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Associations between well-being and nature-based recreation: A cross-sectional study among adults in the United States, Brazil, and Spain

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A R T I C L E I N F O

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A B S T R A C T

Growing evidence suggests that engagement in nature-based recreation can improve people's well-being. However, there is a lack of information regarding which specific nature-based recreation activities are related to specific well-being indicators. We conducted a cross-sectional study to explore how different types of nature-based recreation (i.e., any nature-based activities, forest-based activities, gardening, nature-based adventure activities) relate to five indicators of well-being on the WHO-5 index among American ($n = 606$), Brazilian ($n = 448$), and Spanish ($n = 438$) adults. Americans and Brazilians who reported engaging in nature-based recreation at least monthly in the last 12 months, or weekly during a typical week, were more likely to feel cheerful, relaxed, vigorous, rested after waking up, and interested in life than those who did not engage that frequently. Results in these two countries were similar across all five indicators of well-being and types of nature-based activity, except for gardening, where we observed slightly weaker correlations. In Spain, the correlation between nature-based recreation and well-being tended to be null or even negative, highlighting some variability in these relationships across countries. Further cross-country experimental work is needed to support these findings and identify the relative efficacy of specific nature-based interventions for enhancing human well-being around the world.

Improving people's well-being through physical (Bull et al., 2020) and mental (Singh et al., 2023) health promotion is a global priority. This goal is often achieved through behavioral changes (Lundgren et al., 2021), enhanced social interactions (Hartig, 2021), or improved environmental conditions (South, Hohl, Kondo, MacDonald, & Branas, 2018). However, multiple factors can compromise people's well-being, including the COVID-19 pandemic (World Health Organization, 2022), war (Spiegel, Kovtoniuk, & Lewtak, 2023), physical inactivity (Bull et al., 2020), and environmental problems such as climate change (Richardson et al., 2023). The prevalence of chronic diseases (Center for Disease Control and Prevention, 2023) and mental health problems such as depression and anxiety (World Health Organization, 2022) are also persistent threats, underscoring the need for innovative and effective strategies that improve people's well-being worldwide.

Participation in nature-based activities as a strategy to improve well-being is gaining attention from researchers and practitioners for multiple reasons. First, these opportunities are typically free, ubiquitous, and widely accessible (Hordyk, Hanley, & Richard, 2015). Second, time in nature has been associated with physical, mental, and social well-being benefits (Bratman et al., 2019; Hartig, 2021; Hartig, Mitchell, de Vries, & Frumkin, 2014; James, Christiana, & Battista, 2019; Rosa et al., 2023). These findings are supported by several theories and frameworks suggesting that activities in nature offer various well-being benefits (e.g., Fernee, Gabrielsen, Andersen, & Mesel, 2017; Hartig, 2021; Houge Mackenzie et al., 2021; S. Kaplan, 1995; Ulrich et al., 1991), including attention restoration theory (ART, R. Kaplan & Kaplan, 1989) and stress reduction theory (SRT, Ulrich et al., 1991). Both theories propose that exposure to nature can help restore depleted resources (e.g., directed

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attention and positive emotions) necessary to deal with everyday demands. Spending time in nature can diminish people's stress levels (Mygind et al., 2021), improve their mood (Browning et al., 2020), boost a sense of getting away from daily worries (Hartig, 2021; Hartig et al., 2014), and enhance their feelings of calmness and relaxation (Vert et al., 2020). These benefits are closely related to improved well-being (Topp, Østergaard, Søndergaard, & Bech, 2015). In addition, nature-based activities can benefit well-being because they usually involve some form of physical exercise (Rosa et al., 2023; Singh et al., 2023) and social interactions (Hartig, 2021; Jennings & Bamkole, 2019; Rosa et al., 2023), both of which are positively associated with well-being.

To better understand the relationship between participation in nature-based activities and people's well-being, many studies have compared participation in these activities and average scores from the WHO (five) Well-Being Index (WHO-5) (Elliott et al., 2023; Jackson, Stevenson, Larson, Peterson, & Seekamp, 2021a; Jackson et al., 2021a, Jackson et al., 2021b; Jakstis & Fischer, 2021; Jenkins et al., 2021; van Lier et al., 2017; Wendtlandt & Wicker, 2021), a tool used around the world to quickly and accurately assess self-reported, subjective well-being (Topp et al., 2015). These studies found a positive correlation between the frequency of participation in nature-based activities and the WHO-5 index score, indicating that people who engage in nature-based activities regularly tend to feel better than people who do not. An improvement in an average WHO-5 score can be observed in a variety of situations. For instance, it may occur due to improved quality of sleep or mood. Alternatively, it may be explained because people started doing things they enjoy. Only a look at the level of the indicators can precisely explain why the average WHO-5 score was improved. In practice, these specific improvements can help practitioners select the activities they will provide to their clients by, for example, selecting an activity associated with feeling active and vigorous for an individual who is lacking vitality (Fried & Nesse, 2015; Kondo et al., 2020; Nguyen, Astell-Burt, Rahimi-Ardabili, & Feng, 2023). Unfortunately, little is known about how nature-based activities relate to specific well-being indicators. As an exception, Vert et al. (2020) found that people are more likely to feel cheerful, relaxed, vigorous, rested after waking up, and interested in life when spending time at the beach than when spending the same amount of time in an urban area or a study room. However, this study focused on only one type of nature-based activity—walking at the beach—which limits the generalization of these results to other nature-based activities.

As calls grow to identify the specific types of natural settings and activities that facilitate positive health outcomes (Coventry et al., 2021; Twohig-Bennett & Jones, 2018), three kinds of nature-based activities have received considerable attention from researchers and practitioners as strategies to improve well-being (Coventry et al., 2021; Harper, Fernee, & Gabrielsen, 2021): forest-based activities, nature-based adventures, and horticultural activities. These activities are typically recreational because people usually choose to do them during their free time (Rosa et al., 2023). Forest-based activities comprise conducting activities in a forested area, such as meditating, walking, or birdwatching, either alone or in a group (Rosa, Larson, Collado, & Profice, 2021). Nature-based adventures involve any activity that contains elements of adventure (e.g., challenge, excitement) conducted in a natural setting (Rosa et al., 2023), such as hiking, camping, surfing, and mountain climbing. Finally, horticultural activities encompass gardening-type activities (e.g., planting and taking care of plants), such as seeding and harvesting (Rosa et al., 2023). In addition to activity type, there is ongoing debate regarding the duration and intensity of nature activity engagement needed to impact health in meaningful ways (Meredith et al., 2020; Shanahan et al., 2016). Furthermore, though many have analyzed the relationship between nature-based recreation and health (Bressane et al., 2022; Elliott et al., 2023; Jenkins et al., 2021; e.g., Ricciardi et al., 2023; Wolsko, Lindberg, & Reese, 2019), few studies reported results for different countries (Braçe et al., 2020; Geiger et al., 2023; Samus, Freeman, Dickinson, & van Heezik, 2022). For instance, Geiger et al. (2023) analyzed the association between visits to coastal areas and self-reported general health. Among the 15 countries evaluated, people from Italy and Spain presented the weakest association between visits to coastal areas and self-reported general health. These findings suggest that people from different countries may benefit differently from nature-based recreation (Geiger et al., 2023).

The current study explored how different types of nature-based activities relate to specific WHO-5 well-being indicators across different countries and timeframes. We examined the following research questions (RQs):

RQ1: Is participation in any nature-based recreation activity - as well as specific forest-based activities, nature-based adventure activities, and gardening associated with well-being?
RQ2: Are there differences in the associations between nature-based recreation and specific indicators of well-being?
RQ3: Are associations between nature-based recreation and well-being consistent across U.S.A., Brazilian, and Spanish adults?
RQ4: Are the associations between nature-based recreation across different timeframes (i.e., last 12 months and typical week) and well-being consistent?

1. Methods

1.1. Participants

Individuals aged 18 years or older who were capable of responding to a brief web-based survey were considered eligible for participation in this study. The survey targeted students from the [blinded for review] University in the U.S.A. (hereafter, we refer to these participants as "Americans" to ease the reading) as well as the general population in Brazil and Spain but participants did not need to reside in one of the three target countries to participate. These countries were chosen for convenience and variety (i.e., representing three different continents and a variety of contexts for nature-based recreation). For example, in Brazil, beach visits are a popular nature-based activity for people who have access to beaches; in contrast, participants in the U.S.A. may have greater opportunities for hiking and forest-based activities (Rosa et al., 2023). The English version was emailed to a random sample of 5000 undergraduate and 2500 graduate students. Since we lacked access to a random sample of student emails in Brazil and Spain, we sent emails with an invitation letter to the authors' network as well as through various social media platforms such as WhatsApp, Facebook, and Instagram. In the invitation, individuals were encouraged to participate in our survey and to share it with others. We aimed to reach as many participants as possible to achieve narrower confidence intervals (CIs) for our estimates; thus, no formal sample size calculation was conducted (Cumming, 2014). Most participants spent less than 10 min voluntarily completing our online survey, with the median completion time being 6.7 min.

Across all countries, a total of 1853 individuals clicked on the survey link. However, five participants were excluded due to being under 18 years old (U.S.A.: $n = 1$; Brazil: $n = 2$; Spain: $n = 2$) or failing to provide their age. We analyzed the data from participants who completed at least 96% of the survey, as these individuals only missed the final page for submitting the completed survey. This resulted in 1492 valid responses, representing a completion rate of 80.5% among all individuals who clicked on the survey link (Table 1).

The prevalence of missing data was minimal, with less than 1% missing on any variable. Across all three survey versions, the typical participant was a young adult, with an average age of 27.2 years. The majority of participants were well-educated females, with (close to) average family incomes compared to others in their respective countries, and lived in urban areas. In the American and Spanish samples, most respondents identified as having white or near-white skin tones, while the majority of Brazilian participants reported having dark or near-dark

Table 1
Participants' sociodemographic characteristics.

Variable %	Survey language		
	English	Portuguese-Brazil	Spanish
Number of valid responses	606	448	438
Age	Mean = 23.7 Range = 18 to 61	Mean = 32.7 Range = 18 to 70	Mean = 26.4 Range = 18 to 83
18 to 39	96.7	77.0	89.0
≥ 40	3.3	23.0	11.0
Gender	–	–	–
Man	42.6	32.8	24.7
Women	54.5	66.1	73.7
Gender variant/Non-confirming	3.0	1.1	0.7
Not listed	0.0	0.0	0.9
Highest education	–	–	–
Secondary (High) school	50.8	30.4	32.8
Vocational school	1.8	3.8	11.2
College or University	27.6	33.9	34.9
Graduate (Master or equivalent)	18.6	22.1	14.4
Doctoral Degree	1.2	9.8	6.7
Family income	–	–	–
Well below average	9.6	5.8	4.1
Slightly below average	16.0	15.8	14.4
Average	30.9	48.2	57.8
Slightly above average	32.8	23.0	21.8
Well above average	10.7	7.1	1.8
Urbanicity	–	–	–
Urban	75.9	90.2	64.8
Rural	17.5	4.5	27.2
Not sure	6.6	5.4	8.0
Skin color	–	–	–
Whiter (2 or less on the NIS Skin Color Scale)	74.8	35.9	80.3
Darker (3 or more in the NIS Skin Color Scale)	25.2	64.1	19.7
Country participants were living			
United States of America	99.7	0.4	0.2
Spain	0.0	0.0	98.9
Brazil	0.0	98.2	0.0
Other	0.3[a]	1.3[c]	0.9[b]

Note.
[a] Two participants were living in India when they filled in the English survey.
[b] Two participants were living in Italy, one in Madagascar, and one in France when they filled in the Spanish survey.
[c] Two participants were living in Peru, one in France, one in Portugal, and one in the Equator when they filled in the Portuguese-Brazil survey.

skin tones. Only a small number (<1%) of participants in the American ($n = 2$), Brazilian ($n = 5$) and Spanish ($n = 4$) surveys did not reside in the U.S.A., Brazil, or Spain at the time of data collection (Table 1).

1.2. Procedure and measures

We conducted a cross-sectional observational study (von Elm et al., 2007) using an online survey sampling approach. We developed the online survey using the platform Qualtrics. The study was approved by the ethics committee at University of Santa Cruz (reference: CAAE:56750322.0.0000.5526), and all participants provided informed consent at the beginning of the study. Data collection took place between February 01 and June 26, 2023.

We collected data on participants' interaction with nature, their well-being, and sociodemographic information. The online survey was designed in English and then translated into Portuguese and Spanish. Subsequently, we translated the survey back into English and compared it with the original version. Following this comparison, minor translation discrepancies were addressed. We then proceeded with interviews involving potential participants to ensure the comprehensibility of survey items, and no issues were identified in terms of understanding (Peterson, Peterson, & Powell, 2017).

Participation in nature-based recreation: We developed items to assess participants' frequency of participation in nature-based recreation based on previous studies (e.g., Edwards, Duerden, Lizzo, Campbell, & Kamper, 2014; Holland et al., 2021). This was done because, to date, there is no validated instrument to assess participation in specific nature-based recreational activities. We asked three experts on the effect of contact with nature on human health to evaluate the first draft of our items, with special attention to the items' validity and comprehensibility. Based on the experts' feedback, we edited the content of the items until all items were comprehensible and the response options were appropriate. The items included a general question about the frequency of participation in any form of nature-based recreation plus one item for each of three types of activities: forest-based activities, gardening, and nature-based adventure (AERA, 2014; Rosa et al., 2023). Before replying to the questions, participants read the definition of nature-based recreation: "Nature-based recreation and leisure activities are activities in contact with nature that you choose to do during your free time". For each type of nature-based recreation, we assessed both participation in the past 12 months and participation during a typical week. The question about participation in these three types of nature-based activities in the past 12 months was as follows: "In the past 12 months, how often have you engaged in the following activities?" Response options included the specific activities (i.e., Activities in forested areas, activities related to gardening, and nature-based adventure activities) and, for each of them, respondents could choose between I never participated; I rarely participated (a few times a year); I sometimes participated (about once a month); I often participated (several times each month); I very often participated (pretty much every week). Engagement in these three nature-based activities during a typical week was assessed with the following question "On how many days in a typical week do you participate in the following activities? [For example, if you typically go to the beach 2 days in a week and garden on 2 different days out of that same week, your answer would be 4 days.]". Again, response options included the three specific activities and, for each one, the response options were: None (never participate); 1 day; 2 days; 3 days; 4 days; 5 days; 6 days; Every day.

As for the participation in *any* nature-based recreational activity in the two timeframes (i.e., during the 12 months and in a typical week), the questions were the following: "In the past 12 months [in a typical week], which of the following best describes your participation in ANY type of nature-based recreation and leisure activities?". Response options were similar to the ones described above for the specific nature-based activities. The complete surveys in English [https://univiepsy.qualtrics.com/jfe/form/SV_7V5aUWIZsWwEsbY], Portuguese-Brazil [https://univiepsy.qualtrics.com/jfe/form/SV_ac68XwULUWx3L5I], and Spanish [https://univiepsy.qualtrics.com/jfe/form/SV_0pIe471jMeI2WoK] are available online and in Supplementary File 1.

Well-being: The WHO-5 index was used to assess participants' well-being (World Health Organization, 1998). This scale has been translated into more than 30 languages (Topp et al., 2015), including Spanish and Portuguese-Brazil (Lara-Cabrera, Mundal, & De Las Cuevas, 2020; Souza & Hidalgo, 2012; World Health Organization, 1998). The validity and reliability of this instrument have been acknowledged, and the scale is well-accepted by research participants (Bonnín et al., 2018; Campo-Arias, Miranda-Tapia, Cogollo, & Herazo, 2015; Caycho-Rodríguez, Ventura-León, Azabache-Alvarado, Reyes-Bossio, & Cabrera-Orosco, 2020; Hall, Krahn, Horner-Johnson, & Lamb, 2011; Lara-Cabrera et al., 2020; Topp et al., 2015). People replying to the WHO-5 are asked how they have been feeling over the last two weeks. To do this, they have to choose the response option that best represents each feeling, considering: 0 = at no time; 1 = some of the time; 2 = less than half of the time; 3 = more than half the time; 4 = most of the time; 5 = all the time (World Health Organization, 1998). The WHO-5 items are positively worded and relate to mood (i.e., I feel cheerful and in good spirits), calmness (I feel calm and relaxed), vitality (I feel active and vigorous), sleep quality (i.e., I wake up feeling fresh and rested), and interest in life (i.e., My daily life is filled with things that interest me).

Sociodemographic information: We collected information about participants' age, gender, highest educational level, average family income, skin color, urbanicity, and country (see Table 1).

1.3. Data analyses

We used descriptive statistics to describe the overall frequency of nature-based recreation, well-being, and participants' sociodemographic information. We then assessed relationships between the frequency of nature-based recreation and WHO-5 well-being indicators using means as well as a dichotomized approach to facilitate the interpretation of results (von Elm et al., 2007). We dichotomized the frequency of nature-based recreation engagement during the past 12 months into less than monthly (code = 0) and at least monthly (code = 1). We chose this timeframe because engaging in nature-based recreational activities once per month may be an achievable goal for most people (Edwards et al., 2014; Holland et al., 2021). A similar logic was followed to dichotomize the frequency of engagement in nature-based recreation during a typical week. We used code 0 for participants who reported not engaging in nature-based recreational activities at all, and 1 for participants who reported engaging in these activities at least one day during a typical week. Finally, we used code 0 for participants who replied to WHO-5 well-being indicators with "Less than half of the time" or less frequently and 1 for participants who replied "More than half of the time" or more frequently. We chose this dichotomization strategy because, for most of the WHO-5 well-being indicators, approximately half of the participants were in each of these categories (von Elm et al., 2007).

We used fixed-effects meta-analyses (Bender et al., 2018) to estimate the mean difference in each WHO-5 well-being indicator score between groups dichotomized according to the frequency of participation in nature-based recreation (as described above). In the meta-analyses, we considered each sample (i.e., Americans, Brazilians, and Spanish) as a different study (Higgins et al., 2019). When working with mean differences, we report results in a standardized metric (Hedges'*g*) beyond the raw mean differences to facilitate results interpretation by a wider audience. Hedges'*g* may be interpreted similarly to Cohen's *d* (Sawilowsky, 2009): 0.1 = very small, 0.2 = small, 0.5 = medium, 0.8 = large, 1.2 = very large, and 2.0 = huge. We also calculated the difference in the prevalence of individuals who replied to WHO-5 items with "More than half of the time" or more frequently (Code 1) according to nature-based recreation groups, i.e., a Prevalence Ratio (PR),[1] (Gnardellis, Notara, Papadakaki, Gialamas, & Chliaoutakis, 2022). We opted for PRs because they are easier to understand than odds ratios. The visual inspection of PRs indicates whether a result is statistically significant or not (i.e., significant when the estimate does not cross 1). In addition, *p*-values are available in Supplementary File 2 and https://osf.io/3he4p/?view_only=a752c5c55bf647b7aba750c563a4380c). We ran fixed-effects (instead of random effects) meta-analyses because estimates of statistical heterogeneity are imprecise with very few studies (Bender et al., 2018; Higgins et al., 2019). Lower overlap among confidence intervals of effect sizes is associated with higher statistical heterogeneity (Higgins et al., 2019). So, we examined each estimate and its confidence intervals when interpreting results (Cumming, 2014). Inferential analyses were conducted using the free software RevMan (*Review Manager (RevMan) [Computer Program], 2020*) and IBM SPSS.

[1] Prevalence Ratios (PRs) are calculated using the same formulae than Risk Ratios (RRs). The former term is used in cross-sectional studies and the later in the longitudinal ones (Gnardellis et al., 2022). The term "Risk Ratio" appears in the forest plots in Supplementary File 1 because this is the default term used by the statistical software RevMan.

2. Results

Across all countries, a minority (6.4%) of respondents indicated that they had not participated in any nature-based recreation in the past 12 months. Conversely, a majority (74.7%) reported engaging in such activities at least once a week during a typical week. When considering the specific activities assessed in this study, forest-based activities were the most commonly practiced, followed by nature-based adventure, and gardening (see Supplementary Tables 1 and 2 in Supplementary File 1 for a detailed description per country).

Concerning well-being, across all countries the average on all WHO-5 well-being indicators was between 2 and 3 suggesting that, during the two weeks previous to data collection, participants tended to feel cheerful, calm, vigorous, rested after waking up, and interested in life about half the time (Supplementary Table 3 in Supplementary File 1). In general, a small proportion of participants (less than 5%) reported these feelings "At no time". It should be noted that the proportion of people reporting feeling fresh and rested after waking up "At no time" was considerably greater, 12.5%, than the other well-being indicators (see Supplementary Table 4 in Supplementary File 1 for a detailed description per country).

2.1. Relationship between nature-based recreation and WHO-5 well-being indicators

We assessed the difference in WHO-5 well-being indicators mean scores according to whether participants regularly engaged in nature-based recreational activities or not (Table 2). Considering pooled data from the three samples, the WHO-5 mean indicator scores of participants who engaged at least monthly in nature-based recreation were, on average, higher than the ones who did not engage that frequently (Table 2). These differences in WHO-5 mean indicator scores ranged from −0.14 to −0.56. In a standardized metric (Hedges' *g*), these differences ranged from −0.12 to −0.46. The mean differences in well-being across nature engagement groups were consistent in the American and Brazilian samples (Supplementary File 2). However, Spanish means differences were closer to 0 and, for some well-being indicators (i.e., feeling calm, active, and rested), the mean differences held the opposite direction than the one in the Brazilian and American samples (Supplementary File 2). These differences across countries produced high statistical heterogeneity in the meta-analyses (i.e., little overlap among confidence intervals of the estimates, see Supplementary File 2). Results were similar when considering participation in nature-based recreational activities on a typical week, indicating that participants who engaged at least weekly in nature-based recreation reported higher mean scores on WHO-5 indicators than those who did not engage that frequently (Table 2). Mean differences ranged from −0.15 to −0.57. Hedges'*g* for the typical week timeframe ranged from −0.12 to −0.46. In the Spanish sample, the mean differences were closer to zero and sometimes in the opposite direction than in the American and Brazilian samples (Supplementary File 2). Considering both timeframes, associations with well-being indicators were slightly stronger for nature-based adventure and forest-based activities compared to gardening. Differences tended to vary only slightly across indicators. The same patterns were not observed in the Spanish sample (Table 2, and Supplementary File 2).

To enhance the interpretation of the results, we compared the prevalence of participants who reported feeling "More than half the time" cheerful, relaxed, vigorous, rested after waking up, and interested in life, according to monthly and weekly participation in nature-based recreation (Table 3). The results were similar to those observed using mean scores. PRs ranged from 1.14 to 1.58. To illustrate, we found a 58% greater prevalence of participants feeling active and vigorous "More than half the time" among the participants who engaged in nature-based recreation at least weekly than among those who did not engage in nature-based activities that frequently. Again, the results from

Table 2

Fixed-effects meta-analyses of the mean differences in WHO-5 well-being mean scores (95% CI) according to frequency of participation in nature-based recreation. Estimates are based on pooled data from the North American, Spanish, and Brazilian samples.

	Any nature-based recreational activity		Forest-based		Gardening		Nature-based adventure	
	Monthly	Weekly	Monthly	Weekly	Monthly	Weekly	Monthly	Weekly
I feel cheerful and in good spirits	−0.54 [-0.67, −0.42]	−0.57 [-0.71, −0.43]	−0.42 [-0.55, −0.29]	−0.37 [-0.50, −0.23]	−0.26 [-0.39, −0.13]	−0.22 [-0.35, −0.10]	−0.47 [-0.59, −0.34]	−0.40 [-0.52, −0.28]
I feel calm and relaxed	−0.36 [-0.50, −0.22]	−0.45 [-0.59, −0.30]	−0.23 [-0.36, −0.09]	−0.26 [-0.40, −0.13]	−0.28 [-0.42, −0.14]	−0.26 [-0.39, −0.13]	−0.40 [-0.53, −0.27]	−0.30 [-0.43, −0.17]
I feel active and vigorous	−0.48 [-0.62, −0.34]	−0.46 [-0.61, −0.30]	−0.37 [-0.51, −0.23]	−0.38 [-0.53, −0.24]	−0.14 [-0.28, −0.00]	−0.15 [-0.28, −0.01]	−0.48 [-0.61, −0.34]	−0.42 [-0.55, −0.29]
I wake up feeling fresh and rested	−0.44 [-0.59, −0.30]	−0.50 [-0.65, −0.35]	−0.34 [-0.49, −0.19]	−0.36 [-0.51, −0.21]	−0.38 [-0.53, −0.23]	−0.38 [-0.52, −0.24]	−0.45 [-0.59, −0.30]	−0.39 [-0.53, −0.25]
My daily life is filled with things that interest me	−0.56 [-0.69, −0.42]	−0.55 [-0.70, −0.40]	−0.44 [-0.57, −0.30]	−0.38 [-0.52, −0.24]	−0.31 [-0.45, −0.17]	−0.23 [-0.36, −0.10]	−0.38 [-0.51, −0.24]	−0.32 [-0.45, −0.19]

Note. [a] Negative mean differences indicate that participants who engaged in nature-based recreation at least monthly during the past 12 months or weekly during a typical week held higher WHO-5 well-being mean scores than participants who did not. WHO-5 response options are 0 = at no time; 1 = some of the time; 2 = less than half of the time; 3 = more than half the time; 4 = most of the time; 5 = all the time. Results are statistically significant when the 95% CI of the estimate does not cross the 0.

Table 3

Results from Fixed-Effects Meta-Analyses Estimating the Prevalence Ratio [95% CI] of WHO-5 Well-Being Indicators According to Frequency of Participation on Nature-based Recreation. Estimates are based on pooled data from the North American, Spanish, and Brazilian Samples.

	Any nature-based recreational activity		Forest-based		Gardening		Nature-based adventure	
	Monthly	Weekly	Monthly	Weekly	Monthly	Weekly	Monthly	Weekly
I feel cheerful and in good spirits	1.55 [1.37, 1.76]	1.57 [1.36, 1.81]	1.39 [1.25, 1.56]	1.31 [1.17, 1.47]	1.26 [1.14, 1.39]	1.22 [1.10, 1.34]	1.39 [1.26, 1.53]	1.35 [1.22, 1.48]
I feel calm and relaxed	1.35 [1.18, 1.54]	1.40 [1.19, 1.63]	1.25 [1.10, 1.42]	1.22 [1.07, 1.40]	1.31 [1.16, 1.47]	1.24 [1.11, 1.40]	1.33 [1.18, 1.50]	1.28 [1.14, 1.43]
I feel active and vigorous	1.50 [1.30, 1.73]	1.58 [1.33, 1.86]	1.34 [1.18, 1.53]	1.31 [1.14, 1.50]	1.23 [1.09, 1.39]	1.14 [1.01, 1.28]	1.49 [1.32, 1.67]	1.38 [1.23, 1.56]
I wake up feeling fresh and rested	1.35 [1.15, 1.59]	1.43 [1.19, 1.73]	1.27 [1.09, 1.49]	1.26 [1.08, 1.48]	1.32 [1.14, 1.53]	1.31 [1.13, 1.51]	1.34 [1.16, 1.54]	1.28 [1.12, 1.48]
My daily life is filled with things that interest me	1.49 [1.32, 1.69]	1.50 [1.30, 1.72]	1.34 [1.20, 1.49]	1.28 [1.14, 1.43]	1.26 [1.15, 1.39]	1.17 [1.06, 1.29]	1.29 [1.17, 1.42]	1.21 [1.10, 1.33]

Note. A Prevalence Ratio greater than 1 indicates that participants who were engaged in nature-based recreational activities at least monthly during the last 12 months or weekly during a typical week were more likely to feel WHO-5 well-being indicators "More than half the time" than the participants who did not engage in nature-based recreation that frequently. Results are statistically significant when the 95% CI of the estimate does not cross the 1.

the Spanish sample differed from the results from the American and Brazilian ones. Among Spanish, the PRs tended to be closer to zero or even in the opposite direction (see Supplementary File 2).

Finally, because in the Spanish sample, the direction of the differences in well-being indicators varied to some extent depending on the well-being indicator, we analyzed the differences in WHO-5 mean index scores (i.e., the sum of the scores from the five WHO-5 indicators divided by five). Overall, Americans and Brazilians who engaged in nature-based recreation at least monthly held a higher mean WHO-5 index score than the ones who did not engage that frequently (Fig. 1). However, the difference in mean WHO-5 index scores in Spanish was close to zero and in some cases in the opposite direction than the American and Brazilian samples. Results were similar for the weekly timeframe, and the negative correlation between mean WHO-5 index sum scores and nature-based recreation in the Spanish sample was even stronger (Fig. 2). These results are presented in Hedge's *g* in Supplementary Figs. 1 and 2 in Supplementary File 1. Similar to what was observed at the level of the individual indicators, slightly larger differences in WHO-5 index sum scores were observed in any nature-based recreation, nature-based adventure, and forest-based activities than in gardening (Figs. 1–3).

Further sensitivity analyses show that choosing different cut-offs would have provided similar results (see Supplementary Figs. 3 and 4). Americans and Brazilians who engaged in nature-based recreation at least a few times a year or several times monthly presented better well-being than Americans and Brazilians who did not engage that frequently. Again, the results for Spanish were close to 0, indicating no difference between groups. Additional sensitivity analyses confirmed that (a) excluding the participants who were not living in their respective countries at the moment of data collection (Supplementary Table 6 in Supplementary File 1) and (b) controlling for gender, age, income, and skin color (Supplementary Table 7 in Supplementary File 1) did not influence the results.

3. Discussion

In this study, we explored the relationship between nature-based recreation and the WHO-5 well-being indicators among people in three different countries (U.S.A., Brazil, and Spain). We found a relatively consistent pattern across nature-based activities (any nature-based recreation, forest-based activities, nature-based adventure, and gardening) among Americans and Brazilians: More nature-based recreation was associated with higher scores on all WHO-5 well-being indicators (RQ1). Moreover, these correlations are substantial and consistent across all indicators, since Americans and Brazilians who engage in nature-based recreation are considerably more likely to feel cheerful, relaxed, vigorous, rested after waking up, and interested in life (Table 3; RQ2). These associations were not found in the Spanish sample (RQ3). The correlations between nature-based recreation and well-being for both monthly and weekly engagement tended to be slightly stronger for any type of nature-based recreation, nature-based adventure, and forest-based activities than for gardening (RQ4). Although these broad frequencies do not highlight a specific dosage of nature needed to

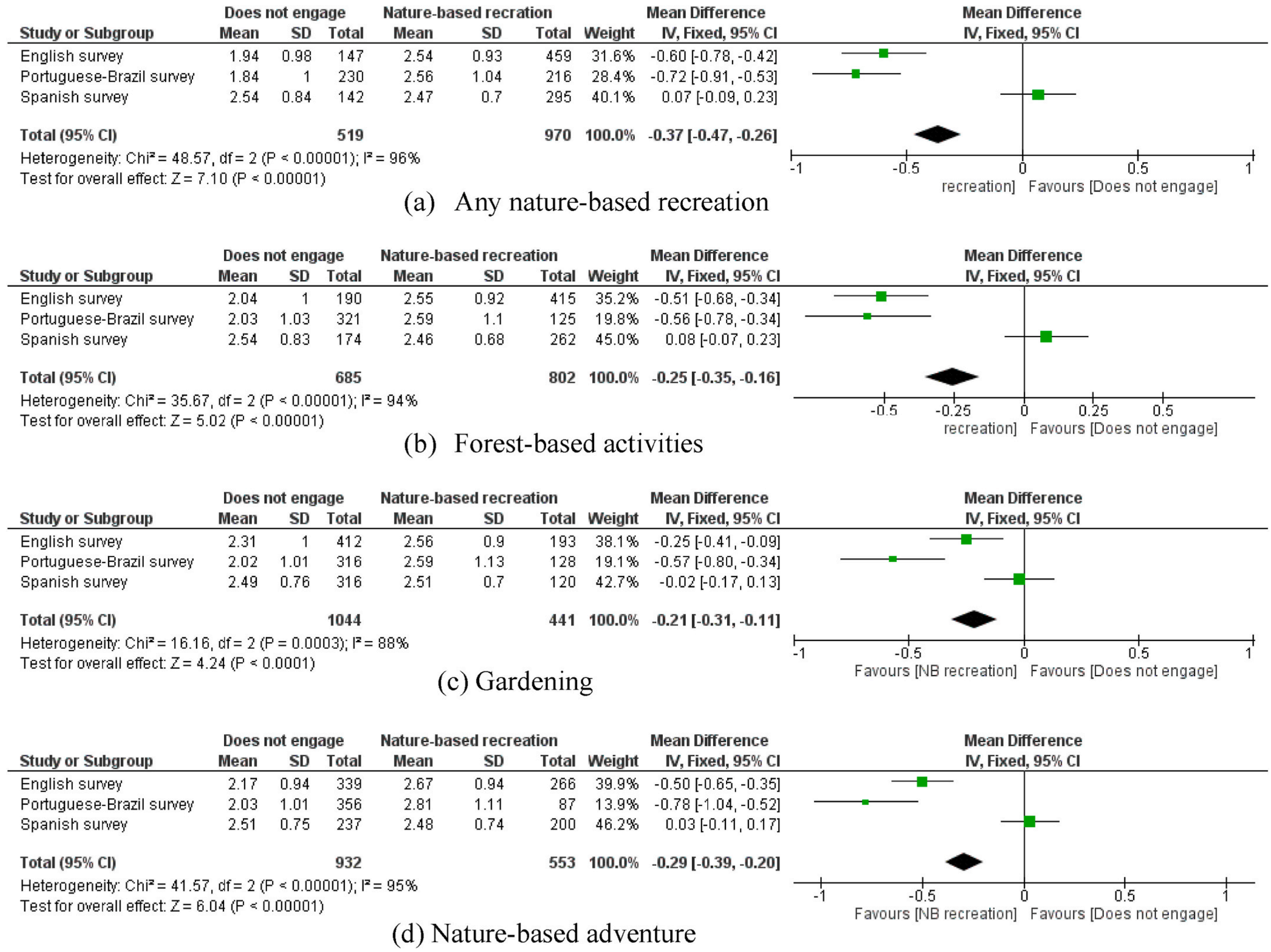


Fig. 1. Fixed-Effects Meta-Analyses of the Difference in WHO-5 mean sum-scores (95% CI) According to Monthly Participation in Nature-Based Recreation. Estimates are Based on Combined Data from the North American, Spanish, and Brazilian Participants. (a) Refers to any Nature-Based Recreational Activity. (b) Refers to Forest-Based Activities. (c) Refers to Gardening. (d) Refers to Nature-Based Adventure.
Note: WHO-5 response options are 0 = at no time; 1 = some of the time; 2 = less than half of the time; 3 = more than half the time; 4 = most of the time; 5 = all the time. Results are statistically significant when the 95% CI of the estimate does not cross the 0.

achieve mental health benefits, which has been the goal of other recent studies (Cox, Shanahan, Hudson, Fuller, & Gaston, 2018; Meredith et al., 2020), they indicate that regular contact with nature can have health benefits. Moreover, our analysis suggests that specific types of nature-based recreation (e.g., nature-based adventure, forest-based activities) are more strongly associated with well-being than others. This is in line with previous studies suggesting the potential of some nature-based adventure activities (Rosa et al., 2023) and forest-based activities (Rosa et al., 2021) to improve people's health. In the context of the present study, gardening might not be as immersive as nature-based adventure or forest-based activities (Mygind et al., 2019). For example, while nature-based adventure or forest-based activities usually require the person to commute to a natural area away from home, gardening can be practiced at home or in nearby settings (e.g., urban gardens), which can hinder the sense of being away from normal routines. In turn, gardening can be more accessible, especially when considering activities that do not require specific gardening tools such as sowing (Soga, Gaston, & Yamaura, 2017). Thus, when other nature-based recreation opportunities are not available, gardening might be a valuable health promotion alternative as confirmed by other studies (Rosa et al., 2023).

The positive correlation between nature-based recreation and well-being observed in this study is in line with theories explaining the health benefits of contact with nature (Fernee et al., 2017; Hartig, 2021; S. Kaplan, 1995; Ulrich et al., 1991) as well as with randomized trials documenting similar effects (e.g., Buru et al., 2021; Ghanbari, Jafari, Bagheri, Neamtolahi, & Shayanpour, 2015; Shin, Shin, & Yeoun, 2012; Sturm et al., 2012; Vert et al., 2020). Previous studies showed that contact with nature is linked to positive mood (Browning et al., 2020), reduced stress (Mygind et al., 2021), feelings of being relaxed and forgetting about every day's demands (S. Kaplan, 1995), and feeling vigorous and with energy (Vert et al., 2020). All of these are closely related to well-being. If our findings are confirmed by future experimental studies, social and health practitioners may consider providing or recommending nature-based recreation to improve their clients' well-being. Nature prescriptions are already gaining traction in many countries around the world (Nguyen et al., 2023) though they might not be equally effective across different countries.

The fact that the relationship between nature-based recreation and well-being in our Spanish sample tended to be null or even negative warrants further discussion. Similar results were found in a previous study with Spanish residents of Carmona (Braçe et al., 2020). Braçe et al. (2020) found that, on average, individuals who visit greenspaces daily are more likely to experience depressive symptoms than individuals who

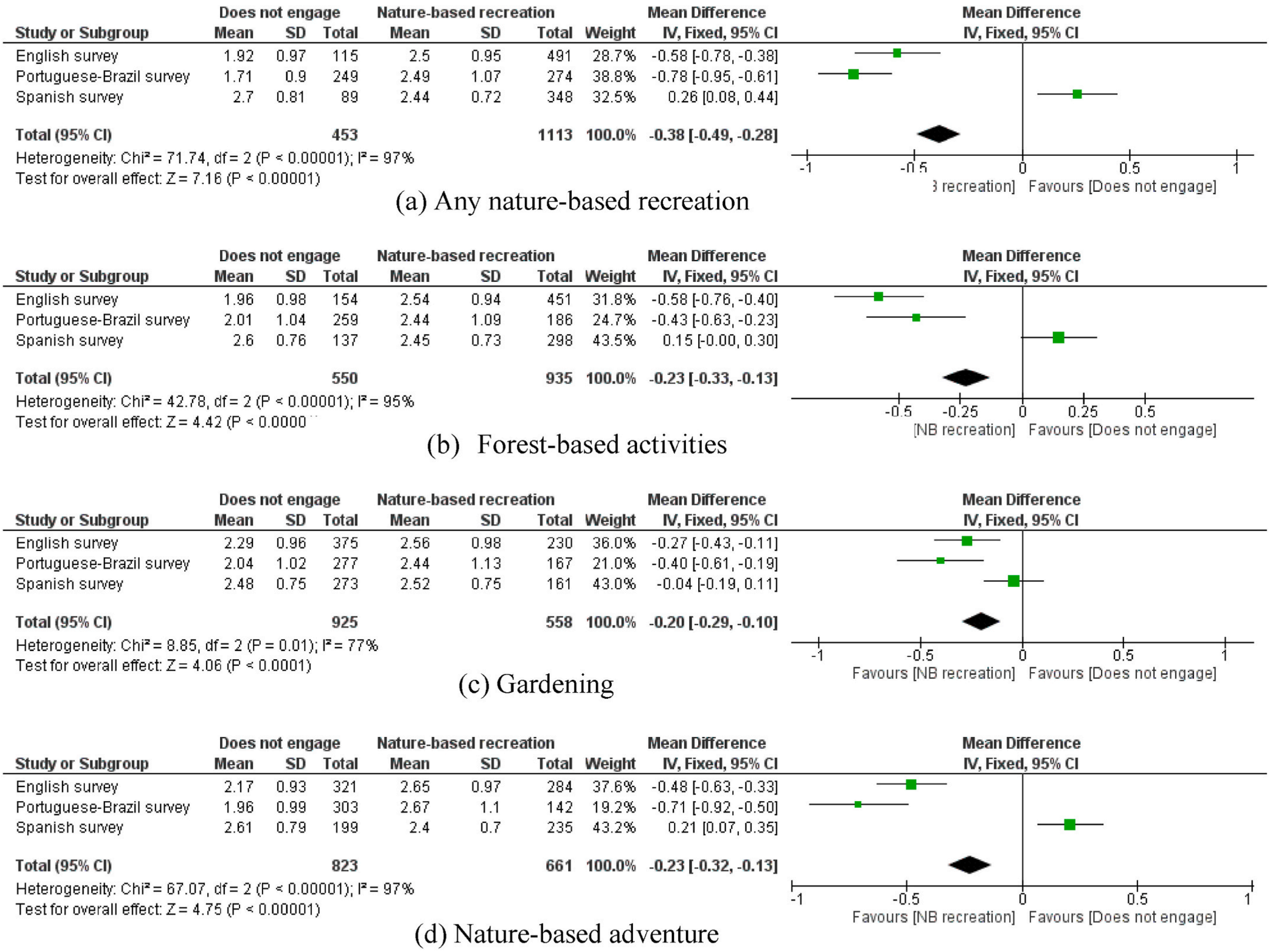
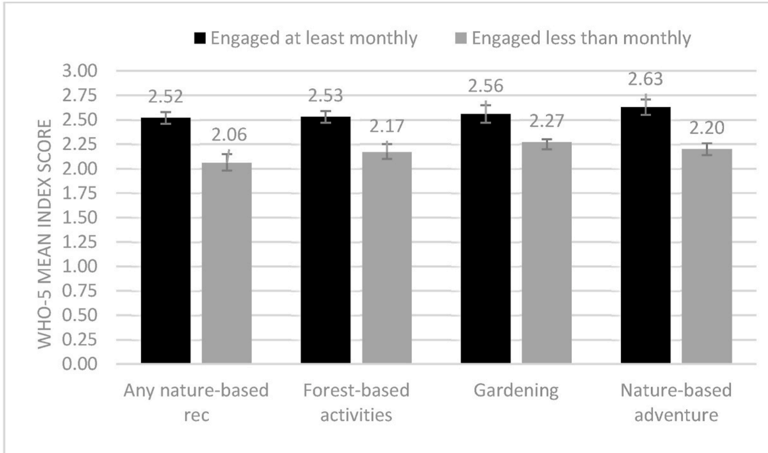


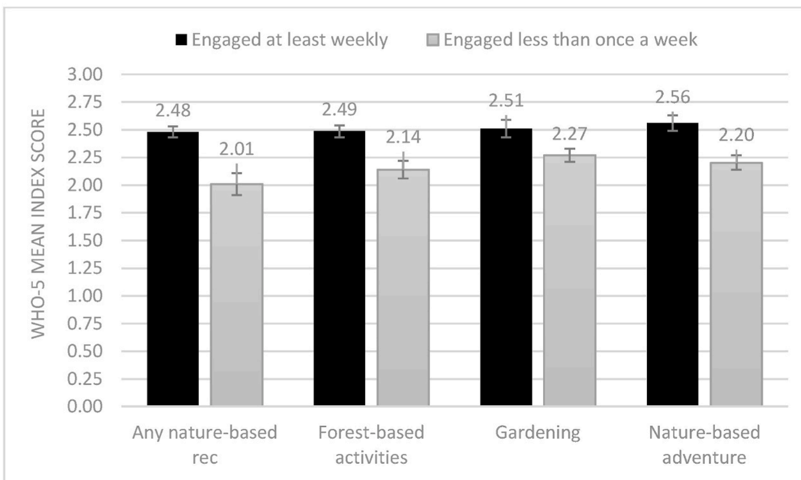
Fig. 2. Fixed-Effects Meta-Analyses of the Difference in WHO-5 mean sum-scores (95% CI) According to Weekly Participation in Nature-Based Recreation. Estimates are Based on Combined Data from the North American, Spanish, and Brazilian Participants. (a) Refers to any Nature-Based Recreational Activity. (b) Refers to Forest-Based Activities. (c) Refers to Gardening. (d) Refers to Nature-Based Adventure.
Note: WHO-5 response options are 0 = at no time; 1 = some of the time; 2 = less than half of the time; 3 = more than half the time; 4 = most of the time; 5 = all the time. Results are statistically significant when the 95% CI of the estimate does not cross the 0.

do not engage that frequently. Although our results align with those of previous studies (Braçe et al., 2020; Geiger et al., 2023), we can only speculate why nature-based recreation does not seem to be related to well-being in our Spanish sample. It might be that a greater proportion of Spanish participants than Americans and Brazilians engage in nature-based recreation to improve some existing health problem (e.g., depression or anxiety) making the differences between people who engage in these activities and the ones who do not engage less accentuated (Rosa et al., 2023). Unfortunately, our study design does not allow us to attribute the observed differences in the Spanish sample, compared to Americans and Brazilians, exclusively to the country these people live in. Notwithstanding, our findings highlight the relevance of examining the relation or impact of nature-based recreation on health outcomes by considering different countries separately as we did in the present study. Moreover, these findings point to the need for future research exploring the reasons behind this null or even negative correlation between nature-based recreation participation and well-being in Spain. These findings, do not mean, however, that Spanish people will not benefit from participating in nature-based recreation. In fact, there is evidence from both experimental (Vert et al., 2020) and observational studies (Tomasi, Di Nuovo, & Hidalgo, 2020) that nature-based recreation can improve well-being among some subgroups of the Spanish population. Identification of specific subpopulations of Spanish people, and why they do or do not experience well-being benefits from nature-based recreation, could be explored in future research.

Because our study was cross-sectional, there are other possible interpretations for the observed patterns of correlations between nature-based recreation and well-being (Levin, 2006; Sedgwick, 2014; von Elm et al., 2007). Many studies have recognized a bi-directional relationship between contact with nature and mental health. This implies that while engaging in nature-based activities can enhance mental well-being, individuals with severe mental health issues may avoid participating in nature-based activities (e.g., Bressane et al., 2022; Bu, Steptoe, Mak, & Fancourt, 2021). Nevertheless, most studies - including those with experimental design - support the premise that contact with nature improves well-being (Bratman et al., 2019; Hartig et al., 2014; Rosa et al., 2021; Rosa et al., 2023; Rosa et al., 2023). Another limitation of our study is the use of convenience samples. This means that the characteristics of our sample may differ substantially from the characteristics of the general population. For example, our Spanish sample presented a substantially lower well-being mean score compared to the one observed in Spanish on the 6th European Working Condition Survey (Sischka, Costa, Steffgen, & Schmidt, 2020). Thus, employing a non-probabilistic sampling method restricts the applicability of our



(a)



(b)

Fig. 3. Comparison of Self-Reported Well-being Scores (WHO-5 Index) for Participants Who Were Engaged, at Least (a) Monthly During the Last 12 Months or (b) Weekly During a Typical Week, versus those Not Engaged in a Variety of Different Nature-Based Recreation Activities.
Note. Scores represent pooled means for respondents across the United States, Spain, and Brazil (total n ranges from 1483 to 1489). Well-being scores were statistically higher ($p < 0.001$) for every type of activity. Error bars are 95% confidence intervals. *P*-values and CIs were created based on Welch's *t*-tests (Delacre, Lakens, & Leys, 2017).

findings to broader populations, although it does not render it entirely impossible (Rothman, Gallacher, & Hatch, 2013). The consistent positive association between nature-based recreation and well-being observed by previous studies (Elliott et al., 2023; Jackson et al., 2021a, Jackson et al., 2021b; Jackson et al., 2021a; Jakstis & Fischer, 2021; Jenkins et al., 2021; van Lier et al., 2017; Wendtlandt & Wicker, 2021) suggests that it is unlikely to be predominantly influenced by specific participants' characteristics, such as age or gender. Similar results patterns across our diverse samples support these conclusions, although the results from our Spanish sample warrant further investigation and explanations. Future research could examine connections between socio-demographic attributes, contact with nature, and well-being across diverse contexts. Though we have reported data for specific cut-offs based on participants' frequency of contact with nature, further sensitivity analyses show that choosing different cut-offs would have warranted similar conclusions. Different results might have been observed if participants were asked about their frequency of nature-based recreation during "last week" instead of during a "typical week" as it refers to different timeframes. Prior researchers have acknowledged the challenge of measuring participation in nature-based recreation (Edwards et al., 2014; Holland et al., 2021). Whereas the reported frequencies of nature-based recreation are unlikely to be perfectly accurate, they produced plausible associations with well-being in the present study. Also, weather and seasonal changes might have influenced people's well-being and engagement in nature-based recreation (Geiger et al., 2023). These measurement issues could be further explored in future research that employs more overt measures of time spent in nature.

3.1. Future research & implications

Given the prevalence of health problems worldwide, our study highlights the potential value of nature-based interventions as a preventive strategy or treatment to enhance well-being across countries. Future studies could build on our results showing that different types and doses of nature-based activities are linked to the expression of self-reported well-being indicators across unique countries. More specific information on dosage (as opposed to dichotomous monthly or weekly engagement), and a greater variety of nature-based recreation activity types, could help practitioners and researchers identify customized solutions to match specific country contexts. Future studies can compare different nature-based activities performed in different types of natural environments, including walking, meditation, birdwatching, planting, and surfing. They could also explore how activities within each of our categories (i.e., forest-based, nature-based adventure, and gardening) differ in terms of physical activity and social interactions, and whether these differences, in turn, relate to well-being outcomes. We encourage researchers to pursue new studies to investigate relationships between nature and well-being both at the index score and the indicator level, as we have done in the present study, to provide insights into what types of activities improve different aspects of well-being. Although our study hints at positive associations between nature-based recreation and well-being across American and Brazilian adults, more research is needed to identify and implement specific nature-based solutions for addressing global health challenges.

Declaration of conflict of interest

The authors declare they have no conflict of interest.

Data statement

The files with the data were submitted as supplementary files and uploaded on a free-access website.

CRediT authorship contribution statement

Claudio D. Rosa: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Lincoln R. Larson:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Investigation, Conceptualization. **Silvia Collado:** Writing – review & editing, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Conceptualization. **Sandra J. Geiger:** Writing – review & editing, Visualization, Validation, Methodology, Investigation, Conceptualization. **Christiana C. Profice:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Investigation, Conceptualization. **Marcos R.T.P. Menuchi:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Conceptualization.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2024.102438.

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