Human-nature connectedness and chronic disease: a scoping review

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Declaration

This article contains no material which has been accepted for the award of any other degree or diploma in any University, and, to the best of my knowledge, contains no materials previously published except where due reference is made.

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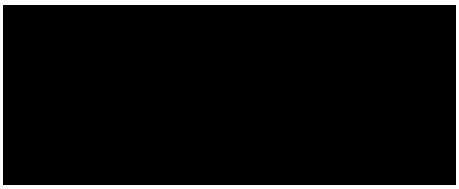

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Statement of Contribution

I generated the idea for the project, which was refined in consultation with my supervisor. I wrote and published the scoping review protocol in the Open Science Framework with help from my supervisor. I developed the search strategy in consultation with a liaison librarian, who is experienced in database searches for the faculty of health and medical sciences at the University of Adelaide and with advice from an Ovid platform senior training consultant. I conducted the title, abstract, and full-text screening with my supervisor (two reviewers). I extracted the data from the included studies and contacted the authors for further information as was required. The visualisations in this thesis were constructed by me from templates provided by Page et al. (2021) and a rmarkdown script initiated by my supervisor (Allaire et al., 2021). I wrote the original draft of the article. I chose the short list of appropriate journals for publication of my article which was refined in consultation with my supervisor.

Cover page for submission to Journal of Environmental Psychology

Human-nature connectedness and chronic disease: a scoping review

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Declarations of interest

None.

CRediT authorship contribution statement (To be inserted at the end before submission to journal)

Sue Conaghty: Conceptualisation, Methodology, Screening, Data Extraction, Writing – original draft, Visualisation.

This article is intended for submission to the **Journal of Environmental Psychology**, which adheres to the American Psychological Association reference style. In accordance with the specifications of sections I have included a numbered section headings (1. Introduction and 5. Limitations and Further Directions). At present the article has been written to the Master of Psychology (Health) Research Report requirements of 6,000-8,000 words which meets the 10,000-word limit specified by the Journal of Environmental Psychology for review article submissions. The relevant page from the submission guidelines for the Journal of Environmental Psychology can be found as Appendix A.

Abstract

Chronic disease is placing a significant burden on health systems that are supporting increasingly urbanised lifestyles. Engaging in healthy lifestyle behaviours — such as being physically active, eating a healthy diet, and not smoking — may help to ease this burden by preventing the development of chronic disease. One psychological attribute that is positively associated with these healthy lifestyle behaviours is human-nature connectedness, which is relatively easy to measure and modify. If people who feel more connected to nature experience less chronic disease, then interventions increasing human-nature connectedness may be important ingredient in upstream public health interventions. In this scoping review, we map empirical studies that measure human-nature connectedness in chronic disease populations and compare them to general populations. We conducted a systematic, comprehensive search of current literature and identified just six studies out of 1490 that included a valid baseline measure of human-nature connectedness in relevant chronic disease populations. Among chronic the few disease populations sampled in these studies, we observed that human-nature connectedness was highly variable compared with normative samples. Our review primarily highlights a significant gap in research on human-nature connectedness in the context of chronic disease and the absence of a clear definition of human-nature connectedness in public health research. We offer a definition of human-nature connectedness that distinguishes psychological connectedness from physical engagement with nature and suggest directions for future research focussed on human-nature connectedness for chronic disease prevention.

Keywords: Human-nature connectedness, Chronic disease, Nature-based interventions, Behaviour change, Preventative medicine, Scoping review

1. Introduction

Chronic diseases are long-term illnesses with persistent effects. The National Centre for Chronic Disease Prevention and Health Promotion (2022) defines chronic diseases as conditions lasting longer than one year which require ongoing medical attention and/or limit the activities of daily living. Globally, chronic disease is associated with significant costs to individual wellbeing, workplace productivity, and health care services (Australian Institute of Health and Welfare, 2023). Unfortunately, the global burden of chronic disease continues to increase (James et al., 2018). In Australia, nearly half (47.3%) of the population has at least one chronic condition, with many (18.6%) having multimorbidity, or more than one chronic condition at the same time (Australian Bureau of Statistics, 2022).

Importantly many chronic diseases are preventable. The cause of morbidity is often associated with modifiable socioeconomic and behavioural determinants (Australian Institute of Health and Welfare, 2023; Solar & Irwin, 2010). In a landmark case-control study, protective and risk factors in over 15,000 individuals presenting with premature cardiac disease were compared to a similar number of healthy controls. The authors concluded that 90% of all heart diseases can be prevented by lifestyle changes (Yusuf et al., 2004). Individual risk behaviours such as smoking, drinking alcohol, physical inactivity, and poor diet can lead to vulnerable health states, including mental illness, obesity, and hypertension, which significantly increase the risk of developing chronic heart, lung, and kidney diseases, type 2 diabetes, stroke, osteoporosis, as well as some cancers, pain, mental health conditions, and other preventable chronic diseases (Australian Institute of Health and Welfare, 2023). Furthermore, at a community level there are many social determinants of health contributing to the burden of chronic disease including, access to healthcare and education, cost of living, psychosocial stressors, and the influence of social norms (Farrow et al., 2017; Marmot, 2008; Wilks et al., 2020). Due to the dependence on modifiable risk factors, there is a demand for

evidence-based biopsychosocial interventions — integrated therapies considering biological, psychological, and socio-environmental factors underlying the development of disease — focused on changing well-being and lifestyle behaviours associated with the increasing burden of preventable chronic disease (Ali & Katz, 2015; Deter, 2012; Engel, 1977, Porter, 2016).

In parallel to the increase in global chronic disease prevalence there has been an increase in urbanisation. More than 50% of people now live in urban, compared to rural areas with predictions for 68% by 2050 (World Health Organisation, 2023). While there are some health benefits associated with urban living, social and health scientists are finding that urbanisation is associated with a number of negative health outcomes (World Health Organisation, 2023). While Moore et al., 2003 were able to provide a review of health hazards and risks associated with urbanisation (substandard housing and sanitation, poor nutrition, pollution, increased stress), other studies have highlighted poor health outcomes. For example, in a large Swedish survey, Sundquist et al. (2004) showed a significant increased risk of psychosis and depression associated with high urbanisation and Little & Wyver (2008) reported risks to child psychological wellbeing as opportunities for free outdoor play continue to decline in urban settings. But this association between some facets of urban living and poor health outcomes does not mean that rural living is a panacea for chronic disease. In fact, emerging research has suggested that the extent to which people feel psychologically connected to nature (irrespective of living environment) may influence the extent to which they engage in behaviours (e.g., healthy diet, physical activity, reduced consumption and waste, and practicing compassion and empathy for all living things) associated with better long-term health outcomes (Mayer, 2018). Psychological interventions to improve human-nature connectedness may thus hold promise as a protective factor against behaviours linked with chronic disease. Thus, in this review we explore the empirical

evidence for (and against) the proposition that human-nature connectedness can significantly influence the prevention and management of chronic diseases (Dadvand et al., 2018; Shanahan et al., 2016).

We use the term 'human-nature connectedness' (HNC) to describe *the extent to which an individual feels connected to and/or identifies as being a part of the natural environment.* Human-nature connectedness is generally thought to have three distinct dimensions: affective, cognitive, and experience-based. For example, during the development of the now widely used Nature Relatedness (NR) questionnaire, Nisbet et al. (2009) asked 831 participants to score 30 candidate items and conducted an exploratory factor analysis based on their responses. The final 21 items were shown to measure three domains of human-nature connectedness: emotional or affective connection to nature ("My relationship to nature is an important part of who I am."), cognitive connection to nature ("Animals, birds and plants have fewer rights than humans."), and physical experiences in the natural environment ("I enjoy being outdoors, even in unpleasant weather."). These three dimensions capture the different relationships people have with the natural environment, linked by a sense of connection.

Human-nature connectedness has been strongly correlated with a variety of human attitudes and behaviours. Relevant to healthy lifestyle behaviours, Nisbet et al. (2009) found construct validity studies that the nature relatedness construct was highly correlated with the Consideration of Future Consequences scale (CFC; Strathman, Gleicher, Boninger, & Edwards, 1994). The Consideration of Future Consequences scale is indicative of health lifestyle behaviours such as reduced smoking, reduced alcohol consumption, eating healthy diets, and exercise (Murphy & Dockray, 2018). In a large Austrian survey, Haluza and colleagues (2014) explored the impact of human-nature connectedness on health behaviours and found that people who feel more connected to nature spend more time performing

outdoor sport activities and are less likely to smoke. More recently, meta-analytic evidence was published showing that individuals with higher human-nature connectedness demonstrated more behaviours that enhanced wellbeing (e.g., affect, subjective happiness, life satisfaction, and psychological wellbeing measures) and were significantly healthier (e.g., stress, vitality, physical activity, and general health measures) than those with lower human-nature connectedness scores (Barragan-Jason et al., 2022). Finally, in an editorial for the special issue of Ecosystems and People, Riechers and colleagues (2021) describe human-nature connectedness interventions as "transformative public health initiatives" which can promote sustainable lifestyles at a population level.

But why should a sense of feeling connected to the natural environment be positively associated with well-being and healthy lifestyle behaviours? The prevailing explanation for this association is that people with higher human-nature connectedness spend more quality time engaging with natural environments and their elements (Lumber et al., 2017; Mayer et al., 2009). In a meta-analysis of 143 studies, Twohig-Bennett and Jones (2018) found that exposure to greenspace was associated with a wide range of health benefits including statistically significant decreases in incidence of diabetes, and all-cause and cardiovascular mortality. Structured exposures to natural environments and natural elements have also been proposed by Maller et al. (2006) as important upstream public health initiatives. Such nature-based interventions have been shown to confer multiple benefits for preventing and managing a broad range of physical health conditions and mental health disorders (Craig et al., 2016; Kotera et al., 2020; Lackey et al., 2019; Shanahan et al., 2019). Specifically, nature-based interventions have been shown to improve several health indices associated with chronic disease (Frumkin et al., 2017; Han et al., 2016), reduce many of the psychosomatic and psychosocial symptoms experienced by people with chronic disease (Taylor et al., 2022), and to help change behaviours that are known intermediary determinants of common chronic

diseases (Craig et al., 2016; Gorman & Cacciatore, 2020; Pretty et al., 2017; Wilkie et al., 2021). However, the results are inconsistent (Folk & Dunn, 2023) and it seems not everyone benefits from spending time in nature. The extent to which people feel connected to the natural environment has been found to be a key psychological attribute shaping human-nature interactions and has been found to be an important moderator of the effectiveness of nature-based interventions (Gosling & Williams, 2010; Martin et al, 2020; Mayer et al., 2009; McMahan et al., 2018; Watson et al., 2020).

Human-nature connectedness is positively associated with a number of factors that have been shown to mitigate chronic disease. These factors include good mental health (e.g., developing healthy mindsets), mindfulness (e.g., noticing different sensory stimulants in nature), regular autonomic stress restoration (e.g., calming behaviours that change body chemistry), vitality (e.g., feeling alive, alert, and energetic), protective personality traits (e.g., agreeableness), positive values and attitudes (e.g., community, honesty, satisfaction), health promoting behaviours (e.g., physical exercise, healthy diet), and social connection (Barragan-Jason et al., 2022; Cleary et al., 2020; Keenan et al., 2021; McEwan et al., 2019; Wang et al., 2022). Feeling strongly connected to nature is also positively associated with avoidance behaviours that protect against exposure to environmental hazards (Nieuwenhuijsen et al., 2017).

Most important for the prevention of chronic disease, human-nature connectedness is modifiable (Lumber et al., 2017). Participants exposed to interventions designed to increase human-nature connectedness report enduring changes in the extent to which they feel connected to the natural environment (Barragan-Jason et al., 2022). Thus, interventions to increase individual and population levels of human-nature connectedness could offer a promising new approach to improving health outcomes and changing human behaviour in the service of chronic disease prevention (Cleary et al., 2020).

While many studies have shown an association between human-nature connectedness and wellbeing or 'wellness' in healthy populations, fewer studies have focused on the relationship between human-nature connectedness and 'illness' in chronic disease populations (Beyer et al., 2018; Dean et al., 2018). The objective of this scoping review is to examine the relationship between human-nature connectedness and chronic disease status. By way of a quasi-natural experiment, this review explores literature reporting on human-nature connectedness among different chronic disease populations and asks whether people living with preventable chronic disease differ in the extent to which they feel connected to the natural environment relative to the general population. To our knowledge there is no current answer to this question and a scoping review approach was needed to explore the extent to which the human-nature connectedness concept has been included in the chronic disease literature (Munn et al., 2018). A preliminary search of *JBI Evidence Synthesis*, the International Journal of Environmental Research and Public Health, the Cochrane Library (online), PubMed, PsychINFO, Embase, ScienceDirect, and Public Health Database was conducted on April 13, 2023. No relevant current or in-progress scoping reviews or systematic reviews on the topic were identified.

A secondary objective of this review is to examine how clinical research conceptualises and measures the human-nature connectedness construct in the context of chronic disease.

2. Methods

The methods for the scoping review were designed in accordance with the JBI Manual for Evidence Synthesis, Chapter 11, Scoping reviews (Peters et al., 2020) and the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA- ScR) (Tricco et al., 2018). The corresponding PRISMA checklist can be

seen in Appendix B. Prior to beginning the search strategy, a scoping review protocol was registered with the Open Science Framework on the 15th of May 2023 (https://osf.io/t4hzs).

To account for the apparent limited direct evidence linking human-nature connectedness to chronic disease status we deliberately kept our research question for this scoping review quite broad: *Does human-nature connectedness differ among populations with chronic disease, relative to general populations?* To address this question, existing data published on human-nature connectedness scores in chronic disease populations was reviewed and compared to normative samples from more general populations. The sub-questions in this scoping review further explore how the human-nature connectedness concept is conceptualised and measured in the chronic disease literature. The search strategy was based on the population, concept, context (PCC) framework outlined in Table 1.

Table 1.

PCC Framework Identifying the Core Elements of the Scoping Review (Peters et al., 2020).

P – population	People with chronic disease conditions limited to arthritis, asthma, back pain, cancer, cardiovascular disease, chronic obstructive pulmonary disease, diabetes, chronic kidney disease, mental health conditions and osteoporosis.
C – concept	Human-nature connectedness
C – context	Chronic disease literature

To be included in this scoping review articles needed to report quantitative scores of human-nature connectedness in chronic disease populations at baseline (pre-intervention). Furthermore, only articles reporting scores derived from validated human-nature connectedness measures were included in this scoping review (Keaulana et al., 2021; Salazar

et al., 2021; Tam, 2013). Included studies were also restricted to adults (over 18 years old) who either reported, or were diagnosed with, one or more chronic diseases from one of the 10 major chronic disease groups listed by the Australian Institute of Health and Welfare (arthritis, asthma, back pain, cancer, cardiovascular disease, chronic obstructive pulmonary disease, diabetes, chronic kidney disease, mental health conditions and osteoporosis) (Australian Institute of Health and Welfare, 2023). Within the included disease groups, the specific disease type needed to be chronic and considered preventable. Participants needed to be experiencing symptoms, or diagnosed with the chronic disease, within 1 year of the baseline measurements provided in the article. Diseases lasting less than a year or caused by unpreventable factors were not included (e.g., diabetes type I, acute respiratory infections).

A comprehensive selection of databases was chosen to capture the multidisciplinary nature of human-nature connectedness research in the context of chronic disease and preventative medicine. Databases included: PubMed, Public Health Database, Scopus, PsycINFO, Web of Science, ScienceDirect, and Embase. Only primary literature written in English was included and there was no limits for the date of publication, participant gender, or study setting. Reviews and qualitative studies were excluded from this scoping review as they do not report primary quantitative human-nature connectedness data. Non-human studies were also excluded.

The search strategy was developed in consultation with a liaison librarian, who is experienced in database searches for the faculty of health and medical sciences at the University of Adelaide and with advice from an Ovid platform senior training consultant. Search terms based on the key concept “human-nature connectedness” and population criterion “chronic disease” were combined as demonstrated in the final Scopus search strategy outlined in Appendix C. The first author conducted the database searches on the 8th and 11th of May 2023 and uploaded the results into the online systematic review platform

Covidence (Veritas Health Innovation, Melbourne, Australia). The Covidence platform automatically recorded the number of articles imported from each database and removed most duplicates. Search phrases “nature connectedness” AND (“chronic disease” OR clinical) were used in Google Scholar Advanced to search the gray literature. We also supplemented the database search by screening the reference lists of the articles selected for full text review and any related systematic reviews identified in the preparation for this scoping review. A lack of sensitivity inherent in key words (‘nature’, ‘connected’ and ‘related’) and the absence of database MeSH terms for the concept ‘human-nature connectedness’ was noted for this research topic.

Title and abstract screening were conducted independently by two reviewers (first and second authors) in Covidence (Veritas Health Innovation, Melbourne, Australia). Interrater reliability was fair (Cohen’s Kappa 0.32), and any discrepancies were resolved by consensus. Full-text screening was initiated by the first author who excluded articles with no baseline human-nature connectedness score, invalid human-nature connectedness instruments, or unlisted diseases. This initial process eliminated most of the full-text articles. Both reviewers completed the full-text screening.

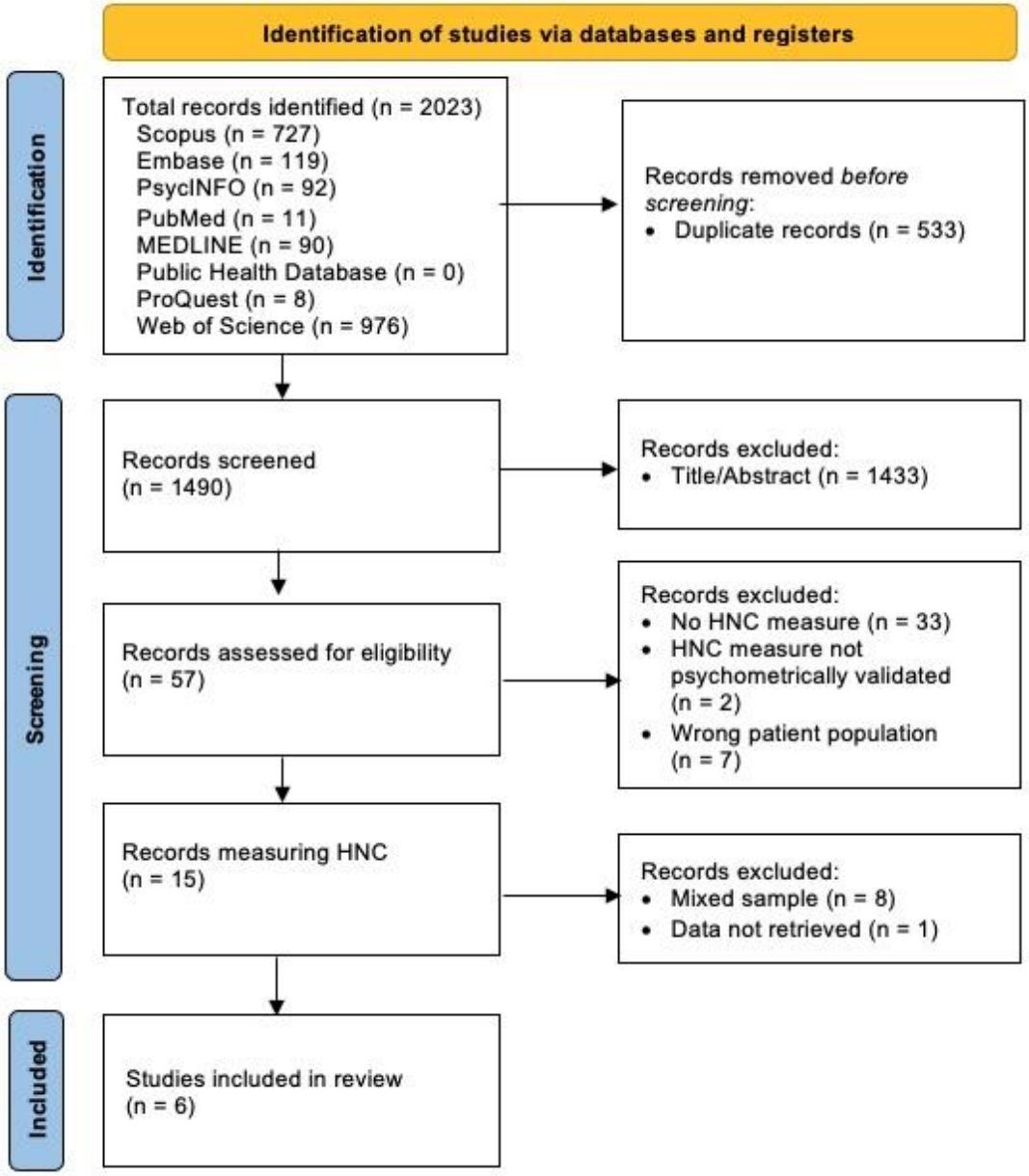
A custom data extraction table was piloted and then used by the first author to extract data from each of the included studies. Authors of included articles were contacted to provide baseline human-nature connectedness scores if not reported in the article or supplementary material. Data extracted included article characteristics (author, author discipline, country, year), study methods and participant characteristics (sample size, participant demographics, disease type, sample size), human-nature connectedness information (measure, baseline score), and contextual factors relating to the human-nature connectedness variable in a clinical sample in chronic disease research (aims/purpose, results, definition, theories). The final version of the custom data extraction table can be viewed in Appendix D.

3. Results

After removing duplicates, 1490 search results were screened by title and abstract. 1433 studies were excluded as they were not relevant to the research question. In the full-text screening most excluded studies did not include a valid human-nature connectedness score for a clinical population. Seven articles were excluded because the clinical population was subsumed within a larger general population and it was not possible to extract human-nature connectedness scores for the clinical population from the article. No compliant articles were identified in the gray literature search or from reference list searches. Ultimately, six studies were selected from 57 full-text articles for inclusion in this review (Figure 1.).

Figure 1.

PRISMA Flow Diagram of the Screening Process (Page et al, 2021).



Note: HNC – Human-nature connectedness

3.1 Study Characteristics

The six studies included in this scoping review were published between 2018 and 2023 and originated from six western countries: Germany, New Zealand, Canada, the United States of America, Ireland, and the United Kingdom. Included studies are listed in Table 2.

Table 2.

Studies included in the review

Study ID	Authors	Year	Title	Journal
Joschko 2023	Joschko, L., Pálsdóttir, A.M., Grahn, P., & Hinse, M.	2023	Nature-Based Therapy in Individuals with Mental Health Disorders, with a Focus on Mental Well-Being and Connectedness to Nature—A Pilot Study	International Journal of Environmental Research and Public Health.
Chin 2022	Chin, S., Cavadino, A., Akroyd, A., Tennant, G., Dobson, R., Gautier, A., & Reynolds, L.	2022	An Investigation of Virtual Reality Nature Experiences in Patients with Metastatic Breast Cancer: Secondary Analysis of a Randomized Controlled Trial	Journal of Medical Internet Research Cancer.
Keenan 2021	Keenan, R., Lumber, R., Richardson, M., & Sheffield, D.	2021	Three good things in nature: a nature-based positive psychological intervention to improve mood and well-being for depression and anxiety	Journal of Public Mental Health.
Morris 2021	Morris, S.L., Newhouse, I., Larocque, T., Gillis, K.-J., Smith, L., & Nisbet, E.K.	2021	Becoming One with Nature: A Nature Intervention for Individuals Living with Cancer Participating in a Ten-Week Group Exercise and Wellness Program	International Journal of Exercise Science.
Pearson 2021	Pearson, A.L., Breeze, V., Reuben, A., & Wyatt, G.	2021	Increased use of porch or backyard nature during covid-19 associated with lower stress and better symptom experience among breast cancer patients	International Journal of Environmental Research and Public Health.
Lyons 2018	Lyons, T., & Carhart-Harris, R.L.	2018	Increased nature relatedness and decreased authoritarian political views after psilocybin for treatment-resistant depression	Journal of Psychopharma-cology.

In this scoping review we limited our search to human-nature connectedness research in the context of chronic disease populations. We extracted contributing author disciplines and affiliations and the disciplinary scope of publishing journals. Five of the included studies

listed at least one contributing author with a psychology or psychiatry background. Other disciplines included three authors from social sciences, three allied health professionals, three authors affiliated with health services, two authors representing preventative or public health, and one author with a geological affiliation. Three studies were published in two interdisciplinary journals: the International Journal of Environmental Research and Public Health, and the Journal of Public Mental Health. The other three articles were published in discipline specific journals: International Journal of Exercise Science, Journal of Medical Internet Research Cancer, and the Journal of Psychopharmacology.

3.2 Participant Characteristics

Participants from five of the six studies were middle-aged (Mean age 40.34 to 63.1) and five of the six participant samples were predominantly female (>60%) and Caucasian. Two studies diverged from these trends. Joschko et al. (2023) had young participants with a mean age of 21.32 and Lyons et al. (2018) participants in the experimental group were 100% male. Three of the included articles studied clinical populations with a diagnosis of cancer and three studied participants with a mental health diagnosis (see Appendix E).

3.3 Critical appraisal of included studies

As this was a scoping review, we did not formally evaluate the quality of the included studies. However, we did consider indicators of study quality as a part of our interpretation of the review results. We extracted information on study design, sample size, selection method, and reported limitations in the included studies (Table 3). All the included studies were underpowered, reporting small sample sizes. Self-report measures were used to measure most of the outcome variables, there was only one study designed as a randomised controlled trial (Lyons & Carhart-Harris, 2018), and there was no blinding of study participants, researchers,

or data analysts. Notably, Morris et al. (2021) used a self-selection method for recruiting participants, rather than randomisation. All six of the included studies reported limitations which impacted meaningful interpretation of their results and prevented generalisation to broader populations.

Table 3.

Extracted Data for Critical Appraisal: Study Design, Sample Size, Selection Method, and Reported Limitations.

Study	Study Design	Sample Size	Selection method	Limitations reported
Joschko 2023	Mixed methods. Observational real-world data, prospective, cohort study	19	Consenting patients in the psychosomatic ward of a hospital in Berlin. All participated in NB therapy as standard practice during their stay. Severe acute or chronic illness prevented participation. Baseline data was collected on the first day of NBT.	• Low power • Pilot study design, • Nature-based intervention embedded in larger integrated therapy program
Chin 2022	Secondary analyses from a randomised controlled crossover design	38	Participants were recruited via advertising flyers sent by email to breast cancer support organisations. They each received NZ$100 for participating.	• Low power • Secondary analysis • No control or comparison • Only used self-report measures
Keenan 2021	Experimental design. Randomisation to experimental or control group, two time points.	50	Recruitment from mental health services and public. Most participants were in recovery and already walked one or twice a week in nature. Potential participants were sent study information including intent to join guided nature walks prior to consent.	• Low power • Researcher effect • Nature-based intervention embedded in larger integrated therapy program
Morris 2021	Quasi-experimental mixed-methods	19	Self-selection of those willing to go outside daily and experience nature. In this sample, qualitative results identified pre-	• Low power • Exploratory analysis • Control group not comparative

Study	Study Design	Sample Size	Selection method	Limitations reported
	(sequential-explanatory)		existing strong HNC, proximity to nature, and nature engagement and benefits from nature were considered by the authors to be gained prior to the study.	• Nature-based intervention embedded in larger integrated therapy program
Pearson 2021	Cross-sectional online survey	56	Survey (nature engagement), consent form and reminder emails were sent to breast cancer patients who volunteer on a US health research register. Response rate was approx. 5%.	• Low power • Survey tool not piloted before use • High homogeneity of participants • Only used self-report measures
Lyons 2018	Open-label pilot study with a mixed-model design	7	General practitioners were asked to identify potential patients with treatment-resistant depression and self-referral.	• Low power • Control was not gender matched to experimental group • Psilocybin intervention embedded in larger integrated therapy program

Note: HNC – human-nature connectedness

3.4 How is human-nature connectedness defined in chronic disease research?

To examine how clinical research conceptualises and measures human-nature connectedness in the context of chronic disease we started by extracting terminology and definitions used for the human-nature connectedness construct. Human-nature connectedness related terms included ‘connectedness to nature’ (Joschko et al., 2023), ‘connection with nature’ (Chin et al., 2021), ‘nature connectedness (NCx)’ (Keenan et al., 2021), and ‘nature relatedness’ (Lyons & Carhart-Harris,2018; Morris et al., 2021; Pearson et al., 2021). Two of the three studies that used the term nature relatedness for the construct of interest also used terms such as ‘nature-connectedness’, ‘connection/connectedness with/to nature’, ‘connection with the natural world’, ‘connection one has with nature’ (Lyons & Carhart-Harris,2018;

Morris et al., 2021). Only three of the six included studies gave definitions for human-nature connectedness and related concepts (Table 4).

Table 4.

Definitions of Human-nature Connectedness Extracted from Included Studies

Study	Definition
Joschko 2023	"How strongly individuals feel they belong to nature and their individual emotional and cognitive beliefs about feeling related to nature (Mayer & Frantz, 2004; Richardson et al., 2019; Zelenski & Nisbet, 2014)".
Morris 2021	"Nature relatedness; ones' relationship with nature."
Lyons 2018	"The subjective sense of connection with the natural environment."

The included studies cited multiple psychological theories associated with improved mood and well-being e.g., attention restoration theory (ART; Kaplan & Kaplan, 1989), calm and connection theory (Grahn et al., 2021). Lyons et al. (2018) discussed a neural pathway linking perceived connectedness to nature with reduced mental rumination, thereby alleviating depressive symptoms. However, the authors cautioned this was a new theory requiring further research. Three of the six included studies did not offer a theoretical framework or mechanism for explaining the hypothesised effects of human-nature connectedness on health and disease.

3.5 What is the rationale for examining human-nature connectedness in chronic disease research?

To further understand why authors included a measure of human-nature connectedness we extracted summaries of the aims and results pertaining to human-nature

connectedness for each study (Appendix F). Table 5 summarises the four broad research questions explored by the studies included in this review.

Table 5.

Paraphrased Research Questions Pertaining to the Human-nature Connectedness Concept Extracted from Included Studies.

Study	Research Question
Joschko 2023, Keenan 2021, Morris 2021 & Lyons 2018	Do nature-based interventions and psilocybin dosing increase human-nature connectedness scores?
Joschko 2023, Chin 2022 & Morris 2021	Does human-nature connectedness moderate the effectiveness of nature-based interventions?
Chin 2022	Do health metrics differ in people with high human-nature connectedness, relative to people with low human-nature connectedness?
Pearson 2021	What is the mean human-nature connectedness in a clinical sample of people living with cancer?

Note: The studies Joschko 2023, Chin 2022, and Morris 2021 reported on two research questions.

3.6 How is human-nature connectedness operationalised in chronic disease research?

The scales used to measure human-nature connectedness primarily corresponded with the terms authors used to describe human-nature connectedness. The three studies (Morris et

al., 2021, Pearson et al., 2021, & Lyons & Carhart-Harris,2018) that focused on the nature relatedness construct used the short-form Nature Relatedness Scale (NR-6; Nisbet & Zelenski, 2013). The two studies that used the term 'nature connectedness' (Joschko et al., 2023) & Keenan et al., 2021) used the Mayer & Frantz (2004) Connectedness to Nature Scale (CNS), and Chin and colleagues (2022) used the single item graphical scale - Inclusion of Nature in Self (INS; Schultz, 2001). There was no information describing the rationale for choice of the applied human-nature connectedness measure in any of the six studies.

We also extracted other outcome variable data from the included studies to explore the range of variables used in human-nature connectedness research in the context of chronic disease. Self-report questionnaires were the main method of collecting data on well-being, quality of life, mental health, general health, pain, and fatigue. Lyons et al. (2018) correlated human-nature connectedness scores with reports from a political perspective questionnaire and Morris et al. (2021) used objective physiological measures but these were incidental and not associated with human-nature connectedness in the reviewed studies.

3.7 Does human-nature connectedness differ among populations with chronic disease, relative to healthy populations?

The aim of this scoping review was to determine if there was existing evidence for whether people living with preventable chronic disease differ in the extent to which they feel connected to the natural environment relative to the general population. To examine this question directly, we extracted the mean human-nature connectedness scores reported in the six studies with samples from chronic diseases populations. Some studies used Likert scale limits ranging from 1 – 7, and others used scale limits ranging from 1 – 5. Thus, for ease of comparison, we first converted all mean human-nature connectedness scores to a standardised score out of 5 (see Table 6).

Table 6.

Sample Size and Disease, Human-nature Connectedness Measure Type, Range, and Score, and Mean Score for Clinical Samples

Study	N	Clinical Sample	Scale Name	Scale Limits	Reported HNC Mean (SD)	Standardised[a] Mean (SD)
Morris[b] 2021	19	Cancer	NR-6	1 - 5	4.05 (0.65)	4.05 (0.65)
Joschko 2023	19	Depression	CNS	1 - 7	3.91 (0.76)	2.79 (0.54)
Chin 2022	38	Metastatic breast cancer	INS	1 - 7	3.95 (1.97)	2.82 (1.41)
Keenan 2021	50	Depression and/or Anxiety	CNS	1 - 5	3.16 (0.29)	3.16 (0.29)
Pearson 2021	56	Breast cancer	NR-6	1 - 5	3.70 (0.70)	3.70 (0.70)
Lyons 2018	7	Depression	NR-6	1 - 5	3.67 (1.00)	3.67 (1.00)
Mean (SD)[c]						3.23 (0.36)

Note: HNC – human-nature connectedness; N – sample size; SD –standard deviation; CNS - Connectedness to nature scale (Mayer & Frantz, 2004); INS - Inclusion of nature in self (Schultz, 2001); NR-6 - Short-form Nature Relatedness Scale (Nisbet & Zelenski, 2013); NR-21 – Nature Relatedness Scale (Nisbet et al., 2009).

[a] Standardised scores were calculated for scores generated by scales ranging from 1 – 7 by multiplying by 5/7.

[b] Self-selected sample exhibiting high HNC behaviours

[c] Mean and standard deviation were calculated after excluding outlier Morris 2021

Next, we compared the reported human-nature connectedness scores among the clinical samples from the extracted studies to human-nature connectedness reported studies on more general populations. For this comparison, we extracted mean human-nature connectedness scores from seminal human-nature connectedness studies using identical measures (Connectedness to Nature Scale, Inclusion of Nature in Self scale, and Nature Relatedness Scale; see Table 7).

Table 7.

Sample Size and Population, Human-nature Connectedness Measure Type, Range, and Score, and Mean Score for General Samples

Study	N	Clinical Sample	Scale Name	Scale Limits	Reported HNC Mean (SD)	Standardised[a] Mean (SD)
Nisbet[b] 2015	6,724	Community	NR-6	1 - 5	4.24 (0.62)	4.24 (0.62)
Nisbet 2013	84	Community	Mean[c] of NR-21, NR-6	1 - 5	3.58 (0.84)	3.58 (0.84)
Tam 2013	185	Community	Mean[c] of CNS, INS, NR-21	1 - 7	4.77 (1.33)	3.41 (0.95)
Mayer 2004_1	60	Community	CNS	1 - 5	3.65 (0.64)	3.65 (0.64)
Mayer 2004_4	135	Community	CNS	1 - 5	3.52 (0.56)	3.52 (0.56)
Mean (SD)[d]						3.54 (0.75)

Note: HNC – human-nature connectedness; N – sample size; SD –standard deviation; CNS - Connectedness to nature scale (Mayer & Frantz, 2004); INS - Inclusion of nature in self

(Schultz, 2001); NR-6 - Short-form Nature Relatedness Scale (Nisbet & Zelenski, 2013); NR-21 – Nature Relatedness Scale (Nisbet et al., 2009).

[a] Standardised scores were calculated for scores generated by scales ranging from 1 – 7 by multiplying by 5/7.

[b] Self-selected sample exhibiting high HNC behaviours

[c] Mean of scores from multiple scale responses from participants in one study

[d] Mean and standard deviation were calculated after excluding outlier Nisbet 2015

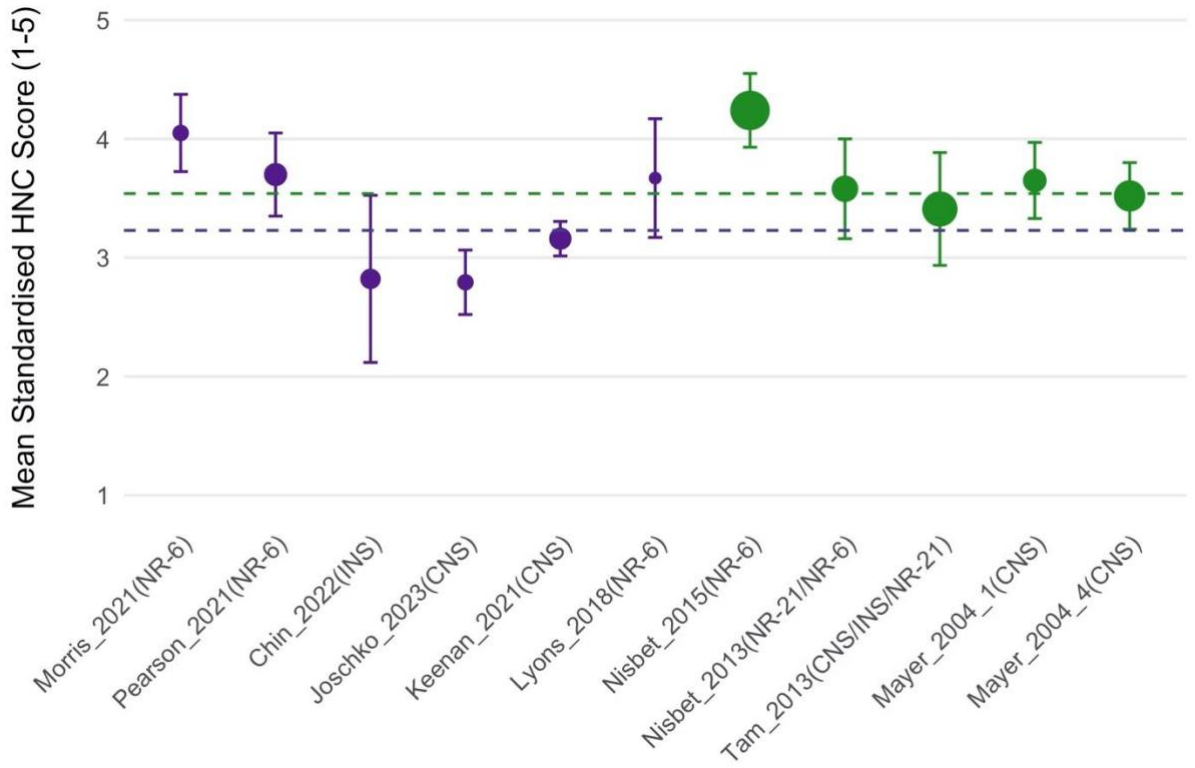
Mean human-nature connectedness scores for five of extracted chronic disease studies were lower on average (Mean = 3.23; SD = .36) than the mean scores reported in the studies of more general populations (Mean = 3.54; SD = .75) (see Figure.2). When calculating these means, the score reported by Morris and colleagues (2021) was considered an outlier and not included. Morris et al. (2021) considered the relatively high mean nature relatedness score of 4.05 (SD 0.65) atypical and proposed that this was due to a self-selection sampling bias (i.e., participants likely self-selected into the study because they were interested in the intervention and already highly connected to nature). Support for this sampling bias was evidenced in qualitative data from the participants in this study, as well as a reported ceiling effect (Morris et al., 2021). Corroboratory evidence is found in the literature. High baseline nature relatedness scores were reported by a community population of 6,724 individuals who self-selected into a nature-based intervention, rather than being randomly assigned. This study reported a relatively high mean of 4.24 (SD 0.62) for people who choose regular nature contact, compared to a previously reported mean of 3.44 in a random community sample

(Nisbet, 2015) (See Tables 4, & 5.). Consequently, means from the Morris (2021) study, and the comparable Nisbet (2015) study, were excluded from the calculation of means.

Even after accounting for the relatively high score reported by Morris et al. (2021) considerable inter-study variability was observed between the remaining human-nature connectedness scores were compared to the human-nature connectedness scores from the general population. In the survey conducted by Pearson and colleagues, the baseline NR-6 score for people living with breast cancer was slightly higher (3.7) than both the healthy sample comparison reported in the article and the general sample mean calculated for this review. In contrast, two studies, Joschko et al. (2023) and Chin et al. (2022) reported baseline HNC scores under 3.0 (2.79 and 2.82 respectively), which are relatively low scores when compared to general community samples.

Figure 2.

Scatterplot with SD error bars showing HNC scores for clinical (purple) and general (green) samples. Size of dot represents sample size. Dotted lines represent mean of study HNC scores for clinical (purple) and general samples (green).



Note: This figure shows a scatterplot of human-nature connectedness scores from the extracted clinical samples plotted alongside human-nature connectedness scores from general populations. This plot was produced using rmarkdown and ggplot2 packages in R (version 4.0.3) (Allaire et al., 2021; R Core Team, 2013; Wickham, 2016).

X axis legend format: First Author_year (HNC instrument used); HNC – human-nature connectedness; N – sample size; CNS - Connectedness to nature scale (Mayer & Frantz, 2004); INS - Inclusion of nature in self (Schultz, 2001); NR-6 - Short-form Nature Relatedness Scale (Nisbet & Zelenski, 2013); NR-21 – Nature Relatedness Scale (Nisbet et al., 2009). If one study used multiple instruments for the same sample, the average HNC score was reported (e.g., Tam (2013); CNS/INS/NR-21).

4. Discussion

This scoping review examined empirical studies measuring the extent to which humans feel connected to the natural environment in populations with chronic disease.

Overall, we found that human-nature connectedness was highly variable in clinical samples compared with general population samples. We also extracted data including study characteristics, conceptualisation and measurement of the human-nature connectedness concept, and study quality indicators from the six included studies. From this data we found explanations that may account for the high variability between extracted human-nature connectedness scores in this review.

One explanation for the high variability in human-nature connectedness among chronic disease populations was that the included studies each reported significant methodological limitations, including small sample sizes. Small sample sizes in research can lead to variable scores due to factors including sampling error, random variation, sensitivity to outliers, and limited statistical power. Not only were the sample sizes in each of the included studies small but the overall number of studies included in this scoping review was small. A greater number of studies is needed to gauge the level of human-nature connectedness more accurately in different chronic disease populations. Furthermore, the chronic disease population of interest was not well represented by the included studies. Only two of the ten chronic disease groups (cancer and mental health) were represented in our final sample. Interestingly, this disease group bias also appears to be present more broadly in research on nature-based interventions showing that mental health conditions, in particular depression and anxiety, are the more prevalent clinical sample studied in nature-based research. Among the physical health conditions, cancer is the most prevalent chronic disease group to be exposed to nature-based interventions (Taylor et al., 2022).

Another explanation for the variability in human-nature connectedness among the sampled chronic disease populations is the dissimilarity between participant characteristics in each study. Age, gender, season, parenting attitudes, and previous experiences in the natural environment are just a few individual characteristics that have been proposed to impact

baseline human-nature connectedness (e.g., Cleary et al., 2020; Price et al., 2022). For example, in a psychometric study, student samples reported lower human-nature connectedness scores and poorer mental health status than reported by a more diverse community sample (Nisbet 2015). In this scoping review Joschko's study reported a relatively lower mean age than the other five studies, which may have influenced the baseline HNC scores. However, research in this area is not consistent and some studies have reported that participant characteristics, including age, do not moderate the relationship between human-nature connectedness and well-being metrics (Dean et al., 2018).

Although valid human-nature connectedness measures have been found to measure a common construct and are strongly intercorrelated, there are also differences which contribute to interstudy variability in human-nature connectedness (Mayer et al., 2009; Tam, 2013; Zelenski & Nisbet, 2014). Three scales were used to measure human-nature connectedness: the short-form Nature Relatedness Scale (NR-6; Nisbet & Zelenski, 2013), the Connectedness to Nature Scale (CNS; Mayer & Frantz, 2004), and the single item graphical scale - Inclusion of Nature in Self (INS; Schultz, 2001). These are the most common scales used to measure human-nature connectedness (Capaldi, 2014). In a meta-analysis investigating the relationship between nature and happiness, Capaldi and colleagues (2014) found that how researchers defined, and measured, human-nature connectedness influenced the strength of association between human-nature connectedness and happiness indicators. In 2022, Barragan-Jason and colleagues also found that measures used to operationalise human-nature connectedness impacted the effect sizes of correlations between HNC scores and health outcomes. Notably, the three highest baseline human-nature connectedness scores were derived from the short-form Nature Relatedness Scale.

Another important finding from the review was the paucity of human-nature connectedness research in the chronic disease literature. Only six studies that reported

baseline human-nature connectedness among people living with preventable chronic diseases were retrieved, after a comprehensive literature search. We describe some possible explanations (and remedies) for this gap in the research below.

One potential reason for the lack of research on human-nature connectedness and chronic disease is a lack of theory. The extracted articles did not provide a clear, unified definition of human-nature connectedness, or other related concepts. Moreover, a clear definition of human-nature connectedness was not established as a salient variable in the introduction of most of the included studies. A clear and operationalisable definition of human-nature connectedness would help researchers to develop and test health interventions that specifically target the psychological aspects of nature connectedness separately from (or in addition to) the physical aspects of nature contact and immersion. As a starting point, we combined common words in the included articles with the definitions proposed by Restall and Conrad (2015) and Barragan-Jason et al. (2021) to propose a new definition of human-nature connectedness as "the extent to which an individual feels connected to and/or identifies as being a part of the natural environment". This definition distinguishes between psychological connectedness with nature and physical engagement with nature. Feeling connected to the natural environment and spending time in nature are often conflated in the literature and a likely source of the conflicting mixed findings. As an example, one of the studies in this scoping review focused on data related to *nature contact*, or *exposure to nature*, implying that nature connection was literal and involved physical contact with the natural environment (Chin et al., 2022). It is possible to change psychological human-nature connectedness without any physical contact with nature (Barragan-Jones et al., 2022), so it is equally important that we understand the nature and impacts of psychological connectedness on health outcomes as it is that we understand how spending time in nature impacts health outcomes. Human-nature connectedness and nature contact are related, but they are distinct

concepts and psychological human-nature connectedness offers a whole range of new interventions for increasing human-nature connectedness in vulnerable populations who are unable, or unwilling, to access the natural environment directly.

The lack of clear definition of human-nature connectedness is exacerbated by an absence of theory on the casual pathways for affecting change in health outcomes among four of the six studies. There is no current scientific consensus on how high human-nature connectedness might affect health outcomes. However, a promising research area is emerging within public health domain focussed on applying behaviour change theories, such as the theoretical domains framework (TDF, Cane et al., 2012) and the capability, opportunity, and motivation system of behaviour (COM-B, Michie et al., 2011). These, and other relevant behaviour change theories, combine psychological attributes with behaviour and provide possible pathways for human-nature connectedness to positively affect lifestyle behaviours and downstream health outcomes (Asdecker, 2022). Further development of such theoretical frameworks would help to guide the development and selection of better human-nature connectedness measures and more appropriate health and behaviour outcome variables (Husk et al, 2020; Wilkie & Davinson, 2021).

The limited use of clinically relevant health and behaviour outcome measures is another possible explanation for gap in research on nature-connectedness and chronic disease. Self-reported wellbeing and general health reports were the predominant outcome variables found in this review. This finding supports the consensus view that physiological, diagnostic, physical health, and health behaviour outcomes are generally under-represented in nature-based research (Folk & Dunn, 2023; Wilkie & Davinson, 2021). It has been suggested that limited empirical evidence relating to objective health and behaviour outcomes may contribute to an air of scepticism toward nature-based health benefit claims (Tambyah et al., 2022).

Finally, when we extracted study characteristics of the articles included in this scoping review, we identified a disciplinary gap as well. Only one of the included studies was written by medical professionals and published in a medical journal. Consistent with previous reviews, the included authors were predominantly from psychological, allied health, social science, and environmental science disciplines (Ives et al., 2017; Keniger et al., 2013). Public health researchers, specifically medical researchers, are grossly underrepresented in human-nature connectedness research (Ives et al., 2017). The paucity of studies from within the medical domain — where much of the chronic disease literature is generated — may help to explain the low number of human-nature connectedness studies published in the context of chronic disease prevention and management.

5. Limitations and Future Directions

This review was not without limitations. Due to the indiscriminate words ‘nature’, ‘connected’, and ‘related’ included in our keywords our research returned a large number of irrelevant studies excluded by title and abstract screening. It is possible that some articles were mistakenly excluded as they published a baseline human-nature connectedness score without reporting this data in the abstract. However, to minimising false exclusions it was decided by the reviewers during the resolution process to prioritise sensitivity and forward any doubtful abstracts on for full-text screening. Secondly, during the data extraction phase the authors decided by consensus to exclude surveys in which both healthy and clinical populations were subsumed within a general population sample. It was considered beyond the scope of this review to extract human-nature connectedness scores for a clinical subset of participants to determine the clinical sample mean. Consequently, the original exclusion criteria were amended to exclude studies in which a defined clinical sample was subsumed within a general population. Finally, as with all scoping reviews there was no analysis of data

and so no specific knowledge contribution. The quantitative results presented in this scoping review are descriptive only. Additionally, there was no requirement for a formal assessment of article quality and our critical appraisal was also descriptive only.

This scoping review has highlighted specific knowledge gaps in human-nature connectedness research in the chronic disease context. Moreover, variability between studies is high, the human-nature connectedness variable is poorly defined, studies are largely atheoretical, causal pathways are unclear, and results are inconsistent. These issues have been associated with nature-based research more generally (Bowler et al., 2010; Folk & Dunn, 2023; Frumkin et al., 2017; Yao et al., 2021). There is a need for a greater number of good quality studies asking purposeful research questions to accurately explore the role of human-nature connectedness in chronic disease populations. Opportunities for future research have been highlighted by this scoping review. Firstly, identifying participant characteristics – such as age, gender, season, parenting attitudes, and sociocultural factors - that reliably impact human-nature connectedness scores would allow researchers to account for these confounders in future research. Secondly, research exploring the impact of human-nature connectedness on health and lifestyle behaviour outcomes is warranted. Validating self-report data with direct measures of health and lifestyle behaviours along with corroborating qualitative data is recommended to increase rigour and confidence in results. Another opportunity identified for future research is the development and testing of theoretical pathways and mechanisms by which human-nature connectedness may be related to improved health and behaviour outcomes.

In this scoping review we were interested in chronic diseases more broadly, however in nature-based intervention research it has been suggested that distinct clinical samples may have different responses. For example, depression symptoms may influence the effects of

viewing nature (Meuwese 2021). Our results indicate that future research in clinical samples is warranted, and furthermore research comparing distinct chronic disease groups - such as preventable cancers, type 2 diabetes, and depression – may be important. Perhaps most importantly, multidisciplinary basic and experimental human-nature connectedness research in chronic disease populations, integrating both psychological and medical perspectives, will provide an empirical knowledge-base for emerging translational research exploring human-nature connectedness interventions for preventing and managing chronic disease.

6. Conclusion

Preventable chronic disease is placing a significant burden on the health systems that support our increasingly urbanised lifestyles. The extent to which individuals feel connected to and/or identify as being a part of the natural environment may influence the health and behavioural factors related to chronic disease. The aim of this scoping review was to conduct a systematic review of the current literature to extract information on the psychological attribute human-nature connectedness in chronic disease populations. We found six studies that reported on human-nature connectedness in relevant clinical samples. The available research suggests that human-nature connectedness scores in chronic disease populations are more variable than normative scores from general populations and the high variation could be largely explained by the low number of under-powered studies, the variation in sampling methods and population demographics, and the variety of human-nature connectedness measures used. Despite these methodological issues preliminary findings from this scoping review suggest further research into subjective human-nature connectedness in the context of preventative chronic disease research is warranted.

A strength of this review was the focus on the psychological construct of human-nature connectedness in clinical samples. Reviews to date have either focused on nature-based interventions in clinical samples (e.g., Taylor et al., 2022) or human-nature

connectedness in general samples (e.g., Barragan-Jones et al, 2022). We opted for a scoping review anticipating that studies focusing on human-nature connectedness in clinical samples would be heterogenous and underrepresented in the literature and have subsequently found a dearth of relevant high-quality research on the topic. Data extracted from the included studies in this scoping review suggested several possibilities for this gap. In agreement with previous authors, we found that medical disciplines are poorly represented in the human-nature connectedness research (Ives et al., 2017). Furthermore, there may be scepticism caused by the lack of an accepted scientific definition and theory of human-nature connectedness in the public health context. Moreover, the absence of good quality, clinically relevant measures of health and behaviour outcomes in the literature may be a roadblock to research on human-nature connectedness among chronic disease populations. Emerging evidence suggests that modifying the extent to which individuals feel connected to and/or identify as being a part of the natural environment may be an important initiative in the fight against chronic disease. This scoping review has identified a need to further explore the role for human-nature connectedness in the prevention and management of chronic disease.

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Appendix A

Journal of Environmental Psychology – Submission Guidelines, Author Information Pack, 6 Sep 2023, page 6 – 15. www.elsevier.com/locate/jep

GUIDE FOR AUTHORS

INTRODUCTION

The *Journal of Environmental Psychology* is the premier journal in the field, serving individuals in a wide range of disciplines who have an interest in the scientific study of the transactions and interrelationships between people and their surroundings (including built, social, natural, and virtual environments, the use and abuse of nature and natural resources, and sustainability-related behavior). The journal publishes internationally contributed empirical studies and systematic and meta-analytic reviews of research on these topics that advance new insights.

As an important forum for the field, the journal publishes some of the most influential papers in the discipline that reflect the scientific development of **environmental psychology**. Contributions on theoretical, methodological, and practical aspects of all **human-environment interactions** are welcome, along with innovative or interdisciplinary approaches that have a psychological emphasis.

Research areas include:

•Psychological and behavioral aspects of people and nature
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•Ecological consequences of human actions
•Theories of place, place attachment, and place identity
•Environmental risks and hazards: perception, behavior, and management
•Perception and evaluation of buildings and natural landscapes
•Effects of physical and natural settings on human cognition, health, and well-being
•Theories of proenvironmental behavior, norms, attitudes, and personality
•Psychology of sustainability and climate change
•Psychological aspects of resource management and crises
•Social use of space: crowding, privacy, territoriality, personal space
•Design of, and experiences related to, the physical aspects of workplaces, schools, residences, public buildings and public space

The journal does not typically publish highly exploratory, descriptive case studies, narrative reviews, or rapid scoping reviews. The desk rejection rate of the *Journal of Environmental Psychology* is about 75%.

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You can use this list to carry out a final check of your submission before you send it to the journal for review. Please check the relevant section in this Guide for Authors for more details.

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• All tables (including titles, description, footnotes)
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Graphical Abstracts / Highlights files (where applicable)
Supplemental files (where applicable)

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• A competing interests statement is provided, even if the authors have no competing interests to declare
• Journal policies detailed in this guide have been reviewed
• Referee suggestions and contact details provided, based on journal requirements

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BEFORE YOU BEGIN

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Reporting sex- and gender-based analyses

Reporting guidance

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Definitions

Sex generally refers to a set of biological attributes that are associated with physical and physiological features (e.g., chromosomal genotype, hormonal levels, internal and external anatomy). A binary sex categorization (male/female) is usually designated at birth ("sex assigned at birth"), most often based solely on the visible external anatomy of a newborn. Gender generally refers to socially constructed roles, behaviors, and identities of women, men and gender-diverse people that occur in a historical and cultural context and may vary across societies and over time. Gender influences how people view themselves and each other, how they behave and interact and how power is distributed in society. Sex and gender are often incorrectly portrayed as binary (female/male or woman/man) and unchanging whereas these constructs actually exist along a spectrum and include additional sex categorizations and gender identities such as people who are intersex/have differences of sex development (DSD) or identify as non-binary. Moreover, the terms "sex" and "gender" can be ambiguous—thus it is important for authors to define the manner in which they are used. In addition to this definition guidance and the SAGER guidelines, the resources on this page offer further insight around sex and gender in research studies.

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For more details about the journal's submission types and priorities, please refer to the latest editorial

Peer review
This journal operates a double anonymized review process. All contributions will be initially assessed by the editor for suitability for the journal. Papers deemed suitable are then typically sent to a minimum of two independent expert reviewers to assess the scientific quality of the paper. The Editor is responsible for the final decision regarding acceptance or rejection of articles. The Editor's decision is final. Editors are not involved in decisions about papers which they have written themselves or have been written by family members or colleagues or which relate to products or services in which the editor has an interest. Any such submission is subject to all of the journal's usual procedures, with peer review handled independently of the relevant editor and their research groups. More information on types of peer review.

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This journal uses double anonymized review, which means the identities of the authors are concealed from the reviewers, and vice versa. More information is available on our website. To facilitate this, please include the following separately:
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REVISED SUBMISSIONS

Use of word processing software
Regardless of the file format of the original submission, at revision you must provide us with an editable file of the entire article. Keep the layout of the text as simple as possible. Most formatting codes will be removed and replaced on processing the article. The electronic text should be prepared in a way very similar to that of conventional manuscripts (see also the Guide to Publishing with Elsevier). See also the section on Electronic artwork.
To avoid unnecessary errors you are strongly advised to use the 'spell-check' and 'grammar-check' functions of your word processor.

Article structure

Subdivision - numbered sections
Divide your article into clearly defined and numbered sections. Subsections should be numbered 1.1 (then 1.1.1, 1.1.2, ...), 1.2, etc. (the abstract is not included in section numbering). Use this numbering also for internal cross-referencing: do not just refer to 'the text'. Any subsection may be given a brief heading. Each heading should appear on its own separate line.

Introduction
State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

Material and methods
Provide sufficient details to allow the work to be reproduced by an independent researcher. Methods that are already published should be summarized, and indicated by a reference. If quoting directly from a previously published method, use quotation marks and also cite the source. Any modifications to existing methods should also be described.

Theory/calculation
A Theory section should extend, not repeat, the background to the article already dealt with in the Introduction and lay the foundation for further work. In contrast, a Calculation section represents a practical development from a theoretical basis.

Results
Results should be clear and concise.

Discussion
This should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

Conclusions
The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a Discussion or Results and Discussion section.

Appendices
If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq. (A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on. Similarly for tables and figures: Table A.1; Fig. A.1, etc.

Essential title page information

• ***Title.*** Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible.
• ***Author names and affiliations.*** Please clearly indicate the given name(s) and family name(s) of each author and check that all names are accurately spelled. You can add your name between parentheses in your own script behind the English transliteration. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name and, if available, the e-mail address of each author.

• ***Corresponding author.*** Clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication. This responsibility includes answering any future queries about Methodology and Materials. **Ensure that the e-mail address is given and that contact details are kept up to date by the corresponding author.**
• ***Present/permanent address.*** If an author has moved since the work described in the article was done, or was visiting at the time, a 'Present address' (or 'Permanent address') may be indicated as a footnote to that author's name. The address at which the author actually did the work must be retained as the main, affiliation address. Superscript Arabic numerals are used for such footnotes.

Highlights

Highlights are mandatory for this journal as they help increase the discoverability of your article via search engines. They consist of a short collection of bullet points that capture the novel results of your research as well as new methods that were used during the study (if any). Please have a look at the example Highlights.

Highlights should be submitted in a separate editable file in the online submission system. Please use 'Highlights' in the file name and include 3 to 5 bullet points (maximum 85 characters, including spaces, per bullet point).

Abstract

A concise and factual abstract is required. The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separately from the article, so it must be able to stand alone. For this reason, References should be avoided, but if essential, then cite the author(s) and year(s). Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

Graphical abstract

Although a graphical abstract is optional, its use is encouraged as it draws more attention to the online article. The graphical abstract should summarize the contents of the article in a concise, pictorial form designed to capture the attention of a wide readership. Graphical abstracts should be submitted as a separate file in the online submission system. Image size: Please provide an image with a minimum of 531 × 1328 pixels (h × w) or proportionally more. The image should be readable at a size of 5 × 13 cm using a regular screen resolution of 96 dpi. Preferred file types: TIFF, EPS, PDF or MS Office files. You can view Example Graphical Abstracts on our information site.

Keywords

Immediately after the abstract, provide a maximum of 6 keywords, using British spelling and avoiding general and plural terms and multiple concepts (avoid, for example, 'and', 'of'). Be sparing with abbreviations: only abbreviations firmly established in the field may be eligible. These keywords will be used for indexing purposes.

Acknowledgements

Acknowledgements should be submitted in the title page of the submission. They should not be included in the main source file. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

Formatting of funding sources

List funding sources in this standard way to facilitate compliance to funder's requirements:

Funding: This work was supported by the National Institutes of Health [grant numbers xxxx, yyyy]; the Bill & Melinda Gates Foundation, Seattle, WA [grant number zzzz]; and the United States Institutes of Peace [grant number aaaa].

It is not necessary to include detailed descriptions on the program or type of grants and awards. When funding is from a block grant or other resources available to a university, college, or other research institution, submit the name of the institute or organization that provided the funding.

If no funding has been provided for the research, it is recommended to include the following sentence:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Math formulae
Please submit math equations as editable text and not as images. Present simple formulae in line with normal text where possible and use the solidus (/) instead of a horizontal line for small fractional terms, e.g., X/Y. In principle, variables are to be presented in italics. Powers of e are often more conveniently denoted by exp. Number consecutively any equations that have to be displayed separately from the text (if referred to explicitly in the text).

Footnotes
Footnotes should be used sparingly. Number them consecutively throughout the article. Many word processors build footnotes into the text, and this feature may be used. Should this not be the case, indicate the position of footnotes in the text and present the footnotes themselves separately at the end of the article.

Artwork

Electronic artwork
General points
• Make sure you use uniform lettering and sizing of your original artwork.
• Preferred fonts: Arial (or Helvetica), Times New Roman (or Times), Symbol, Courier.
• Number the illustrations according to their sequence in the text.
• Use a logical naming convention for your artwork files.
• Indicate per figure if it is a single, 1.5 or 2-column fitting image.
• For Word submissions only, you may still provide figures and their captions, and tables within a single file at the revision stage.
• Please note that individual figure files larger than 10 MB must be provided in separate source files.

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You are urged to visit this site; some excerpts from the detailed information are given here.
Formats
Regardless of the application used, when your electronic artwork is finalized, please 'save as' or convert the images to one of the following formats (note the resolution requirements for line drawings, halftones, and line/halftone combinations given below):
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TIFF (or JPG): Bitmapped line drawings: use a minimum of 1000 dpi.
TIFF (or JPG): Combinations bitmapped line/half-tone (color or grayscale): a minimum of 500 dpi is required.
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• Supply files that are optimized for screen use (e.g., GIF, BMP, PICT, WPG); the resolution is too low.
• Supply files that are too low in resolution.
• Submit graphics that are disproportionately large for the content.

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Please submit tables as editable text and not as images. Tables can be placed either next to the relevant text in the article, or on separate page(s) at the end. Number tables consecutively in accordance with their appearance in the text and place any table notes below the table body. Be sparing in the use of tables and ensure that the data presented in them do not duplicate results described elsewhere in the article. Please avoid using vertical rules and shading in table cells.

References

Citation in text

Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Any references cited in the abstract must be given in full. Unpublished results and personal communications are not recommended in the reference list, but may be mentioned in the text. If these references are included in the reference list they should follow the standard reference style of the journal and should include a substitution of the publication date with either 'Unpublished results' or 'Personal communication'. Citation of a reference as 'in press' implies that the item has been accepted for publication.

Web references

As a minimum, the full URL should be given and the date when the reference was last accessed. Any further information, if known (DOI, author names, dates, reference to a source publication, etc.), should also be given. Web references can be listed separately (e.g., after the reference list) under a different heading if desired, or can be included in the reference list.

Data references

This journal encourages you to cite underlying or relevant datasets in your manuscript by citing them in your text and including a data reference in your Reference List. Data references should include the following elements: author name(s), dataset title, data repository, version (where available), year, and global persistent identifier. Add [dataset] immediately before the reference so we can properly identify it as a data reference. The [dataset] identifier will not appear in your published article.

Preprint references

Where a preprint has subsequently become available as a peer-reviewed publication, the formal publication should be used as the reference. If there are preprints that are central to your work or that cover crucial developments in the topic, but are not yet formally published, these may be referenced. Preprints should be clearly marked as such, for example by including the word preprint, or the name of the preprint server, as part of the reference. The preprint DOI should also be provided.

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Most Elsevier journals have their reference template available in many of the most popular reference management software products. These include all products that support Citation Style Language styles, such as Mendeley. Using citation plug-ins from these products, authors only need to select the appropriate journal template when preparing their article, after which citations and bibliographies will be automatically formatted in the journal's style. If no template is yet available for this journal, please follow the format of the sample references and citations as shown in this Guide. If you use reference management software, please ensure that you remove all field codes before submitting the electronic manuscript. More information on how to remove field codes from different reference management software.

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There are no strict requirements on reference formatting at submission. References can be in any style or format as long as the style is consistent. Where applicable, author(s) name(s), journal title/ book title, chapter title/article title, year of publication, volume number/book chapter and the article number or pagination must be present. Use of DOI is highly encouraged. The reference style used by the journal will be applied to the accepted article by Elsevier at the proof stage. Note that missing data will be highlighted at proof stage for the author to correct. If you do wish to format the references yourself they should be arranged according to the following examples:

Reference style

Text: Citations in the text should follow the referencing style used by the American Psychological Association. You are referred to the Publication Manual of the American Psychological Association, Seventh Edition, ISBN 978-1-4338-3215-4, copies of which may be ordered online.

List: references should be arranged first alphabetically and then further sorted chronologically if necessary. More than one reference from the same author(s) in the same year must be identified by the letters 'a', 'b', 'c', etc., placed after the year of publication.

Examples:

Reference to a journal publication:

Van der Geer, J., Hanraads, J. A. J., & Lupton, R. A. (2010). The art of writing a scientific article. *Journal of Scientific Communications, 163*, 51–59. https://doi.org/10.1016/j.sc.2010.00372.

Reference to a journal publication with an article number:

Appendix B

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	6
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	12
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	12
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	13
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	13,14
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	14,15
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	64
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	15

Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	15, 65
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	15, 65
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	19, 34
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	15
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	16,17
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	18
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	15
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	17 – 29, 66 - 67
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	17 – 29, 66 - 67
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	29 - 33
Limitations	20	Discuss the limitations of the scoping review process.	34
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	35
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	N/A

Appendix C

Example Search Strategy - Scopus. (n.d.). Elsevier. Search conducted May 8, 2023

Search #	Search terms	Records retrieved
#1 Chronic Disease	{Chronic disease} OR {chronic illness} OR {long-term illness} OR {mental health conditions} OR arthritis OR asthma OR {back pain} OR cancer OR {cardiovascular disease} OR {chronic obstructive pulmonary disease} OR diabetes OR {chronic kidney disease} OR osteoporosis OR Cardiovascular OR Hypertension OR {high blood pressure} OR {Coronary Heart Disease} OR {heart disease} OR {Coronary Disease} OR {vascular disease} OR {Pulmonary Heart Disease} OR {Pulmonary disease} OR {Respiratory disease} OR {chronic obstructive lung disease} OR {diabetes mellitus} OR {Kidney disease} OR {Chronic kidney disease} OR {renal insufficiency} OR {chronic renal insufficiency} OR {renal disease} OR {chronic renal disease} OR {Anxiety disorder} OR depression OR {mood disorder} OR {affective disorder} OR{mental illness} OR {mental disorder}	8,652,659
#2 Human-Nature Connectedness	(Nature W/1 (deficit OR concern OR attach* OR inclusion OR commit* OR affinity OR connect* OR engag*)) OR {care for nature} OR {nature-based} OR {human-nature} OR {nature relatedness} OR {nature related} OR “relationship* with nature” OR “relationship* between nature” OR “relationship* to nature” OR “nature relationship” OR “human–nature relationship” OR “association with nature” OR “environmental identity” OR "environmental attitude" OR "environmental concern" OR "environmental values" OR “identi* with nature” OR “nature identi*” OR biophil* OR “therapeutic landscapes” OR “place attachment” OR "concept* of nature" OR “appreciation for nature” OR “New Environmental Paradigm” OR “Inclusion of Nature in the Self” OR “Environmental Identity Scale” OR “Connectedness to Nature Scale” OR “Nature Relatedness scale”	60,017
#3	#1 AND #2 AND Limits (language: English, type: article) AND Exclude (exact key word: non-human, child)	727

Appendix D

Custom Extraction Table

Author(s) and year	
Journal	
Origin	
Author disciplines	
Participant characteristics	
Service setting	
Population/sample size	
Methodology / methods / type of study	
Chronic disease diagnosis	
Method of diagnosis, duration and/or severity of disease at baseline	
Research Question	
Human-nature connectedness score (Mean and standard deviation)	
Range and post-vention scores	
Intervention type	
Research sub-question	
Relevant aims and results of study	
Human-nature connectedness measure	
Other outcome measures	
Human-nature connectedness definition and relevant theories.	
Human-nature connectedness rationale for inclusion in chronic disease research	
Other key findings	

Appendix E

Participant Demographics and Disease Information

Study ID	Age (Mean)	Gender	Disease Type	Disease severity
Joschko (2023)	21.32	16 Female 3 Male	Metastatic breast cancer	mixed
Chin (2022)	51	38 Female	Depression	mixed
Keenan (2021)	40.34	30 Female 20 Male	Depression and/or Anxiety	mixed
Morris (2021)	58.95	14 Female 5 NR	Cancer	mixed
Pearson (2021)	63.1	55 Female 1 Male	Breast cancer	Stage 2 – 3
Lyons (2018)	48.3	7 Male	Depression	moderate to severe

Appendix F

Aims and results associated with human-nature connectedness of the extracted studies.

Study	Aims	Results
Joschko 2023	To increase the understanding of the relationship between nature-based therapy, connectedness to nature, and mental health & well-being outcomes.	1) A significant increase in participants' HNC scores after the nature-based therapy intervention, 2) no significant difference was reported between people who had high baseline HNC scores, relative to people who had low baseline HNC scores, on the effectiveness of nature-based therapy for improving mental health outcomes.
Chin 2022	To investigate whether feeling disconnected from nature (low baseline HNC scores) would moderate the effectiveness of a virtual nature-based intervention aimed at improving self-reported mental and physical health outcomes.	1) A significant improvement in measures of depression in people reporting low baseline HNC scores, relative to people with high baseline HNC scores. 2)people with low baseline HNC scores reported greater fatigue, depression, anxiety, and poorer spirituality than people with high baseline HNC scores.
Keenan 2021	To use a between-subjects experiment to compare differences in HNC after a	The nature-based intervention showed significantly greater improvements in HNC, relative to the urban-based intervention.

Study	Aims	Results
	nature-based intervention, and an urban-based intervention.	
Morris 2021	To conduct a secondary analysis to investigate the moderating effect HNC may have on a nature-based intervention for breast cancer.	1) no significant change in HNC after participating in the nature-based intervention, and 2) no significant effect of baseline HNC scores on the effectiveness of a nature-based intervention to improve mental health and well-being outcomes.
Pearson 2021	To measure HNC in a cross-sectional survey clinical population.	The mean population NR scores for the surveyed population were described as similar in magnitude to community sampling previously reported in the literature (Nisbet & Zelenski, 2013). It was also noted that HNC scores were higher in the low socio-economic category. No other associations between HNC and population characteristics were reported.
Lyons 2018	To explore whether a HNC intervention (psilocybin dosing) would increase HNC scores in the short-term and 1 year later.	The experimental psilocybin dosing regimen significantly increased levels of self-reported HNC in the short-term and at follow up 7 – 12 months later.