing to increase their use.²⁴ Lack of green space, which can contribute to quality of spaces through noise and air pollution, are related to mental health (e.g., depressive mood) and should be taken into account during the planning process.²³

Key message: There is some evidence to suggest that the safety and maintenance of natural environments, as well as the noise levels surrounding these sites, has a positive impact on mental health and well-being. However, the pathways and strengths of these associations are unknown.

Quantity of Natural Environments

Objective and subjective measurements of existing green space

Of the 14 reviews we evaluated, 6 (43%) discussed the quantity of green and/or blue spaces and their relationship to mental health and well-being.^{6,19–23} The indicators for quantity of natural environment were most often defined by a) the amount of space or b) the number of spaces. Percentage of green and/or blue space and tree canopy coverage were most commonly measured using a geographical information system (GIS) within a specific buffer distance or at a census area unit (CAU) level using land-cover maps. Many studies within the review by Gascon et al., used the Normalized Difference Vegetation Index (NDVI) to measure the amount of surrounding green space within a specific buffer (i.e., 100 m, 250 m, 500 m, one kilometre) either from a residence or within a neighbourhood.²¹ van den Berg et al. measured the number or presence of green spaces within a certain distance.⁶ Studies within the Hassen review suggested that subjective perceptions of greenness within a neighbourhood could also serve as

an indicator for the quantity of natural environment.¹⁹ In addition to these objective and subjective measurements of existing green space, one review examined the impact of interventions to increase green space on mental health and well-being.

van den Berg et al. was the only review to provide strong evidence showing a positive relationship between the quantity of green space (in a small area or around a residence) and perceived mental health.⁶ That conclusion was based on five high quality studies which demonstrated statistically significant findings. For example, one study included in that review found significant associations between reduced depressive symptoms and amount of greenness measured by: NDVI ($\beta=-1.005$, $p<0.05$), percentage of tree canopy coverage ($\beta=-1.369$, $p<0.05$) and a combination of the two measures ($\beta=-1.379$, $p<0.05$).¹⁶ Another study found that the percentage of green space reduced mental distress ($\beta=-0.004$, $p<0.001$), a finding which did not change when gardens were excluded.¹⁶

Three other reviews also confirmed positive association between surrounding greenness or exposure to blue spaces and mental health, but there was no proof of a causal relationship.^{19,21,22} Gong et al. and Rautio et al. also recognized green space as one of many aspects of living environment that could impact mental health and well-being.^{20,23} Their focus on quantity of green space, however, was limited in comparison to the other four reviews. They acknowledged that cross-sectional studies demonstrated associations between the characteristics of the living environment (i.e., lack of green space) and psychological distress, but they could not prove causality.^{20,23}

Interventions to increase the amount of green space

Only one review looked at green space interventions and the impact on health.²⁴ The authors found promising evidence for several interventions that would increase the amount of green space and impact mental health/well-being, including park improvements and greening vacant lots and urban streets. The types of park improvements that were associated with mental health and well-being varied depending on the needs of the community and the existing condition of the park; examples included adding play structures for all abilities, landscaping, and removing graffiti or vandalism. The expansion of parks, by creating openings to adjacent sports fields for public use or adding connecting trails, was also considered an improvement.²⁴

Greening activities had positive effects on outcomes related to mental health and well-being. Greening of vacant lots included activities such as removing litter, debris and graffiti and planting vegetation. The authors found this intervention reduces crime, increases public perception of neighbourhood safety and reduces stress. Planting trees along streets and adding gardens increases bird biodiversity, reduces air pollution and reduces illegal dumping of garbage.²⁴

The review found that the evidence is inconclusive for the impact of urban trails, physical changes to parks without additional promotion or marketing and pocket parks on mental health and well-being.²⁴ They found there was limited evidence for the long-term impacts of urban green space interventions as well as economic benefits for the community.²⁴ Meanwhile, the World Health Organization found no evidence (due to a lack of research) for the impact of green walls, allotment or community gardens and urban agriculture-based interventions on well-being.²⁴ However, our search strategy found two moderate quality systematic reviews that focused on gardening and mental health/well-being. The findings from those studies will be presented in the next section. The World Health Organization also found that there was a lack of evidence about adverse or unintended consequences of these interventions such as the potential for increased heat-related illnesses, allergies and sunburns.²⁴

Theme summary

All included reviews suggest that more green/blue spaces are positively correlated with enhanced mental health and well-being. Heterogeneity of studies and the lack of longitudinal designs inhibited the identification of a causal relationship between the variables and the performance of a meta-analysis. Interventions such as park improvements or greening of urban areas are simple measures that could positively impact mental health and well-being by increasing surrounding greenness.

Key message: All reviews suggest that greater quantities of natural environments are associated with improved mental health and well-being. Improving parks and promoting the changes, greening vacant lots and planting trees along streets are promising interventions to increase the quantity of natural environments and impact mental health and well-being.

Interactions with the Natural Environment

Of the 14 systematic reviews included, 5 (36%) discussed specific interactions or activities carried out in natural environments and their effects on mental health and well-being and compared these interventions to those carried out in non-naturalized environments, such as indoor activities or urbanized areas.

Gardening

Two moderate quality systematic reviews examined the effects of allotment gardening and horticultural therapy on mental health and well-being.^{4,5} Allotment gardening refers to the provision of space for an individual to grow vegetable or fruit crops for non-commercial use, which differs from community gardens where individuals do not have personal responsibility for an individual plot.⁴ Genter et al. examined the contributions of allotment gardening to health and well-being.⁴ Both qualitative (seven studies) and quantitative (three studies) analyses concluded that individuals gardening in allotment gardens experienced self-reported pleasure and satisfaction, enhanced well-being (based on composite measures), improved positive mood and lower stress compared to control groups (i.e., indoor gardeners, home gardeners, indoor exercisers and non-gardening interventions).⁴

Horticultural therapy is the practice of engaging patients in gardening activities to improve health.⁵ Soga et al. conducted a meta-analysis examining the effects of gardening - including horticultural therapy - on well-being and mental health. Mental health outcomes included depression, anxiety, stress, mood, positive affect and psychological well-being.⁵ The meta-analysis included 22 studies which all compared gardening treatment groups to controls (i.e., before gardening or non-gardeners). Although the duration and frequency of the gardening interventions varied, there was a significant medium sized effect of gardening on health outcomes even after adjusting for significant heterogeneity (pooled effect size=0.47, 95% CI: 0.36-0.57).^{5,d} A positive association with gardening was observed, including reductions in depression and anxiety symptoms, stress and mood disturbance, as well as increases in quality of life and a sense of community.⁵ The meta-analysis found evidence that reduced depression

^d The effect size is a measure that quantifies the size of difference or association between two groups. It is often used in meta-analyses to combine and compare estimates from different studies (i.e., is pooled). Generally, 0.2 is considered a small effect size, 0.5 is considered a medium effect size and 0.8 is considered a large effect size.

severity and improved life satisfaction persisted at three months after the intervention, suggesting that the effects of gardening interventions may be sustained. Importantly, no significant differences were found in characteristics or socioeconomic status of gardeners and non-gardeners.⁵

These papers suggest that gardening, including allotment gardening, may enhance health and well-being through a number of pathways including: having a direct experience and contact with nature (i.e., attention restoration theory, or ART); increasing outdoor physical activity levels; by improving social interactions and community networks, particularly with community and allotment gardens; providing a sense of personal development and by improving one's access to fresh fruits and vegetables thereby leading to a healthier lifestyle.^{4,5}

Forest therapy

Forest therapy or forest bathing is defined as visiting a forest or engaging in various therapeutic activities in a forest environment to improve health.² Forest therapy interventions can include activities such as forest viewing, walking in a forest or yoga and/or meditation in forests. Two systematic reviews examined the effects of forest therapy on health and well-being.^{2,26} A moderate strength systematic review by Rugel et al. found that forest therapy program participants and walking in forests (forest bathing) improved self-reported mental health and reduced depression and anxiety compared to non-forest therapy participants.² However, the strength of these associations was not clear.

A high quality systematic review by Lee et al. examined the effectiveness of forest therapy interventions on self-reported depressive symptoms.²⁴ Forest therapy intervention programs varied in duration from one day to 12 weeks, content (forest viewing, walking in the forest, forest meditation) and settings. Walking in the forest was a key component of all therapy interventions in all studies but one. Despite the variances in interventions, the authors concluded that forest therapy is effective in improving depression, particularly for adults with health problems.²⁴ Unfortunately, the authors did not provide the results of individual studies and were unable to conduct a meta-analysis, so the strength of this association is unknown. However, programs that targeted only healthy adults and the ones that used viewing or walking in the forest as the only main intervention failed to demonstrate a significant improvement in the level of depression, suggesting that viewing nature or being present near nature may not be enough to

have a significant impact on the level of depression. Future studies testing the effects of forest therapy should investigate the effects of higher dosages of forest therapy and conduct long-term follow-up assessments.

Green exercise in natural environments

One moderate quality systematic review by Rugel et al. compared exercise done in green spaces, such as parks, reserves and arboretums to exercise done in non-naturalized environments or urban spaces.² They found that exercising (i.e., walking, bicycling, trail running) in natural environments, green spaces, arboretums or forests improved self-esteem, mood and positive affect and reduced stress, anxiety and feelings of depression compared to those exercising in less natural environments.² The health effects of green exercise in a range of natural environments and at a variety of intensities led to improvements in self-esteem and mood, particularly among individuals with mental illness.² Walking in a tended forest with low amounts of dead and brush wood increased positive mood and a sense of calmness compared to walking in a wild forest.² However, the strength of these associations were not discussed. Further research should be conducted looking at the length of interventions, the setting (type of natural space) the quality of the natural environment (tended versus wild forest) and long-term follow-up assessments to determine if the results are sustained.²

Environmental enhancement and conservation activities

Two reviews investigated how environmental enhancement, environmental volunteering and conservation activities may benefit health and well-being. Activities included watershed restoration, woodland management, habitat maintenance and restoration, conservation gardening, trail creation and maintenance of creeks and reserves.^{2,3} All activities in the reviewed studies aimed to improve, conserve or develop the outdoor natural environment. Rugel et al. found that semi-weekly environmental volunteering and monthly volunteering at natural urban and rural sites improved individuals' self-reported mental health and social skills, as well as providing participants with a sense of satisfaction from contributing to their communities.² However, no comparisons were drawn to volunteering programs indoors or in less natural environments and the strength of these associations are unknown.

In a high quality systematic review by Lovell et al. the researchers explored how environmental enhancement and conservation activities may benefit health and well-being.³ The review included both quantitative and qualitative studies. The majority of the quantitative evidence (13 studies, all of poor quality) was inconclusive, though a small number of positive and negative associations were observed.³ Most outcomes were not statistically significant or were inconsistent. What specific activities were included in the studies, how long the activities lasted, and the intensity or frequency of activities were unclear. The qualitative evidence indicated that health and well-being were perceived to be improved following engagement in activities. Participants reported to achieve benefits through a variety of pathways including: personal satisfaction and achievement, physical contact and exposure to the natural environments, opportunities to learn new skills, and social contact gained through participation in activities. This was particularly true for those experiencing social isolation and poor mental health.³ Overall, there was insufficient evidence to conclude whether the continued use of environmental enhancement and conservation activities is justified.

Theme Summary

At this time there is weak or inconclusive evidence regarding the actual benefits of green exercise or conservation activities on improved health or well-being, suggesting the need for further research with higher quality designs.^{2,3} There is evidence that forest therapy is effective in improving depression, particularly for adults with health problems. However, the evidence for positive effects of forest therapy on healthy adults is less clear and may not be enough to have a significant impact on level of depression.²⁶ The positive effects of gardening on health were significant. The evidence from our rapid review suggests that increasing opportunities for people to engage in gardening could improve mental health and well-being.

Key message: Gardening, including horticultural therapy and allotment gardening, was positively associated with mental health and well-being. Forest therapy was found to benefit mental health, particularly for adults with health problems.

Limitations

Many of the included reviews did not consider whether the impact of natural environments on mental health and well-being was different between different groups of people (e.g., by age, for people with children, for people who are health conscious). These comparisons are important because these people may choose to live closer to natural environments, use natural environments in different ways and have different health outcomes for reasons unrelated to their exposure to natural environments. In particular, although our research question was focused on youth, there were no systematic reviews available that focused specifically on children and youth. Instead, there was a wide range of participants with respect to age. Additionally, most studies were conducted in high income or well-developed countries with an urban focus. There was very little information available for rural areas, which limits the applicability of findings to other settings.^{6,19}

Within the characteristics of natural environments, this review found that there is a knowledge gap regarding the relationship between quality of natural environments and mental health and well-being as most studies focus on quantity of natural environments.⁶ However, the information gained through this review offers a starting point to understand what evidence exists regarding the relationship between natural environments and mental health and well-being. There is value in continuing to explore associations between the natural environment and mental health and well-being. Further research should focus on exploring relationships between more detailed or specific characteristics of quantity and quality of natural environments in both urban and rural settings and more specific health outcomes in different population subgroups and in different countries.⁶

Many of the included studies have methodological limitations with reliance on self-reported health data and perceptions of natural environments, in particular green space.^{1,2,5,6,19,26} Furthermore, there was a general absence of defining what is good physical and mental health.

Studies of this nature are generally limited to natural experiments because researchers cannot ethically randomly assign neighbourhoods to have green space built. Importantly, with these types of study designs, conclusions cannot be drawn about causation, but there is some evidence of associations between natural environments and mental health and well-being. These associations are plausible given the established pathways between natural environments

and mental health/well-being (i.e., direct physiology, physical activity, social interaction and/or sense of contribution and buffering effects).¹⁻⁶ Despite these limitations, these types of studies are likely the highest level of evidence that will be generated for this topic.

However, there are some areas of focus where studies with stronger methodological rigor and more sophisticated designs would allow researchers to better understand the potential benefits to mental health and well-being among different subgroups of the population, including adolescents and young adults.^{1,6,21,26} Due to a lack of research for this population, we were unable to draw conclusions about the characteristics of natural environments associated with mental health and well-being among adolescents and young adults. Rather, the results were found to apply more broadly to the population. Similarly, relative to green space, there was little research available on the associations of blue space with mental health and well-being.

Considerations and Next Steps

Based on the best available evidence, key messages to take forward to individuals involved in urban planning or activities conducted outdoors (such as municipalities and school boards) are:

- Natural environments need to be available and accessible (within short distances, ideally under one kilometre) of all those living in the community
- Natural environments need to feel welcoming by having features that reduce noise
- Natural environments need to have well maintained equipment and grounds so that people feel safe in them
- Natural environments should be designed to provide opportunities for all individuals to engage with the environment's features despite different needs related to age, gender, socioeconomic status and health
- Natural environments should be designed to support physical activity and other health promoting behaviours (e.g., meditation)
- Natural environments should be designed to promote individual's participation in their upkeep, conservation and features, for example through allotment gardening

Additionally, one systematic review found promising evidence for several specific interventions that could increase residents' proximity or access to natural environments, increase the quantity of natural environments and improve the quality of natural environments.²⁴ These interventions include making improvements to parks when combined with promotion to increase use, greening of vacant lots and greening of urban streets. However, there is currently limited evidence available about the long-term effects of these interventions and unintended potential adverse effects such as increased allergies, sunburns and heat-related illnesses.²⁴

Notably, the four main themes included in this review are highly intertwined. In particular, the quantity of natural environments was found to be highly related to residents' proximity and access to natural environments: the more natural environments that are present in a community, the more likely it is that people live in close proximity, which may facilitate increased access to natural environments. Similarly, the quality of natural environments along with proximity/access and quantity could greatly impact the activities done in natural environments, which in turn are associated with mental health and well-being. Public health and land-use planning professionals should consider all of these factors together when considering characteristics of natural environments that may impact mental health and well-being.

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Appendix A: Literature Search

Guidelines and review articles (e.g., systematic reviews, scoping reviews, realist reviews) were searched for in seven databases, including Ovid MEDLINE®; Embase; PsycINFO; Ovid MEDLINE® epub ahead of print, in-process and other non-indexed citations and daily update; Environment Complete, GreenFILE and PubMed. The search strategy was limited to review articles in order to meet timelines needed for a rapid review (i.e., 6 months or less). Similarly, articles were limited to those published from 2012-current in order to synthesize the most recent research and to limit the scope for feasibility. The full search strategy for Ovid MEDLINE® is provided in Table 2.

Grey literature was searched for using custom search engines set up by Amy Faulkner, Librarian at Simcoe Muskoka District Health Unit, searching for Canadian public health information, U.S. state government information, information from Ontario public health unit websites and Canadian public health associations, and included the National Institute for Health and Care Excellence (NICE) evidence search and a general Google custom search. The first 100 articles from each of these custom searches were double-screened for inclusion. This approach was used due to the large number of results that were returned. An additional repository, desLibris, was search on January 10, 2018, using the key term “green health”, including English-language articles published from 2012-2018 (54 results returned). Amy Faulkner also provided 26 links to sources/reports that she was aware of from conducting a preliminary scoping search of the topic.

Table 2. Full search strategy in Ovid MEDLINE®, 1946 to December Week 3 2017

#	Searches	Results	Type
1	Depression/ or Mental Health/ or exp mental fatigue/ or exp stress, psychological/ or Stress, Physiological/ or exp anxiety/ or exp orientation/	394156	Advanced
2	Adaptation, Psychological/ or affect/ or exp anger/ or apathy/ or attitude/ or boredom/ or courage/ or emotional adjustment/ or emotions/ or euphoria/ or expressed emotion/	590220	Advanced

#	Searches	Results	Type
	or exp fear/ or Feedback, Psychological/ or forgiveness/ or frustration/ or exp guilt/ or happiness/ or hate/ or hope/ or hostility/ or irritable mood/ or jealousy/ or laughter/ or loneliness/ or optimism/ or Orientation/ or Orientation, Spatial/ or personal satisfaction/ or Personality/ or pessimism/ or Quality of Life/ or relaxation/ or Resilience, Psychological/ or self care/ or social participation/ or Self Concept/ or Self Efficacy/ or sense of coherence/ or social isolation/		
3	((psychological or psychosocial or "psycho social" or emotional) adj1 (adjust* or distress* or develop* or factor? or function* or health* or impact* or influenc* or problem* or restor* or recuperat* or state*)).mp.	91271	Advanced
4	(life satisfaction or (mental adj3 health) or "quality of life" or restoration or restorative* or "recuperative capacity" or (social adj3 function*) or (social adj1 adjust*) or well-being or "well being").mp.	604272	Advanced
5	Nature/	811	Advanced
6	Environment/	64004	Advanced
7	Environment Design/	5814	Advanced
8	Parks, Recreational/	517	Advanced
9	Plants/ or Trees/ or Taiga/ or Forestry/	105969	Advanced
10	Residence Characteristics/ [1968]	31908	Advanced
11	Conservation of Natural Resources/	38727	Advanced
12	Sunlight/	15008	Advanced

#	Searches	Results	Type
13	Wilderness/	277	Advanced
14	(bluespace* or blue space* or built environment* or foliage or forest or forests or fountain* or garden* or grass or grasses or green gym* or green space* or greener* or greening or greenspace* or green infrastructure* or green corridor* or green plan or green plans or green planning or green roof* or greenway* or natural environment* or natural landscape* or naturescape* or open space* or outdoor* or park or parks or parkette* or playground* or ravine* or reforest* or shrub* or soundscape* or therapeutic landscape* or trail or trails or trailway* or wooded or woodland*).mp.	142396	Advanced
15	(green adj3 (environment* or space*)).mp.	1034	Advanced
16	(neighbo?rhood* adj2 environment*).mp.	1298	Advanced
17	(green or nature).ti,kf.	56859	Advanced
18	(restorative adj3 (nature or environment*)).mp.	71	Advanced
19	(countryside* or country side).mp.	1214	Advanced
20	fresh water/ or lakes/ or ponds/ or rivers/	60554	Advanced
21	(creek or creeks).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	2631	Advanced
22	ecological reserve*.mp.	64	Advanced
23	(conservation adj5 (authorit* or area or areas)).mp.	1509	Advanced

#	Searches	Results	Type
24	(protected adj3 (land* or area or areas)).mp.	3159	Advanced
25	((exposure* or expos*) adj2 (nature or environment?)).mp.	1710	Advanced
26	(Shade or (shady adj2 (area* or space*))).mp.	4637	Advanced
27	(shoreline* or waterfront* or shores or shore).mp.	5822	Advanced
28	(water adj3 (catchment* or feature*)).mp.	811	Advanced
29	(horticultural therap* or ecotherap* or "forest bath*" or biophili* or "mood walk*" or nature deficit? or "Shinrin yoku" or (nature adj2 therap*)).mp.	478	Advanced
30	trail making test*.mp.	2789	Advanced
31	or/1-4 [Outcome concepts]	1238999	Advanced
32	or/5-28 [characteristics]	477365	Advanced
33	(human or humans or man or woman or men or women or boy or boys or girl or girls or child or children or adult? or adolescen* or people* or population* or cohort* or female* or male? or community or communities or participant? or person? or patient or patients).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	21260283	Advanced
34	31 and 32	30359	Advanced
35	34 not 30 [removing trail making test articles]	29861	Advanced
36	limit 34 to humans	19897	Advanced

#	Searches	Results	Type
37	animals/ not (animals/ and humans/)	4773308	Advanced
38	35 not 37	25576	Advanced
39	33 and 38	21421	Advanced
40	29 or 36 or 39	22333	Advanced
41	limit 40 to (english language and yr="2012 -Current")	8813	Advanced
42	cochrane database*.jn. or intervention*.ti. or review.pt. or "Review Literature as Topic"/ or search*.mp.	2711390	Advanced
43	((abbreviated or accelerated or brief or expedited) adj2 (review? or synthes?s)).mp.	15861	Advanced
44	((meta adj2 (method* or evaluat*)) or "meta analy*" or metaanaly* or "meta synth*" or metasynt*).mp.	144693	Advanced
45	((comprehensive* or eviden* or fast* or integrative* or literature* or rapid* or realist* or scop* or speed* or streamline* or streamline* or systematic* or umbrella) adj2 (approach* or assess* or bibliographic* or evaluat* or hta? or review? or synthes?s)).mp.	314323	Advanced
46	((research* or information) adj2 synthes?s).mp.	1139	Advanced
47	(medline or cochrane or embase or psychinfo or psycinfo or cinahl or "science citation index" or scopus).ab. or (handsearch* or hand search*).mp.	123378	Advanced
48	(data adj2 (synthes* or extract* or abstract*)).mp.	52218	Advanced
49	(mantel haenszel or peto or der simonian or dersimonian or fixed effect* or latin square* or meta regression* or metaregression*).mp.	25467	Advanced

#	Searches	Results	Type
50	algorithms/ or Consensus/ or guidance.mp. or guideline*.ti. or guidelines as topic/ or practice guidelines as topic/ or Health Planning Guidelines/ or practice guideline*.mp. or guideline*.pt. or best practice*.ti.	527593	Advanced
51	or/42-50 [review or guidelines]	3312307	Advanced
52	41 and 51	1584	Advanced
53	remove duplicates from 52	1303	Advanced
54	from 53 keep 1-1000	1000	Advanced
55	from 53 keep 1001-1303	303	Advanced

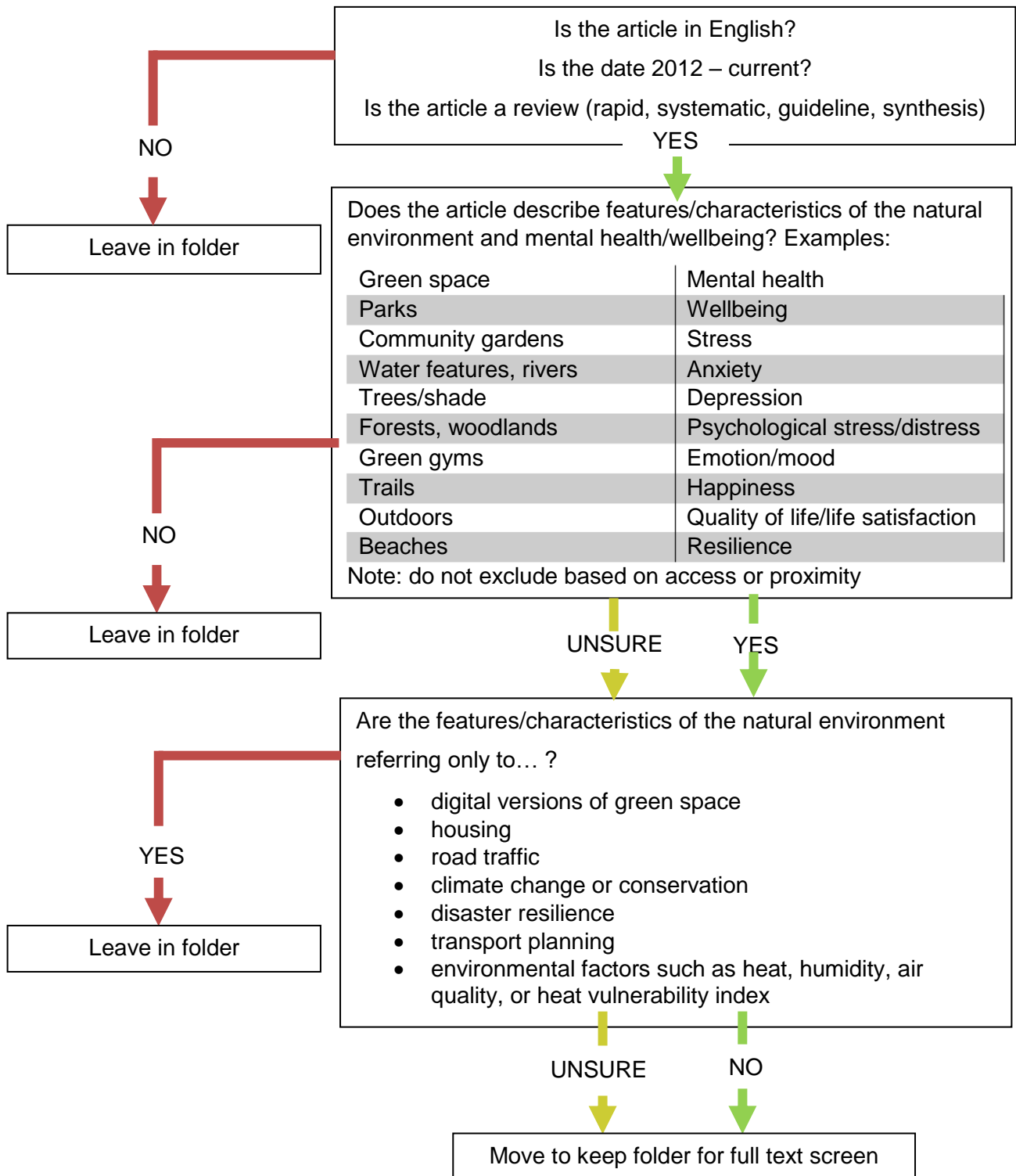
Appendix B: Relevance Assessment

Although the public health practice question was focused on adolescents (12 to 17 years) and young adults (18 to 24 years), the search strategy and inclusion/exclusion criteria were not limited by age. This was done purposefully with guidance from Donna Ciliska, Senior Knowledge Translation Advisor at the National Collaborating Centre for Methods and Tools, and Amy Faulkner due to concerns of limited research focusing on those age groups. The full list of inclusion and exclusion criteria is outlined in Table 3. Articles were independently double-screened for both the title/abstract screening phase and the full text review. The author pairs met after independent screening was complete to come to a consensus on which articles should be included in the review. A screening procedure flow chart was used to ensure consistency between pairs of screeners (Figure 3). Decisions were made by the group during the full text screening phase to exclude conceptual frameworks that did not test the framework (i.e., measure items in framework). Additionally, research protocols were only included if the corresponding results from the study were published. Review articles that did not contain adequate information about methods (i.e., databases, key terms and years searched) were excluded because they would be considered low quality when completing quality assessments.

Table 3. Inclusion and exclusion criteria

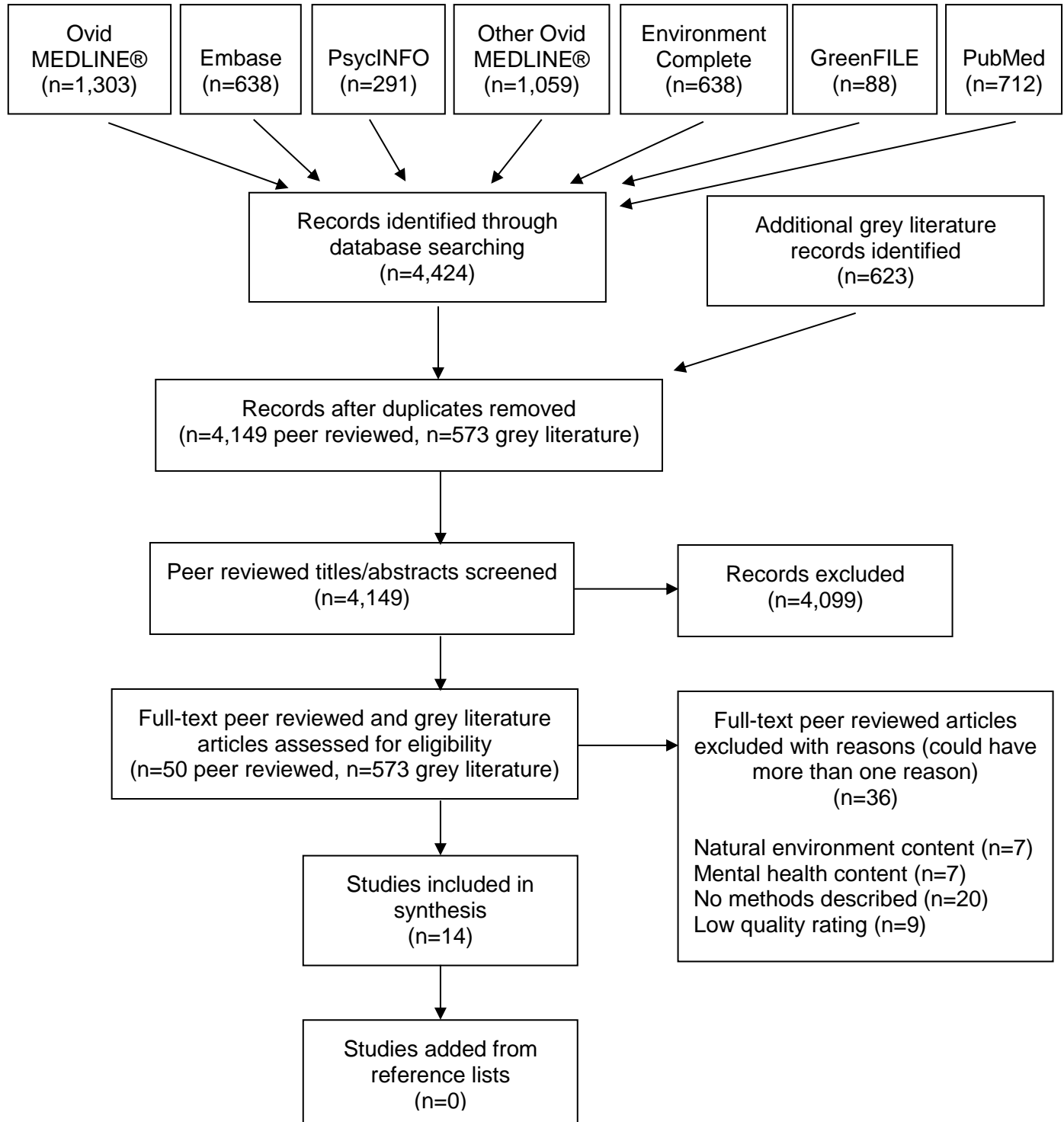
Inclusion	Exclusion
Mental health and well-being outcomes, such as anxiety, depression and psychological stress/distress	Non-green public areas (e.g., digital versions of green space, housing, road traffic, climate change or conservation, disaster resilience, transport planning or environmental factors such as heat, humidity, air quality, or heat vulnerability index)
Published 2012 – current	Only physical outcomes such as obesity, asthma and diabetes
English-language	Single studies (e.g., interventions, cohorts)
Review article (e.g., systematic review, scoping review, realist review) or practice guideline	
Must describe features/characteristics of the natural environment	

Figure 3. Screening procedure flow chart



Appendix C: Results of the Search

Figure 4. PRISMA flow diagram²⁷



Appendix D: Critical Appraisal

The reviews that were included after full text screening were critically appraised using the Health Evidence Quality Assessment Tool for review articles.¹⁸ In the case of articles already appraised in the Health Evidence repository, the existing quality rating was used. This was only the case for one article.²⁸ Overall, there were 9 articles with a weak quality rating, 6 with a moderate quality rating and 8 with a strong quality rating. The 9 articles with a weak quality rating were excluded, resulting in a total of 14 studies included in the review (Figure 4). For the included reviews, the overall quality rating and the individual scores for each item are outlined in Table 4 and Table 5.

Table 4. Quality appraisal score of included articles, by quality assessment items, ordered by first author

Quality assessment items	Gascon (2015)	Gascon (2017)	Genter (2015)	Gong (2016)	Hassen (2016)	Lee (2017)	Lovell (2014)	Lovell (2015)
Clearly focused question	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Appropriate inclusion/exclusion criteria	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Describe search strategy that was comprehensive	No	No	Yes	No	Yes	No	Yes	Yes
Search strategy covered adequate number of years	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Describe level of evidence in primary studies included in review	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Assess methodological quality of primary studies	Yes	Yes	No	Yes	No	Yes	Yes	Yes
Results are transparent	Yes	Yes	No	Yes	No	Yes	Yes	Yes
Appropriate to combine findings across studies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Appropriate methods used to combine or compare results across studies	No	No	No	No	No	Yes	Yes	Yes
Data supports author's interpretation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Overall score and rating	7 (moderate)	8 (strong)	7 (moderate)	8 (strong)	7 (moderate)	9 (strong)	10 (strong)	10 (strong)

Table 5. Quality appraisal score of included articles, by quality assessment items, ordered by first author

Quality assessment items	Rautio (2018)	Rugel (2015)	Soga (2017)	Toronto Public Health (2015)	van den Berg (2015)	World Health Organization (2017)
Clearly focused question	Yes	Yes	Yes	Yes	Yes	Yes
Appropriate inclusion/exclusion criteria	Yes	Yes	Yes	Yes	Yes	Yes
Describe search strategy that was comprehensive	No	Yes	No	Yes	No	Yes
Search strategy covered adequate number of years	Yes	Yes	Yes	Yes	Yes	No
Describe level of evidence in primary studies included in review	Yes	Yes	Yes	Yes	Yes	Yes
Assess methodological quality of primary studies	Yes	No	No	Yes	Yes	No
Results are transparent	Yes	No	No	No	Yes	No
Appropriate to combine findings across studies	Yes	No	Yes	Yes	Yes	Yes
Appropriate methods used to combine or compare results across studies	No	No	Yes	Yes	Yes	No
Data supports author's interpretation	Yes	No	Yes	No	Yes	Yes
Overall score and rating	8 (strong)	5 (moderate)	7 (moderate)	8 (strong)	9 (strong)	6 (moderate)

Appendix E: Description of Included Studies

Data extraction was completed independently by two authors using a standardized Excel table and finalized by consensus between author pairs (AM & CW; MM & MV; CLC & TJ). An overview of study characteristics is presented in Table 6.

Table 6. Characteristics of included studies (continued on subsequent pages)

First author (year)	Search dates	Number of included studies	Populations included	Setting	Exposures	Outcomes	Associations	Conclusions
Gascon (2015)	Not specified	28	No restrictions	Mainly urban	Surrounding/amount of greenness, access to green space, quality of green space, blue spaces	Stress, distress, depression, anxiety and mood disorders	Associations between surrounding greenness or access to green space and mental health for each study are provided in Table 3 and vary by study. Estimates were not provided for blue spaces.	Limited evidence of long-term beneficial mental health effects of surrounding greenness in adults and evidence was inadequate for access to green space, quality of blue spaces and for studies in children
Gascon (2017)	All prior to July 1, 2016	35 (12 focused on mental health/well-being)	No restrictions	Rural and urban	Outdoor blue space environment of residence, school and leisure	Behavioural/emotional problems, well-being, self-esteem, mood, perceived stress, and psychological distress, perceived depression/anxiety, visits to mental health specialists and medication intake	Associations are provided for each study in Table 2 and vary by study. For example, people reported greater life satisfaction when living less than 2 km from the coast compared to those living greater than 5 km away ($\beta=0.835$, $p\leq 0.05$).	Some good quality studies reported an association between residential blue spaces/the use of outdoor blue spaces and mental health/well-being, however there is limited evidence of any direct causation
Genter (2015)	1998-2015	10	Adults 18+ years	UK, did not specify rural or urban	Active allotment gardening (excludes community gardens)	Did not specify, some studies report measures such as composite scores,	This review did not quantify the strength of associations for the three quantitative studies (i.e., did not do a meta-analysis or provide individual results	They conclude that allotment gardening does impact health and well-being and recommend it as a therapy for people with health problems and as a health

First author (year)	Search dates	Number of included studies	Populations included	Setting	Exposures	Outcomes	Associations	Conclusions
						positive mood and cortisol levels	of studies, such as odds ratios, mean differences) but provided qualitative themes	promoting occupation for the general population
Gong (2016)	2000-2012	11	Individuals 16+ years	Urban	Neighbourhood environment, including some aspects of the natural environment (e.g., parks, green space)	Psychological distress defined as the common symptoms of depression and anxiety, but not psychiatric conditions (e.g., schizophrenia)	A greater amount of green space within a 1 km radius around residents' homes was statistically significantly associated with a lower prevalence of anxiety (OR=0.95, 95% CI: 0.94-0.97) and depression (OR=0.96, 95% CI: 0.95-0.98) in one study	Some aspects of the urban environment measured objectively have significant associations with psychological distress, such as architectural features (e.g., housing with deck access) and the amount of green space
Hassen (2016)	2005-2015	16	No restrictions	Urban, high-income countries	Areas with grass, trees or other vegetation that are designated for recreational or aesthetic purposes, excluding workplace related green space exposure and eco-therapy	Focused on emotional, mental health and well-being and excludes cognitive, social and behavioural processes and diagnosed mental illnesses	This review did not quantify the strength of associations (i.e., did not do a meta-analysis or provide individual results of studies, such as odds ratios, mean differences)	Based on existing evidence, 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. The quantity of green space has the least evidence, although having green space is still important.
Lee (2017)	1996-2016	28	Adults 18+ years	Urban	Forest therapy - defined as "visiting a forest or engaging in various therapeutic activities in a forest environment to	Depression	This review did not quantify the strength of associations (i.e., did not do a meta-analysis or provide individual results of studies, such as odds ratios, mean differences)	Forest therapy is effective in improving depression, particularly for adults with health problems; however, "viewing nature" or "being present near nature" may not be enough to have a

First author (year)	Search dates	Number of included studies	Populations included	Setting	Exposures	Outcomes	Associations	Conclusions
					improve one's health and well-being"			significant impact on levels of depression
Lovell (2014)	1980-2012	17	No restrictions	Rural and urban	Biodiversity, species richness and/or settings protected because of its biodiversity	Any self-reported or objective measure of mental health or well-being, or secondary health-related outcomes including measures of improved health behaviors (e.g., physical activity)	This review did not quantify the strength of associations (i.e., did not do a meta-analysis or provide individual results of studies, such as odds ratios, mean differences)	Overall, the evidence is inconclusive and fails to identify a specific role for biodiversity in the promotion of better health
Lovell (2015)	1990-2012	32	No restrictions	Rural and urban, OECD countries *	Outdoor, physically active environmental enhancement or conservation activities, built or natural environments	Scales measuring mental well-being, self-esteem, mood and emotional state	This review did not quantify the strength of associations for the three quantitative studies (i.e., did not do a meta-analysis or provide individual results of studies, such as odds ratios, mean differences) but provided qualitative themes	Could not make conclusions about effect but qualitative research indicated that people felt the activities were valued and contributed to better health and well-being, which is plausible
Rautio (2018)	All prior to October 2016	57 (11 related to green spaces)	No restrictions	Rural and urban	Not specified but included aesthetics of living environment, green areas and accessibility of living environment	Depressive mood - diagnosis of depression/ affective disorder or depressive, affective or mood symptoms	Associations are provided for each study in the supplement Table 1 and vary by study. For example, total amount of green area (1 km radius) was protective against depression (OR=0.86, 95% CI: 0.79-0.93).	Most of the studies showed statistically significant associations with at least one of the characteristics of living environment and depressive mood, but results in relation to aesthetics and walkability of living environment were more inconsistent

First author (year)	Search dates	Number of included studies	Populations included	Setting	Exposures	Outcomes	Associations	Conclusions
Rugel (2015)	All prior to 2014	45	No restrictions	Rural and urban	Green space - any form of nature featuring vegetation, including virtual exposures such as viewing a photograph of a forest	Not defined and included many different mental health outcomes, ranging from ratings of well-being and symptoms to disorders and physiological measures	This review did not quantify the strength of associations (i.e., did not do a meta-analysis or provide individual results of studies, such as odds ratios, mean differences)	Exposure to green space has clear benefits for mental health, including overall mood and feelings of stress and anxiety; however, this is based on weak evidence
Soga (2017)	2001-2016	21	No restrictions	Not specified	Gardening as horticultural therapy, daily gardening and short-term gardening	Anger, anxiety, depression, general health, hope, life satisfaction, loneliness, mood and positive affect	Significant medium sized effect of gardening on health outcomes (pooled effect size=0.42, 95% CI: 0.36-0.48) even after adjusting for significant heterogeneity (pooled effect size=0.47, 95% CI: 0.36-0.57)	Even short-term (several hours) of exercise in gardens can provide instant benefits through reduction in depression and anxiety, but it is unknown how long this lasts
Toronto Public Health (2015)	2000-2014	106 (37 measured mental health, 23 measured well-being – some may measure both)	No restrictions	Urban and peri-urban in North America, Europe, Australia or New Zealand	Green space - any vegetated land within an urban area; it includes parks, gardens, playing fields, children's play areas and school yards, woods and other natural areas, grassed areas and green corridors	Stress, anxiety, depression, self-reported mental health and self-reported well-being	This review did not quantify the strength of associations (i.e., did not do a meta-analysis or provide individual results of studies, such as odds ratios, mean differences)	Green space improves mental health and well-being of urban residents; frequent access to nearby green space is important, especially for children; nearby green space may provide added benefit in low income neighbourhoods; green space that is perceived as unsafe and poorly maintained does not provide health benefits
van den Berg (2015)	All prior to	34 (19 focused on)	No restrictions	Rural and urban	Green space - open spaces with natural elements such as parks, playgrounds	Perceived mental health (many different measures)	Associations are provided for each study in the supplementary Table S2.2 and vary by study. For	There is strong evidence for a positive association between the quantity of green space in people's

First author (year)	Search dates	Number of included studies	Populations included	Setting	Exposures	Outcomes	Associations	Conclusions
	October 2014	mental health)			and recreation areas, excluding settings such as work, schools, hospitals and nursing homes		example, one study found that the percentage of green space within a 1 km radius around one's residence was negatively associated with poor self-rated mental health ($\beta = -0.005$, $p \leq 0.01$)	living environment (i.e., in small area or around residence) and perceived mental health in general adult populations, but associations with quality of green space and mental health were inconclusive
World Health Organization (2017)	Did not specify	38	No restrictions	Urban	Green space interventions - changes that significantly modify availability and features through creating new green space, changing or improving characteristics, use and functions or removing/replacing green space; green space was defined as urban space covered by vegetation of any kind	No specific mental health/well-being outcomes, have examples of depression, stress and anxiety	Limited information about associations are provided for each study in Annex 1 (typically just p-value). For example, one study found that construction of improved footpaths, clearing trash and signs of vandalism, signage and entrance gateways, improved appearance and safety of trees and vegetation (improved views and visibility) and group activities increased quality of life and perceptions of safety ($p \leq 0.05$).	There is promising evidence for park-based interventions that specifically combined a physical change to the green space and promotion programs, interventions that involved greening of vacant lots, greening of urban streets and green infrastructure for managing storm water impacts. There is inconclusive evidence for park-based interventions that only involved physical changes to the green space, urban greenways/trails, pocket parks and green infrastructure for cooling areas, as well as the long-term impact, economic benefits and impacts of interventions on various equity indicators. There was no evidence for green walls, allotments/community gardens and urban agriculture-based interventions, as well as adverse or unintended

First author (year)	Search dates	Number of included studies	Populations included	Setting	Exposures	Outcomes	Associations	Conclusions
								consequences of interventions.

*OECD = Organization for Economic Cooperation and Development

Appendix F: Excluded Studies

This list includes potentially relevant peer reviewed and grey literature review articles that were read in full text form but excluded from the review because they did not describe characteristics of natural environments, did not include mental health or well-being as an outcome or did not have an adequate methods section (i.e., did not describe the databases, years and key terms searched).

1. Alaimo K, Beavers AW, Crawford C, Snyder EH, Litt JS. Amplifying health through community gardens: a framework for advancing multicomponent, behaviorally based neighborhood interventions. *Curr Environ Heal Reports*. 2016;3(3):302–12.
2. Banay RF, Bezold CP, James P, Hart JE, Laden F. Residential greenness: current perspectives on its impact on maternal health and pregnancy outcomes. *Int J Womens Health*. 2017;9:133–44.
3. Barnett A, Zhang CJP, Johnston JM, Cerin E. Relationships between the neighborhood environment and depression in older adults: a systematic review and meta-analysis. *Int Psychogeriatrics*. 2017;1–24.
4. Bell SL, Foley R, Houghton F, Maddrell A, Williams AM. From therapeutic landscapes to healthy spaces, places and practices: A scoping review. *Soc Sci Med*. 2017/11/28. 2017;196:123–30.
5. Berto R. The role of nature in coping with psycho-physiological stress: a literature review on restorativeness. *Behav Sci (Basel)*. 2014;4(4):394–409.
6. Beute F, de Kort YA. Salutogenic effects of the environment: review of health protective effects of nature and daylight. *Appl Psychol Health Well Being*. 2014;6(1):67–95.

7. Beyer KMM, Kaltenbach A, Szabo A, Bogar S, Nieto FJ, Malecki KM. Exposure to neighbourhood green space and mental health: evidence from the survey of the health of Wisconsin. *Int J Environ Res Public Health*. 2014;11(3):3453-3472.
8. Bragg R, Atkins G. A review of nature-based interventions for mental health care [Internet]. Natural England Commissioned Reports, Number 204; 2016 [cited 2018 Feb 28]. Available from: <http://publications.naturalengland.org.uk/publication/4513819616346112>
9. Bratman GN, Hamilton JP, Daily GC. The impacts of nature experience on human cognitive function and mental health. *Ann N Y Acad Sci*. 2012;1249:118–36.
10. Capaldi CA, Dopko RL, Zelenski JM. The relationship between nature connectedness and happiness: a meta-analysis. *Front Psychol*. 2014;5:976.
11. Chevalier G, Sinatra ST, Oschman JL, Sokal K, Sokal P. Earthing: health implications of reconnecting the human body to the Earth's surface electrons. *J Environ Public Heal*. 2012;2012:291541.
12. Choudhry KZ, Coles R, Qureshi S, Ashford R, Khan S, Mir RR. A review of methodologies used in studies investigating human behaviour as determinant of outcome for exposure to “naturalistic and urban environments.” *Urban For Urban Green*. 2015;14(3):527–37.
13. Christian H, Zubrick SR, Foster S, Giles-Corti B, Bull F, Wood L, et al. The influence of the neighborhood physical environment on early child health and development: A review and call for research. *Health Place*. 2015;33:25–36
14. Clark NE, Lovell R, Wheeler BW, Higgins SL, Depledge MH, Norris K. Biodiversity, cultural pathways, and human health: a framework. *Trends Ecol Evol*. 2014;29(4):198–204.
15. Clatworthy J, Hinds J, Camic PM. Gardening as a mental health intervention: A review. *Ment Heal Rev J*. 2013;18(4):214–25.
16. Connellan K, Gaardboe M, Riggs D, Due C, Reinschmidt A, Mustillo L. Stressed spaces: mental health and architecture. *HERD*. 2013;6(4):127–68.

17. Coutts C, Hahn M. Green infrastructure, ecosystem services, and human health. *Int J Environ Res Public Health*. 2015;12(8):9768–98.
18. Curtis S, Pain R, Fuller S, Khatib Y, Rothon C, Stansfeld SA, et al. Neighbourhood risk factors for common mental disorders among young people aged 10-20 years: a structured review of quantitative research. *Health Place*. 2013;20:81–90.
19. Detweiler MB, Sharma T, Detweiler JG, Murphy PF, Lane S, Carman J, et al. What is the evidence to support the use of therapeutic gardens for the elderly? *Psychiatry Investig*. 2012;9(2):100–10.
20. Dzhambov AM, Dimitrova DD. Urban green spaces' effectiveness as a psychological buffer for the negative health impact of noise pollution: a systematic review. *Noise Health*. 2014;16(70):157–65.
21. Douglas O, Lennon M, Scott M. Green space benefits for health and well-being: A life-course approach for urban planning, design and management. *Cities*. 2017;66:53–62.
22. Franco LS, Shanahan DF, Fuller RA. A review of the benefits of nature experiences: more than meets the eye. *Int J Environ Res Public Health*. 2017;14(8):1.
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26. Hansen MM, Jones R, Tocchini K. Shinrin-Yoku (forest bathing) and nature therapy: a state-of-the-art review. *Int J Environ Res Public Health*. 2017;14(8):28.

27. Hartig T, Mitchell R, de Vries S, Frumkin H. Nature and health. *Annu Rev Public Health*. 2014;35:207–28.
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34. McCormick R. Does access to green space impact the mental well-being of children: a systematic review. *J Pediatr Nurs*. 2017;37:3–7.
35. McSweeney J, Rainham D, Johnson SA, Sherry SB, Singleton J. Indoor nature exposure (INE): a health-promotion framework. *Health Promot Int*. 2015;30(1):126–39.
36. Naeem S, Chazdon R, Duffy JE, Prager C, Worm B. Biodiversity and human well-being: an essential link for sustainable development. *Proc R Soc London Ser B Biol Sci*. 1844;283(1844):14.

37. Passmore H-A, Howell AJ. Eco-existential positive psychology: Experiences in nature, existential anxieties, and well-being. *Humanist Psychol.* 2014;42(4):370–88.
38. Pleasant A, Scanlon MM, Pereira-Leon M. Literature review: Environmental design and research on the human health effects of open spaces in urban areas. *Hum Ecol Rev.* 2013;20(1):36–49.
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41. Sandifer PA, Sutton-Grier AE, Ward BP. Exploring connections among nature, biodiversity, ecosystem services, and human health and well-being: opportunities to enhance health and biodiversity conservation. *Ecosystem Services.* 2015;12:1-15.
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