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Human-Nature Relationship:
A Source to Overcome Today's Societal Challenges, Increase Well-Being, and Improve Mental Health

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Wisdom and Spirit of the universe!

Thou Soul that art the eternity of thought!

That givest to forms and images a breath

And everlasting motion!

– **William Wordsworth, “The Prelude” (1850)**

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List of Abbreviations

ART	Attention Restoration Theory
CNS	Connectedness to Nature Scale
COSMIN	COnsensus-based Standards for the selection of health Measurement INstruments
e.g.	for example
HNR	Human-Nature Relationship
i.e.	that is
NBS	Nature-Based Solutions
NCD	Non-communicable diseases
n.d.	No date
OECD	Organization for Economic Co-operation and Development
<i>p</i>	p value
PEB	Pro-Environmental Behavior
PICo	Population, Interest and Context
PRISMA-P	Preferred reporting items for systematic review and meta- analysis protocols
QAPAQ	Qualitative Assessment of Physical Activity Questionnaires
SDH	Social Determinants of Health

SDGs	Sustainable Development Goals
SEP	Socioeconomic Position
UN	United Nations
WHO	World Health Organization

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Abstract

Environmental research indicates that strengthening the Human-Nature-Relationship (HNR), the bond between individuals and the natural environment, not only positively affects mental health but also enhances overall well-being. A crucial aspect in nurturing this bond and addressing societal challenges is the concept of connectedness to nature. However, research on HNR, particularly regarding connectedness to nature, is still in its early stages. There is a notable limitation in developing dependable measurement scales, as well as in investigating this topic in developing countries, both of which directly impact the mental health and well-being of individuals. Therefore, aiming to contribute to the formulation of strategies for enhancing mental health and well-being across all individuals, and to contribute to the advancement of sustainable societies, we conducted two studies addressing the identified shortcomings. As an initial step, the first study entails a systematic review of validated explicit measures of the connectedness to nature construct among children, adolescents, and adults, encompassing individuals with special and additional needs. This endeavor illuminates the scarce research conducted on connectedness to nature in developing countries. Consequently, the second study, a cross-sectional analysis, was conducted among university students from both private and public universities in Mexico. The selection of these universities represents the socioeconomic position (SEP) of the students. Research has shown that SEP has a direct impact on mental health and well-being. The findings of the first study not only highlight the need for the development of high-quality measurement scales that measure the construct of connectedness to nature but also open the door for the development of a scale that measures urban nature connectedness and emphasize the imperative need to conduct research on this topic across a more diverse global context. The results of the second study indicate that students from different socioeconomic backgrounds exhibit comparable levels of connectedness to nature and commitment to the environment. However, notable gender differences are evident, which is a topic that also relates to the mental health and well-being of individuals. In summary, the studies included in this research add to the knowledge on

human connectedness to nature and how to measure it. This may eventually contribute to the development of more sustainable societies and promote a greater range of sources for improving mental health and increasing well-being.

Key words: nature connectedness, mental health, gender, inequality, developing countries

1. Introduction

Humanity is exalted not because we are so far above other living creatures, but because knowing them well elevates the very concept of life.

– **Edward O. Wilson**

The current state of human existence is undergoing a transformative shift. Presently, humanity finds itself confronted with a multitude of stressors that exert substantial impacts on their lives. Pollution, global warming, and inequality serve as merely a few exemplifications, which are further exacerbated by the escalating urbanization phenomenon experienced on a global scale (Scopelliti et al., 2016; van den Bosch & Nieuwenhuijsen, 2017). Living in urban environments clearly brings numerous benefits, as seen through the current economic prosperity and social advancement (Nieuwenhuijsen, 2020). However, it is important to recognize that urbanization has significant effects on the physical and mental well-being of the population, which should be taken into serious consideration (Cox et al., 2018).

With the aim of alleviating the situation that humanity is facing, various institutions and organizations are developing programs and initiatives focused on promoting greater well-being at a global level. The United Nations (UN) leads this list of these organizations and proposed 17 goals aiming to encourage the development of actions that will lead people towards the generation of a better and more sustainable future (United Nations, 2022).

The research presented in this dissertation aligns with specific goals outlined by the United Nations. These goals include Goal 3, which focuses on promoting well-being and health for individuals of all age groups. Additionally, Goal 5 aims to achieve gender equality and empower women and girls. Goal 10 centers on reducing inequality within and between countries, while Goal 11 emphasizes the creation of sustainable cities and communities (United Nations, 2022).

Given the pressing need to discover methods to enhance the mental health and well-being of individuals in today's society, this dissertation aims to make significant contributions by developing strategies to achieve these objectives. The approach embraced involves promoting nature as a substantial source of health and well-being (Annerstedt van den Bosch & Depledge, 2015; Houlden et al., 2018). Nevertheless, it is important to emphasize that humans can fully enjoy the benefits of nature primarily when there is a close relationship between them and the natural environment. For instance, a person who goes hiking solely for the sake of completing a tour may experience more limited benefits compared to someone who genuinely appreciates and embraces the wonders that nature offers during this activity (Van Gordon et al., 2018). Thus, this allows us to recognize the crucial importance of conducting research on the benefits that nature has on the mental health and well-being and therefore, generate sustainable cities. In order to accomplish these objectives effectively, the research will entail a meticulous examination of measurement scales pertaining to the concept of connectedness to nature, which, up to date, has exhibited uncontrolled and ambiguous expansion. Furthermore, an investigation will be conducted in a developing country, as there is currently a scarcity of research on the topic in this context, and the need for valuable insights and perspectives in this area is critically necessary.

1.1 Theoretical Approaches

Over the last decades, there has been growing interest in viewing and understanding the relationship between human and nature. To date, one way of understanding this relationship in research has been through the generation of various theoretical approaches (Kahn et al., 2009; Kaplan, 1995; Ulrich et al., 1991; Wilson, 1984). In the following section, we will provide

a concise overview of some theoretical approaches that offer valuable insights for the development of this dissertation.

1.1.1 Biophilia Hypothesis

The Biophilia hypothesis is one of the most important theoretical approaches proposed in environmental research (Barbiero & Berto, 2021; Wilson, 1984). The term biophilia, which means love of life, comes from the conjunction of two Greek roots: *bio* (life) and *filia* (love) (Barbiero & Berto, 2021). Fromm (1973) and Wilson (1984) used this term to develop an ontogenetic and phylogenetic description respectively (Barbiero & Berto, 2021). However, for the purpose of this dissertation, only the phylogenetic approach was addressed.

In his Biophilia Hypothesis, William Wilson stated that all individuals possess an innate connectedness to nature. Later on, together with Kellert, he specified that this connection is capable of increasing our well-being, our quality of life, and our physical and mental health (Kellert & Wilson, 1993). Within the various theoretical approaches that environmental research supports, the biophilia hypothesis adds a particular value to this dissertation, as it proposes that through contact with nature, individuals can attain greater health and well-being. To date, there is no consensus about the mechanisms underlying the relationship between the Biophilia Hypothesis and health (de Vries et al., 2013; Groenewegen et al., 2006; Sugiyama et al., 2008). However, in alignment with the aims of the present dissertation, we will adopt those proposed by Kuo (2015), who specifically presents an alternative view on how the connection with nature promotes health.

The mechanisms proposed from this perspective are: active ingredients such as environmental biodiversity, nature images and nature sounds; physiological and psychological states such as relaxation and stress reduction, awe, vitality and attention restoration; and behaviors and conditions such as physical activity, sleep and social ties (Kuo, 2015). These mechanisms are relevant to this dissertation, as they provide access to various benefits related to mental health

(e.g., decreased anxiety disorders, reduced depression symptoms), which encompasses mental health, a key component of the health construct (World Health Organization, 2006),

1.1.2 Attention Restoration Theory

The Attention Restoration Theory (ART) is another theoretical approach that was developed by Kaplan and Kaplan (1989). This theory suggests that attention and concentration can be improved through direct exposure to nature (Kaplan, 1995). This theoretical framework is relevant to this dissertation because, as research has shown, attention is one of the components of mindfulness (Lau et al., 2018), and mindfulness is strongly correlated to mental health (Marais et al., 2020), well-being (Bennett & Dorjee, 2015), and contact with nature (Kaplan 2001, Wolsko 2013).

Moreover, research has shown several mechanisms that compose the ART. One of them is known as "Directed Attention", which is the attention individuals use when voluntarily attend to something. The Directed Attention is the type of attention that involves effort and therefore can generate fatigue. This fatigue is understood as "Directed Attention Fatigue", which in turn is recognized by greater distractibility, a reduced ability to solve problems, greater irritability, behavioral alterations and therefore less effectiveness in performing tasks (Ohly et al., 2016). The alternative to solve this fatigue is through the promotion of "Effortless Attention" which will allow the demands made on the Directed Attention to decrease and thus obtain time to rest and restore (Basu et al., 2018). For instance, one qualitative study conducted with twenty participants in England, found that bird sounds may promote attention restoration (Ratcliffe et al., 2013). This is relevant since bird sounds represent a focal point of attention (Gibson, 2019) that can be effectively integrated within a mindfulness practice. The practice of listening to bird sounds, along with using other focal points based on nature, may potentially facilitate attention restoration, thereby contributing to the promotion a mindfulness state and thus mental health (Lymeus et al., 2018).

1.1.3 Stress Reduction Theory

The Stress Reduction Theory, developed by (Ulrich et al., 1991), posits that exposure to natural environments facilitates a faster and more complete recovery from stress compared to exposure to urban environments. This theory originated from a study involving 120 participants who were exposed to a stressful movie, followed by a video of either a natural or urban environment, based on their assigned group. Analysis of physiological measures, such as parasympathetic nervous system activity, and psychological self-reports revealed that the individuals experienced quicker recovery when exposed to natural environments as opposed to urban settings.

One of the main challenges humanity is currently facing is stress, which significantly affects mental health and well-being (World Health Organization, 2023b). Therefore, the stress reduction theory, emphasizing the role of contact with nature in alleviating stress, holds vital importance for the objectives of this dissertation.

In addition, research exploring this theory suggests that the insights it provides are valuable to stakeholders and urban planners for making decisions when designing urban spaces (Berto, 2014). This aligns closely with the aim of this thesis to contribute to the development of sustainable societies. In support of this notion, a study divided 154 participants into three groups, subjecting them to virtual reality environments of a forest, park, and urban setting. Each group experienced visual, olfactory, and auditory stimuli, and participants were exposed to mild electroshocks to induce stress. Skin conductance was used as a biological marker to assess their stress response. The results revealed a marked reduction in stress for participants exposed to the park and forest settings, while the urban setting did not show significant stress reduction (Hedblom et al., 2019). These findings underscore the importance of incorporating green spaces into urban planning, as they offer stress-reducing benefits and contribute to the overall well-being of individuals in urban environments.

1.1.4 Technological Nature

The ongoing use of technology is witnessing unparalleled growth, and it currently stands as a catalyst for social development and progress. One of its advantageous aspects for contemporary society is the facilitation of easy access to nature (Frumkin et al., 2017), which has been observed to promote mental health and well-being among individuals (Annerstedt van den Bosch & Depledge, 2015; Houlden et al., 2018; Shanahan et al., 2019).

Due to the aforementioned reasons, this theoretical approach aligns with the aims of this dissertation. Moreover, it adapts to the current global situation, where the possibility of having real contact with nature is diminishing. The present theoretical approach is influenced by the research conducted by Peter J. Kahn and colleagues, wherein they investigated the advantages of exposure to nature through various technological means, such as robotic pets, videos, and immersive nature experiences (Kahn, 2011).

For instance, in two studies involving participants exposed to natural environments, built environments, and environments with nature presented through technology, the researchers discovered that exposure to nature through technology (e.g., watching nature videos, using virtual reality devices for green exercise, interacting with a robot dog) was superior to exposure solely to built environments. However, it was also found that exposure to nature through technology did not surpass the benefits of real contact with nature (Kahn et al., 2009). This finding enables researchers to understand the impact of nature contact under both natural and artificial conditions, thereby aiding in making informed decisions for the generation of interventions and policies.

1.2 Human-Nature Relationship

The interdependence between humans and nature, or in other words, the relationship of mutual dependence between humanity and the natural world, is known as Human-

Nature Relationship (HNR) (Brymer et al., 2020). This relationship can be understood from a transactional perspective (Gifford, 2014) and is intrinsically related to strategies that aim to mitigate the stressors to which humanity is currently exposed e.g. climate change, heat stress and high rate of non-communicable diseases (van den Bosch & Nieuwenhuijsen, 2017).

1.2.1 Nature and Well-Being

In recent years, there has been a significant surge in research focusing on well-being. This has led to the fact that there is no single definition of this construct. However, most conceptualizations agree that well-being is a reflection of the general state of a person (Seligman, 2011; World Health Organization, 2012). Nowadays, it has been seen that a key way to promote the state of well-being is through connectedness to nature (Shanahan et al., 2019). Connectedness to nature is a key construct within HNR since it indicates the degree to which human include nature in themselves (Schultz, 2002). Increasing connectedness to nature helps to mitigate societal challenges that humanity is currently experiencing (i.e., inequality, floodings, non-communicable diseases, stress, global warming) and that inevitably deteriorate our physical, mental, social health and overall well-being (Brymer et al., 2019).

To date, intriguing findings have emerged, indicating that spirituality and meaning in life serve as mediators in the relationship between well-being and connectedness to nature. These findings provide valuable insights into the intricate nature of the connection between connectedness to nature and well-being, shedding light on the underlying complexities of both phenomena (Howell et al., 2012; Kamitsis & Francis, 2013)

1.2.2 Nature and its Mechanisms

For decades, studying how the HNR improve health has gained relevance. For instance, one cross-sectional study showed that nature near people's homes can generate various health benefits, such as a decrease in depression levels, improved mood, reduced mortality due to cardiovascular diseases and disease prevention (Cox et al., 2017). Another cross-sectional study found that people who have weekly direct contact with nature for more than 120 minutes have better health (White et al., 2019). Nevertheless, the rise of the factors that are increasing the mortality and the morbidity (van den Bosch & Nieuwenhuijsen, 2017) are motivating to understand in depth the relationship between individuals and nature, as well as the mechanisms that this relationship has.

To date, there has been no common agreement about the mechanisms underlying the relationship between nature and health. However, for the purposes of this dissertation, the mechanisms reported in the Health Council of the Netherlands (2004) were used. These mechanisms were chosen because they show how scientific evidence is used to generate public health policies. In addition, several correlations were noted between these mechanisms and those proposed in other studies (Hartig et al., 2014; Kuo, 2015; Mayer et al., 2008). The mechanisms are: “recovery from stress and attention fatigue, encouragement to exercise, facilitating social contact, encouraging optimal development in children, and providing opportunities for personal development and a sense of purpose” (Health Council of the Netherlands, 2004, p.16), which, at the same time, are encompassed in the constitution of health from the World Health Organization (WHO) (World Health Organization, 2006).

1.2.3 Nature and Health

Connectedness to nature has demonstrated numerous benefits in health (Hartig et al., 2014). Nevertheless, there is an ongoing discussion where some research suggests that the benefits of connectedness to nature on health can be observed after minimal exposure (Kahn et al., 2009), while other studies propose that these benefits are only observed when a person is

capable of mindfully noticing and engaging with nature (Wolsko & Lindberg, 2013). Currently, there is no consensus in this topic, although several studies have sought to approach this by specifying the amount of exposure time and space necessary to begin experiencing the benefits of connectedness to nature (Cox et al., 2017; Ekkel & de Vries, 2017; White et al., 2019). Nonetheless, what remains undeniable is the fact that the connection to nature can act as a mediator between mental health, well-being, and nature exposure (Frantz et al., 2005; Zhang et al., 2014), making further research on this mediation imperative.

In the last decade, the WHO (2016) has developed a definition within its constitution that incorporates physical, mental, and social health as part of the complex health framework. From this perspective, research shows that nature positively impacts the prevention and treatment of several diseases (Lahart et al., 2019), as it is in the cardiovascular diseases, cancer, immune system diseases, respiratory diseases and vertigo (Kuo, 2015) as well as cardio-metabolic health (Paquet et al., 2013) and type 2 diabetes (Bodicoat et al., 2014). For instance, one research study with 153 participants over a 4-week duration, where only two weeks involved intervention, three groups were assigned specific activities: 1) relaxation exercises, 2) walking in the park, and 3) continuing with usual break activities. The findings indicated that participants who walked in the park showed a promising effect on blood pressure, although no significant impact on cortisol levels was observed (Torrente et al., 2017). Investigations like this demonstrate the potential of nature exposure as a tool for positively influencing individuals' physical health.

Mental health is another essential component of the construct of health. Moreover, it is one of the central topics of the present dissertation. A plethora of benefits has been discovered from exposure and connectedness to nature (Kotera et al., 2020; Tillmann et al., 2018). For instance, the relation to meaning in life (Howell et al., 2012), the promotion of spirituality (Navarro et al., 2019), and the possibility of improving self-esteem (Swami et al., 2019) and resilience (Marselle et al., 2019) through connectedness to nature are just some of the examples. In line with this, a systematic review that included 52 studies for their narrative

synthesis revealed that exposure to nature has innumerable benefits in mental health. However, the authors pointed out that the evidence was not currently sufficient for making decisions or planning interventions. Therefore, they recommended conducting more research in this area (Houlden et al., 2018). As can be seen, environmental research in the area of mental health is still in its infancy. Thus, it is important to continue promoting research in this field so that gradually the current research gap can be narrowed.

Another component of the concept of health previously mentioned is social health. Social health is also an essential element of this dissertation, since it also aims to promote the generation of sustainable societies. Social health refers to both micro (e.g. interpersonal, as well as intrapersonal) and macro levels (e.g. policies and norms) (World Health Organization, 2022a). At the micro level, problems like isolation and the positive impact of nature on it are described (Leavell et al., 2019). For instance, one study demonstrated that contact with nature can reduce social isolation and provide individuals with a way to increase their sense of connection (Cartwright et al., 2018). On the other hand, at the macro level, studies have detected the influence of nature on aspects like socioeconomic position (SEP), gender and urbanization (World Health Organization, 2022a).

In terms of socioeconomic position (SEP), one study conducted in Wales showed that facilitating exposure to nature can be a way to reduce socioeconomic inequalities (Garrett et al., 2023). Another investigation examined data obtained from the 2012 European Quality of Life Survey, and discovered that socioeconomic disparities in mental health were less pronounced among respondents who reported favorable access to green areas as opposed to those with limited access (Mitchell et al., 2015). Researches like these allow stakeholders to take assertive action and create policies that are more adequate to the current needs (Mears et al., 2019).

Moreover, research on the topic of gender within investigations that address various interventions to improve health, whether physical, social, or mental, is crucial (Day et al.,

2016). For instance, one study, in which this topic was of particular importance, examined a sample of women who showed improved mood and decreased anxiety levels after taking nature walks (Song et al., 2019). This information is essential because women have a higher prevalence of depression, anxiety, and substance abuse compared to men and this therefore, can allow to generate gender-sensitive interventions (World Health Organization, 2022b) which, in turn, can significantly improve the positive impact of the intervention on the participant..

Another objective of this dissertation is the promotion of sustainable societies. Nevertheless, it is noteworthy to mention that to date 55% of the world's population lives in urban settings (World Health Organization, 2021), which offer diverse benefits (e.g., access to amenities) but also pose multiple challenges (e.g., limited exposure to nature, non-communicable diseases) (van den Bosch & Nieuwenhuijsen, 2017; van den Bosch & Ode Sang, 2017). To address these challenges, the implementation of Nature-Based Solutions (NBS) has being encouraged. NBS encompass strategies, programs, or activities that aim to enhance the health and well-being of individuals by bringing them into contact with nature (e.g., green spaces in hospitals, outdoor fitness equipment, green corridors) (Shanahan et al., 2019). One high-quality study that analyzed the perspectives, perceptions, and preferences from citizens and stakeholders regarding Nature-Based Solutions (NBS) revealed several findings. Among them: (1) there is a lack of research on the topic in southern Europe, and there is no research on this topic in South America and Africa; (2) Few studies focus on the economic benefits generated by NBS, as well as the improvement in the quality of life experienced by cities after implementing them; (3) Few studies take into account the observed influence of NBS in reducing social injustices (Ferreira et al., 2020). This study demonstrates the significance of including NBS not only in the repertoire of communities but also within that of stakeholders, as this is the sole means to ensure their proper implementation.

In addition, it is necessary that both the community and implemented policies are adjusted to increase the use of actions to safeguard the environment. These actions are

commonly referred to and operationalized as "Pro-Environmental Behavior" (PEB) (Lange & Dewitte, 2019). In the one hand, at the individual level, research shows that one result of increasing the connectedness to nature is the increase in the awareness about the importance of protecting the environment (Mackay & Schmitt, 2019). For instance, one study conducted in a sample of 973 students in the university of Granada revealed that feeling strongly connected with nature is a key factor that influence PEB and also well-being (Ibáñez-Rueda et al., 2020). Moreover, at the community level, behaviors like reuse, recycling and waste management can be considered like PEB (Li et al., 2019). One example of promoting PEB can be observed in a study that highlights how PEB promotion through policies enhances accessibility to nature and encourages behaviors among the general population that contribute to environmental care (Annerstedt van den Bosch & Depledge, 2015). Furthermore, in its report for the implementation of urban green spaces, the WHO describes different actions to increase the use of green spaces in urban settings., which works as a public health prevention strategy (World Health Organization, 2017). All of the above reveals that promoting connection with nature has a significant beneficial effect on people's mental health, and consequently, on the co-construction of reality and the society in which we dwell.

1.3 Measurement of the Human-Nature Relationship

An intriguing aspect of environmental science is the measurement of HNR. Both objective (i.e. electrocardiogram, blood test, saliva test) and subjective (i.e. CN, exposure to nature, PEB) measuring instruments have been used to gather necessary information to meet research objectives.

1.3.1 Objective Measurements

There are diverse perspectives regarding objective measurements in psychology. Generally, these measurements are considered as instruments that provide unbiased, reliable, and quantifiable results reflecting the current state of the subject or object being measured, such as EEG, EKG, and saliva tests (Mobbs, 2021). On the one hand, it is observed that these measures do not rely on the subjective judgment of the examiner or the study subject (Voukelatou et al., 2020). On the other hand, it is mentioned that the interpretation of these measures can be challenging due to the significant inter-individual variation observed in physiological assessments (Herold et al., 2021).

There is no consensus to date regarding the understanding of these scales; however, it is certain that they continue to be widely used in research to address various investigative questions. This is evident in environmental research, where studies have shown that exposure to nature results in noteworthy outcomes, including decreased cortisol levels in saliva, more balanced blood pressure, improved heart rate variability, restored amygdala activity, and reduced frequency in frontal areas of the brain. (Norwood et al., 2019; Shuda et al., 2020; Yao et al., 2021). These results are often understood as the positive impact that nature has on individuals.

1.3.2 Subjective Measurements

Another approach used to measure the perception or the abstract manifestation of a construct is through subjective measurements. The development of subjective scales used to quantify constructs pertaining to HNR have gained importance in the last years (i.e. PEB scales, connectedness to nature scales) (Kleespies et al., 2021; Li et al., 2019). However, the lack of an unanimous consensus in the conceptualization of the constructs as well as their ambiguity make their subjective measurement complicated

(i.e. scales combining PEB with the construct of connectedness to nature) (Tam, 2013). This circumstance has facilitated an uncontrolled and disorganized growth of subjective measurement scales (Restall & Conrad, 2015).

For instance, one of the most widely used subjective scales in environmental research is the connectedness to nature scale (CNS) (Mayer & Frantz, 2004). This scale aims to measure connectedness to nature. However, there are other scales which essentially measure the same construct, but call it by different names (i.e. Environmental Identity Scale, Inclusion of Nature in Self Scale, Nature Relatedness Scale) (Clayton et al., 2021; Nisbet et al., 2008; Schultz et al., 2004)

1.4 Current State of Research

The research in the field of environmental science is still in its infancy, leading to several limitations. Firstly, there is ambiguity and interchangeability of terms within this field, such as environment and nature, human-nature interaction, HNR, connectedness to nature, and connectedness to nature. This lack of clarity contributes to the disorganized growth of environmental research and measurement tools (Cox et al., 2018; Flint et al., 2013; Nisbet & Zelenski, 2013; Olivos & Aragonés, 2014; Pasca et al., 2017; Pasca et al., 2020)

Additionally, there is a lack of consensus on the metrics required to determine a positive health response resulting from exposure to nature. For example, Cox et al. (2017) suggest that mental health benefits can be observed with nature exposure as short as 10 minutes to as long as 5 hours in the neighborhood. In contrast, White et al. (2019) argue that a minimum of 120 minutes of exposure is necessary to derive tangible health and well-being benefits.

Furthermore, most of the research conducted focuses on nature's green contexts, neglecting other natural environments such as lakes, rivers, deserts, or snowy areas. This limitation restricts the generalizability of research findings, as different settings can impact the human-nature relationship (Ekkel & de Vries, 2017).

Moreover, there is a significant gap in cross-cultural research on HNR, particularly in developing countries, with little attention given to vulnerable populations and gender considerations. This not only hampers the generalization of scientific results but also impedes the development of effective disease prevention programs that meet the specific needs of diverse populations (Scopelliti et al., 2016).

Lastly, there is a scarcity of longitudinal studies, with most research adopting a cross-sectional design. This limitation hinders the ability to observe changes over time in individuals' experiences related to HNR concepts (Haluza et al., 2014; Martin & Czellar, 2016; Richardson et al., 2015).

2. Aim of the Studies

Nurturing the connection between individuals and nature is emerging as a promising avenue to improve well-being and address the societal challenges at hand. Therefore, the overall aim of this dissertation is to contribute to the generation of strategies for promoting mental health in all individuals, as well as to contribute to the development of sustainable societies

In order to advance to these goals, two studies were conducted. First, an overview of the current status of measuring the connectedness to nature construct was needed. Therefore, the first study involved a systematic review of existing scales measuring connectedness to nature. Among the objectives of this study was an evaluation of the methodological quality of studies validating explicit scales for measuring connectedness to nature in children, adolescents, and

adults, including those with special needs. This study provided several findings, one of which highlighted a significant research gap in this field particularly regarding developing countries.

To address this gap, the second study was conducted as a cross-sectional investigation in a developing country. The aim of the study was to examine the levels of connectedness to nature and commitment to the environment among students from different socioeconomic backgrounds in Mexico. The results of this study not only complemented the first study, but also addressed the imbalance in environmental research, which predominantly focuses on developed countries, leaving a scarcity of research in developing (Astell-Burt et al., 2014; Mears et al., 2019; Mitchell et al., 2015).

3. Methodology

To accomplish the aforementioned objectives, the following studies were conducted.

3.1 Article 1

The first article is a systematic review that evaluated the methodology and presented an overview of manuscripts of explicit scales of connectedness to nature in children, adolescents and/or adults with/without special or additional needs. The target population was intentionally diverse to develop a tool to be used with different demographic cohorts for potential application in subsequent scientific inquiries, as well as in the sample involved in the article 2.

To carry out this systematic review, we needed to establish agreement on defining the concept that includes essential data from related constructs of the connectedness to nature previously developed (refer to Table 1) as well as crucial insights from existing literature on the topic.

Table 1*Descriptions of the Connectedness to Nature Construct as Found in Existing Literature*

Author (Year)	Synonyms of connectedness to nature	Definition
Clayton (2003)	Environmental Identity (EID)	This term refers to the connection that exists between a person and his or her non-human environment.
Davis et al. (2011)	Commitment to the Environment	“psychological attachment and long-term orientation to the natural world” (p. 174)
Dutcher (2007)	Connectivity With Nature	“perception of sameness between the self, others, and the natural world” (p. 474)
Kals et al. (2016)	Emotional Affinity Toward Nature (EATN)	This term refers to a preference for nature that will facilitate actions to protect it.
Mayer & Francis (2004)	Connectedness to Nature (CN)	This term refers to one’s affective, experiential sense of oneness with the natural world.
Nisbet et al. (2008)	Nature Relatedness (NR)	“individual levels of connectedness with the natural world” (p. 718)
Perkins (2010)	Love and Care for Nature (LCN)	“deep love and caring for nature which includes a clear recognition of nature’s intrinsic value as well as a personal sense of responsibility to protect it from harm” (p. 456)
Schultz (2002)	Connectedness With Nature	This term refers to the extent to which an individual includes nature within his/her cognitive representation of self.
Suganthi (2019)	Ecospirituality	This term refers to the feeling of oneness that a person has with the environment, as well as the amazement generated by understanding it. It is also a reflection of the awareness of the danger that can be generated by creating an imbalance in it.

Based on this, we did a preliminary construct that was based in essential data regarding the synonymous constructs of connectedness to nature, along with pivotal insights from the literature. The preliminary definition states like this: “People have a basic need of belonging (Baumeister & Leary, 1995), which can be satisfied by being subjectively (Pritchard et al., 2019) and positively (Barrable et al., 2021) connected to nature. Being connected to nature includes being close to (Wilson, 1984) or one with (Mayer & Frantz, 2004)the natural world.”

The review was performed according to the guidelines established by the "Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement" (Page et al., 2021).

A comprehensive literature search was developed following the PICO (i.e. Population, Interest and Context) guidelines (Murdoch University, 2021). Only manuscripts were included if: 1) they described the validation process of an explicit measurement of the connectedness to nature construct; 2) went through a peer-review process before publication; 3) were published in English, 4) publication was between the years 2000 and 2021; 5) were primary literature and 6) were aimed at children, adolescents and/or adults with or without special needs or additional needs.

The study information was compiled through an adapted version of the Qualitative Assessment of Physical Activity Questionnaires (QAPAQ) checklist (Terwee et al., 2010). The quality assessment was based on the detailed CONsensus-based Standards for the selection of health Measurement INstruments (COSMIN) Risk of Bias checklist (Mokkink et al., 2018). Data was summarized narratively.

3.2 Article 2

This article intended to measure connectedness to nature and commitment to the environment in two universities in Mexico. It also attempts to show the connection that exists between connectedness to nature and SEP, which as the literature indicates is linked to health. For instance, people with better socioeconomic possibilities tend to live in or have more access to nature. This possibility allows this group to have a stronger connectedness to nature and at the same time have a lower risk of suffering from mental health diseases (Annerstedt van den Bosch & Depledge, 2015; Marmot, 2017; Mears et al., 2019).

Hence, this cross-sectional study was conducted in Mexico, which is classified as a developing country (World Bank, 2023a, 2023b), and presents several social disparities (Federal Ministry for Economic Cooperation and Development, 2023) . To operationalize the socioeconomic position (SEP) construct, we selected both a public and a private university. These universities were chosen based on their semester fees, with the public university representing a low-cost option and the private university representing a high-cost option. Studies indicate that students' socioeconomic position (SEP) typically mirrors the access their families have to financial, cultural, social, capital, and human resources. Therefore, in essence, it often reflects the socioeconomic status of the family household (Cowan et al., 2012). Students from the selected public university typically lack the financial means to enroll in the selected private university, which is why they were classified into the low socioeconomic group. Additionally, to ensure the socioeconomic position of the students, a brief socioeconomic questionnaire with questions adapted from the "Encuesta Nacional de la Dinámica Demográfica 2018" was administered during the informed consent process (INEGI, 2018). The data acquired from the questionnaire substantiated the categorization of socioeconomic status according to university type (e.g. public, private). Furthermore, a back-translated version of the Spanish version of the Connectedness to Nature Scale (Pasca et al., 2017) and the Commitment to the Environment Scale (Davis et al., 2009) were implemented. Participants also completed an ethics approval form and a demographic questionnaire.

4. Results

4.1 Article 1

Authors: Ximena Tiscareno-Osorno, Yolanda Demetriou, Adilson Marques, Miguel Peralta, Rafael Jorge, Tadhg E MacIntyre, Deirdre MacIntyre, Stephen Smith, David Sheffield, Marc V Jones, Jürgen Beckmann, Dorothea M I Schönbach

Title: Systematic Review Protocol of Explicit Instruments Measuring Nature Connectedness: What do We Know and What is Next?

Journal: Environment and Behavior

Summary: The literature shows a continuous usage of the connectedness to nature construct. This has given rise to a rather arbitrary development of measurement tools. A systematic review was conducted to provide an overview, as well as a methodological evaluation of manuscripts of explicit nature connection scales in children, adolescents and/or adults with or without special needs or additional needs created to date. The review was conducted following the guidelines of the "Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement". A search strategy based on PICO and piloted before conducting the literature search in six electronic databases. Subsequently, the reference list of included records was screened. After this process, two independent extractors found 35 records that met the previously mentioned criteria. A spreadsheet was generated for data extraction based on the adapted version of the Qualitative Assessment of Physical Activity Questionnaires (QAPAQ) checklist and the "Consensus-based Standards for the selection of health

Measurement INstruments" Risk of Bias checklist. The spreadsheet was piloted in 3 studies by 4 independent extractors prior to use. The results showed that none of the studies complied with all the sections suggested by the quality assessment tool used and only 6 studies were evaluated with a high/adequate quality. Likewise, other aspects were found that should be taken into account in future research, such as the lack of scales performed in developing countries or the lack of scales in children and vulnerable populations.

Systematic Review of Explicit Instruments Measuring Nature Connectedness: What Do We Know and What is Next?

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Abstract

This systematic review assesses the methodological quality of manuscripts focusing on scales that explicitly measure nature connectedness. A literature search in six electronic databases was conducted using a search strategy based on PICO guidelines. Only peer-reviewed primary research available in

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English language, published between 2000 and 2021, meeting the scope of this review were included. Data from 35 studies were narratively analyzed. Their methodological quality was assessed using the COSMIN Risk of Bias checklist. Only five studies were rated as high/adequate quality. Based on the findings we make the following recommendations: (a) the need for the development of a more universal nature connectedness construct, (b) the requirement to increase the methodological quality of the scales, (c) the need to identify which the scales measure trait or state, (d) the need to increase the validate scales cross-culturally, and (e) the need to develop scales that can be employed with non-adult samples.

Keywords

connectedness to nature, validity, reliability, PRISMA, PICO

Introduction

Both access to natural areas and engagement with nature can help to alleviate some of the societal challenges that we are facing (Barboza et al., 2021; Murphy et al., 2022; Nieuwenhuijsen et al., 2022). Global challenges in mental health (World Health Organization (WHO), 2021) are exacerbated by issues such as urbanization (WHO, 2021) which exposes city dwellers to numerous stressors. Nature has the capacity to ameliorate stressors as demonstrated with both specific nature-based interventions (Gritzka et al., 2020) and more generally, by accessing nature (White et al., 2021). A recent health impact assessment (Barboza et al., 2021) estimated that up to 43,000 lives could be saved annually in European cities if the WHO guidelines for nature access were met (i.e., 0.5 hectares within 5 min. walk of residence). The imperative to provide access to greenspace for urban citizens is highlighted by the Sustainable Development Goal 11, which is a United Nations initiative, focusing on the development of sustainable cities and communities, and the specific target 11.7 according to which “universal access to safe, inclusive and accessible, green and public spaces, particularly for women and children, older persons and persons with disabilities” (United Nations, 2022c, para.11.7) should be provided (United Nations, 2022a, 2022b, 2022c). Greenspace access is considered important for urban health and mental health, but what are the key psychological factors underlying this association.

The impact of nature experience on cognitive functioning, emotional well-being, and other dimensions of mental health has been highlighted in a recent conceptual review. This paper states that stakeholders should use a tool to

anticipate the impact on mental health of the decisions they make at the environmental level. Furthermore, it strongly mentions that accessibility to nature must be increased in order to reduce health inequalities (Bratman et al., 2019). However one topic that was overlooked in that review was the concept of nature connectedness which, although it has no single definition today (Tam, 2013a), has shown a strong association with mental health and well-being (Murphy et al., 2022; W. P. Schultz, 2002; Sheffield & Lumber, 2020). Previously, nature connectedness was positively associated with positive well-being (Capaldi et al., 2014) with greater benefits for those with higher levels of nature connectedness. In addition, it has also been shown that fostering a deep sense of nature connectedness holds significant potential in encouraging individuals to engage in behaviors to protect the environment, which is important given that pressing environmental issues such as climate change are caused by human activities (Mackay & Schmitt, 2019; Oreskes, 2004). More recently, White et al. (2021), in a Pan-European study, reported that nature connectedness was also positively associated with positive well-being, negatively associated with mental distress and was, in addition to green space visits, associated with a lower likelihood of using medication to alleviate depression. Hence, it is vital to ensure further research to explore the importance of fostering the relationship between humans and nature as a pathway to well-being, mental health and pro-environmental behavior.

Up to now, various high-quality reviews have revealed that being connected to nature enables people to have a better mental health, be happier, have a greater eudaimonic well-being and in general flourish in their life (Arola et al., 2023; Capaldi et al., 2014; Pritchard et al., 2020; Yao et al., 2021). Furthermore, another systematic review found that nature connectedness is directly related to life satisfaction and quality of life (Houlden et al., 2018). More recently, a scoping review that aimed to identify and synthesize “existing measures of land, nature, and/or environmental connectedness, relatedness, and attitudes,” with a primary focus on indigenous communities, concluded that nature connectedness is not only vital for human well-being but also strongly connected to other factors, such as health, education, research, and politics. In the educational domain, for example, it highlights the relevance of including environmental education in schools, which play a decisive role in promoting nature connectedness education and fostering a connection with ancestral lands. At the policy level, for example, it highlights the significance of supporting the connection to the land, which has predominantly positive impacts on indigenous groups who have been remarkably disconnected from their lands (Keaulana et al., 2021).

It is important to point out from the aforementioned systematic reviews that all included studies used different scales based on different definitions of

nature connectedness (Cervinka et al., 2012; Howell et al., 2013; Kashima et al., 2014). This disagreement in the nature connectedness construct has led to an arbitrary, confusing and disorganized growth of measurement scales (Tam, 2013a). The difficulty for researchers and clinicians is that it becomes challenging to clearly understand the measurement of the construct as an array of different instruments are employed. Such instruments include, for instance, a scale measuring nature connectedness and pro-environmental behavior (i.e., New Environmental Paradigm Scale (Dunlap & Van Liere, 1978)), or nature connectedness and empathy toward nature (i.e., Dispositional Empathy with Nature Scale (Tam, 2013b)). This lack of clarity in measurement potentially leads to confusion among stakeholders, who wish to use valid and reliable tools to measure this specific construct (Restall & Conrad, 2015; Tam, 2013a). Therefore, this systematic review aims to provide an overview, and assess the methodological quality of research validating explicit instruments that measure the nature connectedness construct in children, adolescents and/or adults with or without special needs.

Methods

The methodological procedure of this systematic review is described in greater detail in the related protocol, which, unlike this review, provides a comprehensive account of the data management and screening process utilized (Schönbach et al., 2022). This article was drafted using the “Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement” (Page et al., 2021).

To conduct this systematic review, it was necessary to reach a consensus on defining the construct that encompassed both: key data from the synonymous constructs of nature connectedness that have previously been developed (see Table 1) and key information from the literature on the subject. This operational definition was developed from the extant literature and a more comprehensive definition should be developed in further research.

Based on the above, we developed the following preliminary definition for the purpose of conducting this review: People have a basic need of belonging (Baumeister & Leary, 1995), which can be satisfied by being subjectively (Pritchard et al., 2020) and positively (Barrable et al., 2021) connected to nature. Being connected to nature includes being close to (Wilson, 1984) or one with (Mayer & Frantz, 2004) the natural world.

Eligibility Criteria

The eligibility criteria for this systematic review is detailed in Table 2 below.

Table 1. Definitions of the Nature Connectedness Construct from the Extant Literature.

Author (Year)	Synonyms of nature connectedness	Definition
W. P. Schultz (2002)	Connectedness With Nature	This term refers to the extent to which an individual includes nature within his/her cognitive representation of self.
Clayton (2003)	Environmental Identity (EID)	This term refers to the connection that exists between a person and his or her non-human environment.
Mayer and Frantz (2004)	Connectedness to Nature (CN)	This term refers to one's affective, experiential sense of oneness with the natural world.
Dutcher et al. (2007)	Connectivity With Nature	"perception of sameness between the self, others, and the natural world" (p. 474)
Nisbet and Zelenski (2013)	Nature Relatedness (NR)	"individual levels of connectedness with the natural world" (p. 718)
Perkins (2010)	Love and Care for Nature (LCN)	"deep love and caring for nature which includes a clear recognition of nature's intrinsic value as well as a personal sense of responsibility to protect it from harm" (p. 456)
Davis et al. (2009)	Commitment to the Environment	"psychological attachment and long-term orientation to the natural world" (p. 174)
Kals et al. (2016)	Emotional Affinity Toward Nature (EATN)	This term refers to a preference for nature that will facilitate actions to protect it.
Suganthi (2019)	Ecospirituality	This term refers to the feeling of oneness that a person has with the environment, as well as the amazement generated by understanding it. It is also a reflection of the awareness of the danger that can be generated by creating an imbalance in it.

Table 2. Eligibility Criteria.

Inclusion criteria	Exclusion criteria
Manuscripts that describe the validation process of an explicit instrument/scale/questionnaire that measures the nature connectedness construct. Thus, not all dimensions in the scale (i.e., care, ecology) have to fulfill our definition.	Manuscripts that do not describe the validation process of an explicit instrument to measure the construct of nature connectedness (i.e., implicit association test).
Manuscripts that have passed through a peer-review process before publication.	Manuscripts that did not pass a peer-review process (i.e., gray literature) and/or were secondary literature (i.e., meta-analysis).
Manuscripts that are primary literature.	Manuscripts that describe the validation process of an explicit instrument that does not measure the construct of nature connectedness (i.e., pro-environmental behavior scale and dispositional empathy with nature scale) (Schönbach et al., 2022)
Manuscripts that were published between 2000 and 2021, since during that time, there was a significant increase in the development of instruments that measure nature connectedness (Martin & Czellar, 2016).	Manuscripts that were published before the year 2000.
Manuscripts that focus on scales addressing children, adolescents and/or adults with or without special needs or additional needs.	
Manuscripts that were published in English.	

Note. To be included in this review, manuscripts needed to directly refer to a validation process of an explicit nature connectedness scale.

Search Strategy and Databases

For this systematic review, an exhaustive search strategy based on the categories of “PICO” (i.e., population, interest, context) (Murdoch University, 2021) was generated by and XT-O, with the assistance of two librarians (Schönbach et al., 2022). DMIS and XT-O previously piloted the search strategy before being entered into the following databases used for the search: PsycINFO: EBSCO, PSYINDEX: EBSCO, PubMed: NCBI, PsycARTICLES:

EBSCO, Scopus: ELSEVIER, and Web of Science: Clarivate Analytics. These databases were selected because they are multidisciplinary and include topics in environmental psychology.

The search formula employed in the systematic review is outlined below: (child* OR infan* OR adolescen* OR preadolescenc* OR juven* OR teen* OR young* OR youth* OR kid* OR pediatric* OR pediatric* OR boy* OR girl* OR preschool* OR schoolchild* OR schoolboy* OR schoolgirl* OR student* OR pupil* OR woman OR women OR man OR men OR adult* OR grown-up* OR elderly OR human* OR people OR person* OR individual*) and (questionnaire* OR survey* OR questionar* OR instrument* OR tool* OR scale* OR dimension* OR item* OR element* OR component* OR construct OR concept OR measur* OR evaluat* OR assess* OR rate* OR rating OR report* OR descri*) and (“commitment to nature” OR “commitment with nature” OR “connect* to nature” OR “connect* with nature” OR “relat* to nature” OR “relat* with nature” OR “emotional affinity toward* nature” OR “emotional affinity with nature” OR “inclusion of nature in self” OR “inclusion of nature in the self” OR “nature commitment” OR “nature connect*” OR “nature relat*” OR “human-nature connect*” OR “human-nature relat*” OR “self-nature connect*” OR “self-nature relat*” OR “being one with nature” OR “interconnection with nature” OR “interconnection to nature”). The terms used in the search formula mentioned above were based on existing literature (Capaldi et al., 2014; Häyrynen & Pynnönen, 2020; Pritchard et al., 2020).

Study Selection

The identified papers were imported into EndNote (Version X9), where duplicates were removed manually. Any disagreement between both reviewers was resolved by discussion. The study selection process is shown in Figure 1. Authors of relevant papers were contacted a maximum of two times to request the full text if it could not be found.

Data Extraction

Data extraction was performed by two independent extractors XT-O and SM. Any disagreement between both extractors was resolved by discussion. In case of a continued disagreement, the opinion of a third independent data extractor was needed and DMIS was consulted. As a consensus was always reached as a result of this procedure, no inter-rater agreement between extractors could be computed. The data of the same measuring instruments were extracted separately from each paper, if they analyzed a different type of validity and/or reliability. In the case two publications analyzed the same

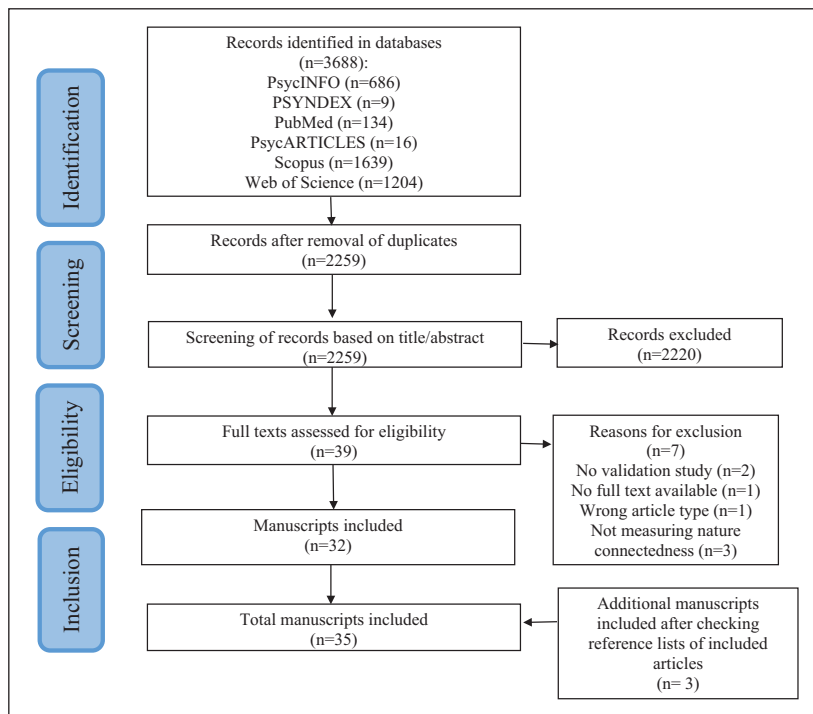


Figure 1. Flow diagram of the study selection process.

psychometric properties, data extraction from one was omitted. Data were extracted using a spreadsheet that [a] and [b] previously piloted as independent data extractors based on three randomly chosen articles. If data intended to be extracted was missing or uncertain, authors of included papers were contacted no more than two times. The following information was extracted based on the adapted Qualitative Assessment of Physical Activity Questionnaires (QAPAQ) checklist (Terwee et al., 2010):

- (a) General details (i.e., author(s), publication year)
- (b) Participants (i.e., recruitment rate, sample size, age)
- (c) Measuring instrument (i.e., name of measuring instrument, construct and dimensions intended to be measured)
- (d) Study design
- (e) Statistical analysis
- (f) Results (i.e., validity types, reliability)

Methodological Quality Assessment

The quality assessment of this systematic review was based on the comprehensive CONsensus-based Standards for selecting health Measurement INSTRUMENTS (COSMIN) Risk of Bias checklist (Mokkink et al., 2018). The COSMIN checklist was previously piloted by all three independent reviewers based on three randomly chosen papers. Subsequently, three separate reviewers XT-O and AM/MP assessed the methodological quality from each study. In case of disagreement in the rating given to each item belonging to the evaluated components an independent reviewer RJ was also consulted. We assessed content validity, structural validity, internal consistency, cross-cultural validity/measurement invariance, reliability, measurement error, criterion validity, and hypotheses testing for construct validity components, as they are aligned with the aim of this review. The components PROM development and responsiveness were not assessed. The rating of the checklist is “very good,” “adequate,” “doubtful,” “inadequate,” or “not applicable.” The hypothesis testing for construct validity is comprised by convergent and discriminant validity. To assess convergent validity, we utilized all nature connectedness scales presented in studies, which include scales that were included in the content validity assessment (i.e., Nature Relatedness Scale, Nature Connectedness Scale, Environmental Identity Scale, Inclusion of Nature in Self). Additionally, based on the expert statistical discussion and on its recommendation, we decided not to use the checklist item asking about “any other major flaws in the design or statistical methods” as this item increases the degree of subjectivity of the tool, which depends entirely on the examiner’s criteria. Thus, including this item in the checklist could bias the final rating of the components and the final rating of the entire quality assessment. This is particularly pertinent as the criterion that will be used to rate the scale is the “lowest/worst score counts,” commonly used to evaluate the COSMIN checklist (Hidding et al., 2017, 2018). Separate quality assessments for each instrument validated were performed for both the component-based and overall rating. If the information intended to be assessed uncertain, authors of included papers were contacted on two further occasions to elicit the information.

Therefore, the consultants were not blinded to the general information of the investigations (i.e., author(s)). The rating scale was based on the COSMIN Methodology for Systematic Reviews of Patient Reported Outcome Measures (PROMS) (Prinsen et al., 2018). In addition, one of the tool’s representatives was consulted about evaluating the content and construct validity sections, which are composed of subsections 5 and 2, respectively. Each subsection was rated and indicated as “not reported” when authors had not considered the topic during their scale evaluation.

Data Synthesis

Data extracted from each of the studies included in this systematic review and the results of the methodological quality assessment of each instrument reported, was summarized narratively. Both the methodological quality ratings of individual components and the resulting overall quality rating based on COSMIN, were reported separately in figures and tables under consideration of the stage of life of the studied sample (i.e., children ≤ 12 years, adolescents ≥ 13 years, adults ≥ 18 years).

Results

A total of 3,688 records were found (Figure 1). After removing 1,429 duplicates, 2,259 records were screened based on title and abstract. Subsequently, 39 full texts were assessed for eligibility. Finally, 35 manuscripts were included in the systematic review, which included three manuscripts identified after screening the reference lists of included articles.

General Information of Included Manuscripts

Within the 35 manuscripts, a total of 70 studies, 75 different samples, 34 different scales and 48 scales were found (see Table 3). An increasing interest in scale validation was detected in 2011 to 2013 and 2017 to 2021. Fourteen manuscripts originated from Europe (i.e., the UK, Germany, Switzerland, Greece, Austria, France, and Sweden); Spain was the most frequent country of study ($n = 5$). Nine manuscripts originated from North America, of which seven were from the USA and two from Canada. South America was the origin of three manuscripts in Brazil, Peru and Chile. Eight manuscripts originated from Asia, of which five were conducted in China. Three manuscripts originated from Australia. The most common study design used was cross-sectional ($n = 35$); one study also included a longitudinal study (See Figure 2).

Throughout 35 manuscripts, the following dimensions were measured: affective, such as the emotion that generates or supports nature connectedness (77%); cognitive, such as beliefs, knowledge, attitudes, values, identity, and awareness that are related to nature connectedness (69%); behavior, such as the commitment that a person has with nature (49%); experiential, such as the direct exposure and experience (14%); and philosophical, such as spirituality (11%). Concerning dimensionality, 48% of the scales were reported as unidimensional, 6% as bidimensional, 25% as multidimensional, and 21% did not report their dimensionality.

Depending on the authors' perspective, nature connectedness can be classified as a consistent personality trait or a temporary state. The vast majority

Table 3. General Information About Characteristics of Included Manuscripts, Sorted by Age Group.

Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Scale	
			Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
Children	Cheng & Monroe (2010); USA; Cross-Sectional; "Children's Connection to Nature Index"	Sample size and status: 1,432 students (26% fourth grade students) Gender: NR Age: NR	Multidimensional (affective, experiential, and cognitive): (a) enjoyment of nature, (b) empathy for creatures, (c) sense of oneness, (d) sense of responsibility Settings: urban/rural Theoretical background: Yes Measuring state/trait: NR	16 items (NR); 5-point Likert Scale
			Study 1a Sample size and status: parents of 31 children Gender: NR Age: children aged 2 to 5 (2.16 ± 0.90) years Study 1b Sample size and status: 20 parents Gender: NR Age: children aged 2 to 5 years Study 2 Sample size and status: 299 families Gender: 51% boys, 90.5% mothers, 9.1% fathers, and 0.3% others Age: children aged 2 to 5 (2.7 ± 1.2) years	Multidimensional (adults: affective, cognitive, behavior; children: affective and cognitive): (a) enjoyment of nature, (b) empathy for nature, (c) responsibility toward nature, (d) awareness of nature Settings: urban/rural Theoretical background: Yes Measuring state/trait: NR

(continued)

Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Scale		
		Participants (per sub-study)	Dimension(s) setting(s) theoretical background measuring state/trait	
Children, adolescent, and adults	Clayton et al. (2021); US, Russia, Switzerland, Taiwan, Peru; Cross-Sectional; "Revised Environmental Identity Scale (EID-R)"	Sample 1	Unidimensional (cognitive, affective, and behavior) Settings: urban/rural and natural Theoretical background: Yes Measuring state/trait: NR	14 items (NR); 7-point Likert Scale
		Sample size and status: 220 U.S. residents		
		Gender: 36%F, 74%M		
		Age: NR		
		Sample 2		
Sample size and status: 484 U.S. visitors to zoo and leisure Settings				
		Gender: 58%F, 42%M		
		Age: NR		
		Sample 3		
		Sample size and status: 45 U.S. high school students		
		Gender: 62%F, 38%M		
		Age: NR		
		Sample 4		
		Sample size and status: 310 Russian university students		
		Gender: 80%F, 19%M		
		Age: NR		
		Sample 5		
		Sample size and status: 343 Swiss university students		
		Gender: 36%F, 64%M		
		Age: NR		

(continued)

Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Scale	
			Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
		<p>Sample 6 Sample size and status: 91 Taiwanese undergraduate students Gender: 79%F, 21%M Age: NR</p> <p>Sample 7 Sample size and status: 224 Peruvian farmers, tourists, urban residents rural residents Gender: 45%F, 55%M Age: NR</p>		
	<p>Kleespies et al. (2021); Germany; Cross-Sectional; "Extended Illustrated Inclusion of Nature in Self Scale (IINS)"</p>	<p>Study 2 Sample size and status: 588 students Gender first data set: 64,3% women, 33,9% men, 1,8% no answer; second data set: 62,0% women, 35,3 men, 2,6 no answer</p> <p>Age: first data set: $M_{age} = 20.44$ years; second data set: $M_{age} = 20.51$ years</p> <p>Study 3 Sample size and status: 106 students with special needs Gender: 45% women 54% men 1% not specified Age: 9 to 14 years</p>	<p>Unidimensional (cognitive, affective, behavior) Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR</p>	<p>Single item (NR); 7 graphical questioning tool</p>

(continued)

Table 3. (continued)

		Scale		
Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
	Mundaca et al. (2021); Chile; Cross-Sectional; "The Emotion and Cognitive Scale of the Human-Nature Relationship (ECS-HNR)"	Sample size and status: 474 inhabitants from 38.40% Curicó, 21.31% Talca, 13.29% Santiago, and 7.17% Concepción Gender: 55.49% women to 43.88% men Age: NR	Bidimensional (cognitive and affective): (a) cognitive and (b) affective Setting: urban/rural Theoretical background: Yes Measuring state/trait: EAW measures state and EAF NR	24 items (6 reverse wording reported); 5-point Likert Scale
	Richardson et al. (2019); UK; Cross-Sectional; "Nature Connection Index (NCI)"	Study 1/ Factor analysis 1 Sample size and status: 3,568 adolescents and adults participants Gender: 1826 women, 1,742 men Age: 49.98 ± 20.05 Study 2/ Factor analysis 2 Sample size and status: 553 participants Gender: 267 men, 286 women Age: NR Study 3/Factor analysis 3 Sample size and status: 351 children and adolescents participants Gender: 177 women, 174 men Age: NR	Unidimensional (affective, cognitive and behavior) Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR	6 items (NR); 5-point Likert Scale
Children and adults	Li & Lang. (2014); China; Cross-Sectional; "Human-Nature Relationship Scale (HNR-Scale)"	Sample size and status: 1,307 Children + Parents Gender: Children: 53.9% boys and 46.1% girls. men children mean 0.539 Parents: 44% fathers and 587 56% mothers. Age: Children: NR Parents: NR	Bidimensional: (cognitive and behavior): NR Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR	5 items (2 reverse wording reported); 4-point Likert Scale

(continued)

Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Scale	
			Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
Adolescents and adults	Chew (2019); Singapore; Cross-Sectional; Scale 1 "Environmental Identity Scale (EID)" (long and short version) Scale 2 "Nature Relatedness Scale (NRS)" (long and short version)	Sample size and status: 209 Singaporean undergraduate students Gender: 67.9% women Age: 22.03 ± 4.56 years	Scale 1 Short version Unidimensional (NR) Setting: NR Theoretical background: Yes Measuring state/trait: NR Long version Unidimensional (NR) Setting: NR Theoretical Background: Yes Measuring state/trait: NR Scale 2 Short version Unidimensional Setting: urban/rural Theoretical background: Yes Measuring state/trait: Trait Long version Multidimensional (affective, cognitive and experiential): (a) NR-self (b) NR-experience (c) NR-perspective Setting: urban/rural Theoretical background: Yes Measuring state/trait: Trait	Scale 1 EID long version 24 items (NR); 5-point Likert Scale EID short version 11 items (NR); 5-point Likert Scale Scale 2 NRS long version 19 items (NR); 5-point Likert Scale NRS short version 6 items (NR); 5-point Likert Scale

(continued)

Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Scale		
		Participants (per sub-study)	Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
	Clayton et al. (2019); Russia; Cross-Sectional; "Russian version of the Environmental Identity Scale"	<p>Study 1 Sample size and status: 222 participants Gender: 180 women Age: 23.6 ± 6.7 years</p> <p>Study 2 Sample size and status: 94 participants; Gender: 78 women Age: 18.6 ± 1.2 years</p> <p>Study 3 Sample size and status: 200 participants Gender: 168 women, 84% women Age: 22.5 ± 6.2 years</p>	<p>Unidimensional (cognitive, behavior and affective) Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR</p>	24 items (NR); 5-point Likert Scale
	Davis et al. (2009); U.S.A.; Study 1 Cross-sectional and correlational Study 2 Cross-sectional and causal; "Environment Scale (COM)"	<p>Study 1 Sample size and status: 71 undergraduate students Gender: 26 men, 45 women Age: NR</p> <p>Study 2 Sample size and status: 70 undergraduate students Gender: 35 men, 35 women Age: NR</p>	<p>Unidimensional (behavior) Setting Studies 1 + 2: urban/rural Theoretical background: Yes Measuring state/trait: NR</p>	11 items (1 reverse question); 9-point Likert Scale

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Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Scale		
		Participants (per sub-study)	Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
	Martin and Czellar (2016); Switzerland; Study 2a + 2b + 3a + 3b Cross-Sectional Study 4 Longitudinal: "Extended Inclusion of Nature in Self Scale (EINS)"	<p>Study 2a Sample size and status: 107 students Gender: 65% men Age: NR</p> <p>Study 2b Sample size and status: 585 participants Gender: 42% men Age: NR</p> <p>Study 3a Sample size and status: 189 participants Gender: 45% men Age: NR</p> <p>Study 3b Sample size and status: 178 participants Gender: 50% men Age: NR</p> <p>Study 4 Time 1 Sample size and status: 38 students Gender: 48% men Age: NR</p> <p>Study 4 Time 2 Sample size and status: 94 participants Gender: 47% men Age: NR</p>	<p>Unidimensional (cognitive and behavior) Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR</p>	<p>4 items (NR); 7 illustrations per item</p>

(continued)

Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Scale	
			Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
	Mayer and Frantz (2004); USA; Study 1 + 3 + 4 + 5	Study 1 Sample size and status: 60 individuals Gender: 31 men, 29 women Age: 31 ± 13 years	Unidimensional (affective) Setting: urban/rural Theoretical background: Yes Measuring state/trait: Trait	14 items (3 reverse wording); 5-point Likert Scale
	Cross-Sectional Study 2 Longitudinal; "Connectedness to Nature Scale (CNS)"	Study 2 Sample size and status: 102 students Gender: 42 men, 60 women Age: NR		
		Study 3 Sample size and status: 270 students Gender: NR Age: NR		
		Study 4 Sample size and status: 135 members outside the college community Gender: 31 men, 89 women, and 15 who did not disclose their gender Age: 36 ± 19 years		
		Study 5 Sample size and status: 46 undergraduate psychology majors Gender: NR Age: NR		

(continued)

Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Dimension(s) setting(s) theoretical background measuring state/trait	Scale	Amount and type of items; amount and type of response
	Nisbet and Zelenski (2013); Canada, Study 1 + 2 + 3 Cross-Sectional Study 4 Longitudinal: "Nature Relatedness Scale-6 (NR-6)"	Study 1 Sample size and status: 184 students; Gender: 67.4% women (n=124; n=60 men) Age: 19.48 ± 2.83 years Study 2 Sample size and status: 145 Canadian middle managers Gender: 87 men, 56 women, 2 did not indicate sex Age: 42.37 ± 8.80 years Study 3 Sample size and status: 354 students Gender: 59.9% women (n=212), men (n=142) Age: 20.03 ± 4.36 years Study 4 Sample 1 Sample size and status: 207 community Gender: 78.6% community women (n=84) Age: 37.86 ± 15.01 years Study 4 Sample 2 Sample size and status: 123 students Gender: 77.2% students women (n=123) Age: 20.95 ± 5.60 years	Bidimensional (cognitive, affective and experiential): (a) self and (b) experience Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR	Scale	6 items (NR); 5-point Likert Scale

(continued)

Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
	Nisbet et al. (2008); Canada; Study 1 + 2 Cross-Sectional; "Nature Relatedness Scale (NRS)"	Study 1 Phase 1 Sample size and status: 831 Canadian undergraduate psychology students Gender: NR Age: NR Study 1 Phase 2 Sample size and status: 184 random selection of the Canadian undergraduate psychology students Gender: 67.4% women $n = 124$ women; $n = 60$ men Age: 19.48 ± 2.83 years Study 2 Sample size and status: 145 executives from the government and private sector Gender: 61% men $n = 87$, $n = 56$ women, 2 participants did not indicate gender Age: 42.37 ± 8.80 years	Multidimensional (affective, cognitive and experiential): (a) NR-self, (b) NR-perspective, (c) NR-experience Setting: urban/rural Theoretical background: Yes Measuring state/trait: trait	21 items (1 reverse wording); 5-point Likert Scale
	Pasca et al. (2020); Spain; Cross-Sectional; "Love for Nature Scale (LNS)"	Study 1 Sample size and status: 51 undergraduates Gender: 90.20% women Age: 20.37 ± 1.04 years Study 2 Sample size and status: 1,071 participants Gender: 56.70% women; Age: 26.42 ± 14.58 years Study 3 Sample size and status: 151 general population Gender: 53.6% women Age: 40.96 ± 12.50 years	unidimensional (affective): (a) connectedness (b) well-being Setting: urban/rural Theoretical Background: Yes Measuring state/trait: NR	10 items (NR); 7-point Likert Scale

(continued)

Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
	Tam (2013a, 2013b); China; Cross-Sectional; Scale 1 "Commitment to Nature (COM)"	Study 1 Sample size and status: 322 students Gender: 173 men, 146 women, and 3 NR Age: 20.36 ± 1.34 years	Scale 1: NR (affective and behavior) Setting: urban/rural Theoretical background: NR Measuring state/trait: NR	Scale 1 11 items (NR); 7-point Likert Scale Scale 2 14 items (NR); 7-point Likert Scale
	Scale 2 "Connectedness to Nature (CTN)"	Study 2 Sample size and status: 185 residents in the U.S. Gender: 67 men and 118 women Age: 33.43 ± 13.20 years	Scale 2: NR (affective and cognitive) Setting: urban/rural Theoretical background: NR Measuring state/trait: NR	Scale 3 4 items (NR) + diagram; 7-point Likert Scale
	Scale 3 "Connectivity with Nature (CWN)"		Scale 3: NR (NR) Setting: urban/rural	Likert Scale
	Scale 4 "Emotional Affinity Toward Nature (EATN)"		Theoretical background: NR Measuring state/trait: NR	Scale 4 16 items (NR); 7-point Likert Scale
	Scale 5 "Environmental Identity (EID)"		Scale 4: NR (affective) Setting: urban/rural	Likert Scale
	Scale 6 "Inclusion of Nature in Self (INS)"		Theoretical background: NR Measuring state/trait: NR	Scale 5 24 items (NR); 7-point Likert Scale
	Scale 7 "Nature Relatedness (NR)"		Scale 5: NR (affective and cognitive) Setting: urban/rural	Scale 6 4 items (NR); Diagram
	Scale 8 "Allo-Inclusive Identity (AID)"		Theoretical background: NR Measuring state/trait: NR	Scale 7 21 items (NR); 7-point Likert Scale
	Scale 9 "Love and Care for Nature (LCN)"		Scale 6: NR (cognitive) Setting: urban/rural Theoretical background: NR Measuring state/trait: NR	Scale 8 8 items (NR); 7-point Likert Scale
			Scale 7: NR (affective, cognitive and experiential) Setting: urban/rural	Scale 9 15 items (NR); 7-point Likert Scale

(continued)

Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Scale	Amount and type of items; amount and type of response
ADULTS	Beery (2013); Sweden; Cross-Sectional; "Measure of Environmental Connectedness (EC)"	Sample size and status: 120 Swedish law students Gender: 55% women and 45% men Age: NR	Theoretical background: NR Measuring state/trait: NR Scale 8: NR (cognitive) Setting: urban/rural Theoretical background: NR Measuring state/trait: NR Scale 9: NR (affective) Setting: urban/rural Theoretical background: NR Measuring state/trait: NR	3 items (NR); NR
	Braitto et al. (2017); Austria and the U.S.A.; Cross-Sectional; "Human-Nature Relationship Scale"	Sample size and status: 402 participants (45% BOKU, 55% USU) Gender: 38% men, 62% women Age: NR	Unidimensional (philosophical, behavior and NR) Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR Multidimensional (behavior and NR): (a) Positionality dimensions, (b) Character of bond dimensions, (c) Understanding of nature dimensions Setting: Urban/rural Theoretical Background: Yes Measuring state/trait: NR	NR (NR); 5-point Likert Scale (Modules 2–5).

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Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Scale	Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
	Brügger et al. (2011); Switzerland; Cross-Sectional; "Disposition to Connect with Nature Scale (DCN)"	Sample size and status: 1,309 participants Gender: women = 45.16% Age: 34.05 ± 15.30 years		Unidimensional (behavior and NR) Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR	40 items (3 items in reverse wording); (a) 17 items measured in a 3 point Likert Scale, (b) 9 items in dichotomous y/h, (c) 14 items in dichotomous y/h 14 items (3 reverse wording); NR
	Cheung et al. (2020); China; Cross-Sectional; "Chinese version of the CNS"	Pilot Sample size and status: 30 TCM practitioners in Hong Kong Gender: NR Age: NR Testing Sample size and status: 84 TCM practitioners across China's Guangdong province Gender: 64 men, 24 women Age: NR		Unidimensional (affective) Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR	
	Dutcher et al. (2007); U.S.A.; Cross-Sectional; "Connectivity with Nature"	Sample size and status: 741 landowners Gender: men > women Age: 57 ± 14.12 years		Multidimensional (affective, cognitive, philosophical and behavior): (a) connectivity with nature, environmental concern, (c) environmental behavior Theoretical Background: Yes Setting: urban/rural Measuring state/trait: NR	16 (3 reverse wording); 9 items with 5-point Likert Scale, 1 item with Venn diagram, 6 dichotomous answer (Y/N)

(continued)

Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Dimension(s) setting(s) theoretical background measuring state/trait	Scale	Amount and type of items; amount; and type of response
	Glargavouzi et al. (2021); Greece; Cross-Sectional; Scale 1 Connectedness to Nature Scale (CNS) Scale 2 Environmental Behavior (EB) Scale 3 Environmental Concern (Construct measured through the "Environmental Motives Scale(EMS)")	Study 1 Sample size and status: 400 general population contacted by phone calls in Greece Gender: 52.23% Women, 47.7% Men Age: 39.85 ± 15.11 years Study 2 Sample size and status: 400 general population contacted by phone calls in Greece Gender: 52% women, 48% men Age: 38.36 ± 14.29 years	Scale 1 Unidimensional (NR) Setting: urban/rural Theoretical Background: Yes Measuring state/trait: NR Scale 2 Multidimensional (NR): NR Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR Scale 3 Multidimensional (NR): NR Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR	Scale 1 14 items (NR); 5-point Likert Scale Scale 2 12 items (NR); 5-point Likert Scale Scale 3 10 items (NR); 5-point Likert Scale	
	Hatty et al. (2020); Australia; Cross-Sectional; "Connection with Nature-12 (CN-12)"	Study 1 Sample size and status: 3,090 residents in the state of Victoria Gender: NR Age: NR Study 2 Sample size and status: 1,069 participants— Gender: 48.7% women Age: 52.81 ± 14.8 years	Scale 1 Multidimensional (affective, cognitive and behavior); (a) identity, (b) experience, (c) philosophy Setting: urban/rural Theoretical Background: Yes Measuring state/trait: NR	12 items (NR); 7-point Likert Scale	

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Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Scale		
		Participants (per sub-study)	Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
	Matas-Terrón and Elósegui-Bandera (2012); Spain; Cross-Sectional; "Spanish adaptation of the Connectedness to Nature Scale (CNS)"	Sample size and status: 430 university students Gender: 76.04% women, 23.95% men Age: 21.7 ± 5.19 years	Unidimensional (cognitive) Setting: urban/rural Theoretical Background: Yes Measuring state/trait: NR	14 items (3 reverse wording); 5-point Likert Scale
	Meis-Harris et al. (2020); Australia; Cross-Sectional; "AIMES Connection with Nature Scale"	Sample size and status: 3,090 Victorians Gender: 50.2% women Age: 47 ± 16.31 years	Multidimensional (affective, cognitive, behavior and philosophical): (a) identity (b) materialism, (c) experiential and (d) philosophical Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR	19 items (NR); 5-point Likert Scale
	Navarro et al. (2017); France; Cross-Sectional; "CNS French version"	Study 1 Sample size and status: 204 participants from France Gender: 72% women Age: 29 ± 10.37 years Study 2 Sample size and status: 153 general population Gender: 58.8% women Age: 30.5 ± 10.75 years Study 3 Sample size and status: 322 participants total Subsample 1 Sample size and status: 267 French students Gender: 19.60 ± 3.75	Unidimensional (NR) Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR	11 items (NR); 5-point Likert Scale

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Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Scale	
			Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
		Age: NR Subsample 2 Sample size and status: 55 French students Gender: 61.8% women Age: 22.24 ± 5.04 years		
	Olivos et al. (2011); Spain; Cross-Sectional; "Environmental Identity Scale (EID)"	Sample size and status: 282 university students Gender: 18% men; 81% women Age: 21.4 ± 3.58	Multidimensional (affective, behavior, cognition): (a) environmental identity, (b) enjoying nature, (c) appreciation of nature environmentalism Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR	24 items (NR); NR
	Olivos et al. (2011); Spain; Cross-Sectional; "Spanish version of the Connectedness to Nature Scale"	Study 1 Sample size and status: 247 participants (conformed by 135 university students and 112 general population) Gender: 32% men, 68% women Age: students 20 ± 1.26 years, general population 44 ± 9.09 years Study 2 204 college students Gender: 18% men and 82% women Age: 20 ± 2.55 years	Unidimensional (NR) Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR	13 items (1 reverse wording item); 5-point Likert Scale

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Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Scale		
		Participants (per sub-study)	Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
	Pasca et al. (2018); Spain & U.S.A; Cross-Sectional; "Connectedness to Nature Scale CNS"	<p>Sample size and status: 745 total sample size. Sample divided in:</p> <p>Subsample 1 Sample size and status: 361 Americans- sample taken from the Study made by Mayer and Frantz (2004) Gender: NR Age: 31.29 ± 17.06 years</p> <p>Subsample 2 Total sample size and status: 384 participants from the Spanish group Gender: NR Age: 23.15 ± 7.45 years</p> <p>Study 1 Total sample size and status: 1,008 participants Gender: 74.9% women Age: 21.7 ± 4.2 years</p> <p>Study 2 Total sample size and status: 321 individuals from the general population of Madrid Gender: 53.6% women Age: 45.42 ± 9.62 years</p>	<p>Unidimensional (NR) Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR</p> <p>Unidimensional (cognitive) Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR</p>	<p>13 items (NR); 5-point Likert Scale.</p> <p>7 items (NR); 5-point Likert Scale</p>

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Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Scale	
			Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
	Perkins (2010); Australia; Study 3 + 4 Cross-Sectional; "Love and Care for Nature Scale (LCN)"	Study 1 Total sample size and status: 10 interdisciplinary experts Gender: NR Age: NR Study 2 Total sample size and status: 53 staff members from the university, students and other university members Gender: 44% men and 56% women Age: NR Study 3 Total sample size and status: 307 university students Gender: 62% women and 38% men Age: NR Study 4 Total sample size and status: 261 tourists Gender: 42% men and 58% women Age: NR	Unidimensional (affective) Setting Studies 1 + 2 + 3: urban/rural Setting Study 4: natural Theoretical Background: Yes Measuring state/trait: NR	15 items (NR); 7-point Likert Scale

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Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Scale	
			Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
	Perrin and Benassi (2009); USA; Cross-Sectional; "Connectedness to Nature Scale (CNS)"	<p>Study 1 Total sample size and status: 361 participants from Mayer and Frantz (2004) Gender: NR Age: NR</p> <p>Study 2 Total sample size and status: 231 students Gender: 69 men and 162 women Age: NR</p> <p>Study 3 Total sample size and status: 56 students Gender: 20 men and 36 women Age: NR</p> <p>Study 4 Total sample size and status: 29 students Gender: 12 men and 17 women Age: NR</p> <p>Study 5 Total sample size and status: participants were subjects from study 4 of the original Scale Gender: NR Age: NR</p>	<p>Unidimensional (cognitive) Setting: urban/rural Theoretical background: Yes Measuring state/trait: Trait</p>	<p>14 items (NR); 5-point-Likert Scale</p>
	Rosa et al. (2020); Brazil; Cross-Sectional; "CNS-7 (Brazilian version)"	<p>Total sample size and status: 224 university students Gender: 140 women Age: 23.6 ± 5.96 years</p>	<p>Unidimensional (affective, cognition and behavior) Setting: urban/rural Theoretical Background: Yes Measuring state/trait: NR</p>	<p>7 items (NR); 5-point Likert Scale</p>

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Table 3. (continued)

Stage of life	Author (year); country; design; name of the scale	Participants (per sub-study)	Scale	
			Dimension(s) setting(s) theoretical background measuring state/trait	Amount and type of items; amount and type of response
	P. W. Schultz et al. (2004); U.S.A; Cross-Sectional; "Inclusion of Nature in Self (INS) Scale"	Total sample size and status: 100 undergraduate students Gender: 40 men and 60 women Age: 23.62 ± 5.68 years	NR (NR) Setting: NR Theoretical background: NR Measuring state/trait: NR	1 item (NR); 7 graphical responses
	Suganthi (2019); India; Cross-Sectional; "Ecospirituality Scale (ES)"	Delphi method: Total sample size and status: 10 experts Gender: NR Age: NR Study 1 Total sample size and status: 527 employees Gender: 295 men (56%) and 232 women (44%) Age: NR Study 2 Total sample size and status: 321 general population Gender: 189 men (58.9%), 132 women (41.1%) Age: NR	Multidimensional (philosophical and affective): (a) dwelling, (b) caring, (c) revering, (d) experiencing, and (e) relating Setting: urban/rural Theoretical background: Yes Measuring state/trait: NR	20 items (NR); 7-point Likert Scale

Note. NR=not reported.

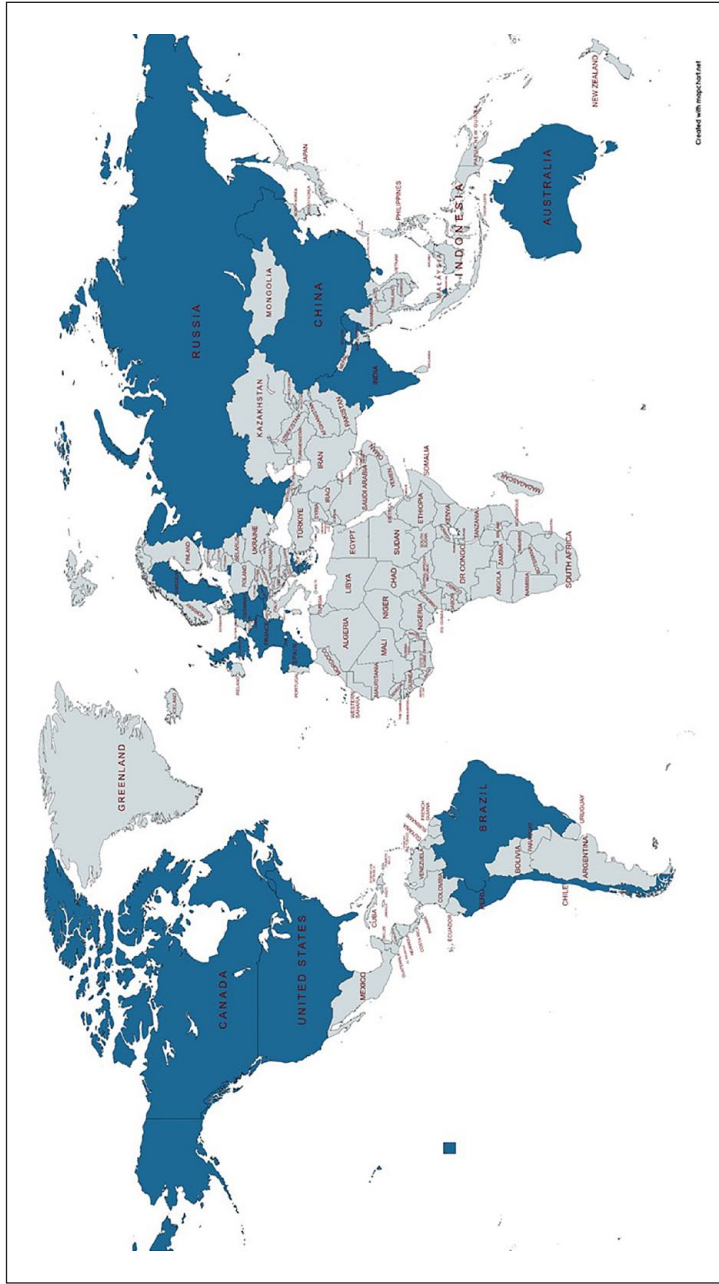


Figure 2. Countries that have validated nature connectedness scales.

of included manuscripts (86%) did not report if they treated nature connectedness as a state or trait. Eight percent of the manuscripts that only validated one scale treated nature connectedness as a trait (Mayer & Frantz, 2004; Nisbet et al., 2008; Perrin & Benassi, 2009). One manuscript, including two different scales, treated nature connectedness as a state in one scale. Still, it remained unclear how it was classified in the second scale (Mundaca et al., 2021). Another study was treated nature connectedness as a trait in one scale, but it was unclear how the authors classified the concept in the second scale (Chew, 2019).

Regarding the provision of instructions, only eight manuscripts reported clearly how to fill out their scale. Concerning the type and amount of items, one scale presented a diagram where participants had to select the option that better described their connection with nature (Tam, 2013a) and in all other scales, several items, ranging from 1 to 40, were provided. The average number of items per scale was 13.4 ($SD=7.4$). The response type mostly used was a Likert Scale ($n=41$), ranging from 9 to 9 point, and only two scales used dichotomous response categories (i.e., Yes/No) (Brügger et al., 2011; Dutcher et al., 2007) or diagrams ($n=5$) (Dutcher et al., 2007; Kleespies et al., 2021; Martin & Czellar, 2016; P. W. Schultz et al., 2004; Tam, 2013a).

One manuscript assessed a proxy report to assess nature connectedness in children between 2 and 5 years old (Sobko et al., 2018). Thirty-four manuscripts assessed self-report scales and the participants' age range was between 13.6 (± 1.2) and 52 (± 14.18) years. Most scales were developed for adults 54%, followed by adolescents and adults 26%, children, adolescents and adults 11%, children 6%, and children and adults 3%. The study samples were mainly students ($n=22$). Only one study validated the scale among children and adolescents with special/additional needs (Kleespies et al., 2021). In one manuscript, the targeted and studied populations did not match (Cheung et al., 2020). Of those studies providing a detailed breakdown of manuscript participants, between 112 and 30,753 volunteers were invited to participate in the included manuscripts, and between 60 and 3,090 completed the study. Of all the samples studied, 48% treated gender as a binary variable. However, several studies did not report the gender of participants ($n=17$). Only one study considered a third gender as the category "other" (Sobko et al., 2018). Most studies validated the scales in urban and/or rural contexts ($n=44$), a term used when there was a lack of clarity/specificity within the studies as to the type of environment in which the validation studies were carried out. Only two studies explicitly conducted their research in natural contexts (Clayton et al., 2021; Perkins, 2010), a term used when the participants of the manuscripts were in direct contact with nature (e.g., walking in the forest, gardening, practising exercise outdoors). The rationale of the dimensions and

constructs of 38 scales was based on theoretical frameworks, and 10 did not report their theoretical underpinnings.

In descending order, the following types of validity were mentioned in included manuscripts (see Table 4): construct ($n=22$), predictive ($n=5$), criterion and content ($n=3$, respectively), concurrent, face and external ($n=2$, respectively), cross-cultural, incremental, ecological, criteria, intercultural, structural, and known-group ($n=1$, respectively). However, the type of validity was not specifically reported in nine studies. About 14% of the manuscripts reported test-retest reliability, while 86% reported internal consistency reliability.

Quality Assessment (QA)

The QA revealed that five manuscripts had a high/adequate quality (see Table 5) (Matas-Terrón & Elósegui-Bandera, 2012; Olivos et al., 2011; Pasca et al., 2020; Perrin & Benassi, 2009; Rosa et al., 2020), nine had a moderate/sufficient quality (Beery, 2013; Brügger et al., 2011; Clayton et al., 2019; Dutcher et al., 2007; Gkargkavouzi et al., 2021; Martin & Czellar, 2016; Mundaca et al., 2021; Navarro et al., 2017; Nisbet & Zelenski, 2013), 10 had doubtful/low quality (Cheng & Monroe, 2010; Cheung et al., 2020; Chew, 2019; Meis-Harris et al., 2020; Nisbet et al., 2008; Pasca et al., 2018; Perkins, 2010; Richardson et al., 2019; P. W. Schultz et al., 2004; Suganthi, 2019), and 11 had inadequate/very low quality (Braitto et al., 2017; Clayton et al., 2021; Davis et al., 2009; Hatty et al., 2020; Kleespies et al., 2021; Li & Lang, 2014; Mayer & Frantz, 2004; Olivos et al., 2011; Pasca et al., 2017; Sobko et al., 2018; Tam, 2013a).

None of the manuscripts performed all sections indicated in COSMIN. Internal consistency was the best-evaluated psychometric property, with 29 manuscripts rated in the high/adequate category. Content validity was the property that was most often rated as doubtful/low. Structural validity was the property most frequently rated as moderate/sufficient. The psychometric property that was most often calculated was structural validity ($n=35$), while measurement error was never calculated ($n=35$). Regarding the validities that determine the extent to which the instrument is designed to measure the construct to be evaluated accurately, it emerged that only 13 manuscripts from the hypothesis testing for construct validity were classified within the high/adequate range, while 12 studies did not calculate the construct validity. On the one hand, 57% of the manuscripts calculated their correlation with one or more scales that also measured nature connectedness (e.g., the Nature Connectedness Scale or the Environmental Identity Scale). The remaining 43% did not calculate their correlation with a scale measuring only nature

Table 4. Explicitly Reported Validity and Reliability of Scales Sorted by Stage of Life.

Stage of life	Author; Year	Name of the scale	Psychometric properties	
			Explicitly reported validity	Reliability
Children, adolescents and adults	Cheng & Monroe (2010)	Children's Connection to Nature Index	NR	$\alpha = .87$
	Sobko et al. (2018)	Connectedness to Nature Index - Parent Preschool Children (CNI-PPC)	Face, construct, external, criteria	Enjoyment of nature: $\alpha = .86$; Empathy for nature: $\alpha = .87$; Responsibility toward nature: $\alpha = .75$; Awareness of nature: $\alpha = .80$
	Clayton et al. (2021)	Revised Environmental Identity Scale (EID-R)	Criterion, cross-cultural, intercultural, face validity	Sample 1: $\alpha = .94$; Sample 2: $\alpha = .94$; Sample 3: $\alpha = .82$; Sample 4: $\alpha = .86$; Sample 5: $\alpha = .87$; Sample 6: $\alpha = .94$; Sample 7: $\alpha = .87$; Overall: $\alpha = .89$
	Kleespies et al. (2021)	Extended Illustrated Inclusion of Nature in Self Scale (IINS)	Study 2 + 3: construct	Correlation of EINS With CNS: $R = .570$; Correlation of EINS With NR-6: $R = .605$
	Mundaca et al. (2021)	The Emotional and Cognitive Scale of the Human-Nature Relationship (ECS-HNR)	Construct	EAW: Perception $\alpha = .73$; Appreciation $\alpha = .71$; Understanding $\alpha = .71$; EAF: Connectedness $\alpha = .75$; Enjoyment $\alpha = .64$; Empathy $\alpha = .64$
Children and adults	Richardson et al. (2019)	Nature Connection Index (NCI)	Concurrent	Adolescents and adults: FAI $\alpha = .92$, FA2 $\alpha = .92$; Children and Adolescents: FA3 $\alpha = .85$
	Li & Lang. (2014)	Human-Nature Relationship Scale (HNR- Scale)	NR	3 Items factor: $\alpha = .669$; 2 Items factor: $\alpha = .629$
	Chew (2019)	(A) Environmental Identity Scale (EID) (Long and Short Version), (B) Nature Relatedness Scale (NRS) (Long and Short Version)	NR	EID full version: $\alpha = .96$; EID Short version: $\alpha = .92$; NRS Full version: NR Self $\alpha = .87$; NR Experience $\alpha = .77$; NR perspective $\alpha = .62$; NRS short version: $\alpha = .82$

(continued)

Table 4. (continued)

Stage of life	Author; Year	Name of the scale	Psychometric properties	
			Explicitly reported validity	Reliability
	Clayton et al. (2019)	Russian Version of the Environmental Identity (EID) Scale	Content, construct	$\alpha = .88$
	Davis et al. (2009)	Environment Scale (COM)	Study 1: construct Study 2: ecological, predictive	$\alpha = .91$
	Martin and Czelar (2016)	Extended Inclusion of Nature in Self Scale (EINS)	Study 2a: Construct, criterion Study 2b: external Study 3a: criterion, construct Study 3b: criterion, construct Study 4: construct	Study 2a: $\alpha = .82$; Study 2b: $\alpha = .87$; Study 3a: $\alpha = .87$; Study 3b: $\alpha = .90$; Study 4: Test-Retest Reliability T1: $\alpha = .88$, T2: $\alpha = .91$, $R = .843$
	Mayer and Frantz (2004)	Connectedness to Nature Scale (CNS)	Study 1: Construct Study 2: construct	Study 1: $\alpha = .72$ and $\alpha = .84$ (after erasing items); Study 2: $\alpha = .82$; Study 3: $\alpha = .82$; Study 4: $\alpha = .79$; Study 5: $\alpha = .79$
	Nisbet and Zelenski (2013)	Nature Relatedness Scale (NR-6)	Study 4: predictive, concurrent	Study 1: $\alpha = .83$; Study 2: $\alpha = .84$; Study 3: $\alpha = .86$; Study 4: Community/Students $\alpha = .90$; .89 at baseline, $\alpha = .89$ /.90 at 1 month
	Nisbet et al. (2008)	Nature Relatedness Scale (NR)	Construct	Phase 1: Overall $\alpha = .87$; NR-Self $\alpha = .84$; NR-Perspective $\alpha = .66$; NR-Experience $\alpha = .80$ Phase 2: (Test-Retest): NR $\alpha = .85$; NR-Self $\alpha = .81$; NR-Perspective $\alpha = .65$; NR-Experience $\alpha = .85$
	Pasca et al. (2020)	Love for Nature Scale (LNS)	Study 3: construct	Study 2: Unidimensional Model $\alpha = .90$; Two-Dimensional Model $\alpha = .87$ /.69; Study 3: $\alpha = .951$

(continued)

Table 4. (continued)

Stage of life	Author; Year	Name of the scale	Psychometric properties	
			Explicitly reported validity	Reliability
Adults	Tam (2013a, 2013b)	(A) Commitment to Nature (COM), (B) Connectedness to Nature (CTN), (C) Connectivity with Nature (CWN), (D) Emotional Affinity Toward Nature (EATN), (E) Environmental Identity (EID), (F) Inclusion of Nature in Self (INS), (G) Nature Relatedness (NR), (H) Allo-Inclusive Identity (AID), (I) Love and Care for Nature (LCN)	Convergent, incremental, construct	Study 1: COM: $\alpha = .83$; CTN: $\alpha = .79$; CWN: $\alpha = .61$; EATN: 0.84 ; EID: $\alpha = .89$; INS: $-.7$; NR: $\alpha = .83$; AID: $-.7$; LCN: $-.7$; Study 2: COM: $\alpha = .93$; CTN: $\alpha = .89$; CWN: $\alpha = .86$; EATN: $\alpha = .93$; EID: $\alpha = .96$; INS: $-.NR$; $\alpha = .83$; NR: $\alpha = .90$; AID: $\alpha = .92$; LCN: $\alpha = .97$
	Beery (2013)	Measure of Environmental Connectedness (EC)	Construct	$\alpha = .83$
	Braitto et al. (2017)	Human-Nature Relationship Scale	NR	α for most single statements: >0.6 ; Reliability for Groups User $\alpha = .43$ Master $\alpha = .53$; Nature Distant Guardian $\alpha = .55$
	Brügger et al. (2011)	Disposition to Connect with Nature Scale (DCN)	Predictive, construct	Rasch-Model-Based Reliability-Estimates or Internal Consistency Reliability $\alpha = .89$
	Cheung et al. (2020) Dutcher et al. (2007)	Chinese Version of the CNS Connectivity with Nature	Construct NR	$\alpha = .74$ First Factor: $\alpha = .72$; Second Factor: $\alpha = .77$; Third Factor: $\alpha = .67$

(continued)

Table 4. (continued)

Stage of life	Author; Year	Name of the scale	Psychometric properties		
			Explicitly reported validity	Reliability	Construct
	Gkargkavouzi et al. (2021)	(A) Connectedness to Nature Scale (CNS), (B) Environmental Behavior (EB), (C) Environmental Concern (Construct measured through the Environmental Motives Scale (EMS))	CNS	Connectedness to Nature $\alpha = .88$; EMS Biospheric Motives Concern $\alpha = .94$; Egoistic Motives Concerns $\alpha = .92$; Altruistic Motives Concerns $\alpha = .87$; EB Environmental Action $\alpha = .90$; Personal Practices $\alpha = .90$	
	Hatty et al. (2020)	Connection with Nature-12 (CN-12)	Construct	Construct, predictive	CN-Total $\alpha = .94$; CN-Identity $\alpha = .88$; CN-Experience $\alpha = .90$; CN-Philosophy $\alpha = .77$
	Matas-Terrón and Elósegui-Bantera (2012)	Spanish Adaptation of the Connectedness to Nature Scale	NR		
	Meis-Harris et al. (2020)	AlMES Connection with Nature Scale	Construct		Attachment $\alpha = .87$; Identity $\alpha = .88$; Materialism $\alpha = .65$; Experiential $\alpha = .84$
	Navarro et al. (2017)	CNS French Version	Study 2: convergent Study 3: convergent, construct, predictive		Study 1: $\alpha = .80$; Alpha Per Item: (A) $\alpha = .78$, (B) $\alpha = .77$, (C) $\alpha = .78$, (D) $\alpha = .82$, (E) $\alpha = .77$, (F) $\alpha = .76$, (G) $\alpha = .76$, (H) $\alpha = .79$, (I) $\alpha = .77$, (J) $\alpha = .78$, (K) $\alpha = .76$, (L) $\alpha = .83$, (M) $\alpha = .78$, (N) $\alpha = .82$; Study 2: $\alpha = .85$; Study 3: $R = .774$
	Olivos et al. (2011)	Environmental Identity Scale (EID)	Construct, predictive		Overall $\alpha = .90$

(continued)

Table 4. (continued)

Stage of life	Author; Year	Name of the scale	Psychometric properties	
			Explicitly reported validity	Reliability
	Olivos et al. (2011)	Spanish Version of the Connectedness to Nature Scale	Construct	$\alpha = .788$
	Pasca et al. (2018)	Connectedness to Nature Scale (CNS)	NR	$\alpha = .811$
	Pasca et al. (2017)	Connectedness to Nature Scale-7 (CNS-7)	Construct	$\alpha = .866$
	Perkins (2010)	Love and Care for Nature (LCN) Scale	Study 3: construct Study 4: content, construct, criterion	$\alpha = .97$
	Perrin and Benassi (2009)	Connectedness to Nature Scale (CNS)	NR	$\alpha = .75$
	Rosa et al. (2020)	CNS-7 (Brazilian Version)	Structural, known-group, predictive, construct	$\alpha = .81$
	P. W. Schultz et al. (2004)	Inclusion of Nature in Self (INS) Scale	NR	Study 2: INS: Immediate Retest: $\alpha = .98$, 1-week Retest: $\alpha = 0.90$, 4-week Retest: $\alpha = .84$
	Suganthi (2019)	Ecospirituality Scale (ES)	Construct, content	Overall $\alpha = .953$

Notes. NR = not reported.

Table 5. Sectional and Global Quality Rating of Each Included Manuscript.

Stage of life	Author (Year)	Content validity										Hypotheses testing for construct validity				Global rating	
		Relevance participants	Comprehensiveness participants	Comprehensibility participants	Relevance professionals	Comprehensiveness professionals	Structural validity	Internal consistency	Cross-cultural validity/ measurement invariance	Reliability	Measurement error	Criterion validity	Convergent validity	Discriminative validity			
Children	Cheng & Monroe (2010)	NR	-	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
Children, adolescents, and adults	Sobko et al. (2018)	-	-	NR	NR	+	+	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Clayton et al. (2021)	-	-	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Kleespies et al. (2021)	-	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Mundaca et al. (2021)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	o
Children and adults	Richardson et al. (2019)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Li & Lang, (2014)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
Adolescents and adults	Chew (2019)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Clayton et al. (2019)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	o

(continued)

Table 5. (continued)

Stage of life	Author (Year)	Content validity										Hypotheses testing for construct validity				Global rating
		Relevance participants	Comprehensiveness participants	Comprehensibility participants	Relevance professionals	Comprehensiveness professionals	Structural validity	Internal consistency	Cross-cultural validity/ measurement invariance	Reliability	Measurement error	Criterion validity	Convergent validity	Discriminative validity		
Adults	Davis et al. (2009)	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	NR	NR	-
	Martin and Czellar (2016)	NR	NR	NR	NR	NR	+	NR	NR	NR	NR	NR	NR	NR	NR	o
	Mayer and Frantz (2004)	NR	NR	NR	NR	NR	+	NR	-	NR	NR	NR	NR	NR	NR	-
	Nisbet and Zelenski (2013)	NR	NR	NR	NR	NR	+	NR	o	NR	NR	NR	NR	NR	NR	o
	Nisbet et al. (2008)	NR	NR	NR	NR	NR	+	NR	-	NR	NR	NR	NR	NR	NR	-
	Pasca et al. (2020)	NR	NR	NR	NR	NR	+	NR	NR	NR	NR	NR	NR	NR	NR	+
	Tam (2013a, 2013b)	NR	NR	NR	NR	NR	+	NR	NR	NR	NR	NR	NR	NR	NR	-
	Beery (2013)	NR	NR	NR	NR	NR	+	NR	NR	NR	NR	NR	NR	NR	NR	o
	Bratto et al. (2017)	-	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	NR	NR	-
	Brigger et al. (2011)	NR	NR	NR	NR	NR	+	NR	NR	NR	NR	NR	NR	NR	NR	o

(continued)

Table 5. (continued)

Stage of life	Author (Year)	Content validity										Hypotheses testing for construct validity					
		Relevance participants	Comprehensiveness	participants	Comprehensibility	Participants	Relevance professionals	Comprehensiveness	Structural validity	Internal consistency	Cross-cultural validity/ measurement invariance	Reliability	Measurement error	Criterion validity	Convergent validity	Discriminative validity	Global rating
	Cheung et al. (2020)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	o
	Dutcher et al. (2007)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	o
	Gkargavouzi et al. (2021)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	o
	Hatty et al. (2020)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Matas-Terrón and Elosegui-Bandera (2012)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	+
	Meis-Harris et al. (2020)	-	-	-	-	-	-	-	-	NR	NR	NR	NR	NR	NR	NR	-
	Navarro et al. (2017)	NR	NR	NR	NR	NR	NR	NR	NR	NR	o	NR	NR	NR	NR	NR	o
	Olivos et al. (2011)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	+
	Olivos et al. (2011)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-

(continued)

Table 5. (continued)

Stage of life	Author (Year)	Content validity										Hypotheses testing for construct validity				Global rating				
		Relevance participants	Comprehensiveness participants	Comprehensibility participants	Relevance professionals	Comprehensiveness professionals	Structural validity	Internal consistency	Cross-cultural validity/ measurement invariance	Reliability	Measurement error	Criterion validity	Convergent validity	Discriminative validity						
	Pasca et al. (2018)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-		
	Pasca et al. (2017)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	
	Perkins (2010)	-	-	-	-	-	o	+	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	
	Perrin and Benassi (2009)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	+
	Rosa et al. (2020)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	+
	P. W. Schultz et al. (2004)	-	NR	-	NR	NR	o	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Suganthi (2019)	-	-	-	-	-	o	+	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-

Note. Scores defined as follows: + = high/adequate; o = moderate/sufficient; - = doubtful/low; - = inadequate/very low; NR = not reported.

connectedness. On the other hand, 23% of the manuscripts calculated their correlation with scales that did not measure connectedness with nature (e.g., New Ecological Paradigm, Positive and Negative Affect Scale, Pro-Environmental Behavior). The remaining 77% did not calculate their correlation with a non-nature connectedness scale. In addition, 25 manuscripts did not calculate content validity. The rating of the remaining studies ($n=10$) ranged between low and very low (see Figure 3). The rationale of the dimensions and constructs of 36 scales was based on a theoretical foundation. In comparison, 12 studies did not report the rationale for the included constructions and dimensions.

Discussion

This systematic review aims to: (1) provide an overview and (2) evaluate the methodological quality of the existing research that validates explicit instruments measuring the construct of nature connectedness in children, adolescents and/or adults with or without special needs. Several findings were obtained from the completion of the current systematic review. For instance, the low representation of developing countries in the validation of nature connectedness measurement scales, the lack of measurement scales that take vulnerable populations into account, the unclear measurement of state or trait nature connectedness, and the scarcity of high-quality research in the validation of nature connectedness construct measurement scales. Each of these findings will be explored below.

General Information of Included Manuscripts

The absence of a concise definition of the construct of nature connectedness was notable. This is consistent with previous research, which has also stated a multiplicity of nature connectedness terms (Tam, 2013a). Furthermore, it is important to mention that the lack of consensus in the operational definitions of the construct is problematic both conceptually and methodologically. For the purpose of this systematic review, the following definition was employed: People have a basic need of belonging (Baumeister & Leary, 1995), which can be satisfied by being subjectively (Pritchard et al., 2020) and positively (Barrable et al., 2021) connected to nature. Being connected to nature includes being close to (Wilson, 1984) or one with (Mayer & Frantz, 2004) the natural world.

This definition was designed to be broad in order to encompass a wide range of concepts. This approach not only reflects the existing literature but also allows for inclusivity in the literature search. However, it is important to

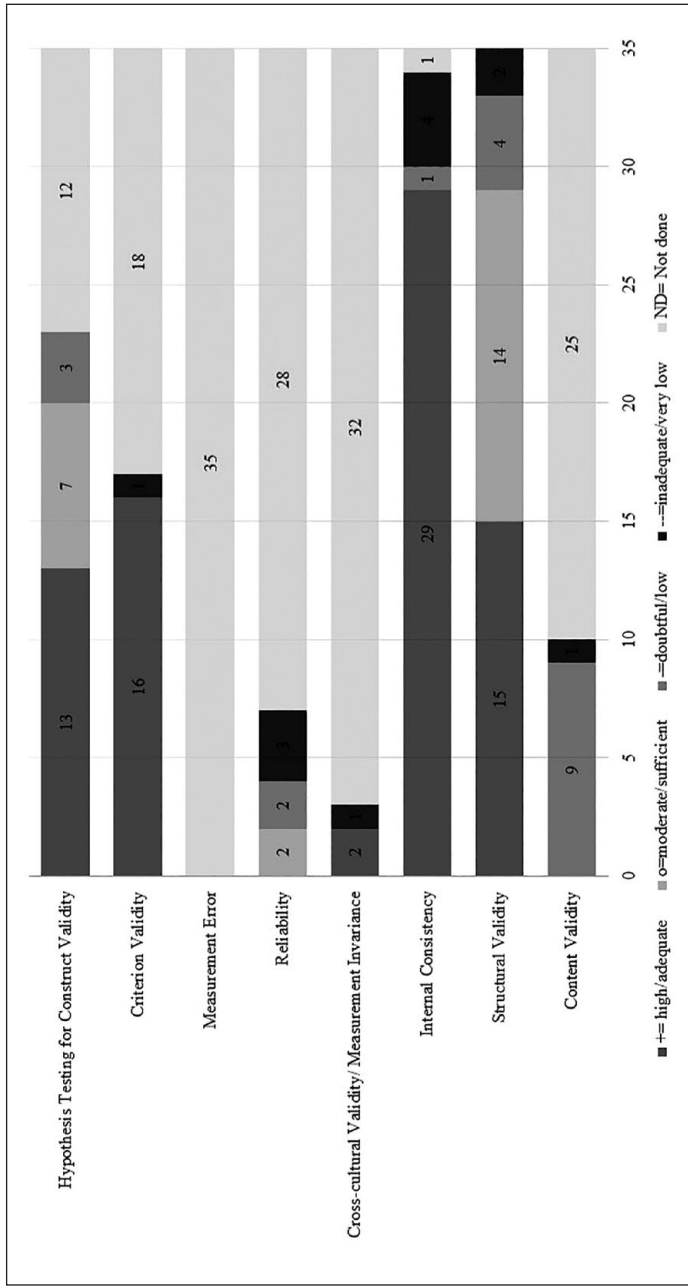


Figure 3. Quality rating per sections across included manuscripts.

argue some terms, psychologically, being one with nature (Mayer & Frantz, 2004) or being close to nature (Wilson, 1984) refers to the phenomena observed within various theoretical approaches that explain the benefits of this relationship for both humans and nature. Examples of such theoretical approaches include the biophilia hypothesis, attention restoration theory, and stress reduction theory (Kaplan, 1995; Ulrich et al., 1991; Wilson, 1984). In addition, the literature has shown a debate in which, on one hand, it argues that nature connectedness is capable of fulfilling belongingness needs (Baumeister & Leary, 1995; L. M. W. Li et al., 2021), while other authors suggest that it is an outcome of having a cognitive connection (Perrin & Benassi, 2009) or an affective connection (Perkins, 2010) with nature, rather than being a defining aspect itself.

Likewise, the authors identified many differing scales that correlate with one another to varying degrees consistent with previous findings (Restall & Conrad, 2015). For instance, W. P. Schultz (2002) characterizes nature connectedness as a cognitive experience, while Clayton (2003) defines it as the bond with nature and, Mayer and Frantz (2004) describe it as a more affective and experiential construct. These attempts of definitions reflect the strong disagreement in the literature. Therefore, despite the debates and divergences present in the literature, and in order to meet the requirements of this systematic review, the aforementioned preliminary definition was formulated.

According to the Human Development Report 2020 (United Nations, 2020), only one scale was developed in a medium human development country (Suganthi, 2019) and none of the studies included were conducted in a low human development country. This low representation of developing countries might be a bias in the measurement of the nature connectedness construct (Häyrynen & Pynnönen, 2020) because the time spent in nature and specific cultural factors have been shown to impact the nature connectedness of people and these elements differ considerably between Low, Medium, High, and Very High Human Development Countries (Dornhoff et al., 2019). Likewise, not all studies of scales performed a cross-cultural validation, which is a process needed to use them in other countries. This limits the measurement of nature connectedness in different nations, the integration of this topic in developing countries and, thus, the globalization of the nature connectedness construct (Scopelliti et al., 2016; Tam & Milfont, 2020).

In addition, it is important to note that the location where the scales were developed relates closely to the level of nature connectedness observed in men and women. This can be seen in previous research showing that nature connectedness in men and women may vary depending on the country (Clayton et al., 2021; Dornhoff et al., 2019). Therefore, the consideration of gender when generating nature connectedness measurement instruments is of

particular pertinence as women are more likely to suffer mental health diseases (i.e., depression) (WHO, 2022). Some research findings suggest that women may have a greater propensity to connect with nature than men (Haluzá et al., 2014), which is an important factor to consider when developing mental health prevention programs for women, given the links between nature connectedness and positive mental health outcomes previously discussed. Furthermore, most of the scales were approached from a binary context (i.e., male/female), another aspect that limits equality (Human Rights Watch, 2022) and, therefore, places restraints upon the capacity for generalization of the scales.

Regarding the population, it was found that just two manuscripts out of 35 used children as the sole study population (Cheng & Monroe, 2010; Sobko et al., 2018), while five combined them with other populations (i.e., adolescents and/or adults) (Clayton et al., 2021; Kleespies et al., 2021; Li & Lang, 2014; Mundaca et al., 2021; Richardson et al., 2019). This not only shows that the measurement of the nature connectedness construct is based upon the opinions and responses of an adult population but also makes evident the lack of developmental research on nature connectedness that has been conducted to date. This is in line with Whitburn et al. (2020), stating that most of the research assessing the nature connectedness and Pro-Environmental Behavior constructs is based on the adult population. Furthermore, among the 35 studies, only one paper addressed a population of children with special needs (Kleespies et al., 2021). This paucity of research not only on children but also on adults with special or additional needs perpetuates the health inequity that this population experience and maintains the exclusion in which they are immersed (United Nations Children's Fund, 2023; WHO, 2023).

In addition, it is important to highlight the significant lack of intergenerational research on nature connectedness. None of the scales found measure nature connectedness specifically in older adults. This has led the research with this population to use unspecific measurement scales to assess levels of nature connectedness in older adults. For instance, Freeman et al. (2019) and Nisbet et al. (2020), conducted a mix-method study and a cross-sectional study respectively where they investigated how nature connectedness impacts age, how it changes over time, and how it impacts well-being. However, neither of them used a scale within their methodology that was specifically intended for an older population. This approach has a knock-on effect in limiting the validity of the study results.

Moreover, the findings demonstrate the lack of consensus in the assessment of the trait or state of the nature connectedness construct (e.g., Mayer & Frantz, 2004; Mundaca et al., 2021). The finding that 83% of the manuscripts

do not specify if nature connectedness is considered to be a trait construct, which means that it is neither modifiable nor malleable, or a state construct, which means that it is temporary and malleable, provides important insights (Schmitt & Blum, 2020). For instance, several studies have reported changes in nature connectedness using tools that did not report measuring trait (Choe et al., 2020; Coughlan et al., 2022; McEwan et al., 2021). This is an important gap that should be addressed in further research.

Sixty-nine percent of the studies validated their scales in urban and/or rural environments. This is critical because 55% of the world's population lives in urban environments (United Nations, 2018). It is important to promote and measure nature connectedness in environments that are related to the current conditions in which the majority of the population lives. This is in line with several research studies that demonstrate the relevance of conducting research, interventions, programs, and public policies to foster contact with nature in urban conditions (Barboza et al., 2021; Nieuwenhuijsen et al., 2022).

Quality Assessment (QA)

The major difficulty in assessing criterion validity was the lack of a consensus in measuring nature connectedness. For this reason, the two most commonly used scales “Inclusion of Nature in Self” and the “Connectedness to Nature Scale” (Mayer & Frantz, 2004; P. W. Schultz et al., 2004) were employed as the comparator instruments to calculate a correlation between the studied instruments.

Relatedly, due to the lack of a previously established instrument to measure convergent and discriminant validity, it was necessary to select scales to measure these two values. For convergent validity, all the scales included in the review were selected. For discriminant validity, all scales that were not included in the review, as they did not assess nature connectedness, were selected (i.e., the New Environmental Paradigm Scale, which intends to assess the level of agreement with a world view that promotes ecological values and attitudes, and the Positive and Negative Affect Scale, which assesses mood and emotion). This is in line with existing research, which states that the convergent validity of the nature connectedness construct has not been strongly studied (Tam, 2013a).

The relationship between humans and nature is intrinsically impacted by culture (Dornhoff et al., 2019). To mitigate the challenges that the world and society are facing, it is necessary to understand the environment in general but also at a more region-specific level. This highlights the need for additional research regarding the manner in which the human-nature relationship changes

from region to region. Therefore, it is important to generate instruments with sufficient psychometric properties to measure the nature connectedness construct across different regions and cultures. When the quality assessment was carried out, it was found that only 25% of the manuscripts that needed to calculate cross-cultural validity did so (Clayton et al., 2021; Li & Lang, 2014; Pasca et al., 2018). The need for cross-cultural research has recently been raised in the sub-discipline of environmental psychology (Tam & Milfont, 2020) and more broadly in psychology. This requirement also emerged in the findings of the current review (Henrich et al., 2010).

Regarding reliability, it was determined that 80% of studies did not calculate any type of reliability, making it impossible to draw firm conclusions on this psychometric property.

Strengths and Limitations

The present systematic review has several strengths but is ultimately limited by the quality of the extant literature as none of the evaluated studies reported all criteria investigated in the quality assessment. For reasons of objectivity, two independent researchers identified relevant scales from the literature, four independent researchers extracted data, and five independent researchers assessed the quality of included scales. In addition, the data extraction spreadsheet was piloted prior to use. A very comprehensive analysis of the studies was also carried out using the COSMIN procedure. Furthermore, both the QA, as well as the interpretation of results were performed separately to enhance the procedure and evaluation transparent.

Our research could be influenced by the absence of a universal definition of nature connectedness, requiring us to formulate our own concept based on existing literature. Consequently, we excluded scales that encompassed dimensions associated with empathy or pro-environmental behavior. Limiting our analysis to articles published in English may have impacted our search via selection bias.

Conclusion

Overall, our findings indicate challenges in the methodological quality of most manuscripts conducted to date. We conclude that the methodological rigor of current scales purporting to assess the concept is insufficient, limiting their wider application. Of 35 manuscripts, only five were reported as having a high/adequate quality rating. Based on this finding, there is a need for more high-quality manuscripts explicitly measuring nature connectedness. Future studies to develop and validate explicit nature connectedness scales should:

(a) Conduct research in a broader scope of continents/countries. (b) Longitudinal study designs are needed to examine test-retest-reliability to identify nature connectedness as a trait or state. (c) Researchers should strive to achieve consensus on the construct of nature connectedness (d) Ensure that the dimensions are adequately reflected in sub-scales. (e) Clear instructions on how to use scales are required to standardize their application. (f) Scales for children and adolescents are currently lacking, and efforts should be made to address this gap in the literature. (g) More heterogeneous samples should be investigated to ensure generalizability of scales (i.e., recruit not only students) and a more inclusive culture in participant recruitment should also be established for this reason (i.e., consideration of people with special or additional needs, with different socioeconomic background, and with diverse gender identity). (h) When reporting studies, it is recommended that a concise checklist be used to ensure that all relevant information is provided (e.g., gender ratio, location as either urban or rural, and theoretical foundation). (i) Scales should be validated systematically in order to consider different types of validity (e.g., cross-cultural or content validity) and reliability (e.g., measurement error). (j) Scales should clearly indicate whether they assess the state or trait dimension of the concept.

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Contribution of Effort

XT-O developed and piloted the strategy of the literature search, extracted data and assessed the quality of all included studies, analyzed data, and drafted the manuscript. AM, MP, and RJ were independent quality assessors. DMIS supervised XT-O. YD was involved in planning the review and had an advisory function in the quality assessment. TM and JB obtained the project's funding. DM proofread the manuscript. AM, MP, RJ, DMIS, YD, TM, DM, SS, DS, MJ, and JB critically reviewed the manuscript. All authors agreed with the final version to be published.

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4.2 Article 2

Authors: Ximena Tiscareno-Osorno, Jihad Hossaini, Sophia Chabursky, Nesma Sayed, Ilayda Temizarabaci, Wiebke Hähl, Jürgen Beckmann

Title: Does Socioeconomic Position and Gender Affect Human Nature Interactions?

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Summary: Today, the strengthening of Human-Nature Interaction (HNI) has come into vogue. This is because they are a great tool for mental health care. HNI explains the relationship between individuals and nature. HNI are composed of aspects such as connectedness to nature and commitment to the environment. Literature shows that connectedness to nature and commitment to the environment relate to the SEP of people. However, most of the studies have been conducted in developed countries, leaving aside developing countries, where this gap is even more pronounced. For this reason, an empirical study was developed to measure the connectedness to nature and commitment to the environment of Mexican students belonging to two different SEP groups. To carry out this study, a survey was sent to the two groups under investigation. The total sample was 210 students and the results showed no difference in connectedness to nature ($p=.480$) and CE ($p=.421$) according to SEP. Nevertheless, a significant difference was found in terms of gender. Females belonging to the low SEP group had higher levels of connectedness to nature than males of the same SEP. This difference was not found in the high SEP. Likewise, it was observed that men have a

higher commitment to the environment regardless of their SEP than women. This study contributes to reduce the research gap that exists between research on this subject in developed and developing countries. It also presents a gender perspective that is important to take into account in further research due to the high vulnerability of women to experience mental health problems compared to men.

Contribution: Ximena Tiscareno-Osorno was principal investigator and author of the published paper. She designed the study. Determined the scales to be used. Carried out the back translation of the used scales. Established contacts with the universities in Mexico. Requested the approval of the ethics committee of the Technical University of Munich and the Instituto Tecnológico y de Estudios Superiores de Monterrey. Wrote and published the article and worked on all feedback provided by co-authors.



Does socioeconomic position and gender affect human-nature interactions?

Ximena Tiscareno-Osorno¹ · Jihad Hossaini¹ · Sophia Chabursky¹ · Nesma Sayed¹ · Ilayda Temizarabaci¹ · Wiebke Hähl¹ · Jürgen Beckmann^{1,2}

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Abstract

Aim The growing number of mental health problems worldwide is alarming. Encouraging human–nature interactions (HNIs) could help to tackle this issue. For this reason, the aim of the present research was to investigate certain components that promote HNI in two groups of students with different socioeconomic positions (SEPs) in Mexico. HNIs describe the direct relationship between humans and nature. HNIs are composed of elements such as connectedness to nature (CN) and commitment to the environment (CE), and are beneficial to both physical and mental health. However, the impact of CN and CE on people's lives seems to depend on their SEP, which has been investigated mainly in developed countries where SEP is less salient compared with developing countries.

Methods A survey was sent to students from two universities representing each group. A total of 210 surveys was collected.

Results The results showed no differences in CN ($p = .480$) and CE ($p = .421$) regarding SEP. However, gender differences were found with females from a low SEP showing higher levels of CN than men ($p = .015$) from the same SEP. For high SEP, no differences were found. In addition, men showed a higher CE than women, regardless of their SEP.

Conclusion Given the high vulnerability of women to mental health problems, it is of major importance to conduct more research considering the relationship between gender, HNI, SEP, and health in developing countries.

Keywords Human–nature interactions · Nature connectedness · Commitment to the environment · Mental health · Socioeconomic position · Gender

The Earth is what we all have in common

Wendell Berry

Global mental health issues are increasing alarmingly (OECD 2018; World Health Organization 2021c). According to the World Health Organization (WHO), a 13% increase in mental diseases was detected up to 2017, and about 20% of children and adolescents worldwide have a mental health condition (World Health Organization 2019). Therefore, several organizations have begun to promote

alternatives to improve mental health and well-being. Various schemes have been proposed to target the increase of human–nature interactions (HNIs) (OECD 2021; United Nations 2021). HNI is an approach that aims to increase the interaction between human beings and their environment, and has been shown to have multiple benefits, with the most important being its positive effects on mental health (Seymour 2016). The effects of HNI can be explained by the biophilia hypothesis, which is the most common theory in environmental psychology (Davis et al. 2009). This hypothesis states that humans have a special relationship with nature and a need to connect with it (Kellert and Wilson 1993). Current research has linked the hypothesis to the understanding of HNI, which involves the effects of HNI on physical and mental health as key components (Brymer et al. 2019; Zuo et al. 2015). Accordingly, greater contact with nature has been shown to increase well-being (Wolsko and Lindberg 2013; Zuo et al. 2015), and accessibility and exposure to nature has been shown to be associated with the prevention of physical and mental illnesses (Cox et al. 2017).

Wiebke Hähl and Jürgen Beckmann contributed equally.

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As suggested by the biophilia hypothesis, this might be due to a positive emotional state evoked by nature (Lumber et al. 2017). This positive state has not only been observed on a subjective level but also within the brain. In an EEG study on brain activity and nature, Mahamane et al. (2020) analyzed the event-related potential of a group of people exposed to both natural spaces and built up areas. Participants showed a higher late positive potential, a marker of emotional dysregulation, when exposed to nature than when exposed to urban settings. This is indicative of a more positive emotional state during the viewing of nature and suggests that natural spaces are perceived as more pleasurable. However, there remains a lack of understanding regarding the exact psychological mechanisms behind the association between HNI and mental health (Brymer et al. 2019; Zuo et al. 2015).

Two constructs that are highly related to HNI and used in research are connectedness to nature (CN) (Brymer et al. 2019; Mayer et al. 2008) and commitment to the environment (CE) (Davis et al. 2009; Seymour 2016). On the one hand, CN is considered as the means by which people make nature part of their self-representation (Schultz 2002). A high CN has positive effects on happiness (Capaldi et al. 2015; Leavell et al. 2019; Richardson and McEwan 2018), quality of life (Cervinka et al. 2012), and well-being (Capaldi et al. 2014; Howell et al. 2012). On the other hand, CE refers to the psychological attachment of a person to nature (Davis et al. 2009). Accordingly, CE is a predictor of past and future behavior toward the environment (Coy et al. 2013; Davis et al. 2009, 2011, 2015) and therefore has a strong relationship with pro-environmental behavior (Davis et al. 2015). For this reason, it can be associated with attention restoration, a reduction in mental fatigue, and an improvement in cognitive functioning (Annerstedt van den Bosch and Depledge 2015; Davis et al. 2009, 2011). Overall, research has shown that these two constructs are strongly related to each other (Yu et al. 2019).

Up until the present moment, it remains unclear how universal the relationship between mental health and CN, as well as CE, is. One major question, for example, is whether the relationship is independent of external factors, such as socioeconomic position (SEP). SEP is considered a broad construct that reflects not only the financial but also the social and cultural condition of an individual, which increases the complexity of its measurement (Cowan et al. 2012). However, SEP can be highly relevant when it comes to HNI. For example, socioeconomic inequalities have been shown to be associated with the relationship between exposure to nature and mental health as well as well-being (Mitchell et al. 2015). This is important to consider because mental health and well-being also vary depending on SEP. For example, people with higher incomes are able to live in neighborhoods where they can access more services, as well

as finance higher costs, to cover their health needs (Marmot 2017). At the same time, people with a higher income may have greater accessibility to nature (Astell-Burt et al. 2014; Mears et al. 2019), which is also related to health (Annerstedt van den Bosch and Depledge 2015). Considering that accessibility to nature highly depends on SEP, it could be assumed the positive effects of HNI on mental health might also depend on SEP.

SEP varies greatly both between and within countries, with differences being very pronounced between developing and developed countries. However, to date, most of the research has been conducted in developed countries and only a few researchers have assessed this relationship in developing countries. For example, Scopelliti et al. (2016) examined CN between the different income groups in Colombia. They found that people belonging to the middle-income group presented a higher well-being as well as a higher CN. Similarly, a study conducted in Chile revealed that the lowest socioeconomic group scored the lowest in pro-environmental behavior (Bronfman et al. 2015). While these findings highlight that a low SEP is associated with low HNI, further research suggests that in low-income countries, SEP is only weakly related to environmental concerns, as opposed to high-income countries, where it is strongly related (Pampel 2014). These findings suggest that SEP plays a particular role in developing countries in regard to CN, CE, and ultimately, in health.

In summary, previous literature asserts that CN and CE are associated with mental health and at the same time are linked to SEP. However, the impact of CN and CE has been mainly studied in developed countries where SEP and the social gradient are less pronounced, while there is a scarcity of research in developing countries. Existing research shows that a low SEP is associated with reduced HNI. For this reason, the present study investigates CN and CE and their associations with SEP in a developing country, namely Mexico. We hypothesize that the reported CN and CE differ in individuals with high and low SEP.

Methods and materials

This cross-sectional survey assessed HNI in Mexican students enrolled in a health-related programs at a public and private university. Both universities were chosen because of the difference in the semester fee. While public universities may be free, or have a very low cost, because they are subsidized by the government, private universities have high fees. Research shows the SEP of students is usually a reflection of the access that the family has to financial, cultural, social, capital, and human resources. Thus, in general, it is a reflection of the SEP of the family household (OECD 2019). Furthermore, students attend different institutions according

to their SEP. These institutions differ not only in their facilities but also in their teaching, the experience or updating of their teachers, and the access and relationship that students and even parents can have with them (Cowan et al. 2012). Finally, it has been observed that students with low SEP are more likely to attend institutions where they do not have easy access to social capital, which is related to networks that later help them to obtain personnel or professional gains (Coleman 1988).

Participants

A total of 349 students agreed to take part in the survey, and 289 of the respondents completed it. After removing respondents with missing data, 210 students were finally included in the study. Undergraduate students of the Instituto Tecnológico y de Estudios Superiores de Monterrey - Campus Ciudad de Mexico (Mexico City; private university; $n = 106$) and Universidad Autónoma Metropolitana - Unidad Xochimilco (Mexico City; public university; $n = 104$) enrolled in a health related program (i.e., medicine, nutrition, dentistry, psychology) were surveyed.

All students had been residing in Mexico for at least one year. A required sample size of 67 participants per group was calculated using G*Power Version 3.1 (Faul et al. 2009), assuming a medium effect size of 0.5 (Cohen 1977) for a two-tailed Wilcoxon–Mann–Whitney test with an α -error probability of 5% and a power of 80%.

Procedure

After giving informed consent, the participants were asked to provide demographic information regarding gender, age, nationality, education level, household expenditure, university type (public or private), occupation, and time residing in Mexico City. CN and CE were then assessed using two validated questionnaires. The Spanish version (Pasca et al. 2017) of the Connectedness to Nature Scale (CNS) (Mayer and Frantz 2004) was used to assess CN. This scale is commonly used to measure an individual's trait of feeling connected to the natural world in an affective and experiential manner (Mayer and Frantz 2004; Pasca et al. 2017). The Spanish adaptation of the CNS is composed of seven items that ask for different experiences with nature (e.g., "I often feel at one with the natural world around me") with responses indicated on a five-point Likert scale ranging from "1 – strongly disagree" to "5 – strongly agree." The Spanish scale utilized was adapted to Mexican Spanish by a panel of three experts familiar with the terminology and topic following the guidelines of the World Health Organization (2021a). This adaptation was required to prevent conceptual confusion based on culture-specific language differences. The adaptation was tested with a sample of 49 students. Reliability testing

revealed a good result as indicated by a Cronbach's α of .87. The reliability achieved in the final sample showed a Cronbach's α of .83.

The Commitment to the Environment Scale (CES) was developed by Davis et al. (2009) and is commonly used to assess psychological attachment toward the natural environment. It consists of 11 items that ask for the extent to which individuals agree with various attitudes about their relationship with nature (e.g., "I believe that the well-being of the natural environment can affect my own well-being"). Responses range from "0 – do not agree at all" to "8 – agree completely." Since no validated Spanish version of the CES existed, we therefore translated the English questionnaire to Mexican Spanish. The translation again followed the guidelines of the World Health Organization (2021a); with the translation being done by a group of health professionals familiar with the terminology. After that, the Mexican Spanish scale was discussed by a panel of three experts, who made any changes required to the terminology used. There were no adaptations to the scale. Finally, the resulting scale was translated back to English by an independent translator. The translated scale was initially tested with a sample of 49 students, which showed a very good internal consistency (Cronbach's $\alpha = .93$). The reliability achieved in the final sample showed a Cronbach's α of .77.

Results

The aim of the present study was to investigate the CN and CE of Mexican students from different SEPs. To test financial differences between the students of the two universities, we compared household expenditure using a two-sample t-test. Results showed that the mean (M) household outlay (pesos/month) of public was 4.359 and the standard deviation (SD) was 3.851. For private university students the results differed significantly showing an $M = 3.0571$, $SD = 2.8993$, students t distribution of 9.14 with 107 degrees of freedom ($t(df)$), and a p -value (p) less than .000. As expected, household outgoings from students of the private university were higher than those of students from the public university.

Two Mann–Whitney U-tests were performed to test the hypotheses regarding differences in CN and CE between the two universities. This non-parametric test was used based on the non-normal distribution as indicated by D'Agostino normality tests. According to the Mann–Whitney U-tests, there was no significant difference between the groups, neither for CN ($p = .480$) nor CE ($p = .421$) (see Table 1).

An explanatory analysis was conducted to further investigate the role of gender within the relationship of CN and CE with SEP. Due to the low and unequal numbers of participants, we decided to compare female (n_{public}

Table 1 Mann–Whitney U-tests comparing connectedness to nature and commitment to environment of students from two universities

Human-nature interactions	Public university		Private university		U	z	p	r
	Mdn	M _{rank}	Mdn	M _{rank}				
Connectedness to nature	3.86	53.5	3.93	52.5	5822.5	0.71	.480	.04
Commitment to the environment	3.55	53.5	3.73	52.5	5867.0	0.81	.421	.05

N = 210

M_{rank} = Mean rank

Mdn = Median

U = U-value from the Mann–Whitney U-test

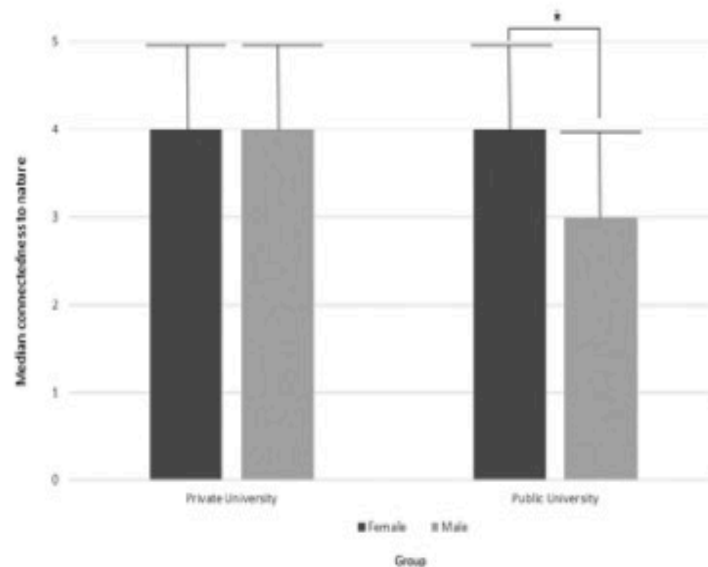
z = z score

p = p-value

r = Pearson's correlation coefficient

All p-values are two tailed

Fig. 1 Median connectedness to nature scores grouped by gender and university * = significant difference



= 78, $n_{\text{private}} = 73$) and male ($n_{\text{public}} = 28$, $n_{\text{private}} = 31$) students within each institution using a non-parametric test. As can be seen in Fig. 1, a Mann–Whitney U-test comparing male and female students of the two universities revealed a significant difference for the public university, showing a U-value from the Mann–Whitney U-test (U) of 753.5, a z score (z) of 2.43, p .015, and a Pearson's correlation coefficient (r) of .16. The median (Mdn) of the CN values for male students was 3.57, which was lower compared to female students ($Mdn = 3.86$). For the private university, no differences were found.

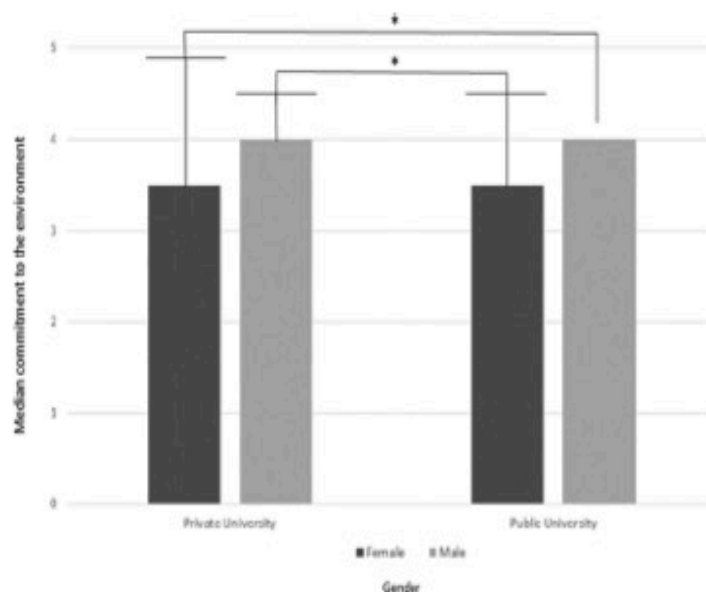
Additionally, there was a significant difference between CE values of men and women, $U = 3504.5$, z

= 2.4, $p = .016$, $r = .17$. Male students ($Mdn = 3.18$) showed a higher CE compared with female students ($Mdn = 3.46$) regardless of their university (see Fig. 2).

Discussion

The present study investigated the relationship between SEP, CN, and CE of students in a developing country. This research was composed of a sample of students from a public and private university in Mexico. The type of university to which the students belonged was used as an indicator of their SEP (Galobardes et al. 2006; Moreno-Maldonado

Fig. 2 Median commitment to the environment scores grouped by gender and university. * = significant difference



et al. 2018). Our hypothesis was that CN and CE vary between high and low SEP individuals. In contrast to our hypothesis, the results revealed no difference in CN and CE between individuals with high and low SEP. These findings are in line with Iskandar et al. (2017) who found no difference between SEP and environmental concern. They suggested that this could be due to lower levels of environmental concerns in developing countries. This assumption is further supported by Pampel (2014) who showed that the association between SEP and environmental concern is weak in low-income nations, whereas SEP and environmental concern are strongly associated in high-income countries.

However, the present findings also contradict other research that supports an association between HNI and income in developing countries. For example, Scopelliti et al. (2016) investigated the effect of contact with nature on well-being in three groups with different incomes in Colombia. They found that the middle-income group had a higher CN compared to the two other high and low income groups. The researchers supposed that this was due to the fact that the low-income group, as well as the high-income group, related their well-being primarily to their income, as opposed to the middle-income group. Hence, they concluded that income plays an important role in HNI. However, the differentiation between the SEP groups is not mentioned explicitly and might therefore not be comparable to the present study, particularly when considering that the gross domestic product in Colombia is lower than in Mexico. Also, their sample was more heterogeneous since they used an

opportunistic sample in a park instead of predefining the target group.

In addition, we found a significant difference regarding gender, CN, and SEP, with female students with a low SEP reporting higher levels of CN than male students with a low SEP. In contrast, these differences were not observed in individuals with a high SEP. This is an important finding, considering that according to the theory of “facultatively-mediated sex differences” (Schmitt 2015), gender differences in personality are related to ecological stress, with less ecological stress leading to stronger differences. Therefore, gender differences in personality are more likely in developed countries (Kaiser et al. 2019). However, this might be counteracted by women having a stronger connection to nature and a greater preference for spending time in outdoor recreational activities than men, regardless of their origin. Moreover, these gender differences have been reported particularly for the present age group, which belongs to the millennial generation (Reese et al. 2020). Furthermore, male students reported higher levels of CE than female students, regardless of their SEP. These findings are in line with Vicente-Molina et al. (2018) who found that men show more pro-environmental behaviors compared with women. This outcome, however, contradicts Clayton et al. (2021) who demonstrated that women are more involved and interested in changing their behavior in favor of the environment than men. However, as they mentioned in their study, their conclusions should be taken with caution, as they may not be considering fundamental factors, such as education.

Finally, considering the increased vulnerability of women to mental disorders (World Health

Organization 2021b) and the positive mental health outcomes reported for HNI (Brymer et al. 2019), the observed gender differences are of particular relevance. Therefore, it is important to understand the complex relationship between gender, nature, and health (MacBride-Stewart et al. 2016). In this respect, females are the most vulnerable group due to their sensitivity concerning changes in nature and the environment. This increased susceptibility, potentially indicated through an increased level of CN, might limit the health benefits of HNI in women if the quality of nature is low (MacBride-Stewart et al. 2016). Environmental degradation, often evident in low income areas, particularly within developing countries, might therefore pose a risk to women's health (MacBride-Stewart et al. 2016; Majeed and Ozturk 2020; Wang and Dong 2019; White et al. 2019). Accordingly, it is essential to include health outcomes in addition to CN to further understand the connection between gender, nature, and health. Future research should focus specifically on health outcomes in women from different SEPs and environmental areas in order to derive practical implications that help foster female participation in pleasant natural environments.

Limitations

Limitations of the present study should be considered. First, the investigation was conducted during the COVID-19 pandemic. Therefore, the participants were more prone to answer the survey from a different area than Mexico City, for example, some students might have gone to their country houses during lockdown, or simply returned to their hometowns where they were more likely to encounter and interact with nature. Therefore, the results may not represent the general level of CN or CE.

Second, we assumed that the two universities were indicative of different SEP, although we were not able to fully test this assumption, while a comparison of financial conditions (such as household expenditure) revealed a difference between the two universities. Because the *SD* of both groups was quite high, this cannot be seen as strong support. For future research, we suggest using a measure that allows comprehensive assessment of SEP, including social and cultural backgrounds.

Finally, to date, there is no validated questionnaire that measures CN in urban conditions. Therefore, we used a questionnaire designed to measure this construct in a general manner only. It is important to highlight that the use of a scale specialized in measuring CN in cities could enable us to gain a clearer picture of HNI in people living in the metropolis. For instance, the way people in contexts where access to nature is more limited relate to and perceive

nature may be different than that of people living in rural places where there are more green spaces. However, in the current study, both universities were located in the same neighborhood within Mexico City. Therefore, access to nature and the environmental setting were comparable.

Conclusion

In summary, this study shows that students from different SEPs, indicated by two disparate universities, had a very similar CN and CE. However, a significant contrast was found regarding gender and CN depending on SEP, with women with a low SEP reporting higher levels of CN than men with a low SEP. In addition, another significant difference found revealed that men had a higher CE, regardless of their SEP. This suggests the importance of conducting future research that addresses the relationship between gender, nature, and SEP in developing countries to help increase health benefits of HNI.

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Authors' contributions All authors contributed significantly to the development of the study. Ximena Tiscareno-Osorno contributed with the study design, the organization of data collection at the universities in Mexico and writing the manuscript. Jihad Hossain contributed in the statistical analysis. Sophia Chaburksy contributed to writing the manuscript and proofreading it. Nesma Saayed and Ilayda Tamar-yabici contributed with data collection and critical analysis of the references. Wiebke Hahl and Jürgen Beckmann contributed equally with this work. They had an advisory function for the execution of the study, supervised the writing process and advised on the publication. All authors agreed with the final version of the study.

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Data availability To access any of the research materials related to this article (i.e. data), please contact the author listed in the correspondence. The data of the study will be kept for 10 years.

Code availability Not applicable

Declarations

Ethics approval This study was approved by the Ethikkommission of the Technische Universität München and the ethics committee of the Tecnológico de Monterrey – Campus Ciudad de México. Thus, it was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki.

Consent to participate All study participants read and accepted an informed consent form prior to their participation in the study. Before signing the consent form, each participant received a document that described the study in detail. In this form, it was explained to them that they could leave the study at any time.

Consent for publication The participants accepted that the collected information was going to be used for the generation of published scientific article and that the information was going to be kept for 10 years.

Ethical statement This study was approved by the Ethics Committee of the Technical University of Munich and the Ethics Committee of the Tecnológico de Monterrey – Campus Ciudad de México.

Conflict of interest The authors declare that they have no conflict of interest.

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5 Discussion

Promoting the Human-Nature Relationship (HNR) as a means to address the societal challenges faced by humanity is receiving increasing attention. Research has unequivocally demonstrated that such a relationship of mutual dependence has positive effects on individuals. For instance, it improves people's mental health (Dean et al., 2018; Houlden et al., 2018) increase well-being (Martin et al., 2020; Shanahan et al., 2019), reduce urbanization-related problems like droughts (van den Bosch & Nieuwenhuijsen, 2017), and addresses social issues like isolation and inequality (Astell-Burt et al., 2014; Astell-Burt et al., 2022). Due to this fact, the primary goal of this dissertation is to make significant contributions towards the development of strategies aimed at promoting mental health and well-being in individuals of all backgrounds, while also fostering the advancement of sustainable societies. The first study provides a synthesis and a methodological quality assessment of the scales validated between 2000 and 2021 to measure the connectedness to nature construct in children, adolescents and adults, with and without special needs or additional needs. Therefore, it aims to facilitate researchers and clinicians to choose instruments that comply with all the guidelines and standards recommended for the development of measurement instruments in the health field. The second study measure the connectedness to nature and commitment to the environment of Mexican students from a private and a public university in Mexico, and thus, provide initial insights on how the relationship between people and nature can contribute to decrease inequalities due to SEP.

5.1 Well-being, Mental Health and Human-Nature Relationship

Thus far, the differentiation between the constructs of health and well-being remains unclear. According to the World Health Organization (WHO), health can be defined as "a state of complete physical, mental, and social wellbeing and not merely the absence of disease or infirmity" (World Health Organization, 2024), indicating an interrelation between both constructs. The aforementioned definition reveals that the health construct comprises mental health, which is explained within the Dual Continuum Model not as the absence of illness, but as a continuum between the dimensions of mental well-being and mental illness (Westerhof & Keyes, 2010), thus reinforcing the notion that both constructs converge. Mental health can be influenced by biological factors (e.g., cortisol levels) (Dziurkowska & Wesolowski, 2021), emotional factors (e.g., chronic stress) (Davis et al., 2017), lifestyle factors (e.g., sleep quality) (Scott et al., 2021), and social factors (e.g., socioeconomic position, gender differences) (Dougall et al., 2023; Wierenga et al., 2024)

Currently, extensive research supports that one available strategy to mitigate the effects of the aforementioned stressors on mental health is the encouragement and promotion of connectedness to nature (Lahart et al., 2019). The results from the second study conducted among university students revealed no difference regarding their socioeconomic position and the markers of human-nature relationship. However, an interesting difference was observed concerning gender, where females from a low socioeconomic position reported higher levels of connectedness to nature compared to males from the same group. This finding aligns with Rosa et al. (2020), who indicated that females from both developed (USA) and developing (Brazil) countries exhibit a higher connectedness to nature than males from the same

countries, and with Garrett et al. (2023) who discovered that nature and its accessibility could serve as a mechanism to alleviate socioeconomic inequality in Wales, UK. However, the findings of this latter study should be approached with caution since they were conducted in a developed country.

Moreover, research has demonstrated that enhancing the sustainability of urban environments can contribute to the well-being of their residents (Crane et al., 2021). Our systematic review findings offer valuable insights into the essential components that scales measuring nature connection should integrate to enhance their validity and reliability, thus serving as robust tools for clinicians, researchers, or stakeholders seeking to utilize them for the advancement of sustainable urban areas and, consequently, the enhancement of human well-being. This assertion is in line with van den Bosch and Nieuwenhuijsen (2017), who emphasized the pressing necessity of developing sustainable cities to address prevailing societal challenges and consequently uplift the health and well-being of individuals, and with Crane et al. (2021) who showed that that enhancing the sustainability of cities can enhance the well-being of their residents.

5.2 Measurement of the Human-Nature Relationship

For several years, researchers have placed significant emphasis on measurement as an initial step in understanding a phenomenon. Consequently, the measurement of Human-Nature Relationship (HNR), particularly in terms of connectedness to nature, has not been overlooked. The measurement of connectedness to nature remains one of the least explored areas within the field of HNR. In light of this, the first study presented in this dissertation project is a systematic review of scales that measure connectedness to nature in individuals of various age groups, including children,

adolescents, and adults with and without special or additional needs. This study yields several insights into problems with the research on nature connectedness that had not yet been sufficiently addressed. Firstly, a lack in the consensus on the definition of the connectedness to nature construct is evident. This lack of consensus complicated a systematic review. Therefore, a first step was to formulate a preliminary definition as mentioned earlier.

In addition, it was observed that the majority of measurement scales for connectedness to nature were developed and validated in developed countries, which introduces a bias that limits the generalizability of these instruments (Tam, 2013). Research has demonstrated that cultural factors also influence the construct of connectedness to nature (Dornhoff et al., 2019), and these factors are undoubtedly different in developing countries. Furthermore, it was observed that the majority of scale validation studies focused on adults, which poses challenges in terms of integrating and generalizing findings related to connectedness to nature, thereby hindering the global understanding of HNR. This is in line with Whitburn et al. (2020) who also stated that the most commonly studied population across the reported scales were adults. In addition, there was a scarcity of scales measuring connectedness to nature in population with special needs. This perpetuates the health inequality this world is experiencing nowadays and hinders the understanding of connectedness to nature in a global way.

Lastly, 69% of the reported scales were validated in settings that were not clearly defined in the studies. This is important as United Nations (2018) reported that 55% of the global population lives in urban conditions, and therefore, increases the importance of measuring connectedness to nature in a similar setting. This is in line with multiple researches that point out the importance of conducting research and programs that promote connectedness to nature in urban conditions (Barboza et al.,

2021; van den Bosch & Nieuwenhuijsen, 2017; van den Bosch & Ode Sang, 2017) and thereby, promote sustainability (Barragan-Jason et al., 2022).

5.3 Inequality and Human-Nature Relationship

Previous research has underscored the importance of access to and connectedness to nature as a means to mitigate socioeconomic and gender inequality, recognizing it as a prominent stressor affecting humanity in modern times (van den Bosch & Nieuwenhuijsen, 2017). However, the majority of environmental studies, particularly those examining specific facets such as connectedness to nature, have been carried out in developed nations where disparities are less pronounced compared to developing countries. Thus, there is a critical need to promote equity both among and within countries (Dean et al., 2018; Scopelliti et al., 2016).

The United Nations (2015) defines equality as the opportunity for accessing resources, while inequality represents its opposite. Presently, inequality is observed across various domains, including socioeconomic status, gender, health, disability, and ethnicity (United Nations, 2023; World Health Organization, 2023a).

5.3.1 Socioeconomic Inequality

In order to support the UN SDGs Goal 10 which includes target 10.2 “By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status” (United Nations, 2023), para.10.2). Research has tried to understand the causes of socioeconomic inequality (Darin-Mattsson et al., 2017; Mitchell et al., 2015; Padilla et al., 2016), and, consequently, propose diverse strategies to mitigate it. One of the most recent recommendations is to use nature as a tool to reduce this type of inequality

(Astell-Burt et al., 2014; Mears et al., 2019) Therefore, the first study reflected that a low number of scales designed to measure connectedness to nature were validated in developing countries. Figure 1 shows that connectedness to nature scales are mostly validated in developed countries. This is in line with Häyrinen and Pynnönen (2020), who had similar findings in their review, and therefore indicates the need for more research in developing countries. Conversely, the second research presented in this dissertation aimed to investigate two elements of HNR (i.e. connectedness to nature and commitment to the environment) in relation to SEP of Mexican students. Surprisingly, no differences were found between the HNR markers used in this study and SEP. This is in line with Iskandar et al., (2017), who also did not find a significant difference between SEP and environmental concern. Nevertheless, this similarity should be taken with cautious because their study was conducted in a developing country that pertain to Southeast Asia contrary to this study that was performed in Latin America. In summary, the second study of this dissertation adds to the number of studies conducted on HNR in developing countries and thereby reduces the research gap.

In summary, it is crucial for future research to examine the human-nature relationship (HNR) in developing countries for several reasons. Firstly, the rich biodiversity found in these nations, including glaciers, deserts, oceans, and forests, may influence the perception of connectedness to nature. Secondly, the cultural and social differences prevalent in these regions can significantly impact individuals' connectedness to nature. Therefore, investigating the HNR in developing countries is essential for a comprehensive understanding of this phenomenon.

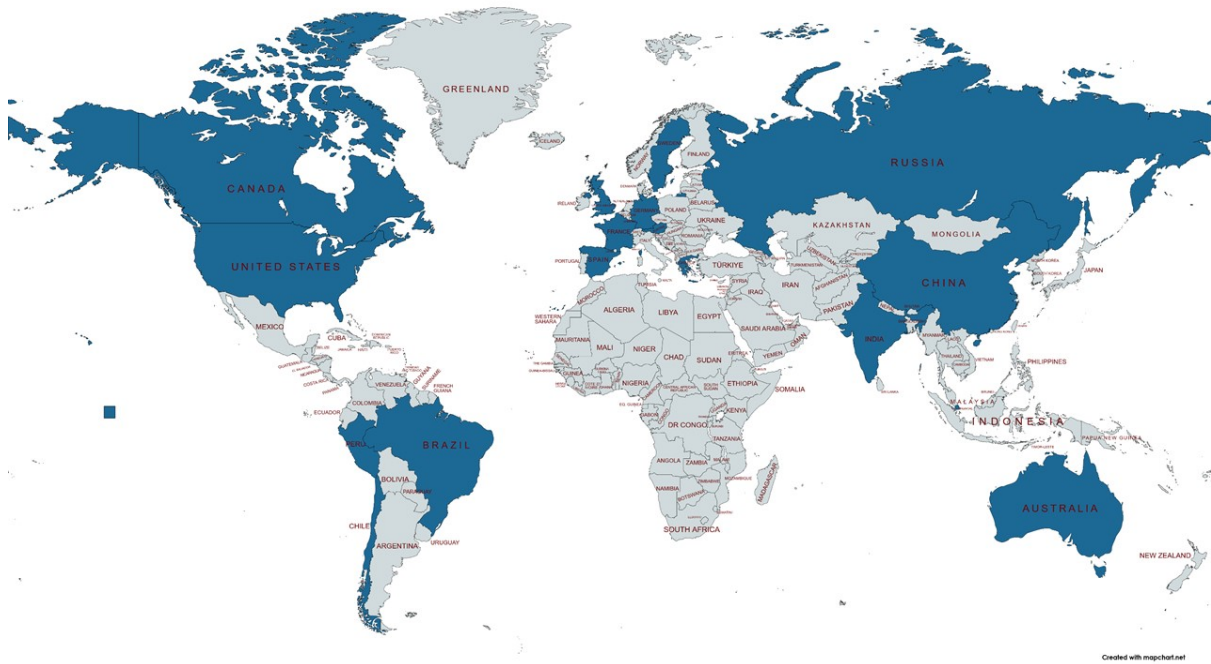


Figure 1. Countries that have validated connectedness to nature scales

5.4 Gender and Human-Nature Relationship

Recently, goal 10 of the UN SDGs mentions, "Achieve gender equality and empower all women and girls". In line with this goal, the second study also revealed interesting results in terms of gender. Firstly, it was observed that most of the analyzed scales measured the gender variable through a binary system (i.e. male/female), which limits connectedness to nature to be measured throughout the entire population (i.e. queer and lgbt population). In addition, it was found that it is important to consider the place where a scale is developed, as the location combined with the gender will also impact the level of connectedness to nature that is observed. This is of vital importance for the development of mental health prevention programs, since, as the WHO (2022) has highlighted, women are particularly susceptible to present mental health diseases, such as depression. Furthermore, the first study presents interesting results where connectedness to nature does not show a relationship with SEP, but with gender. Connectedness to nature was higher in women from a low SEP compared to men. This

is in line with Rosa et al., (2020), who observed that women from Brazil and the U.S have a higher connectedness to nature compared to men. Nevertheless, they did not take into account the SEP in their study. Likewise, the first study of this dissertation showed that men have a higher commitment to the environment compared to women regardless their SEP. These findings are in line with Vicente-Molina et al ., (2017), who showed that men are more likely to acquire pro-environmental behaviors. It is worth noting that both studies examined the significance of gender in the human-nature relationship (HNR). Consequently, it is important for future research to investigate the relationship between gender and HNR in developing countries. Limited research has been conducted in these countries, and it is essential to explore how connectedness to nature may vary based on location and cultural factors. This will contribute to a more comprehensive understanding of the dynamics between gender and HNR in diverse contexts (Clayton et al., 2021; Dornhoff et al., 2019).

5.5 Future Research

Some recommendations based on the results of the studies that comprise this dissertation are the following:

- a) Further research of high quality is necessary to explore the human-nature relationship (HNR) and its specific components, such as connectedness to nature.
- b) Cross-cultural studies that incorporate developing countries and consider gender dynamics are highly recommended.
- c) It is important to investigate HNR in underexplored contexts, such as areas near deserts and snow, to gain a more comprehensive understanding.
- d) Research should include more diverse samples, encompassing children, adolescents, individuals with disabilities, and elderly populations.

- e) The inclusion of a broader gender scope, including third gender identities, in HNR research is crucial.
- f) More research is needed to propose interventions and strategies that leverage HNR to address pressing societal challenges, such as inequality and mental health issues.
- g) Efforts should be made to achieve a consensus on the conceptualization of HNR and its related constructs.

5.6 Strengths and Limitations

The present dissertation possesses several strengths but we are aware of some limitations. On one hand, the first study stands out as an innovative and pioneering investigation conducted with rigorous scientific methodology. The process involved extensive literature screening to identify pertinent scales, followed by data extraction and quality assessment performed by multiple independent researchers. This approach enhances the transparency and reliability of the study. On the other hand, the second study represents one of the scarce research efforts on the subject conducted within a developing country. Moreover, the sample was collected from two well-known public and private universities situated in the capital city of the country. This not only adds to the diversity of research settings but also increases the potential generalizability of the findings. Nevertheless, this dissertation has also some limitations that are important to mention. For instance, in the first study, the lack of a clear definition of the construct of connectedness to nature possibly led to the exclusion of some scales. Similarly, the use of such a subjective tool for quality assessment (i.e. COSMIN) may have hindered a more reliable assessment. Furthermore, in the second study, it was not feasible to calculate the interaction between the variables under investigation. Additionally, a more comprehensive

evaluation of the socioeconomic position (SEP) would have been desirable, taking into account a deeper analysis of social and cultural factors. However, none of the already mentioned limitations constrained the achievement of the aims of the present dissertation.

6 Conclusion

In summary, this dissertation contributes to the development of prerequisites for strategies aimed at promoting mental health and well-being among individuals, and fostering sustainable societies through nature connectedness. This is asserted based on the findings of the studies, which include the significance of enhancing the overall quality of nature connection measurement scales, the necessity to develop sustainable societies, the need for conducting research on this topic across a diverse range of countries, as well as investigating gender differences and addressing social inequality. These findings supported by the research are essential for increasing and enhancing the well-being and mental health of individuals.

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8 Appendix

8.1 Informed Consent

Spanish Version of Informed Consent

Estimado participante,

A continuación, encontrará una detallada explicación del estudio: *Conexión con la naturaleza: Una alternativa para aumentar la igualdad social y la salud. Una investigación transcultural*.

¿De qué trata el estudio?

El objetivo del proyecto de investigación es averiguar cómo perciben los jóvenes de las universidades públicas y privadas de México su conexión con la naturaleza y su preocupación por el medio ambiente.

Además, pretende entender la relación de estos dos factores entre los estudiantes mexicanos y alemanes.

Finalmente, se investigará la relación de estos dos factores y la salud en estudiantes mexicanos y alemanes.

Este estudio se realizará a 816 participantes en 3 lugares distintos. En México se incluirán 408 participantes en el estudio. Este estudio es planeado y llevado a cabo por el Departamento de Psicología del Deporte de la Facultad del Deporte y Ciencias de la Salud en la Universidad Técnica de Múnich y no es financiado por ninguna institución.

Asimismo, se señala que este estudio fue revisado por un comité de ética independiente y durante la consulta no se plantearon objeciones para su realización.

¿Qué voy a tener que hacer?

Para participar en este estudio se le solicita contestar de forma honesta una encuesta que tiene una duración de 10 minutos y se constituye por los siguientes cuestionarios: Información Demográfica, Conexión con la Naturaleza, Compromiso con el Medio Ambiente y Percepción de Salud.

¿Cuáles son los beneficios?

No tendrá ningún beneficio personal por participar en el estudio. Sin embargo, los resultados del estudio pueden ayudar a otras personas en el futuro.

Asimismo, con relación exclusiva de la encuesta se le comenta que tiene derecho a recibir información sobre los datos que le conciernen, también en forma de una copia gratuita. Además, puede exigir la corrección o eliminación de sus datos.

¿Cuáles son los riesgos?

No hay riesgos asociados con la participación en el estudio, más allá de la fatiga que se puede experimentar al momento de responder la encuesta.

¿Qué ocurre en caso de que no quiera participar?

Su participación es completamente voluntaria, por lo que en cualquier momento puede decidir no formar parte e incluso detener su colaboración. Si decide retirarse del estudio sin haber respondido a todos los puntos de la encuesta, su información será eliminada. Sólo se analizarán las encuestas que se contesten completamente de principio a fin.

El consentimiento para el uso de sus datos es voluntario. Puede revocar su consentimiento en cualquier momento sin necesidad de dar razones y sin que ello le suponga un inconveniente.

¿Qué va a ocurrir con la información?

La información que se obtenga va a ser almacenada por 10 años en un espacio seguro en dentro de los servidores del *Leibniz Supercomputing Centre of the Bavarian Academy of Sciences and Humanities*. Tras éste periodo de tiempo la información será destruida. Ni su nombre ni su dirección IP serán grabadas en la encuesta.

¿Qué va a ocurrir al finalizar el estudio?

La información recopilada se utilizará para la generación de artículos científicos. Sin embargo, se le recuerda que todos los datos que se obtengan durante el estudio serán manejados con absoluta confidencialidad y tras 10 años la información será destruida.

Todos los datos por los que se le pueda identificar directamente, por ejemplo, su nombre o su fecha de nacimiento, serán eliminados o modificados de tal manera que prácticamente nadie, incluidos los directores del estudio, podrá averiguar a quién pertenecen los datos (anonimizados).

¿Qué ocurre si tengo más preguntas?

En caso de que tenga más dudas, podrá contactar a la responsable de la investigación para que sean aclaradas. Es importante que sienta que todas sus preguntas han sido

explicadas en todo momento. Asimismo se le comenta que esta persona es la responsable del procesamiento de datos.

Sus datos de contacto se encuentran a continuación:

Información de Contacto

Responsable del Estudio

Mtra. en Psic. Ximena Tiscareño-Osorno
Estudiante de doctorado del Departamento
de Psicología del Deporte
Technische Universität München
Tel. +491 7637 648286
Email. ximena.tiscareno@tum.de

Asimismo, En caso de tener alguna queja se puede contactar con:

Oficial de Protección de Datos de la Universidad Técnica de Munich

Universidad Técnica de Munich
Arcisstr. 21
80333 Munich
E-Mail: beauftragter@datenschutz.tum.de

Comisionado del Estado de Baviera para la Protección de Datos

Dirección postal: Postfach 22 12 19, 80502 Munich
Dirección de la casa: Wagnmüllerstr. 18, 80538 Munich
Correo electrónico: poststelle@datenschutz-bayern.de.

Muchas gracias por su tiempo para leer este documento. ¡Esperamos poder contar con su participación!

Saludos cordiales,

Ximena Tiscareño Osorno
Responsable del Estudio
Technische Universität München

Consentimiento Informado

Título: *Conexión con la naturaleza: Una alternativa para aumentar la igualdad social y la salud. Una investigación transcultural.*

Por favor, lea los siguientes enunciados y en caso de estar de acuerdo con participar en el estudio, seleccione las casillas en las cuales concede su autorización para su realización.

Me informaron sobre el estudio. He recibido y leído la información escrita y el formulario de consentimiento para el estudio mencionado.

Se me informó detalladamente por escrito, sobre el propósito, el curso del estudio, los riesgos de la participación y mis derechos y obligaciones.

He comprendido que los resultados de este estudio serán diseminados con fines científicos, pero en todo momento se protegerá mi información y anonimato.

Estoy informado de que tengo la oportunidad de hacer preguntas. Estas fueron contestadas satisfactoriamente y completamente.

Se me señaló que mi participación es voluntaria y que tengo derecho a retirar mi consentimiento en cualquier momento sin dar razones y sin incurrir en ninguna desventaja..

Tras haber leído cada uno de los enunciados anteriormente descritos, acepto participar en el estudio mencionado y en el tratamiento de datos descrito en la sección sobre protección de datos.

Seleccione la casilla en caso de estar de acuerdo

Seleccione esta casilla para abandonar la página y salir del estudio.

English Version of Informed Consent

Dear participant,

Below you will find a detailed explanation of the study: **Connection with Nature: An alternative to increase social equality and health. A cross-cultural and cross-sectional research.**

What is the study about?

The objective of the research project is to find out how university students perceive their connection with nature and their concern for the environment.

Furthermore, it aims to understand the relationship of these two factors between Mexican and German students.

Finally, the relationship of these two factors to health in Mexican and German students will be investigated.

This study will be carried out on 816 participants in 3 different locations. In Germany, 408 participants will be included in the study. This study is planned and carried out by the Department of Sports Psychology of the Faculty of Sports and Health Sciences at the Technical University of Munich and is not funded by any institution.

It is also noted that this study was reviewed by an independent ethics committee and during the consultation, no objections were raised to its conduct.

What will I have to do?

To participate in this study you are asked to answer honestly a 10-minute survey consisting of the following questionnaires: Demographic Information, Connection with Nature, Commitment to the Environment and Health Perception.

What are the benefits?

You will not have any personal benefits from participating in the study. However, the results of the study may help others in the future.

In addition, you have the right to receive information about the data that concerns you, also in the form of a free copy. In addition, you can demand the correction or deletion of your data at any time without any consequence.

What are the risks?

There are no risks associated with participating in the study, beyond the fatigue that may be experienced when answering the survey.

What happens if I don't want to participate?

Your participation is completely voluntary, so at any time you can decide not to take part and even stop your collaboration. If you decide to withdraw from the study without responding to all the items in the survey, your information will be deleted. Only surveys that are completely answered from beginning to end will be analyzed.

Consent for the use of your data is voluntary. You can revoke your consent at any time without giving reasons and without being inconvenienced.

What will happen to the information?

The information obtained will be stored for 10 years in a secure space within the servers of the Leibniz Supercomputing Centre of the Bavarian Academy of Sciences and Humanities. After this period of time the information will be destroyed. Neither your name nor your IP address will be recorded in the survey.

What will happen at the end of the survey?

The information collected will be used for the generation of scientific articles. However, you are reminded that all data obtained during the study will be handled with absolute confidentiality and after 10 years the information will be destroyed.

All data by which you can be directly identified, for example your name or your date of birth, will be deleted or modified in such a way that practically nobody, including the study directors, will be able to find out who the data belong to (anonymized).

What if I have more questions?

If you have further questions, you can contact the responsible of the study for clarification. It is important that you feel that all your questions have been explained at all times. You are also advised that this person is responsible for data processing.

Your contact details are listed below:

Contact Information

Responsible of the Study

M.A. en Psic. Ximena Tiscareño-Osorno
PhD student in the Department
of Sports Psychology
Technical University of Munich
Phone +491 7637 648286
Email. ximena.tiscareno@tum.de

Also, in case of having any complaint you can contact

Data Protection Officer of the Technical University of Munich

Technical University of Munich
Arcisstr. 21
80333 Munich
e-mail: beauftragter@datenschutz.tum.de

Bavarian State Commissioner for Data Protection

Postal address: Postfach 22 12 19, 80502 Munich
House address: Wagnmüllerstr. 18, 80538 Munich
E-Mail: poststelle@datenschutz-bayern.de

Thank you very much for taking the time to read this document, and we look forward to your participation!

Best regards,

Ximena Tiscareño Osorno
Responsible for the Study
Technische Universität München

Title: Connecting with nature: an alternative to reducing social inequality and improving health. A cross-cultural and cross-sectional study

Please read the following statements and, if you agree to participate in the study, tick the boxes in which you give your consent to conduct the study.

I have been informed about the study. I have received and read the written information and consent form for the above mentioned study.

I understand that the results of this study will be distributed for scientific purposes, but my information and anonymity will be protected at all times.

I was informed that I have the opportunity to ask questions. These were answered satisfactorily and completely.

I have been informed that my participation is voluntary and that I have the right to withdraw my consent at any time without giving reasons and without any disadvantages.

Having read each of the above statements, I agree to participate in the study mentioned above and in the data processing described in the privacy section.

Having read each of the above statements, I agree to participate in the study mentioned above and in the data processing described in the privacy section.

Tick the box if you agree

Check this box to leave the page and exit the study.

8.2 Survey

SURVEY SPANISH VERSION

Sección A.

Información Demográfica

1. Género

- a. Femenino
- b. Masculino
- c. Otro

2. Edad

- a. Scroll bar

3. Nacionalidad

- a. Scroll bar

4. Lleva 1 año o más residiendo en la Ciudad de México

- a. Scroll bar
- Opciones: Sí y No

5. Universidad en la que estudia

- a. Scroll bar
- Opciones: Publica, Privada, No estudio la universidad

6. Semestre o trimestre en el que se encuentra

- a. Scroll bar

7. Área de conocimiento de su formación

- a. Scroll bar Opciones:

- i. Ciencias de la Salud (Etc. Medicina, Nutrición, Psicología, Odontología, Enfermería, etc.)
- ii. Arte, Arquitectura y Diseño (Ej. Arquitectura, Diseño Industrial, Diseño Gráfico, etc.)
- iii. Ciencias Sociales y Humanidades (Ej. Economía, Administración, Política, etc.)
- iv. Otro

8. ¿Cuánto tiempo dedica semanalmente para realizar actividades en las que está en contacto con la naturaleza de forma recreacional? (ej. Visitar parques, ríos, playas, montañas, campos, bosques, etc)

- a. Scroll bar

opciones:

- i. 0 mins
- ii. 1-59 mins
- iii. 60-119 mins
- iv. 120-179 mins
- v. 180-239 mins
- vi. 240-299 mins
- vii. ≥300 mins

9. Por favor escribe cuánto gasta mensualmente en comida, bebidas y tabaco *Le recordamos que ésta información se manejará de forma completamente confidencial y se almacenará en servidores del *Leibniz Supercomputing Centre of the Bavarian Academy of Sciences and Humanities* sin ningún dato que lo identifique y con el único fin de investigación

10. Por favor escribe cuánto gasta mensualmente en transporte (ej. Transporte público o combustible de su automóvil) *Le recordamos que ésta información se manejará de forma completamente confidencial y se almacenará en servidores del *Leibniz Supercomputing Centre of the Bavarian Academy of Sciences and Humanities* sin ningún dato que lo identifique y con el único fin de investigación

11. Por favor escribe cuánto gasta mensualmente en vivienda y electricidad. (ej. La suma de sus gastos de luz, agua, gas, teléfono, etc.) *Le recordamos que ésta información se manejará de forma completamente confidencial y se almacenará en servidores del *Leibniz Supercomputing Centre of the Bavarian Academy of*

Sciences and Humanities sin ningún dato que lo identifique y con el único fin de investigación

12. Por favor escribe cuánto gasta mensualmente en educación (ej. Matrícula o colegiatura) *Le recordamos que ésta información se manejará de forma completamente confidencial y se almacenará en servidores del *Leibniz Supercomputing Centre of the Bavarian Academy of Sciences and Humanities* sin ningún dato que lo identifique y con el único fin de investigación

Sección B.

Escala de Conexión con la Naturaleza (Versión Validada en España)

Por favor responda las siguientes preguntas en forma que reflejen su forma de sentir en general. No hay respuestas correctas o incorrectas. Utilice la escala a continuación para indicar su experiencia personal en la forma más sincera y abierta posible, de acuerdo a lo que actualmente está experimentando.

1	2	3	4	5
Fuertemente en desacuerdo		Neutral		Fuertemente de Acuerdo

1. Pienso en el mundo natural como en la comunidad a la que pertenezco
2. Cuando pienso en mi vida me imagino a mi misma/a formando parte de un proceso cíclico más amplio de la vida
3. A menudo me siento emparentada/o con los animales y plantas
4. Siento como si perteneciera a la Tierra de la misma forma que ella me pertenece a mí
5. Frecuentemente me siento parte de la trama de la vida.
6. Siento que todos los habitantes de la Tierra, humanos y no humanos, comparten una “fuerza vital” común
7. De igual forma que el árbol forma parte del bosque, yo me siento incrustada/o dentro del mundo natural más amplio.

Sección C.

Escala de Compromiso con la Naturaleza

Por favor responda las siguientes preguntas en forma que reflejen su forma de sentir en general. No hay respuestas correctas ni incorrectas. Utilice la escala a continuación para indicar su experiencia personal de la forma más sincera y abierta posible, de acuerdo a lo que actualmente está experimentando.

0	1	2	3	4	5	6	7	8
Completamente en Desacuerdo				Parcialmente de Acuerdo				Completamente de Acuerdo

1. Estoy interesado en fortalecer mi conexión con el medio ambiente en el futuro.
2. Me siento fuertemente ligado al medio ambiente.
3. Cuando hago mis planes, tomo en cuenta qué tanto mis decisiones podrían afectar al medio ambiente.
4. Me parece que los seres humanos y el medio ambiente están interrelacionados.
5. Me siento bien cuando sucede algo que beneficia al medio ambiente.
6. Para mí es importante sentir una conexión con el medio ambiente.
7. Espero que siempre sienta una fuerte conexión con el medio ambiente.
8. Creo que el bienestar del entorno natural puede afectar a mi propio bienestar.
9. Es poco probable que sienta una conexión con el medio ambiente en el futuro.
10. Me siento muy apegado al medio ambiente.
11. Me siento comprometido a tener en cuenta los mejores intereses del medio ambiente.

SURVEY ENGLISH VERSION

Section A.

Demographic Information

1. Gender

- a. Female
- b. Male
- c. Other

2. Age

- a. Scroll bar

3. Nationality

- a. Scroll bar

4. Have you been living in Mexico City for 1 year or more?

a. Scroll bar

Options: Yes and No

5. University you are studying at

a. Scroll bar

Options: Public, Private, Not studying at university

6. Semester or quarter in which you are

a. Scroll bar

7. Area of knowledge of your training

a. Scroll bar

Options:

- i. Health Sciences (Etc. Medicine, Nutrition, Psychology, Dentistry, Nursing, etc.)
- ii. Art, Architecture and Design (e.g. Architecture, Industrial Design, Graphic Design, etc.)
- iii. Social Sciences and Humanities (e.g. Economics, Management, Politics, etc.)
- iv. Other

8. How much time do you spend weekly on activities where you are in contact with nature in a recreational way? (E.g. Visit parks, rivers, beaches, mountains, fields, forests, etc.)

a. Scroll bar

Options:

- i. 0 mins
- ii. 1-59 mins
- iii. 60-119 mins
- iv. 120-179 mins
- v. 180-239 mins
- vi. 240-299 mins
- vii. ≥300 mins

Section B.

Connectedness to Nature Scale (*Spanish Version*)

Please answer each of these questions in terms of the way you generally feel. There are no right or wrong answers. Using the following scale, in the space provided next to each question simply state as honestly and candidly as you can what you are presently experiencing.

	1	2	3	4	5
	Strongly disagree		Neutral		Strongly agree
1. I think of the natural world as a community to which I belong.					
2. When I think of my life, I imagine myself to be part of a larger cyclical process of living.					

3. I often feel a kinship with animals and plants.

4. I feel as though I belong to the Earth as equally as it belongs to me.

5. I often feel part of the web of life.

6. I feel that all inhabitants of Earth, human, and nonhuman, share a common 'life force'.

7. Like a tree can be part of a forest, I feel embedded within the broader natural world.

Section C.

Connectedness to Nature Scale (*Spanish Version*)

Please answer each of these questions in terms of the way you generally feel. There are no right or wrong answers. Using the following scale, in the space provided next to each question simply state as honestly and candidly as you can what you are presently experiencing.

Original Items	0	1	2	3	4	5	6	7	8
	Completely Disagree				Partially Agree				Completely Agree
I am interested in strengthening my connection to the environment in the future.									
I feel strongly linked to the environment.									
When I make plans for myself, I take into account how my decisions may affect the environment.									
It seems to me that humans and the environment are interdependent.									
It makes me feel good when something happens that benefits the environment.									
Feeling a connection with the environment is important to me.									
I expect that I will always feel a strong connection with the environment.									
I believe that the well-being of the natural environment can affect my own well-being.									
It is unlikely that I'll feel a connection to the environment in the future. (R)									

I feel very attached to the natural environment.

I feel committed to keeping the best interests of the environment in mind.

8.3 List of publications

Tiscareno-Osorno, X., Demetriou, Y., Marques, A., Peralta, M., Jorge, R., MacIntyre, T. E., . . . Schönbach, D. M. I. (2023). Systematic Review of Explicit Instruments Measuring Nature Connectedness: What Do We Know and What is Next? *Environment and Behavior*. doi:10.1177/00139165231212321

Tiscareno-Osorno, X., Hossaini, J., Chabursky, S., Sayed, N., Temizarabaci, I., Hähl, W., & Beckmann, J. (2022). Does socioeconomic position and gender affect human-nature interactions? *Journal of Public Health*. doi:10.1007/s10389-022-01762-8

8.4 Acceptance Manuscript 1

11/7/23, 4:35 PM

Mail - ximena.tiscareno@tum.de

Environment & Behavior - Decision on Manuscript ID E&B-23-0057.R1

Environment & Behavior <onbehalf@manuscriptcentral.com>

Sat 9/30/2023 2:29 AM

Inbox

To: Ximena Tiscareno-Osorno <ximena.tiscareno@tum.de>; ximena.tiscareno@gmail.com <ximena.tiscareno@gmail.com>;
Cc: jab908@psu.edu <jab908@psu.edu>;

29-Sep-2023

Dear Ms. Tiscareno-Osorno:

It is a pleasure to accept your manuscript entitled "Systematic Review of Explicit Instruments Measuring Nature Connectedness: What do We Know and What is Next?" in its current form for publication in Environment & Behavior. The comments of the reviewer(s) who reviewed your manuscript are included at the foot of this letter.

Thank you for your fine contribution. On behalf of the Editors of Environment & Behavior, we look forward to your continued contributions to the Journal.

Sincerely,
Dr. Stanley Asah
Editor in Chief, Environment & Behavior
st.asah@dal.ca

Dr. Jacou Benfield
Senior Associate Editor
jab908@psu.edu

Reviewer(s)' Comments to Author:

Reviewer: 1

Comments to the Author

This systematic review explores the state of the literature on measures of nature connectedness (NC), including assessments of study and scale conceptualization and quality. Overall, the authors have been responsive to the reviewers and I have no further requested edits.

Reviewer: 2

Comments to the Author

Thank you for the careful and well-reasoned edits. In particular, I thought the authors did a great job considering different definitions of nature connectedness and emphasizing the lack of available information regarding some of the validity criteria in the discussion. I am now largely satisfied with the manuscript. Just a few small suggestions.

-I appreciate the mention of the importance of nature connectedness for pro-environmental behavior in the Introduction. However, I feel like the sentence on lines 52-54 could be written better. In particular, rather than ending it with the vague "which is a major concern these days", perhaps they could be more specific with a phrase like "which is important given that pressing environmental issues such as climate change are caused by human activities (CITATION; perhaps Oreskes, 2004)".

-Relatedly, the sentence at the end of that paragraph should mention pro-environmental behavior, perhaps something like line 60 being changed to "...as a pathway to well-being, mental health, and pro-environmental behavior".

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Fri 9/30/2022 12:50 PM

To: Tiscareno-Osorno, Ximena <ximena.tiscareno@tum.de>;

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Ms. No. JOPH-D-22-00147R3

Does Socioeconomic Position and Sex Affect Human Nature Interactions?

Journal of Public Health

Dear Ms. Tiscareno-Osorno,

I am pleased to tell you that your work has now been accepted for publication in the Journal of Public Health

Thank you for submitting your work to this journal.

With kind regards

Joachim Kugler
Editor-in-Chief ***
Journal of Public Health

—

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Keywords

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