

Cross-cultural validity of the Nature Relatedness Scale (NR-6) and links with wellbeing

Zsuzsanna Kövi · Hyejeong Kim · Shanmukh Kamble
Veronika Mészáros · Danielle Lachance · Elizabeth Nisbet

Abstract: Nature relatedness refers to individual differences in subjective connectedness with the natural environment. We aimed to cross-culturally validate the Nature Relatedness scale and examine links between nature relatedness and wellbeing. We also tested whether spirituality or self-transcendent emotions such as gratitude mediate the relationship between nature relatedness and wellbeing. University student participants ($N = 798$) from four countries (Hungary, India, South Korea, and Canada) completed the short-form Nature Relatedness scale (NR-6; Nisbet & Zelenski, 2013), the Inclusion of Nature in Self scale (Schultz, 2002a), and measures of hedonic and eudaimonic wellbeing. Cross-cultural differences were found in a number of nature relatedness principal components, as well as differences in links between nature relatedness, spirituality, and wellbeing. In all four countries, gratitude formed a significant indirect path from nature relatedness to mental health and quality of life. The findings suggest that spiritual aspects of human-nature relationships may contribute to wellbeing across cultures.

Keywords: nature relatedness, wellbeing, cross-cultural, spirituality, measurement

1. Introduction

Connecting with the natural environment is not only beneficial to human wellbeing (Capaldi et al., 2015; Hinds & Sparks, 2011) but has also been regarded as a basic psychological need (Baxter & Pelletier, 2019). A growing decline in human-nature interactions may pose substantial threats to human and environmental health, however (Soga & Gaston, 2016). Despite some limited work with non-Western samples, there are few, if any, intercultural comparisons of the links between wellbeing and nature relatedness. Developing a broader understanding of how people from different cultures connect with and benefit from nature may be important for improving human-nature relationships and creating healthy environments.

1.1 Nature relatedness

Numerous terms have been applied to describe human relationships with the natural environment (Beery, 2012; Beery & Wolf-Watz, 2014), including but not limited to: connectedness, affinity, commitment, biophilia, ecological self, environmental identity, inclusion, relatedness, sensitivity, and sense of place or place attachment. Despite this diverse terminology, most of the research instruments used in this field appear to capture the same underlying construct (Tam, 2013). We use the term nature relatedness to refer to and measure individual differences in connectedness with the natural world (Mayer & Frantz, 2004; Nisbet et al., 2009; Schultz, 2002a),

as this construct incorporates affective, cognitive, and experiential elements (Tam, 2013, Zylstra et al., 2014). Nature relatedness includes an emotional affiliation with the natural world (Kals et al., 1999; Perkins, 2010), a shared identity or self-concept with nature (Clayton, 2003; Clayton et al., 2021; Schultz, 2002a), and a familiarity with or attraction to the natural environment (Nisbet et al., 2009). One's beliefs, values, and attitudes toward nature can also be indicative of a sense of relatedness (e.g., Brügger et al., 2011; Dutcher et al., 2007). Nature relatedness extends beyond enjoyment of the aesthetically-pleasing aspects of nature to include an awareness and appreciation of all elements in the natural world (Bruni et al., 2012; Nisbet et al., 2009). The concept of nature relatedness encompasses one's sense of interconnectedness with all other living things on the earth. It is distinct from environmentalism, however, in that it also includes aspects of identity and one's experience with nature.

Although nature relatedness is considered a stable (trait-like) construct, it can fluctuate at the state level (Aspy & Proeve, 2017; Nisbet & Zelenski, 2011; Richardson & Sheffield, 2017; Wheaton et al., 2015). Brief exposures to natural environments can enhance one's nature relatedness (e.g., Mayer & Frantz, 2009; Nisbet et al., 2019), but repeated experiences are likely needed for the development of a trait-level sense of connectedness (Lumber et al., 2017; Rosa et al., 2018).

The Inclusion of Nature in Self scale (INS; Schultz, 2002a), the Connectedness to Nature scale (CNS; Mayer & Frantz, 2004), and the Nature Relatedness (NR) scale (Nisbet et al., 2009) are some of the most commonly used measures of nature relatedness (Capaldi et al., 2014). While the INS and CNS measure cognitive aspects of nature relatedness¹, the Nature Relatedness scale aims to capture affective, cognitive, and experiential aspects of nature relatedness. A short-form version of the NR scale (NR-6; Nisbet & Zelenski, 2013) has been used where space and time are limited, and this version correlates with wellbeing and environmental behavior outcomes similarly to the full scale (e.g., the average absolute value difference between the short form NR-6 and the full scale is .073 and the two versions are highly correlated, .91-.93).²

1.2 Nature relatedness and wellbeing

Nature relatedness has been associated with both subjective and psychological wellbeing (see Capaldi et al., 2015, for a review). Subjective or hedonic wellbeing is described as the emotional or "feeling good" component of wellbeing, whereas psychological or eudaimonic wellbeing is the "functioning well" component (Keyes & Annas, 2009). Those higher in nature relatedness experience greater hedonic wellbeing in the form of more positive emotions and life satisfaction (Capaldi et al., 2014; Desrochers et al., 2022; Howell et al., 2011; Howell et al., 2013; Nisbet et al., 2011), and fewer negative emotions, including less anxiety (Lawton et al., 2017; Martyn & Brymer, 2016; Nisbet & Zelenski, 2011; Zelenski & Nisbet, 2014). Eudaimonic aspects of wellbeing such as vitality, autonomy, personal growth, purpose and meaning in life are also higher in people who are more nature related (Cervinka et al., 2012; Howell et al., 2013; Mayer & Frantz, 2004; Nisbet et al., 2011; Pritchard et al., 2020; Zelenski & Nisbet, 2014).

Links between nature relatedness and other aspects of eudaimonic wellbeing such as a sense of coherence and self-transcendence are understudied. A sense of coherence reflects an ability to cope with life's inevitable stressors and is recognized in the degree to which people find their lives comprehensible, manageable, and meaningful (Antonovsky, 1979, 1987). Self-transcendence, on the other hand, refers to a shift in focus beyond the self to incorporate one's connection with

¹ The CNS was initially proposed to be an affective and cognitive measure of nature relatedness (Mayer & Franz, 2004), but is more recently recognized as a cognitive measure (Perrin & Benassi, 2009).

² Studies and normative data for the NR and NR-6 scales are summarized in supplementary materials, Appendix 1.

others and the universe (Frankl, 1959/2006; Levenson et al., 2005; Peterson & Seligman, 2004). There is some evidence that nature relatedness is positively associated with a sense of coherence (Lipowski et al., 2019) and self-transcendence (Tam, 2013), however, research is lacking.

Gratitude, a self-transcendent emotion (Stellar et al., 2017), has been linked to nature relatedness, however (Petersen et al., 2019). Gratitude has been conceptualized as feeling a sense of abundance (versus feeling deprived), appreciating life's simple pleasures and the contributing role of others to one's own wellbeing (Watkins et al., 2003). A number of nature-related items can be found in gratitude measures (e.g., "Every fall I really enjoy watching the leaves change colors", "I think that it's important to 'stop and smell the roses'"; Simple Pleasures subscale of the Gratitude Resentment and Appreciation Test, Watkins et al., 2003). Moreover, Tam (2022) has proposed that gratitude to nature is associated with experiences in nature, nature relatedness, anthropomorphism of nature, and pro-environmental behavior.

There is some mixed evidence that awe, another self-transcendent emotion (Keltner & Haidt, 2003; Stellar et al., 2017), is associated with nature relatedness (Bethelmy & Corraliza, 2019; Nisbet & Zelenski, 2013). Awe refers to "an emotional response to perceptually vast stimuli that overwhelm current mental structures, yet facilitate attempts at accommodation" (Shiota et al., 2007, p. 944). Natural settings are among the most common elicitors of awe, and engagement with nature's beauty can promote awe, empathy, and trust in others (Piff et al., 2015).

Fisher (2000) has proposed a model in which a sense of awe and wonder in nature, along with relatedness to the environment, constitute the environmental domain of spiritual health. According to Fisher (2000), spiritual health has three other domains (personal, communal, and transcendental) and the four domains are all interrelated. Spirituality — an aspect of eudaimonic wellbeing (van Dierendonck & Mohan, 2007) — has been widely understood as the search for the sacred (Hill et al., 2000), which can incorporate religious perspectives, but is not synonymous with religiosity. There is some limited evidence that nature relatedness is positively associated with spirituality (Dömötör et al., 2017; Köteles, 2017). Structural equation modelling suggests nature relatedness is a good predictor of nonreligious spirituality in adult samples in France and Mexico, for example (Navarro et al., 2020). Connection to something beyond oneself may be an important aspect of both nature relatedness and spirituality. Nature relatedness is a distinct predictor of wellbeing when controlling for other types of connectedness (Zelenski & Nisbet, 2014) but research on nature and the spiritual aspects of wellbeing is lacking.

Self-transcendence and spirituality may mediate the relationship between nature relatedness and multiple dimensions of eudaimonic wellbeing (autonomy, personal growth, purpose in life, self-acceptance, and positive relations with others; Trigwell et al., 2014). A relationship with nature, gratitude, and spirituality are all considered characteristics of the virtue of transcendence (Diessner et al., 2013), yet little is known about how self-transcendence, or self-transcendent emotions such as gratitude, mediate the wellbeing effects of nature relatedness. The positive virtues of spirituality, gratitude, forgiveness, and altruism mediate the relationship between religiosity and wellbeing (Sharma and Singh, 2019). Relatively little research exists on potential mediators of the nature relatedness-wellbeing relationship, particularly in non-Western countries.

1.3 Cross-cultural nature relatedness

To date, most of the studies involving human-nature relationships have been conducted within predominately Western, industrialized countries (Ives et al., 2017). Over 60% of the research on nature relatedness has originated from North America, Australia, the United Kingdom, and the Netherlands (Ives et al., 2018; Restall & Conrad, 2015), rendering an understanding of human-

nature relationships incomplete. It is unclear whether wellbeing indicators associated with nature relatedness are experienced cross-culturally. People's engagement with and attitudes towards nature can be influenced by a culture's beliefs, values, social structures, and affluence (Milfont, 2012; Milfont & Schultz, 2016), and there is evidence that multiple factors can affect people's relationships with nature (e.g., Wilhelm-Rechmann et al., 2014). Nature relatedness may not only be influenced by spiritual, political, economic, and educational contexts, but also by geographical (climate zones) and ecological (flora and fauna) differences.

There is some indication of cross-cultural variation in nature relatedness. Korean students reported higher overall levels of nature relatedness compared to Czech and Swiss students, for example (Barthemess et al., 2013). Turkish preservice preschool teachers' average nature relatedness scores were lower than those in Western samples (Yilmaz et al., 2016), and comparatively lower than a sample of preservice early childhood educators in the USA (Ernst & Tornabene, 2012; see Appendix 1 for normative data). There is also evidence that people from Western countries — particularly English-speaking countries with links to British colonialism — are less connected with nature compared to people in other parts of the world, such as those in Eastern and Southern Europe and Nordic countries (Richardson et al., 2022; White et al., 2021). Despite these differences, there is some evidence that correlates of nature relatedness and subjective wellbeing may occur cross-culturally. A sense of inclusion with nature was positively associated with wellbeing in 18 countries (White et al., 2021). Similarly, nature relatedness was associated with more positive and fewer negative emotions in urban park visitors in Colombia (Scopelliti et al., 2016), with greater happiness in Taiwanese citizens (Wang et al., 2020), greater happiness and life satisfaction in Chinese students (Tam, 2013) and adults in India's tri-city (Kumar et al., 2014), and with better mental wellbeing in urban residents in the Philippines (Aruta, 2021). Nature relatedness also positively correlated with emotional, social, and psychological wellbeing in a sample of Japanese students (Capaldi et al., 2017). Similar to research from Western countries (e.g., Lumber et al., 2017), findings in Japan also indicate that experiences with natural beauty and awe influence nature relatedness (Capaldi et al., 2017; Yang et al., 2018).

Cross-cultural work on nature relatedness and eudaimonic wellbeing is more limited. Both the presence and search for meaning in life mediated the relationship between nature relatedness and wellbeing among residents in the Philippines (Aruta, 2021). Nature relatedness has been associated with self-transcendence in Turkish samples (Sarıçam & Şahin, 2015), suggesting a similar pattern with eudaimonic wellbeing. To our knowledge, with the exception of Tam (2022), few (if any) studies have examined the links between nature relatedness and gratitude on wellbeing, let alone cross-culturally.

2. Methods

2.1 Aim of the study

Cross-cultural measurement invariance calculations can highlight cultural differences in interpretation of items, suitability within a cultural context, or translation issues (Zhou et al., 2019). To our knowledge, research is scarce on measurement invariance for nature relatedness in Eastern Europe, South Korea, or in newly-industrialized countries such as India (cross-age measurement invariance for nature relatedness has been confirmed with Filipino adolescents and adults; Aruta, 2021). The purpose of this study was to address the gap in the literature on nature relatedness and wellbeing in non-Western populations, particularly with understudied indicators of eudaimonic wellbeing such as sense of coherence and self-transcendence (awe, gratitude, self-transcendent spiritual health). Further, we used mediational analyses to explore how transcendent variables play a role in the impacts of nature relatedness on wellbeing, similar

to Sharma and Singh’s (2019) model (transcendental variables of spirituality, gratitude, forgiveness and altruism as mediators of the relationship between religiosity and wellbeing). Previous studies have linked nature relatedness to self-transcendent variables [(e.g. awe, self-transcendental spirituality (Fisher, 2010), and gratitude (Peterson et al., 2019)] which promote mental health and wellbeing (awe: Rudd et al. 2012; gratitude: Wood et al., 2010, self-transcendent spiritual health: Fisher, 2010). Thus, we hypothesized that awe, gratitude and self-transcendent spiritual health would mediate the relationship between nature relatedness and wellbeing.

2.2 Participants and procedure

Student participants ($N = 798$) from four countries (Hungary, India, South Korea, and Canada) were recruited for a study about spirituality (see Table 1 for participant demographics and compensation details, by country). Participants in Hungary and Canada completed all materials in online surveys for course bonus credits. South Korean participants also completed measures online and were entered into a draw for a chance to win gift cards. Indian participants completed paper questionnaires during class time. All measures were completed in the language of students’ study (Hungarian, Korean, and English for both Canadian and Indian³ students). The materials section provides scale-specific translation details. Ethics approval was obtained from each of the appropriate institutional universities, except for South Korea, where the National Ethical Committee approved the study.

Most participants were living in cities and were at the early stages of their university education (except for India). There was a range of reported religious preference, with the majority of students identifying as Christian in South Korea and Hungary, Hindu in India, and Atheist/Agnostic in Canada (see Table 2 for demographics and distribution of religious preference by country). All data was collected during 2019 (Hungary: February-May; Canada: July-October; India: February-August; South Korea: August-November).

Table 1. Demographic characteristics and recruitment information by country

Country	<i>n</i>	Age			Gender			Recruitment Incentive
		<i>M</i>	<i>SD</i>	Range	Male	Female	Other	
Hungary	255	25.26	7.72	18 - 50	46	208	0	Course bonus credit
India	180	21.14	2.41	17 - 31	28	152	0	none
South Korea	208	22.06	2.03	18 - 28	61	147	0	Gift cards through random draws
Canada	154	21.16	5.60	17 - 45	15	138	1	Course bonus credit

2.3 Description of participating countries’ environmental policies

2.3.1 India

India is a highly developing country that aims to double the size of its economy by 2025, which requires an enormous demand for raw materials and energy, extracting natural resources and generating high amounts of waste and pollution (Sawhney, 2021). Sawhney notes that economic performance is often accompanied by high environmental costs and poor environmental performance. This is reflected in the fact that India held the lowest ranking (out of 180 countries)

³ Indian students were studying in English and the readability of the study measures (69.5) was consistent with Flesch Reading Ease recommendations on plain language (Flesch, 1948, Thomas et al., 1975).

on the 2022 Environmental Performance Index (Wolf et al., 2022) — a result of excessive use of chemicals, high electronic waste, degradation of air, water and soil. This also comes with a human cost in terms of morbidity and mortality. Balakrishnan et al. (2019) estimated that air pollution resulted in 1.24 million deaths in 2017 in India. On the other hand, Atteridge et al. (2012) noted that India has become an increasingly influential actor in global climate negotiations, being part of the G77, China Group, and BASIC group.

Table 2. Year in university, childhood and current location, and religiousness distributions by county

		Hungary Column n %	India Column n %	South Korea Column n %	Canada Column n %
Year in university	1	74.5%	21.6%	10.6%	53.5%
	2	19.5%	13.8%	26.0%	29.0%
	3	3.6%	.0%	25.5%	12.9%
	4	2.0%	29.3%	27.4%	2.6%
	5	.4%	31.9%	10.6%	1.9%
	6	.0%	3.4%	.0%	.0%
Childhood location	city downtown	12.2%	22.0%	52.9%	29.7%
	city suburbs	33.7%	12.7%	34.6%	31.0%
	small town	34.5%	38.7%	10.6%	33.5%
	rural or farm	19.2%	24.3%	.0%	5.8%
	other	.4%	2.3%	1.9%	.0%
Current location	city downtown	37.6%	27.6%	38.0%	36.1%
	city suburbs	38.8%	21.8%	45.2%	32.9%
	small town	15.7%	34.5%	16.8%	27.1%
	rural or farm	7.8%	13.8%	.0%	3.9%
	other	.0%	2.3%	.0%	.0%
Religion	Atheist, agnostic	21.0%	.6%	6.7%	37.4%
	Christian	65.5%	32.4%	92.8%	26.5%
	Hindu	.4%	57.5%	.5%	.6%
	Muslim	.8%	7.8%	.0%	3.9%
	Other	12.3%	1.7%	.0%	31.6%

2.3.2 Canada

Canada is an excellent case study for a wide variety of environmental issues and policy actions (Casey, 2011). The world's second largest country by area, Canada has vast uninhabited territory and wilderness along with abundant natural resources, however, urbanisation and agriculture have been impacting nature. According to OECD (2017a) reports, since 2000, Canada has made progress in decreasing air pollution, energy consumption and GHG emissions, but it remains one of the most energy- and emissions-intensive economies. The issue of climate change is a key issue in Canadian environmental policy because of the increases in global temperature already experienced at the poles of the planet (Casey, 2011). However, further progress is needed to transition Canada to a green, low-carbon economy (OECD, 2017a).

2.3.3 Hungary

According to the 2018 OECD report, Hungary has made significant progress in environmental policy due to implementing requirements of EU directives. However, local air quality has not improved significantly, and water quality remains at risk. The OECD report (2018) noted that institutional challenges hinder effective implementation of environmental laws and policies.

Hungary aims to accelerate the transition towards a low-carbon and greener economy, greater emphasis on low carbon emissions from all sectors including heat production methods, the electrical sector and transportation (Fogarassy & Kovacs, 2016). By 2030 a “Nuclear-Carbon-Green” scenario seems likely to be implemented, which implies nuclear energy development.

It should be noted, however, that in a comparison of eco-efficiency (the efficiency with which ecological resources are used to meet human needs; OECD, 2018) in OECD countries — with the analyses of three air pollutants representing the impact on the environment of economic activities — Hungary and Canada were among the worst performers.

2.3.4 South Korea

Threats such as the exhaustion of natural resources, climate change due to overpopulation, and the accelerating economic growth have been recognized in South Korea (Guo et al., 2020). According to the OECD (2017b) Environmental Performance Review, there has been progress towards sustainable development and green growth in Korea. South Korea was among the first countries to announce their intention to implement green growth goals into national strategies (Guo et al., 2020). The Korean Green Growth Initiative (KGGI) was designed by Lee Myung-Bak (Korea's President 2008-2013, the Korean Government, 2008). However, the principles of energy equity and job creation were neglected in KGGI planning (Ha & Byrne, 2008). Guo et al. (2020) found that South Korea, compared to other Asian countries (India, Indonesia, Pakistan), has a higher level in the 2019 Sustainable Development Goals Index but around five times higher CO₂ emission as well.

2.4 Materials

Reliabilities (Cronbach's alphas) were generally acceptable ($> .70$) for all total scales across the four country samples (see Table 3 for descriptive statistics and all scale reliabilities) and also for most subscales ($> .60$). Alphas below $.60$ were found among Mental Health Test (MHT) subscales (Savouring, Executive Functioning and Resilience) in three countries and WHO Social domain in India. MHT and WHO total scores provided adequate reliability, however.

2.4.1 Short-form version of the Nature Relatedness Scale

Trait nature relatedness was assessed using the short-form Nature Relatedness Scale (NR-6; Nisbet & Zelenski, 2013). Participants responded to six items such as “my connection to nature and the environment is a part of my spirituality” and “I feel very connected to all living things and the earth” on a 5-point Likert scale, ranging from 1 (*disagree strongly*) to 5 (*agree strongly*). Average scores were calculated and higher scores indicated a stronger subjective connection with nature. In Hungary and South Korea, original versions of the scale were translated into the native language by a two-member team — a professional English translator and a psychology professor. Further, Korean and Hungarian versions were backtranslated into English by another professional English translator and the back-translations were reviewed by the original scale's author to ensure meaning was consistent with the English version.

2.4.2 Inclusion of Nature in Self (INS) Scale

The INS (Schultz, 2002a) measures the degree to which nature is a part of someone's identity or self-concept. The single-item scale consists of seven Venn diagrams; pairs of circles with the words "self" and "nature", with varying degrees of overlap, represent various levels of interconnectedness. Participants choose the visual diagram that best corresponds to their own relationship with nature.

2.4.3 Mental Health Test

The 17-item Mental Health Test (MHT; Vargha et al., 2020; Zábó et al., 2022) measured mental health with five (5-point Likert) subscales. Global and subjective wellbeing (3 items): the kind of wellbeing experienced globally (e.g., "Joy is present more than sorrow in my everyday."). Savoring: the capacity to appreciate and enhance positive experiences (3 items, e.g., "I like to store memories of fun times that I go through so that I can recall them later."). Creative, executing efficiency (4 items): the ability to reach a goal even in a difficult adaptation situation (e.g., "I can successfully achieve targets which I set for myself."). Resilience (4 items): successful adaptation to stress, psychological resistance (e.g., "It does not take me long to recover from a stressful event."). Self-regulation (3 items): attentional and emotional states, behavior control, and the ability to self-regulate (e.g., "I easily become impatient" – reverse-scored item). With its scales based on these five pillars, the construct of MHT has proved to be a good model for adults as confirmed by item analysis and confirmatory factor analysis (CFA; Oláh et al., 2018; Vargha et al., 2020). The Mental Health Test was created in Hungarian, but an English version has recently been adapted by the original scale's developers (e.g., preprint publication by Zábó et al., 2022). A Korean version was also created for this study, backtranslated into English by a bilingual translator and then checked by creators of the original scale.

2.4.4 Gratitude Resentment and Appreciation Test

The Gratitude Resentment and Appreciation Test (GRAT) was originally developed by Watkins et al. (2003) and is a 44-item measure of dispositional gratitude. We used the shorter (16-item) revised version developed by Thomas and Watkins (2003) in English as well as existing Hungarian (Ferenczi et al., 2021) and Korean (Jung & Han, 2017; Kim & Yi, 2009) translations of the GRAT. The items form 3 subscales. Factor 1 "Sense of Abundance" relates to feelings of abundance in life. Factor 2 "Simple Appreciation" refers to appreciating simple pleasures of life. Factor 3 "Appreciation of Others" means valuing the contribution of others to one's wellbeing. Participants indicated their agreement to scale items using a 9-point Likert response format. The existing Hungarian (Ferenczi et al., 2021) and Korean (Jung & Han, 2017; Kim & Yi, 2009) translations of the GRAT were used.

2.4.5 Sense of Coherence Scale

The short form Sense of Coherence Scale (Antonovsky, 1987) consists of 13 items with a 7-point semantic differential scale that captures meaningfulness, manageability, and comprehensibility. Based on Antonovsky's (1987) recommendations, the sum of all 13 items was used as an indicator of overall coherence. Previously developed Hungarian (Balajti et al., 2007) and Korean versions (Lim et al., 2021) of the Sense of Coherence scale were used.

2.4.6 *Spiritual Health and Life Orientation Scale (SHALOM)*

The Spiritual Health and Life Orientation Measure was developed by Fisher (2010). Respondents rate 20 statements on two criteria: how important the various domains are for ideal spiritual wellbeing (the Spiritual Health measure) and how much this reflects one's lived experience (the Life-Orientation Measure). The scale items encompass four life domains. The Personal domain includes a sense of identity, self-awareness, joy in life, inner peace, and meaning in life. The Communal domain includes love, forgiveness, trust, respect, and kindness towards others. The Environmental domain includes connection with nature, awe at a breathtaking view, oneness with nature, harmony with the environment, and a sense of 'magic' in the environment. The Transcendental domain includes one's personal relationship with the Divine/God, worship of the Creator, oneness with God, peace with God, and prayer life. Scales use a 5-point Likert response format. The Hungarian version of the Spiritual Health and Life Orientation Measure was developed by Tornóczky et al. (2022). The English version was translated into Korean for this study and back translated by a bilingual translator. A psychology professor checked the back translation for consistency.

2.4.7 *Positive and Negative Affect Schedule (PANAS)*

A modified Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) assessed positive and negative affect. We used previously published versions of the Hungarian (Gyollai et al., 2011) and Korean (Lim et al., 2010) PANAS. Respondents rated how much they generally experience 10 positive and 12 negative emotion-related adjectives using a 5-point Likert scale. The positive affect scale captures high arousal associated positive feelings (inspired, enthusiastic, alert). Thus, we added five low arousal positive emotion words to encompass relaxation and restoration (calm, relaxed, balanced, peaceful, harmonic) based on nature's relaxing effects (Hartig & Evans, 1993). These items constituted a principal component with explained variance of 58.65% with component scores in a range from .64 (relaxed) to .86 (peaceful). We named this 'Peacefulness-related affects'. We also added three items (fascinated, curious, in awe) to reflect that nature is often regarded as a fascination-rich environment (Odeh & Guy, 2017), which constituted a principal component with explained variance of 62.75% (with all component scores being at least .78). These items all reflect a state of being intensely interested. We named this component 'Awe-related affects', as the item 'in awe' had the highest loading (.82).

2.4.8 *WHO-QOL BREF*

The WHO-QOL-BREF (WHO-QOL Group, 1998) is a short 26-item version of the WHOQOL-100. It measures four domains related to quality of life: physical health, psychological, social relationships, and the environment. We included 24 items derived from 24 facets of the original WHOQOL-100 (one item represents one facet) and 2 additional items measuring overall QOL and general health. In our analyses we applied the four domain scale scores for physical, psychological, social, and environment domains respectively. We also used the existing Hungarian (Paulik et al., 2007) and Korean versions (Min et al., 2002) of the WHO-QOL-BREF.

2.5 *Statistical analyses*

Statistical analyses were conducted using SPSS version 20.0 (IBM Corp., Released, 2011) and Amos 17.0 (Arbuckle, 2008). Descriptive statistics with skewness and kurtosis values were applied to analyze scale distributions. Generally, skewness and kurtosis values within a range of -1 and 1 are regarded as signs of normal distribution. However, Kim (2013) suggests that even

values outside this range can be accepted as normal (i.e., in sample sizes above 300, an absolute skew value larger than 2 or an absolute kurtosis larger than 7 indicate non-normality).

Cronbach's alphas indicate scale reliabilities. Optimal Cronbach's alpha is above .70, however some researchers (e.g., Spiliotopoulou, 2009; Yaffe, 2018) are more permissive regarding these values, especially for scales with fewer items, accepting alphas at around .6. In fact, Cronbach (1951) and more recent researchers (Voss et al., 2000; Swailes & McIntyre-Bhatty, 2002) have noted that the Cronbach's alpha estimation of reliability increases with scale length. Cronbach (1951) also provided a formula to estimate the mean inter-item correlation independently of scale length. The formula for this calculation is as follows:

$$\rho = \frac{\alpha}{n - (n - 1) * \alpha}$$

where: ρ = an estimator of reliability independent of scale length, α = coefficient alpha, and n = the number of items in the scale. Thus, three items with a Cronbach alpha of .60 (as is the case for some of our scales) and a mean inter-item correlation of .33 can be regarded as acceptable (Clark & Watson, 1995). Therefore, in the case of scales with fewer items, we considered alpha values around .60 to be acceptable.

A more detailed investigation of the structure of the Nature Relatedness scale was conducted using a principal component analysis and a network analysis (run separately for the different cultures). We then examined the correlations between the Nature Relatedness scale and the other measures in our study. Finally, we built a mediation model with nature relatedness as an independent variable, quality of life and mental health scores as dependent variables, and gratitude as a mediator. Based on the method proposed by Preacher and Hayes (2008), bootstrapped mediation analyses were performed to test the mediating role of gratitude in the links between nature relatedness and mental health and quality of life. Using at least 5,000 bootstrap samples, 95% bias corrected and accelerated bootstrap confidence intervals for the indirect links were calculated. Confidence intervals excluding zero indicate significant bootstrapped mediation links. Full mediation occurs when a significant total relation is a result of a significant indirect and non-significant direct links. Partial mediation occurs if total, indirect, and direct links are all significant. Inconsistent mediation occurs if there is not a significant relationship between the independent and dependent variables (McFatter, 1979). Thus, a significant indirect association accompanied by non-significant direct and total links can be regarded as inconsistent mediation (McFatter, 1979; MacKinnon et al., 2000).

3. Results

Descriptive statistics (see Table 3) showed all scales to have skewness and kurtosis values within normal distribution range. Most of the kurtosis and skewness values were between -1 and 1; only some subscales (Gratitude and Spiritual Health) had somewhat higher values. Reliability scores were appropriate in almost all scales and in all countries. Cronbach's alphas below .60 were observed for some mental health subscales, therefore in subsequent analyses we used only total scale scores which reached satisfactory reliability in all cultures.

Reliability of the Nature Relatedness scale was above .70 in all countries, except for South Korea where the item-total correlation for "my ideal vacation spot would be a remote wilderness area..." was under .20. Excluding this first item resulted in a Chronbach's alpha of .72 in South Korea.

A structural analysis of the Nature Relatedness scale (NR-6) items was conducted within the framework of principal component analyses (PCA; results are presented in Table 4). This yielded a one-component solution explaining more than 50% of the variance in the Canadian, Hungarian,

Table 3. Descriptive statistics of study measures

	N	ITEMS	Hungary			India			South Korea			Canada			Skewness	Kurtosis
			α	M	SD	α	M	SD	α	M	SD	α	M	SD		
Nature Relatedness (NR-6)	787	6	.81	-0.08	0.98	.80	0.25	1.18	.67	-0.21	0.79	.83	0.14	0.99	-0.10	-0.28
MHT Global wellbeing	794	3	.81	-0.01	1.00	.63	0.04	0.96	.80	0.07	1.00	.87	-0.12	1.04	-0.61	0.05
MHT Savouring	793	3	.59	0.01	0.99	.55	0.02	0.94	.67	0.09	1.09	.61	-0.16	0.94	-0.60	0.58
MHT Executive functioning	793	5	.68	0.28	0.93	.59	-0.08	0.94	.74	-0.21	1.15	.55	-0.09	0.86	-0.28	0.09
MHT self-regulation	794	3	.84	0.01	1.09	.72	-0.08	0.98	.68	0.10	0.94	.73	-0.06	0.94	0.06	-0.61
MHT resilience	793	3	.84	-0.28	1.04	.31	0.12	0.72	.84	0.28	1.08	.81	-0.05	0.98	-0.17	-0.55
Mental Health total	794	17	.81	0.01	0.99	.74	0.00	0.83	.87	0.09	1.17	.81	-0.14	.095	-0.14	0.18
GRATITUDE Abundance	791	6	.74	0.36	0.90	.64	-0.68	0.87	.81	0.15	0.91	.83	-0.03	1.03	-0.24	-0.56
GRATITUDE Simple Pleasures	790	6	.75	0.11	0.99	.78	-0.34	1.13	.84	0.13	0.97	.69	0.01	0.80	-1.06	1.92
GRATITUDE Appreciation of Others	791	4	.70	-0.05	0.98	.70	-0.37	1.15	.76	0.29	0.82	.72	0.10	0.93	-1.01	1.58
GRATITUDE Total	791	16	.83	0.23	0.96	.71	-0.64	0.91	.87	0.23	0.95	.83	0.02	0.93	-0.40	0.07
Sense of coherence	795	13	.80	0.25	0.98	.69	-0.25	1.00	.77	0.11	0.88	.83	-0.27	1.06	-0.16	0.18
SHALOM Personal	784	4	.82	-0.33	0.97	.78	0.46	0.85	.85	-0.09	0.97	.85	0.15	1.02	-0.45	-0.09
SHALOM Communal	784	4	.74	-0.27	0.99	.60	0.37	0.86	.78	-0.14	0.98	.81	0.20	1.03	-0.53	0.56
SHALOM Environmental	777	4	.83	-0.38	1.00	.66	0.66	0.77	.79	0.05	0.85	.85	-0.12	1.05	-0.38	-0.24
SHALOM Transcendental	782	4	.95	-0.49	1.00	.82	0.78	0.61	.91	0.29	0.75	.94	-0.46	0.96	-0.29	-1.16
SHALOM Personal Importance	776	4	.65	0.14	0.84	.70	0.14	0.89	.85	-0.29	1.11	.84	0.01	1.12	-1.25	1.85
SHALOM Communal Importance	774	4	.77	-0.20	0.99	.72	0.30	0.93	.75	-0.19	0.92	.85	0.26	1.06	-1.14	2.12
SHALOM Environmental Importance	767	4	.77	-0.13	0.98	.69	0.55	0.82	.76	-0.07	0.86	.86	-0.25	1.18	-0.66	0.15
SHALOM Transcendental Importance	773	4	.95	-0.60	1.06	.78	0.67	0.46	.93	0.32	0.74	.97	-0.17	1.01	-0.70	-0.78
PANAS positive affects	786	10	.84	0.03	0.88	.78	0.41	0.96	.84	-0.27	1.02	.89	-0.13	1.05	-0.35	0.10
PANAS negative affects	786	11	.90	-0.45	0.90	.79	0.20	0.84	.89	0.43	1.03	.89	-0.06	0.97	0.28	-0.68
Peacefulness-related affects	775	5	.64	-0.23	0.79	.73	0.68	0.82	.89	-0.05	1.07	.89	-0.27	1.06	-0.23	-0.28
Awe-related affects	771	3	.74	-0.12	0.98	.65	0.38	0.95	.68	-0.19	0.97	.81	0.06	1.02	-0.27	-0.24
WHO domain 1: Physical	795	7	.75	0.41	0.82	.63	-0.10	0.80	.81	-0.36	1.14	.79	-0.08	1.05	-0.70	0.46
WHO domain 2: Psychological	795	6	.81	0.00	0.90	.75	0.27	0.89	.84	0.07	1.01	.87	-0.41	1.12	-0.62	0.41
WHO domain 3: Social	794	3	.64	0.05	0.97	.58	0.03	1.10	.60	0.01	0.87	.65	-0.14	1.08	-0.53	0.27
WHO domain 4: Environment	795	8	.68	0.10	0.86	.77	-0.05	1.06	.76	-0.16	1.03	.81	0.12	1.08	-0.44	0.42
WHO TOTAL	795	24	.87	0.19	0.87	.86	0.04	0.95	.91	-0.16	1.09	.90	-0.14	1.08	-0.62	0.75
Mean of Cronbach alphas			.78			.69			.80			.81				

and Indian data. In South Korea, the first principal component explained only 40.88% of the variance and a low component fit (.22) was observed for the first scale item. The remaining five items constituted a principal component with scores above .5 for all items in all countries and explained the total variance with a range of .48 (in South Korea) to .62 (in Canada). In all countries, only the first principal component had an Eigenvalue greater than 1.

Table 4. Principal Component analyses of Nature Relatedness (NR-6) items

	Hungary	India	South Korea	Canada	Average
My ideal vacation spot would be a remote, wilderness area	.67	.47	.22	.58	.48
I always think about how my actions affect the environment	.57	.69	.53	.72	.63
My connection to nature and the environment is a part of my spirituality	.79	.75	.77	.80	.78
I take notice of wildlife wherever I am	.70	.71	.55	.64	.65
My relationship to nature is an important part of who I am	.80	.83	.79	.86	.82
I feel very connected to all living things and the earth	.77	.82	.77	.82	.80
<i>Explained variance of first principal component</i>	51.94	51.99	40.88	55.58	50.10
I always think about how my actions affect the environment	.59	.69	.52	.75	.64
My connection to nature and the environment is a part of my spirituality	.81	.75	.79	.80	.79
I take notice of wildlife wherever I am	.70	.71	.54	.64	.65
My relationship to nature is an important part of who I am	.80	.85	.79	.87	.83
I feel very connected to all living things and the earth	.79	.83	.78	.84	.81
<i>Explained variance of first principal component</i>	55.18	59.21	48.49	61.46	56.09

Network centrality results are presented in Table 5. The strength of item 1 was below -1 and its expected influence was below -.90 in all countries. The lowest weights (weakest links) were related to item 1, which is illustrated in Figure 1.

Weights indicate the strongest associations were between items 3, 5, and 6. In all four countries, the following three items had the highest PCA loadings and strongest network links: "My connection to nature and the environment is a part of my spirituality", "My relationship to nature is an important part of who I am", and "I feel very connected to all living things and the earth".

Item 1 generated the lowest weights and had the lowest component score in the PCA, particularly for South Korea, thus we excluded it from further analyses with the scale. Cronbach alphas for the five-item version of the NR scale were .84 (Canada), .79 (Hungary), .82 (India), .72 (South Korea).

According to the ANOVA results of cross-cultural mean comparisons (see Table 6) for NR-6 items, the highest cross-cultural variance was observed in the item “I take notice of wildlife wherever I am”, with the highest scores in Canadian participants. There was no significant cross-cultural difference in the mean score of the item “I always think about how my actions affect the environment”. However, the figure of means (see Figure 2) and 95% confidence intervals show that the highest scores were observed in Canada and the lowest in South Korea (which is a significant difference if comparing only two countries; a Bonferroni correction increased the p value above .05 however). For the remaining four items, the explained variance was around 2-3%, with Indian participants having the highest mean scores.

Table 5. Centrality measures of network models of Nature-relatedness (NR-6) items

	Hungary				India				South-Korea				Canada			
	Betweenness	Closeness	Strength	Expected influence	Betweenness	Closeness	Strength	Expected influence	Betweenness	Closeness	Strength	Expected influence	Betweenness	Closeness	Strength	Expected influence
Item 1: My ideal vacation spot would be a remote, wilderness area.	-.60	-1.00	-1.05	-.93	-1.11	-1.23	-1.25	-1.25	-.50	-1.67	-1.43	-1.43	-1.02	-1.13	-1.21	-1.21
Item 2: I always think about how my actions affect the environment.	-.60	-1.04	-1.17	-1.37	-1.11	-1.20	-.72	-.72	-.50	-.12	-.67	-.67	.20	-.03	-.31	-.31
Item 3: My connection to nature and the environment is a part of my spirituality.	-.60	.16	1.01	1.11	.22	.03	-.10	-.10	.00	.58	.72	.72	-1.02	-.10	.26	.26
Item 4: I take notice of wildlife wherever I am.	.60	.62	-.12	-.01	.22	.81	-.29	-.29	-.50	-.53	-.47	-.47	-.41	-1.04	-.78	-.78
Item 5: My relationship to nature is an important part of who I am.	1.79	1.56	1.22	.99	1.55	.57	1.35	1.35	2.00	1.03	1.12	1.12	1.43	1.15	1.61	1.61
Item 6: I feel very connected to all living things and the earth.	-.60	-.30	.10	.21	.22	1.03	1.01	1.01	-.50	.72	.73	.73	.82	1.15	.43	.43

Figure 1. Network analysis graphs of Nature-Relatedness (NR-6) items

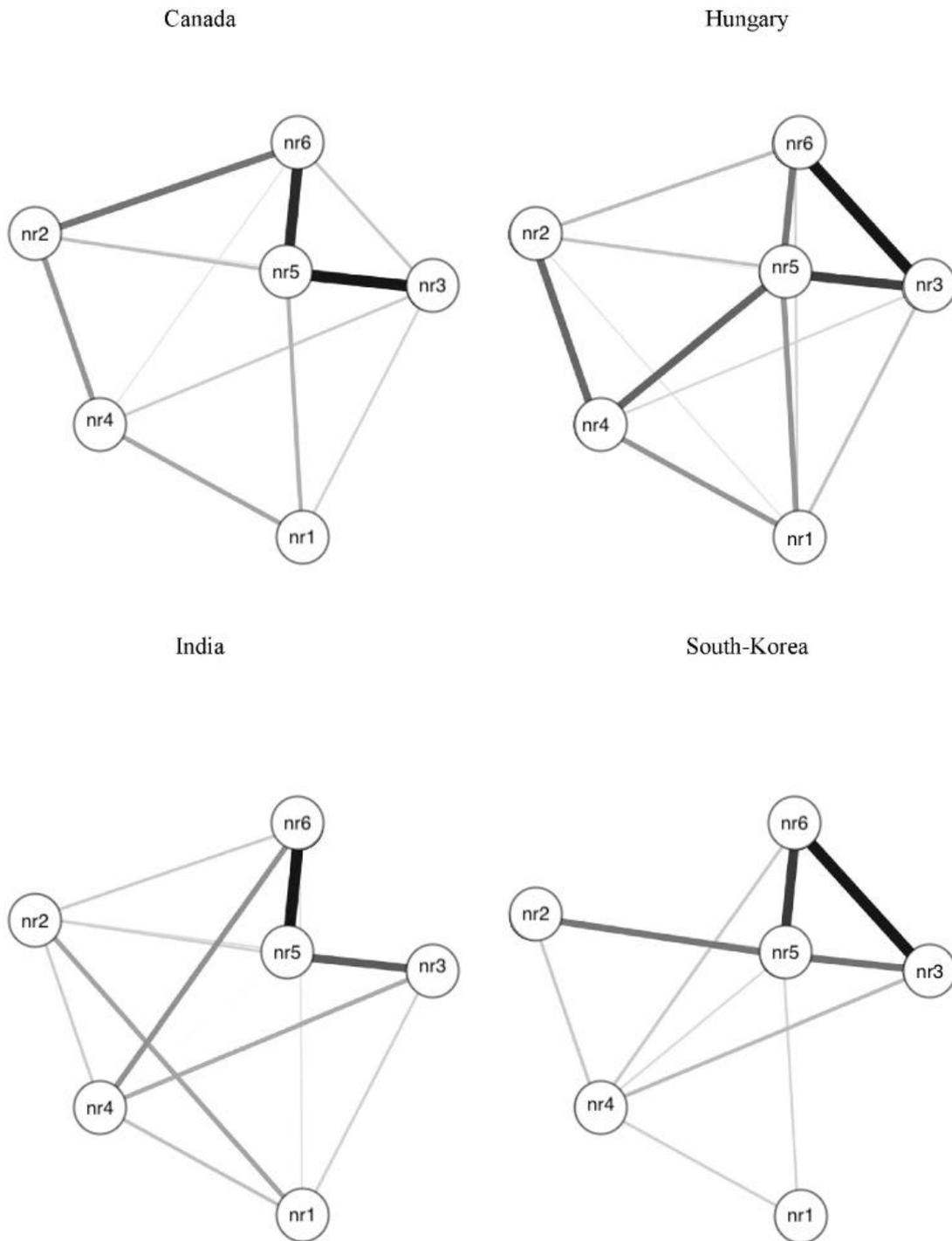
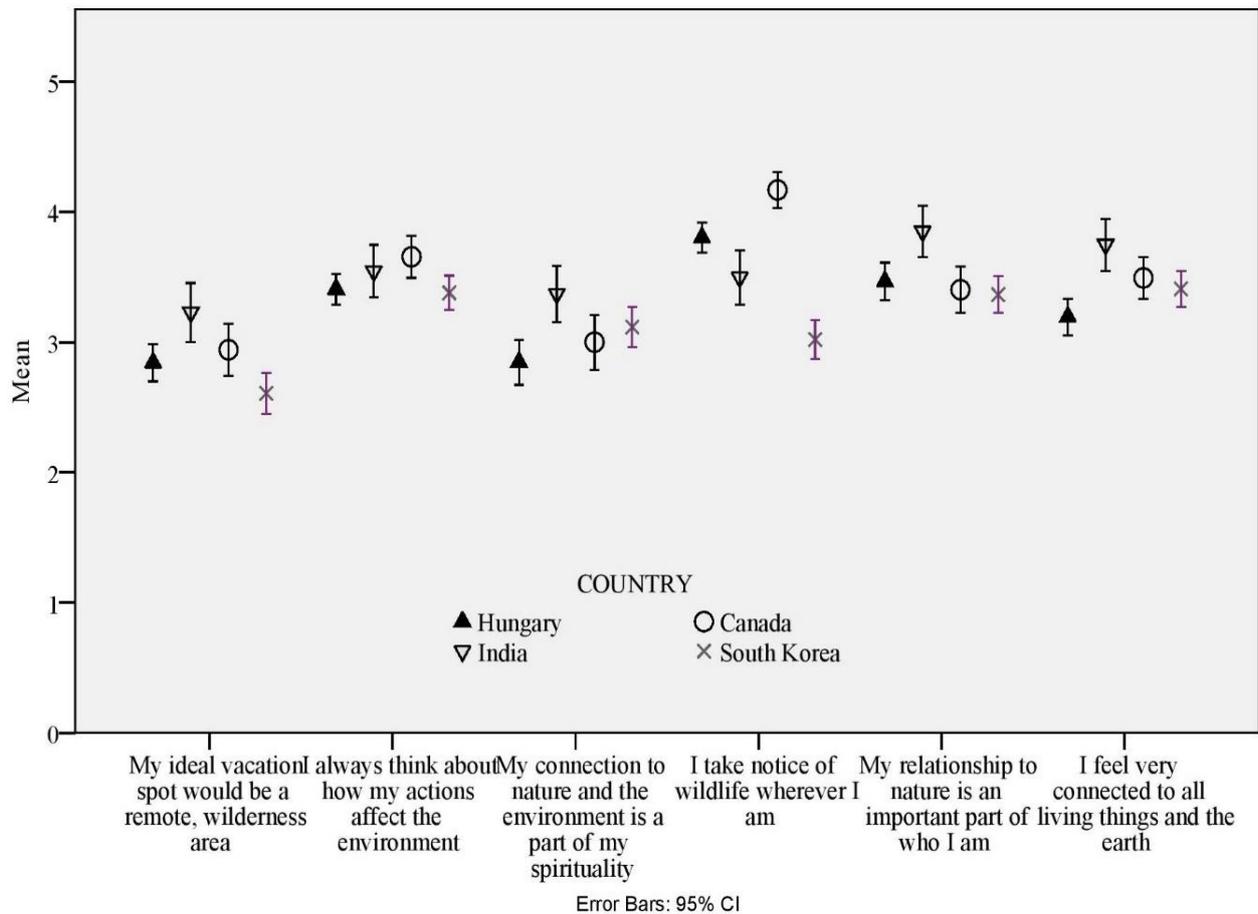


Table 6. Cross-cultural mean comparison of Nature Relatedness (NR-6) items

	Hungary		India		Canada		South Korea		ANOVA				Eta Squared
	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>df</i> (1)	<i>df</i> (2)	<i>F</i>	<i>Sig.</i>	
My ideal vacation spot would be a remote, wilderness area	2.83 _a	1.15	3.25_b	1.49	2.95 _{a,b}	1.26	2.61 _a	1.16	3	783	8.46	.000	3.14%
I always think about how my actions affect the environment	3.41 _a	.96	3.54 _a	1.32	3.65 _a	1.02	3.38 _a	.96	3	780	2.48	.060	.94%
My connection to nature and the environment is a part of my spirituality	2.84 _a	1.40	3.34_b	1.44	2.99 _{a,b}	1.32	3.12 _{a,b}	1.12	3	783	5.17	.002	1.94%
I take notice of wildlife wherever I am	3.80 _a	.92	3.47 _b	1.39	4.17_c	.88	3.02 _d	1.09	3	781	38.52	.000	12.89%
My relationship to nature is an important part of who I am	3.47 _a	1.17	3.84_b	1.31	3.39 _a	1.12	3.37 _a	1.03	3	783	6.39	.000	2.39%
I feel very connected to all living things and the earth	3.18 _a	1.13	3.75_b	1.31	3.48 _{a,b}	1.02	3.41 _a	1.01	3	783	8.65	.000	3.21%
NR-6 Scale mean	3.25 _{a,c}	.81	3.53 _b	.97	3.44 _{a,b}	.82	3.15 _c	.65	3	783	8.41	.000	3.12%

Note. Values in the same row and sub-table not sharing the same subscript are significantly different at $p < .05$ in the two-sided test of equality for column means. Cells with no subscript are not included in the test. Tests assume equal variances. Tests are adjusted for all pairwise comparisons within a row of each innermost sub-table using Bonferroni correction.

Figure 2. Means and 95% confidence intervals for Nature-Relatedness (NR-6) items by country



A number of significant relations were observed through correlational analyses (see Table 7) however, the patterns were not consistent across all countries. Only gratitude (total score and the “Appreciation of Simple Pleasures” subscale), the Environmental domain of spiritual health (sense of awe and wonder and the unity with the natural environment), and Awe correlated significantly with nature relatedness in all countries and only this set of results included correlations above .30. Personal, Transcendental, and Communal domains of spiritual health correlated positively but weakly with nature relatedness in South Korean and Hungarian participants. Quality of life total scores were associated with nature relatedness in Hungary and Canada as well. In Hungary, Canada, and South Korea, highly nature-related participants reported more positive emotions and better mental health, whereas in India, nature relatedness was associated with fewer negative emotions.

Finally, we examined the indirect paths of self-transcendent variables (awe-related affects, gratitude, and transcendental spiritual health) on the links between nature relatedness and mental health and quality of life outcomes (see Table 8). A number of significant indirect links were present between nature relatedness and mental health. An indirect path through gratitude was significant in all countries; the path through awe was significant in Hungary, South Korea, and Canada, and the path through transcendental spiritual health was significant in Hungary and South Korea. Further, indirect paths between nature relatedness and quality of life, through gratitude and awe, were observed in all countries and through transcendental spiritual health in South Korea and Hungary. This resulted in eight full, five partial, and six inconsistent mediation processes (see Table 8).

Table 7. Correlations between nature relatedness (NR-5) and mental health, gratitude, sense of coherence, spiritual health, affect, and quality of life

	Hungary	India	South Korea	Canada
Inclusion of Nature in Self	.60**	.22**	.39**	.64**
Mental Health	.27**	.09	.16*	.30**
GRATITUDE Abundance	.04	.20**	-.03	.22**
GRATITUDE Simple Pleasures	.46**	.25**	.34**	.44**
GRATITUDE Appreciation of Others	.22**	.12	.07	.10
GRATITUDE Total	.30**	.29**	.16*	.33**
SOC Sense of coherence	.15*	.15	.08	.13
SHALOM Personal	.32**	.02	.22**	.16*
SHALOM Communal	.23**	.14	.16*	.13
SHALOM Environmental	.66**	.27**	.58**	.66**
SHALOM Transcendental	.21**	.04	.23**	.04
SHALOM Personal Importance	.22**	.20*	.12	.15
SHALOM Communal Importance	.19**	.23**	.15*	.09
SHALOM Environmental Importance	.72**	.24**	.57**	.46**
SHALOM Transcendental Importance	.20**	.19*	.16*	-.03
PANAS Positive affects	.29**	.11	.20**	.25**
PANAS Negative affects	-.03	-.29**	.06	-.04
Peacefulness-related affects	.27**	.15*	.17*	.25**
Awe-related affects	.38**	.20*	.14*	.34**
WHO Physical	.17**	.05	-.02	.18*
WHO Psychological	.24**	.15	.11	.16*
WHO Social	.10	-.04	.15*	.05
WHO Environment	.04	.05	.05	.19*
WHO TOTAL	.18**	.08	.07	.20*

Notes. Bold font indicates Pearson correlations > .30. * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

Table 8. Summary of mediation results (5,000 bootstrapped samples)

Country	IV	MV	DV	Link between IV on MV (a)	Link between MV on DV (b)	Direct link (c)	Indirect link a x b (95% CI)	Total relation a x b + c	Mediation type
Hungary	NR-5	GRAT	MH	.30***	.50***	.13*	.15 (.09 - .23)	.28 ***	Partial
India	NR-5	GRAT	MH	.22***	.28***	-.00	.06 (.02 - .13)	.07	Inconsistent
Canada	NR-5	GRAT	MH	.32***	.46***	.14	.15 (.06 - .26)	.29***	Full
South Korea	NR-5	GRAT	MH	.19*	.63***	.12	.12 (.01 - .25)	.23*	Full
Hungary	NR-5	GRAT	QoL	.30***	.44***	.03	.13 (.08 - .20)	.16**	Full
India	NR-5	GRAT	QoL	.22***	.31***	-.01	.07 (.03 - .14)	.08	Inconsistent
Canada	NR-5	GRAT	QoL	.32***	.64***	.02	.20 (.09 - .34)	.22*	Full
South Korea	NR-5	GRAT	QoL	.19*	.64***	-.03	.12 (.01 - .24)	.09	Inconsistent
Hungary	NR-5	AWE	MH	.38***	.37***	.14*	.14 (.08-.21)	.28***	Partial
India	NR-5	AWE	MH	.15*	.09	.04	.01 (-.01-.05)	.06	Neither
Canada	NR-5	AWE	MH	.36***	.38***	.15*	.14 (.07-.23)	.29***	Partial
South Korea	NR-5	AWE	MH	.17*	.43***	.13	.07 (-.00-.17)	.16+	Inconsistent
Hungary	NR-5	AWE	QoL	.38***	.25**	.06	.10 (.05-.16)	.16**	Full
India	NR-5	AWE	QoL	.15*	.23**	.02	.04 (.01-.09)	.05	Inconsistent
Canada	NR-5	AWE	QoL	.36***	.39***	.11	.14 (.06-.26)	.25**	Full
South Korea	NR-5	AWE	QoL	.17*	.37***	.03	.06 (.00-.15)	.09	Inconsistent
Hungary	NR-5	TRANSC	MH	.22**	.15*	.24***	.03 (.01-.08)	.27***	Partial
India	NR-5	TRANSC	MH	-.01	.26*	.06	-.00 (-.01-.03)	.06	Neither
Canada	NR-5	TRANSC	MH	-.04	.12	.26**	.00 (-.01-.04)	.26**	Neither
South Korea	NR-5	TRANSC	MH	.21**	.43***	.14	.09 (.03-.19)	.23*	Full
Hungary	NR-5	TRANSC	QoL	.22**	.18***	.12*	.04 (.01-.09)	.16**	Partial
India	NR-5	TRANSC	QoL	.01	.57***	.06	.01 (-.03-.06)	.06	Neither
Canada	NR-5	TRANSC	QoL	.04	-.01	.20*	-.00 (-.02-.01)	.20*	Neither
South Korea	NR-5	TRANSC	QoL	.21**	.36***	.02	.08 (.02-.19)	.09	Inconsistent

Notes. Bold font indicates significant links. * = $p < .05$; ** = $p < .01$; *** = $p < .001$; + = $p < .10$. NR-6: Short Nature-relatedness Scale, GRAT: Gratitude and Resentment Scale, MH: Mental Health, QoL: Quality of Life, TRANSC: Transcendental Domain in Spiritual Health, AWE: Awe-related links

4. Discussion

The purpose of this study was to explore cross-cultural differences in nature relatedness and expand the literature on nature relatedness and wellbeing — particularly indicators of eudaimonic wellbeing, including sense of coherence and self-transcendence — in non-Western populations.

Reliability for the short-form Nature Relatedness scale (NR-6; Nisbet & Zelenski, 2013) was acceptable across the four cultures, but further analyses revealed the relatively low fit of item one ("My ideal vacation spot would be a remote wilderness area"), particularly in South Korea.⁴ Principal component analyses yielded one principal component with scores above .5 in all cultures when five of the six scale items (2 through 6) were included. The stereotype of wilderness adventure may be rooted in colonial systems that are not inclusive or representative of all people.

⁴ Although we are not advocating for a further-reduced short-form scale, there may be contexts in which this is necessary. For example, Massingham et al. (2018) successfully assessed nature relatedness with three of the NR-6 items ($\alpha = 0.72$); this measure was associated with multiple environmental outcomes consistent with what would be expected with the complete scale.

The notion of remote nature as a place to recreate or 'get away' may not apply to those who live or work in rural settings, or where the natural environment is unsafe or unhealthy. When nature is inaccessible (e.g., in dense cities) it may be unfamiliar. In South Korea, unfamiliarity is linked with nature aversion although interest in nature and forest therapy is increasing (Lee & Lee, 2018). It may be that assessing preference for wilderness requires more nuanced or culture-specific language.

There are also personality differences in how wilderness is perceived. Wilderness-related adventure travel is associated with the personality dimension of sensation seeking (Eachus, 2004). Thus, highly nature-related people who are not sensation seekers, may not perceive of wilderness as desirable place to spend leisure time. Fostering a connection with nature may not require wilderness or remote locations. For example, sensory contact with gardens in urban areas can enhance nature connectedness (Hamlin & Richardson, 2022). Work is needed to determine how best to assess the aspect of nature relatedness that involves close contact with natural or 'wild' elements of nature (e.g., beyond overly human-influenced or controlled nature).

In all four samples, items related to spirituality ("My connection to nature and the environment is a part of my spirituality"), identity ("My relationship to nature is an important part of who I am"), and connectedness ("I feel very connected to all living things and the earth") had the highest factor loadings, suggesting these aspects of human-nature relations are relevant to a variety of people from differing cultures. Attitudes towards the environment, noticing wildlife, and seeking wilderness as a holiday destination appear to be less consistently relevant to one's connection with nature across cultures. These findings may reflect cultural differences in people's attitudes towards nature (Milfont, 2012; Milfont & Schultz, 2016) and preferences for different types of natural environments (e.g., Buijs et al., 2009; Herzog et al., 2000; Kaplan & Herbert, 1987).

There was a significant cross-cultural difference in the mean scores for five of the nature relatedness items, with Indian participants scoring highest in four of them (spirituality, identity, vacation spot, and connectedness items), and Canadians scoring highest on one item (noticing wildlife). Historically, preservation and protection of the environment is deeply rooted in Indian culture, where Hindus viewed humans and nature as interdependent (Cower, 2003). Interestingly, 57.5% of Indian students in our research identified themselves as Hindu. Considering India's rich and diverse ecology (Khandekar & Srivastava, 2014) and the fact that Hindus account for 79.8% of India's population (Census Organization of India, 2011), it is understandable that Indian participants in our study scored highly on nature relatedness items about identity, connectedness, and spirituality. On the other hand, it is somewhat surprising that nature relatedness was not significantly linked to either wellbeing (mental health, quality of life, sense of coherence) or spiritual health among Indian participants.

The pattern of findings for Indian participants may be due, in part, to methodological challenges such as how Indian participants may have interpreted the English version of the Nature Relatedness scale⁵. Although Indian participants were studying in English, this was not their native language and this data had generally lower reliability than that from the other cultures (mean Cronbach's alpha was .69, whereas mean alphas in other cultures were well above .70).

It should also be noted that India is currently the most populated country in the world (World Population Review, 2023) and one of the fastest growing economies (World Bank, 2023). Its rapid

⁵ Nature Relatedness was correlated relatively weakly (< .30) with the Inclusion of Nature in Self scale (a more visual measure, which is less reliant on language), cf. Tam, 2013.

development has led to a number of health and environmental concerns including overpopulation and natural resource depletion (Cuff & Goudie, 2009, p. 358), and it ranked the lowest on the 2022 Environmental Performance Index (Wolf et al., 2022). In addition, nature contact in more developed countries is often associated with restoration and recreation, but in developing countries, like India, contact with nature is often a necessity as part of carrying out the demands of everyday life (Marczak & Sorokowski, 2018). These factors may explain the inconsistent links between nature relatedness, wellbeing, and spiritual health in Indian culture and highlights the importance of cultural context when assessing human-nature relationships.

Another potential factor that may influence the relationship between nature and wellbeing is individualism-collectivism. In fact, nature relatedness was associated with better physical and mental health and quality of life somewhat more in individualistic cultures (Canada and Hungary), versus the more collectivistic Asian countries. A vast body of research has established both subjective and psychological wellbeing benefits associated with nature relatedness (see Capaldi et al., 2015, for a review), and there is some evidence of an association with physical health (e.g., Dean et al., 2018; Puhakka et al., 2018) or health-promoting behaviors (Flowers, Freeman, & Gladwell, 2016; Milliron et al., 2022), but mostly in Western countries. Some researchers in collectivist cultures (Tam, 2013: Hong Kong; Adiwena & Diuwita, 2019: Indonesia) have found links between nature relatedness and wellbeing that are consistent with Canadian results (Nisbet et al., 2011). Schultz (2002b) has noted, however, that environmental concerns are more related to personal health and quality of life in individualistic versus collectivistic cultures.

Our results revealed relatively weak relationships, even among individualistic countries. There may be a number of mediator or moderator variables operating to link nature relatedness with wellbeing, such as spirituality, for example (Kamitsis & Francis, 2013; Trigwell et al., 2014). In fact, cultural differences were evident with regards to links with spirituality in our data. Nature relatedness was more consistently associated with the various domains of spiritual health in Hungarian and South Korean participants (countries with high rates of Christianity) compared to Canadian and Indian participants (with lower rates of Christianity). It is possible that the connections people have to nature and to God (creator of nature in some religions) are more intertwined in Christian cultures (cf. Neaman et al., 2021). Fredrickson and Anderson (1999) note that 'transcendent' experiences are often evoked by natural and wilderness outdoors settings, but spirituality – along with the capacity to give a deeper meaning to the experiences – may also have an impact on appreciation of nature-related experiences. Additional studies with non-Christian participants are needed to determine whether there are indeed cross-cultural differences in how the various virtues of transcendence (Diessner et al., 2013) – such as the connection with nature, gratitude, and spirituality – are related.

On the other hand, in all countries, there were self-transcendent variables that formed an indirect path between nature relatedness and mental health or quality of life. Links between nature relatedness and mental health were fully mediated by awe and gratitude in Canada, partially mediated by awe, gratitude and spiritual health in Hungary, inconsistently mediated by gratitude in India, and also inconsistently mediated by gratitude, awe and spiritual health in South Korea.

Links between nature relatedness and quality of life were fully mediated by awe and gratitude in Canada and in Hungary, partially mediated by spiritual health in Hungary, inconsistently mediated by gratitude and awe in India, and also inconsistently mediated by gratitude, awe, and spiritual health in South Korea. Thus, the most cross-culturally stable indirect path from nature relatedness to wellbeing was via gratitude. Although the significance of direct

and total relationships did differ cross-culturally, in each culture there was a significant indirect path through gratitude.

Appreciation of nature is included in the Simple Pleasures subscale of the measure of gratitude (Watkins et al., 2003). Our finding that gratitude forms an indirect path from nature relatedness to mental health and quality of life in all four cultures is in line with previous work (Portocarrero et al., 2020; Wood et al., 2010) showing a moderate to strong positive association between dispositional gratitude and several indicators of wellbeing. Although gratitude is typically regarded as an interpersonal emotion (Algoe, 2012; McCullough et al., 2002), appreciating and wanting to give thanks to nature (with the tendency to anthropomorphize it) is a form of gratitude that is strongly associated with nature relatedness (Tam, 2022). Our mediation results indicate that nature related people may experience psychological wellbeing because their relationship with nature enhances feelings of gratitude.

We note that both gratitude and awe can be regarded as self-transcendent emotions (Stellar et al., 2017), and both provided indirect paths from nature relatedness to at least one of the wellbeing outcome variables in all countries. This is consistent with prior work on self-transcendence as a mediator of the relationship between nature relatedness and multiple dimensions of eudaimonic wellbeing (Trigwell et al., 2014). Interestingly, self-transcendent emotions provided a cross-culturally stable indirect path, but transcendental spiritual health was only a mediator in our data from participants attending Christian universities (South Korea and Hungary). In fact, both gratitude and awe can be experienced regardless of religion, whereas transcendental spiritual health, as defined and measured by Fisher (2010), incorporates belief in a higher power or God.

In sum, our mediation results show that self-transcendent emotions — regardless of religion — can play a significant role in the way nature relatedness promotes wellbeing. All this underlines the importance of mental health professionals' work with self-transcendent emotions in nature-based treatment and intervention programs.

4.1 Limitations and future directions

Although we report data from international samples, in varying cultures, the design of our study limits generalizability and any causal conclusions about the wellbeing benefits of nature relatedness. Our sample of university students from four different countries may provide some insight, however, into how this cohort feels about their relationship with the natural environment. Today's youth are facing unprecedented global environmental challenges and, unfortunately, the ensuing anxiety effects (Clayton & Karazsia, 2020). Thus, there is value in studying how human-nature relationships affect students' wellbeing, in particular, as many will eventually become community leaders, researchers, and environmental professionals. We also note that demographic differences (e.g., age) or variation in data collection parameters (such as differences in incentives or data collection periods) between the samples reduces homogeneity. Moreover, future research should include a diversity of community participants, and people from cultures underrepresented in the environmental psychology literature (e.g., Africa, Latin America; Tam & Milfont, 2020), but ideally with multiple matched samples. Given some of the inconsistent findings on the nature relatedness item assessing 'wilderness' as a vacation preference, further work is needed to replicate the relationships we found between variables. Using the longer version of the NR scale as well as qualitative methods may provide a more nuanced understanding of how nature connectedness varies across cultures. Importantly, longitudinal and experimental designs will be essential to identify causal links between nature relatedness, spirituality, and wellbeing.

Future researchers will hopefully continue to explore these constructs in more countries and cultures, to establish the validity of nature-based measures in multiple languages. Work is needed to determine if nature relatedness has the same links with environmental concern and sustainable behavior in countries facing more immediate threats from global climate change, or where economic pressures conflict with conservation. There is also very little research across diverse countries and cultures on what is 'nature' (e.g., perceptions of wildlife) and how this may affect the measurement of nature relatedness.

For people who care deeply for nature, the climate crisis may have particularly detrimental effects on mental health (e.g., anxiety; Curll et al., 2022). Given that anxiety about climate change is being experienced by people around the globe (e.g., Heeren et al., 2022; Clayton et al., 2017), addressing these challenges will require a deeper understanding of individual differences in nature relatedness and more research to develop culturally-appropriate mental health interventions. We assessed spirituality from the perspective of its importance to wellbeing, however future researchers could test whether certain aspects of spirituality are more or less associated with nature relatedness. Passmore and Howell (2014) have suggested that connecting with nature may be a way to confront and cope with existential anxieties like isolation and death. The potential for nature as a (spiritual) coping resource, in times of existential anxiety or grief, for example, are promising areas for exploration, since people tend to seek comfort in their faith or spiritual communities.

5. Conclusion

Cross-cultural consistencies as well as some anomalies were identified in the links between nature relatedness and psychological wellbeing. Nature relatedness was associated with mental health in Canada, spiritual health in South Korea (with respondents from a Christian university), both mental and spiritual health in Hungary (also respondents from a Christian university) but with neither mental or spiritual health in India. However, the self-transcendent emotions of gratitude and awe formed an indirect path from nature relatedness to wellbeing (either mental or spiritual health) in all countries. Aspects of spirituality that are particularly related to the environment and self-transcendent emotions such as gratitude may be overlooked in terms of how they contribute to nature's effects on wellbeing.

Conflict of interest statement

The authors report no conflicts of interest.

Availability of data and material (data transparency)

Data is available in Figshare: <https://figshare.com/s/bf1ab55e5483dba4b284>

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Author Contributions

Zsuzsanna Kövi contributed the research idea, collected data, conducted analyses, and contributed sections to the manuscript. Hyejeong Kim and Shanmukh Kamble collected data and contributed writing to the

manuscript. Veronika Mészáros conducted analyses and contributed writing to the manuscript. Danielle Lachance contributed writing to the manuscript. Elizabeth Nisbet contributed to the research idea, collected data, and contributed writing to the manuscript.

Authors

Zsuzsanna Kövi
Károli Gáspár University of the Reformed Church
<https://orcid.org/0000-0001-6970-3060>

Hyejeong Kim
Handong Global University

Shanmukh Kamble
Karnatak University
<https://orcid.org/0000-0002-2185-8052>

Veronika Mészáros
Károli Gáspár University of the Reformed Church
<https://orcid.org/0000-0003-4257-745X>

Danielle Lachance
Trent University

Elizabeth Nisbet
Trent University
<https://orcid.org/0000-0002-7071-9956>
elizabethnisbet@trentu.ca

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