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## Gender Differences in Connection to Nature, Outdoor Preferences, and Nature-Based Recreation Among College Students in Brazil and the United States

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### ABSTRACT

Nature-based recreation (NBR) can enhance human health and promote conservation. As a result, there is a growing interest in the drivers of NBR. In two separate surveys of college students in Brazil ( $N=224$ ) and the United States ( $N=207$ ), we found that young adults with stronger connection to nature (CN) have a greater preference for outdoor environments to recreate and that these preferences are associated with more frequent participation in NBR. Fostering connection to nature could therefore alter recreation preferences and enhance NBR. We also discovered gender differences in CN, recreation setting preferences and NBR participation. While women were more connected to nature and tended to prefer outdoor environments to recreate, they were less likely than men to engage in NBR. These relationships were consistent across both countries, raising concerns about gender equity in the outdoors that transcend geographical and cultural contexts.

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experiences in nature;  
leisure; green exercise;  
nature exposure

A growing body of scientific evidence indicates that nature-based recreation (NBR) improves people's health (Hartig et al., 2014; James et al., 2019; Twohig-Bennett & Jones, 2018) and enhances pro-environmental attitudes and behaviors (Larson et al., 2018; Rosa & Collado, 2019, 2020). NBR is broadly defined as leisure activities occurring in natural environments (Jackson, 1986; Larson et al., 2018; Marques et al., 2017). Examples of these activities are hiking, birdwatching, surfing, and canoeing. Despite the importance of NBR, people's experiences in nature may be diminishing for multiple reasons such as increased urbanization, growing use of electronic gadgets, and a lack of interest in nature (Larson et al., 2019; Soga & Gaston, 2016). Researchers have therefore called for efforts to better understand the drivers of and barriers to NBR (Lovelock et al., 2016). Our study examined potential antecedents of NBR, including connection to nature (CN) and recreation settings preferences (RSP), across diverse populations. We also explored how gender interacts with CN, NBR patterns and preferences of

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college students in Brazil and the U.S. This cross-cultural assessment was designed to advance understanding of associations between gender and NBR.

## **1. Literature review**

### ***1.1. Connection to nature and nature-based recreation***

CN refers to the relationship people share with nature; it is related to and often defined by individuals' beliefs, emotions, and behaviors toward nature (Mayer & Frantz, 2004; Whitburn et al., 2020). Substantial literature explores the relationship between CN and NBR (see Rosa & Collado, 2019 for a review), and many authors have suggested that CN is a key driver of NBR (Cheng & Monroe, 2012; Lin et al., 2014; Soga & Gaston, 2016). For example, Lin et al. (2014) found a positive association between CN and park visitation, concluding that CN was a more important predictor of park visitation than the distance to natural areas. Similarly, Flowers et al. (2016) determined that CN was the strongest predictor of frequent visits to local green spaces. This is in line with another study that discovered that high levels of CN are linked to higher levels of exercise and physical activity in green environments (Pyky et al., 2019). Other authors have suggested that weaker CN precipitates a "cycle of disaffection" toward nature, including NBR (Schuttler et al., 2018; Soga & Gaston, 2016). Despite these associations, little is known about the mechanisms and pathways linking CN and NBR.

### ***1.2. Recreation settings preferences and nature-based recreation***

Previous studies suggest that, compared to people with weaker CN, people more connected to nature might have a stronger preference for outdoor environments than for indoor environments (Craig et al., 2018; Taylor, 2018). For example, Craig et al. (2018) found that people with stronger CN perceive nature experiences as more pleasurable than those whose CN is weaker. Taylor (2018) documented a positive association between college students' CN and their appreciation of images of nature. In line with this idea, Tang et al. (2015, p. 595) concluded that "deeper personal connections to nature are associated with greater perceptual evaluations of sense of safety, legibility, mystery, and attentional restorativeness." These authors argue that individuals with stronger CN are likely to see natural landscapes as more attractive and fascinating than individuals with weaker CN (Tang et al., 2015). For these reasons, greater CN has been commonly associated with stronger preferences for natural environments. The link between CN and RSP might help to explain why people with high CN are more likely to engage in NBR (Nisbet et al., 2009). To our knowledge, however, no study has yet investigated direct relationships between CN, RSP, and NBR. The present study aimed to fill this gap in the literature by focusing specifically on these relationships and investigating if they are similar in Brazilian and U.S. college students. We also investigated the relationship between gender and these variables.

### **1.3. Gender and nature-based recreation**

Multiple studies suggest that women are more concerned about the environment and hold stronger pro-environmental attitudes than men (Gifford & Nilsson, 2014; Milfont & Duckitt, 2004), perhaps stemming from stronger CN. For example, in studies focused on youth, girls are often found to have a slightly stronger emotional affinity for or connection to nature than boys (Larson et al., 2010; Müller et al., 2009). Mayer and Frantz (2004) and Dean et al. (2018) also found that adult women report stronger CN than men. Possible reasons for these results vary. Some research suggests that, compared to men, women have different significant life experiences in nature that shape their CN (Miao & Cagle, 2020).

Despite these patterns, previous research has also found that women are less likely to engage in NBR than men (Soga et al., 2018; Thompson et al., 2008). Explanations for these discrepancies abound. Many have argued that gender is a key predictor of broader leisure patterns (Shaw, 1994), which influence outdoor recreation behavior. In a study of public park use, Hutchison (1994) noted that women were underrepresented and tended to engage in activities that reflect traditional gender and family roles. Women also typically face more leisure constraints than men (Henderson & Allen, 1991; Jackson & Henderson, 1995; Lovelock et al., 2016). These constraints include cultural norms and gender socialization patterns that discourage women from spending time outdoors in nature (Lee et al., 2001).

Lower NBR participation rates for women might also be a function of RSP. Men typically report stronger preferences for greener spaces, possibly because women are concerned about safety in these settings (Jorgensen et al., 2002; Thompson et al., 2008). For instance, Jorgensen et al. (2002) found that, compared to men, women believed landscapes relatively distant from urban areas were less safe, and they consequently reported a weaker preference for these areas than men. Similarly, Whiting et al. (2017) found that, in comparison to men, women often prefer developed outdoor areas over more remote natural areas, in part because they value visible management and law enforcement (Virden & Walker, 1999). However, other research on urban park preferences has revealed few gender differences (Ho et al., 2005), raising additional questions about the links between CN, RSP, NBR, and gender.

Further exploration of the relationship between gender and nature is critical because it could help to reveal strategies that facilitate NBR and CN. For example, environmental education interventions could target groups with lower CN. Additionally, managers could develop and promote activities and NBR settings that appeal to both genders and address constraints that prevent women from becoming more avid participants (Lovelock et al., 2016; Mullenbach et al., 2020).

### **1.4. Culture, college students and nature-based recreation**

Though cross-cultural environmental values have been the subject of substantial research (Oreg & Katz-Gerro, 2006; Schultz & Zelezny, 1999), relatively few studies have examined differences in NBR across countries and cultural contexts. Some work has explored cultural differences in outdoor recreation among distinct ethnic groups within the United States (Floyd & Stodolska, 2019; Sasidharan et al., 2005); other studies

have reviewed outdoor recreation patterns and preferences among European city-dwellers (Gentin, 2011). But while issues of inequities – particularly concerning gender (Ferguson, 2011) – have been the subject of a substantial body of literature focused on tourism in the Global South (Telfer & Sharpley, 2015), little academic research has focused on cross-cultural variations in NBR participation in a non-western context. When studies do focus on recreation in developing countries, they often do so in an international tourism context (Nahuelhual et al., 2013; Shrestha & Loomis, 2001) and rarely consider the activities of residents in the Global South, with a few exceptions (e.g. Magi, 1999). Our research attempted to address this gap in the literature by using two parallel studies to explore relationships among CN, RSP, and NBR participation for male and female college students in Brazil and the United States.

Brazil and the United States are interesting places to initiate such an investigation for several reasons. First, Brazil and the United States contain very diverse populations, and therefore a wide range of recreation and leisure preferences. Second, both countries are known for expansive and attractive park systems that provide numerous NBR opportunities (Avila & Rosa, 2018; James et al., 2019). Third, both countries contain large populations of college students, a vulnerable population that stands to benefit substantially from enhanced NBR.

Furthermore, it should be acknowledged that studying for a college degree can have severe impacts on people's mental health (Evans et al., 2018; Ross et al., 1999). Many studies have examined how recreation activities can benefit the mental health of college students, but a majority of this research has centered on campus-based facilities such as recreation centers (Miller, 2011) or organized outdoor orientation programs (Vlamis et al., 2011). However, some research is beginning to demonstrate that leisure time participation in nature-based outdoor activities can also impact multiple dimensions of students' psychological well-being (Wolsko & Lindberg, 2013). Because many forms of NBR have the potential to improve mental health (Corazon et al., 2019), understanding the drivers of NBR among college students is especially relevant for anyone hoping to promote more active, healthy lifestyles.

### **1.5. Research questions**

Within the context described above, our study specifically focused on the following research questions (RQ) within populations of college students in both Brazil and the United States: (1) Are there associations among CN, RSP, and NBR participation across both countries? (2) Are there gender differences in CN, RSP, and NBR participation across both countries? And (3) are the associations examined under RQ1 and RQ2 consistent across countries. Hypotheses for RQ1 and RQ2 were based on previous studies. Specifically, we predicted that stronger CN would be positively associated with preference for outdoor settings and that this preference will be positively associated with NBR participation (Table 1). We also predicted that, while women would hold higher levels of CN than men and might report similar RSP, they would engage less regularly in NBR (Table 1). Because RQ3 was more exploratory and we did not have any reason to believe that the associations investigated differ across countries, we adopted the hypothesis that the associations in RQ1 and RQ2 would be consistent across countries

**Table 1.** Research questions and hypotheses.

Research questions (RQ)	Hypotheses (H) description
RQ1: Are there associations among CN, RSP, and NBR participation?	H1a. People with higher CN are more likely to prefer to recreate in outdoor environments than people with lower CN; H1b. People who prefer to recreate in outdoor environments are more likely to engage in NBR than people who prefer not to recreate in outdoor environments.
RQ2: Are there gender differences in CN, RSP, and NBR participation?	H2a. Women hold higher levels of CN; H2b. Women and men have similar RSP. H2c. Women engage less regularly in NBR than men;
RQ3: Are the associations tested under RQ1 and RQ2 consistent across student samples in both countries?	H3. The associations tested under RQ1 and RQ2 are consistent across both countries.

Note: CN = Connection to nature; RSP = Recreation setting preferences; NBR = Nature-based recreation.

(Table 1). After examining the first two research questions in the Brazilian sample; we then evaluated these same questions in the U.S. sample. Finally, we addressed the third research question by examining the datasets together.

## 2. Study 1: College students in Brazil

### 2.1. Method

#### 2.1.1. Participants and study site

Participants were 224 undergraduate students (62.5% women; Mean age = 23.6 years old,  $SD = 5.96$ ) from a university in Ilhéus, Bahia (northeastern Brazil). They were enrolled across a diverse array of courses (e.g. biology, pedagogy, law, physical education, geography, and economics). The region where the study took place is known for its natural beauty (e.g., beaches, parks, forest, green urban areas, and rivers) and opportunities for NBR (e.g., swimming at the beach, visiting green parks, camping, hiking, and fishing). For example, close to the university campus, the students had easy access to two large open spaces for recreation activities (one grass, the other sand), forest trails, and manicured green spaces.

#### 2.1.2. Data collection

We assessed key variables through an anonymous online survey administered via Google Forms. A link to the survey was emailed and it could be completed only once from each unique IP address. The secretaries of each university course were asked to send the link to enrolled students. A response rate could not be estimated because the number of students who viewed the link is unknown. Data were collected between June and August of 2017. Participation was voluntary and incentives for participation were not provided. To ensure that participants came from the university where the study took place and were 18 years old or above, participants' responses were checked individually before transferring the data to IBM SPSS 21 for analysis.

#### 2.1.3. Measures

*Connection to Nature (CN)*: We used a 13-item Brazilian version (Pessoa et al., 2016) of Mayer and Frantz (2004) Connectedness to Nature Scale (CNS). The unidimensional

structure of this scale has been confirmed (Pessoa et al., 2016). It is a Likert-type, five-point scale rated from 1 = strongly disagree to 5 = strongly agree. Cronbach's alpha for the 13-item scale was = .82 (Revelle's  $\omega = .86$ ).

*Recreation setting preferences (RSP):* We assessed RSP among participants through the following question: "Do you prefer to spend your leisure time indoors (e.g. home, cinema, bar) or outdoors (e.g. beach, square, street)?" Answers were registered as 1 = indoors; 2 = I do not have any preference; 3 = outdoors.

*Nature-based recreation (NBR) participation:* Following previous studies (Larson et al., 2011), NBR participation was assessed by the following question: "Do you regularly practice any leisure activities that involve contact with nature?" Answers were coded as 1 = no; 2 = yes.

*Gender:* Gender was self-reported by participants with the following options: woman (coded as 1) and man (coded as 2). Participants could leave this question unanswered if they felt the two options did not represent their gender. Nonetheless, all participants answered this question.

#### 2.1.4. Data analysis

First, we examined descriptive statistics. Then, we addressed the main hypotheses of the study. In both samples (Study 1 and 2), assumptions for tests were checked before running the analyses. Skewness and kurtosis of each variable were checked to ensure that the data are approximately normally distributed. The assumption of homogeneity of variances and the possible influence of outliers were checked before *t*-tests and regression analyses (Erceg-Hurn et al., 2013). The assumptions of the chi-squared tests were examined by looking at the outputs recommended by Dancey and Reidy (2006). These assumptions were not a concern for any analysis. Following Cumming's (2014) recommendations, our interpretation of results focused more on effect sizes, using *p* values not as a dichotomized threshold but as a likelihood indicator. This means that, when confidence intervals overlap zero, we interpreted the most likely direction of the result (Cumming, 2014).

With Brazilians, hypotheses were tested using Chi-square tests and Student's *t*-tests. For tests where the assumption of equal variances was violated, we used *t*-tests where equal variances were not assumed (Dancey & Reidy, 2006). For CN, we created four quartiles based on participants' mean scores for the CNS and tested if there was an association between these quartiles and participants' RSP (H1a). The cut points for the quartiles were: first  $\geq 4.15$ ; second  $\geq 3.85$  (but less than 4.15); third  $\geq 3.54$  (but less than 3.85); fourth  $< 3.54$ . We classified participants in these quartiles as "most connected," "very connected," "connected," and "least connected," respectively. H1b was tested by a  $3 \times 2$  Chi-square test examining the association between RSP and NBR participation. H2a was examined by performing Student's *t*-tests to assess differences between men and women's CN. H2b was examined using a  $2 \times 3$  Chi-square test to check the association between gender and RSP. H2c was examined using a  $2 \times 2$  Chi-square test to check the association between gender and NBR participation.

We report Cramer's *V* (ranging from 0 to 1) and its 95% confidence interval (based on 1000 bootstrap samples) as an effect size for all Chi-square tests. The interpretation of the size of Cramer's *V* depends on the degrees of freedom of the analysis (Cohen,

**Table 2.** Mean and standard deviation of connection to nature, recreation setting preferences (RSP), and nature-based recreation (NBR) across gender for college students in Brazil.

Variables	Gender	
	Men (N = 84)	Women (N = 139)
Connection to nature (CN) <sup>a</sup>	3.71 (0.55)	3.89 (0.51)
Prefer to recreate indoors (indoor RSP)	26.2%	15.1%
No preference (neutral RSP)	32.1%	39.6%
Prefer to recreate outdoors (outdoor RSP)	41.7%	45.3%
Regularly engage in NBR	57.1%	40.3%

Note: <sup>a</sup>Multi-item scale rated from 1 = strongly disagree to 5 = strongly agree. Mean (SD) is presented for CN.

1988). For *t*-tests, we report Cohen's *d* as a measure of effect size and its 95% confidence intervals, calculated using the Effect Size Calculators available at <https://effect-size-calculator.herokuapp.com/>. Following Sawilowsky (2009), Cohen's *d* is interpreted as: 0.01 = very small, 0.2 = small, 0.5 = medium, 0.8 = large, 1.2 = very large, and 2.0 = huge.

## 2. 2. Results

### 2.2. 1. Descriptive statistics

Participants held a medium-high CN ( $M = 3.82$ ,  $SD = 0.53$ ). Of the 223 participants (one missing value), 19.3% of them prefer to recreate indoors, 36.8% of them did not have any preference, and 43.9% of the participants prefer to recreate outdoors. Almost half of the participants (46.6%) regularly engage in NBR. The mean and standard deviation of these variables by gender are shown in Table 2.

### 2.2. 2. Research question 1: Are there significant associations among connection to nature, recreation setting preferences, and nature-based recreation participation?

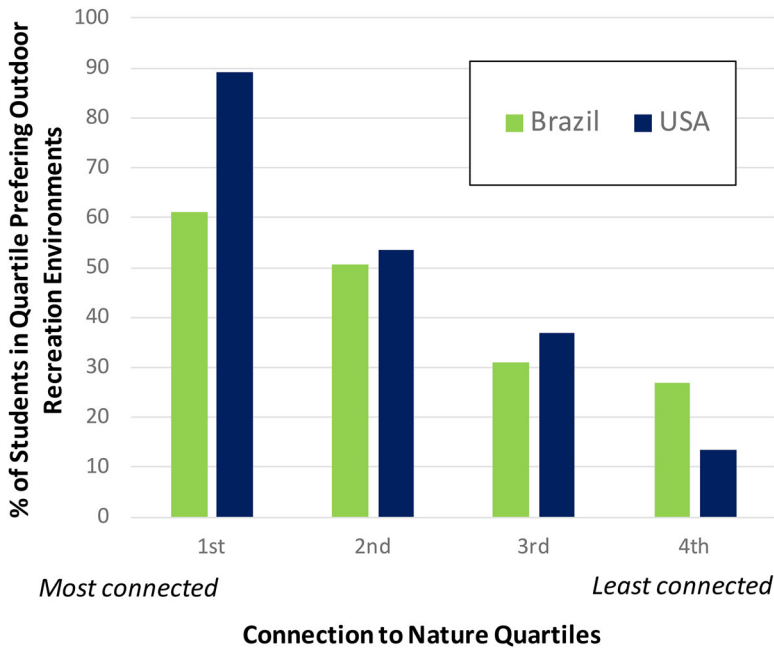
We found a strong association between participants' CN and their RSP (H1a),  $N = 223$ ,  $\chi^2(6) = 22.49$ , Cramer's  $V = .23$  [.16, .33],  $p = .001$  (Figure 1). A also strong association was found when we included in the analysis only individuals in the first and fourth CN quartile,  $N = 111$ ,  $\chi^2(2) = 16.76$ , Cramer's  $V = .39$  [.23, .56],  $p < .001$ .

We observed a moderate association between participants' RSP and their engagement in NBR (H1b),  $N = 223$ ,  $\chi^2(2) = 23.69$ , Cramer's  $V = .33$  [.21, .44],  $p < .001$ . Participants who preferred outdoor recreation environments were more likely to regularly engage in NBR than participants who did not prefer outdoor recreation environments (Figure 2).

### 2.2.3. Research question 2: Are there gender differences in connection to nature, recreation setting preferences, and nature-based recreation participation?

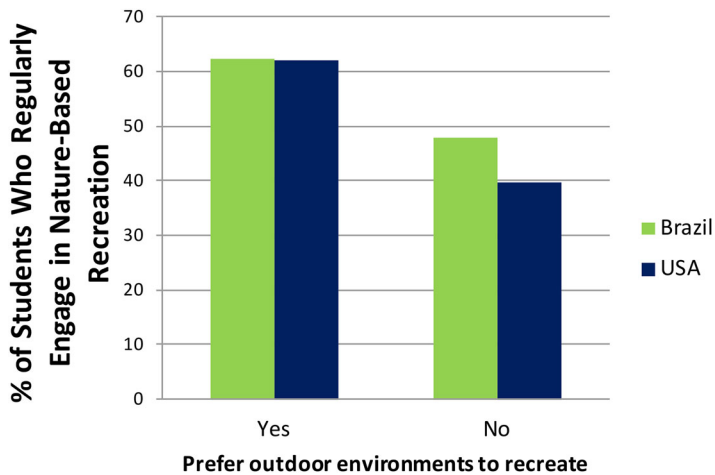
Women expressed stronger connection to nature ( $M = 3.89$ ,  $SD = 0.51$ ) than men ( $M = 3.71$ ,  $SD = 0.55$ ; H2a), but this difference was small,  $t(222) = 2.47$ , Mean difference = 0.18, CI [0.04, 0.32],  $p = .014$ ,  $d = 0.34$  [0.07, 0.61].





**Figure 1.** Relationship between connection to nature (CN) and outdoor recreation setting preferences (RSP) in Brazil ( $N = 223$ ) and the United States ( $N = 202$ ).

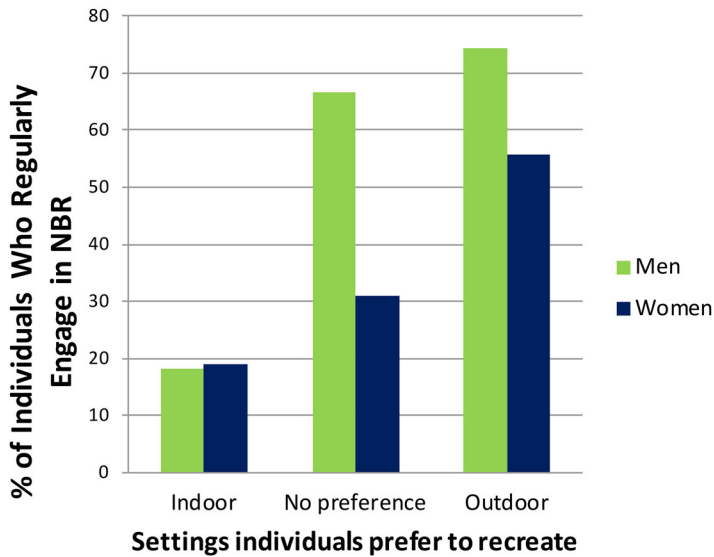
Note: In the U.S sample, RSP data were dichotomized to favor comparison with the Brazilian sample. RSP scores  $> 4$  were considered as a preference for outdoor environments to recreate.



**Figure 2.** Relationship between outdoor recreation setting preferences (RSP) and NBR participation in Brazil ( $n = 223$ ) and the United States ( $n = 202$ ).

Note: In the U.S sample, data were dichotomized to favor comparison with the Brazilian sample. Regular engagement in NBR consisted of 2 or more hours of outdoor time on an average day, and RSP scores  $> 4$  were considered as a preference for outdoor environments to recreate.

Women presented a slightly higher preference (45% vs 42% of men) for outdoor environments to recreate, and a lower preference (15% vs 26% of men) for indoor environments to recreate (H2b),  $N = 223$ ,  $\chi^2(2) = 5.98$ , Cramer’s  $V = .14$  [.04, .28],  $p = .12$ .



**Figure 3.** Relationship between recreation setting preferences (RSP) and nature-based recreation (NBR) by gender in Brazil.

Finally, we found a weak association between gender and engagement in NBR (H2c),  $N=223$ ,  $\chi^2(1) = 4.280$ , Cramer's  $V = .16[.05, .29]$ ,  $p = .014$ . Most men regularly engage in NBR (57%), whereas fewer women (40%) regularly engage in NBR.

The results above show that men and women have similar preferences for outdoor environments to recreate; however, compared to men, women reported lower NBR participation. Based on these results, we checked if the relationship between preferences and participation differed across genders. We found that the association between these variables was stronger among men ( $N=84$ ,  $\chi^2(2) = 18.836$ , Cramer's  $V = .47[.28, .66]$ ,  $p < .001$ ) than among women ( $N=139$ ,  $\chi^2(2) = 12.054$ , Cramer's  $V = .29[.16, .45]$ ,  $p = .002$ ). Graphical analysis shows that when women and men prefer indoor environments to recreate both rarely engage in NBR (Figure 3). However, when women and men have no specific RSP, men's NBR participation is higher than women's. Finally, when both men and women prefer outdoor environments to recreate, men's NBR participation was higher than women's.

### 3. Study 2: College students in the United States

#### 3.1. Method

##### 3.1.1. Participants and study site

In our second study, participants were 207 undergraduate students (43.7% women; 91.1% ages 18-24 years) from two large public universities in different parts of the United States: 114 from a university in North Carolina and 93 from a university in Arizona. Though both universities were located in large cities, the campuses were surrounded by ample open space and NBR opportunities, including easy access to many nearby parks and greenways. Participants were enrolled in intro-level classes attracting a

**Table 3.** Mean (*M*), standard deviation (*SD*), and internal consistency of the connection to nature (CN) and recreation setting preferences (RSP) scales (*N* = 202).

Items	<i>M</i>	<i>SD</i>
<b>CN (<math>\alpha = .85</math>; Revelle's <math>\omega = .86</math>)</b>	<b>3.73</b>	<b>0.88</b>
I feel very connected to all living things and the Earth	3.55	0.98
My relationship to nature is an important part of who I am	3.63	1.08
I think about how what I do affects the Earth	4.00	0.95
<b>RSP (<math>\alpha = .88</math>; Revelle's <math>\omega = .89</math>)</b>	<b>4.08</b>	<b>0.84</b>
I enjoy being outside in nature	4.39	0.75
My favorite places are outside in nature	4.04	0.98
I spend time outdoors whenever I can	3.81	1.05

diverse array of students from various majors and disciplines. Seventy percent of students were white, 6% were African American, 11% were Latino, and 9% were Asian.

### 3.1.2. Data collection

We assessed key variables through an anonymous online survey administered via Qualtrics. A link to the survey was emailed and it could be completed only once from each unique IP address. Course instructors sent the link to all students enrolled in the course in December 2018, and students were asked to complete the questionnaire outside of class time. As in Brazil, because it is not clear how many students viewed the link across multiple entry-level classes, a response rate could not be estimated. Participation was voluntary and incentives for participation were not provided. Following survey completion, incomplete survey responses (8 total) were excluded and the full sample of completed surveys (*N* = 207) was transferred to IBM SPSS 25 for analysis.

### 3.1.3. Measures

Before describing the measures used in the U.S. sample, it should be noted that these metrics differed somewhat from those used in Brazil. This was because both studies were independently conceptualized and executed before synthesis. Nevertheless, because the overarching constructs were compatible (even if their operationalization differed to some degree), we were still able to compare responses and associations across both countries.

*Connection to Nature and Recreation Setting Preferences:* In the U.S. sample, we measured CN and RSP by adapting items on the nature-relatedness (NR) scale developed by Nisbet et al. (2009). We focused on subsets of items used to assess NR-self, a proxy for CN, and NR-experience, a proxy for RSP (Nisbet & Zelenski, 2013). All Likert-type items were rated on a scale from 1 = strongly disagree to 5 = strongly agree. Each scale has three items. The content, mean, standard deviation, and internal consistency of these items are exhibited in Table 3.

*Nature-based Recreation Participation:* We measured NBR participation using the following two items adapted from previous time use studies (Larson et al., 2011; Larson et al., 2019): (1) In an average weekday, about how many hours per day do you spend outdoors in nature (in a park, a forest, a green space with trees, etc.)?; and (2) in an average weekend day, about how many hours per day do you spend outdoors in nature (in a park, a forest, a green space with trees, etc.)?. Responses to both questions were rated on sliding scales with continuous increments up to 8 hours. To calculate average

nature-based time per day, we multiplied the weekday value by five, added the weekend value multiplied by two, and divided by 7 days per week.

*Gender:* Gender was self-reported by participants with the following options: Male, Female, and Not listed.

### 3.1.4. Data analysis

As in Brazil, we examined descriptive statistics before moving to address the main hypotheses of the study and followed Cumming's (2014) recommendations to interpret results based more on effect sizes, using  $p$  values and confidence intervals not as a dichotomized threshold but as a likelihood indicator. We tested our first two hypotheses (H1a, H1b) using the mean score of CN, RSP, and NBR participation in a linear regression model (Hayes, 2018). Gender differences between these variables (H2a, H2b, and H2c) were assessed through Student's  $t$ -tests (Dancey & Reidy, 2006). Regarding the linear regression analyses, we reported  $R^2$  as a measure of effect size and its 95% confidence interval, which was calculated using the Free Statistics Calculators version 4.0 available at <https://www.danielsoper.com/statcalc/calculator.aspx?id=28>. We followed Cohen's (1988) recommendation to interpret Pearson's  $r$ : 0.1 to 0.3 = small, 0.3 to 0.5 = medium and  $\geq 0.5$  = large.

Although our U.S. data included more scaled variables than the Brazilian data, we also made an effort to split scores into quartiles (for CN) or binary high vs. low groupings (for RSP and NBR participation) in most analyses to mimic the approach used in Brazil. For example, cutoff points for our four CN quartiles used in the analysis were scale means of  $\leq 3.0$  (fourth quartile),  $\leq 3.67$  (third quartile),  $\leq 4.33$  (second quartile),  $\leq 5$  (first quartile). Because students tended to cluster around certain scores on the 3-item scale, students were not equally distributed across quartiles. We assumed that individuals with mean scores of greater than 4.0 on the RSP scale had strong NBR preference (with scores of 4 or lower representing weaker NBR preference). As there is no agreement regarding what regular NBR is, we decided to divide high and low levels of NBR based on the median value in our sample (1.97 hours on an average day). We defined regular (or avid) engagement in NBR as 2 or more hours per day and assumed that individuals who participated in less than 2 hours per day were not regular participants.

## 3.2. Results

Overall CN scores for the pooled sample were relatively high ( $N=203$ ,  $M=3.73$ ,  $SD=0.88$ ). Preference for outdoor environments to recreate in the sample was also strong ( $N=203$ ,  $M=4.08$ ,  $SD=0.84$ ). Students reported a wide range of average time outdoors in nature each day, ranging from 0 to 7.29 hours. On weekdays, the average reported time outdoors was 2.25 hours; on weekends, it was 2.73 hours. Overall, students reported a mean of 2.42 hours outdoors per day ( $N=198$ ,  $SD=1.57$ ) with a median value of 1.97 hours; 50% of students engaged in less than 2 hours per day, and 17% of students were outdoors for 1 hour or less. The mean and standard deviation of these variables are detailed for men and women in Table 4.

**Table 4.** Mean and standard deviation of connection to nature (CN), recreation setting preferences (RSP), and nature-based recreation (NBR) across gender for college students in the United States.

Variable	Gender			
	Men (N = 112)		Women (N = 87)	
	M	SD	M	SD
can	3.49	0.88	4.02	0.81
Outdoor RSP <sup>a</sup>	3.99	0.84	4.23	0.80
NBR participation (hours per day)	2.60	1.72	2.15	1.29

<sup>a</sup>Multi-item scale rated from 1 = strongly disagree to 5 = strongly agree.

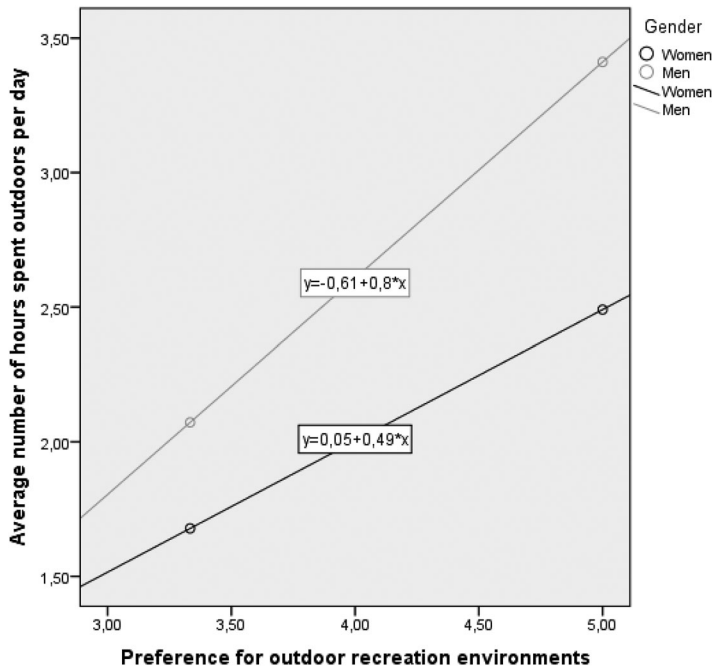
### 3.2.1. Research question 1: Are there significant associations among connection to nature, recreation setting preferences, and nature-based recreation participation?

We observed a strong and positive association between CN and RSP (H1a),  $F(202) = 131.761$ ,  $B = 0.60$ ,  $CI [0.50, 0.70]$ ,  $R^2 = .40[.29, .50]$ ,  $p < .001$ . This means that an increase of a unit in CN is associated with an increase of 0.60 in RSP, and that 40% of the variance in RSP is explained by CN. We observed a small to moderate and positive association between RSP and NBR participation (H1b),  $F(197) = 16.271$ ,  $B = 0.54$ ,  $CI[0.26, 0.80]$ ,  $R^2 = .08[.01, .15]$ ,  $p < .001$ . This means that an increase of a unit in RSP is associated with an increase of 0.54 hours (or 32 minutes) in NBR participation per day and that RSP explains 8% of the variance in NBR participation.

### 3.2.2. Research question 2: Are there gender differences in connection to nature, research setting preferences, and nature-based recreation participation?

Women in the U.S. sample reported higher CN scores than men (H2a),  $t(197) = 4.42$ , Mean difference = 0.53,  $CI[0.30, 0.77]$ ,  $d = 0.63[0.34, 0.92]$ ,  $p < .001$ . U.S. women also held slightly stronger preferences for NBR than men (H2b),  $t(197) = 2.05$ , Mean difference in RSP = 0.24,  $CI[0.01, 0.47]$ ,  $d = 0.29[0.01, 0.57]$ ,  $p = .041$ . However, men reported higher levels of NBR participation on a daily basis (H2c),  $t(192) = -2.12$ , Mean difference =  $-0.46$ ,  $CI[-0.88, -0.03]$ ,  $d = -0.30[-0.58, -0.01]$ ,  $p = .036$ .

Similar to the Brazilian sample, these results suggest that the relationship between RSP and NBR participation varies by gender. More specifically, although women in the U.S. sample reported stronger preferences for outdoor recreation than men, they reported lower levels of actual NBR participation. Thus, we decided to examine whether gender moderates the relation between RSP and NBR participation using the macro PROCESS written by Andrew Hayes. Following the suggestion of Rosopa et al. (2013) to reduce the impact of heteroscedasticity, we used the HC4 heteroscedasticity-consistent estimator developed by Cribari-Neto. The results suggest a weak moderation effect:  $N = 194$ , Interaction Coefficient = 0.32,  $CI[-0.16, 0.79]$ ,  $R^2_{\text{change}} = 0.01$ ,  $p = .19$ , but they are inconclusive. The plot of the moderation analysis (Figure 4) shows that, for men and women, a higher preference for outdoor environments to recreate is associated with higher NBR participation. Similar to findings with Brazilians, the plot also shows a stronger correlation between these variables for men.



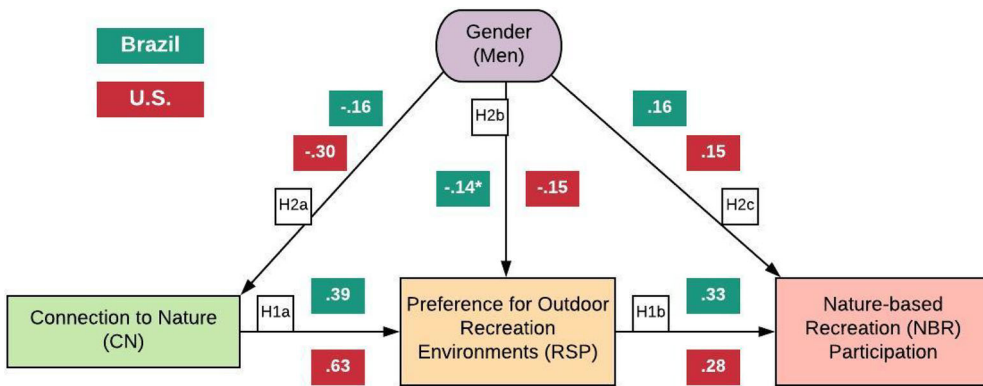
**Figure 4.** Relationship between outdoor recreation setting preferences (RSP) and nature-based recreation (NBR) participation with the U.S data ( $N = 194$ ), by gender.

#### 4. Research question 3: Are the associations tested under RQ1 and RQ2 consistent across college student samples in both countries?

We addressed H3 by checking the pattern of association between our variables of interest (i.e. CN, RSP, NBR participation, and gender) across countries. The integration of the student samples from Brazil and the United States allowed us to examine correlations and visually compare gender differences across countries. For example, in both countries: individuals with higher CN tended to prefer outdoor environments to recreate more than individuals with lower CN; individuals who preferred outdoor environments to recreate were more likely to engage in NBR; women were less likely than men to engage in NBR; and, the relationship between RSP and NBR participation appeared to be stronger for men than women. These similarities in findings and patterns across both the Brazilian and the U.S. student samples were also supported when comparing the data from both countries (Figures 1 and 2; U.S. data were dichotomized *ad hoc* to favor comparability with Brazilian data). Despite the notable difference in the measures used in the two studies, effects sizes were also similar (Figure 5).

## 5. Discussion

Our study revealed similar relationships between CN, RSP, and NBR participation among college students in Brazil and the United States. We found that, across both countries, higher CN was associated with stronger preferences for recreation in outdoor environments. These preferences, in turn, were associated with higher levels of NBR participation. In line with previous studies, results suggest a potentially cyclical relationship



**Figure 5.** Diagram presenting the effect sizes for hypothesized associations (see Table 1) among connection to nature (CN), outdoor recreation setting preferences (RSP), NBR participation, and gender across both countries. Cramer's  $V$  was used with the Brazilian data (except for H2a, where Pearson's  $r$  was used), and Pearson's  $r$  was used with the U.S. data. \*Although Cramer's  $V$  is always positive, the negative sign was used in H2b to enhance interpretation as descriptive statistics show that women in Brazil (as in the U.S.) have a higher preference for outdoor recreation environments than men.

between CN, RSP, and NBR participation (Rosa & Collado, 2019; Schuttler et al., 2018). CN has been linked to time spent outdoors in previous studies (Larson et al., 2019), even when controlling for variables such as gender (Cleary et al., 2020). Our results suggest this relationship might be mediated by shifts in preferences for environments to recreate. In other words, CN boosts people's preferences for outdoor environments which, in turn, stimulate NBR participation. When individuals engage in NBR, those connections and preferences are reinforced (Collado et al., 2017; Rosa & Collado, 2019; Schuttler et al., 2018). Interventions designed to foster any component of this system (CN, RSP and NBR participation) could, therefore, influence the other components as well, helping individuals combat their "extinction of experience" (Schuttler et al., 2018; Soga & Gaston, 2016) and enjoy the health benefits associated with time in nature (Hartig et al., 2014).

Importantly, we discovered gender differences concerning CN, RSP, and NBR participation, and the patterns were remarkably similar across countries. In both Brazil and the United States, women college students reported higher levels of CN. As previously noted, some studies of youth have found that girls display stronger emotional affinity toward nature than boys (Larson et al., 2010). Perhaps this is why, in both samples, women were also more likely to prefer outdoor environments to recreate than men. Nonetheless, the correlation between gender and RSP was relatively weak and, among Brazilian students, the confidence interval for this correlation overlaps zero. Despite this, higher levels of CN and generally higher levels of outdoor RSP for women in both samples raise an important question: why were women across both countries less likely to engage in NBR? This finding, which has been noted in other contexts (e.g. Thompson et al., 2008), raises concerns about the equitable distribution of NBR opportunities and how the health benefits linked to these activities might vary by gender (Richardson & Mitchell, 2010).

Existing research on gender differences in outdoor recreation offers one explanation: adult women face more recreation constraints than men (Jackson & Henderson, 1995), especially when it comes to NBR (Lovelock et al., 2016; Thompson et al., 2008). For example, many women may not feel comfortable outdoors due to their fear of crime or because they have

less free time due to other tasks (Jackson & Henderson, 1995; Keane, 1998). Inadequate facilities and information, and the threat of outdoor pests are other reasons why women may be more likely to stay indoors than men (Johnson et al., 2001; Shores et al., 2007). These patterns might result from different gendered social norms regarding interactions with outdoors (Christian et al., 2017), as well as media representations that perpetuate gender socialization and discourage women from participating in NBR (McNiel et al., 2012). Unequal power relationships in male-dominant outdoor recreation professions could also discourage female participants (Warren, 2016). While all of these barriers to women's outdoor recreation have been previously studied, very rarely have they been investigated across cultural contexts. Our work suggests that, whether a woman is a college student in Brazil or the United States, they likely face more constraints to NBR participation than men. Addressing these social and cultural constraints is one solution for encouraging women's participation in NBR (Mullenbach et al., 2020).

### **5.1. Future research and limitations**

This study raises many questions about how women interact with the outdoors. What specific barriers prevent women from engaging in NBR as often as they would like? How might those barriers be addressed? Given the inter-country similarities in patterns observed, to what extent must these interventions adapt to different cultural contexts? Such questions highlight numerous future research opportunities, and additional work in this area could also address several limitations of our study.

First, we relied on cross-sectional data collected from convenient, non-probabilistic samples of undergraduate students. Data were collected through online surveys, and we were unable to calculate response rates or gather any information from non-respondents. Thus, it is uncertain whether students who took part in the study were substantially different from students that did not participate. Therefore, while our approach provides important insights regarding NBR and its antecedents, it limits causal inferences and generalization of the results to a broader population of college students. Future studies can advance our results by replicating our findings with a larger and more representative sample of students. They might also integrate a mediation analysis to check for possible causal relationships between variables investigated in this study. This mediation analysis should be based on longitudinal data, ideally, from a randomized controlled trial/experiment, to facilitate inferences about causality (Hayes, 2009). Furthermore, as some college students may change their place of residence after graduating, their NBR participation and connection to the outdoors is likely to change as well as access to nature shifts. Longitudinal studies would help to confirm if the relationships found in this study persist over time.

Second, Brazil and the U.S. are two large countries with vastly different geographic regions, and our study only focused on a few specific regions within these two countries. Thus, we cannot ensure that similar results would be found in other geographical and/or cultural contexts within these two countries, not to mention other countries. Future research across different regions and populations would help to illuminate the prevalence of these NBR-related associations and patterns across diverse contexts.

Third, the use of general measures of NBR participation precludes inferences about specific nature-based leisure activities. Future research could, therefore, test our



hypothesized relationships while considering specific outdoor activities. We should also reiterate that our study employed different measures to operationalize key constructs (CN, RSP, and NBR) across different countries. The unique metrics were intentionally selected to match the cultural context and were relevant to different research groups. For instance, the only validated measure of CN within a Brazilian sample is the CNS, so we opted to use that tool instead of others. Moreover, in Brazil, we were particularly interested in understanding if undergraduate students simply participated in NBR, whereas in the United States there was a greater interest in students' total time spent outdoors. Although the use of distinct measures reduced our ability to make direct comparisons between countries, our results suggest that the identified associations may not be dependent on specific measures.

Fourth, the  $p$  values of two analyses – the correlation between RSP and gender in the Brazilian sample and the moderation effect of gender on the RSP-NBR relationship in the U.S. sample – were relatively high (0.12 and 0.19, respectively). As a result, we cannot be highly confident about the direction of these associations. While the similar relationships found across countries increase the confidence in conclusions related to these analyses and all observed patterns, future studies with larger sample sizes could provide more precise estimates and validate our results.

## **5.2. Conclusion**

Given the benefits of NBR for both human health and nature conservation (James et al., 2019; Rosa & Collado, 2019; Twohig-Bennett & Jones, 2018), researchers and practitioners are increasingly interested in understanding the drivers of NBR (Lovelock et al., 2016). Our current study helps to explain the commonly reported link between CN and NBR by suggesting that CN enhances individuals' preferences for recreation in outdoor environments, which in turn fuels NBR participation. Our comparison of CN, RSP, and NBR participation among men and women at universities in two countries highlights potential pathways to promoting NBR. Findings were remarkably similar across both countries, and reveal notably different yet culturally consistent patterns among men and women. Compared to men, women in both countries reported higher levels of CN and slightly higher preferences for outdoor environments to recreate, but lower engagement in NBR. These results suggest that studies concerned with environmental justice in outdoor recreation, often focused on race/ethnicity (Floyd & Johnson, 2002; Floyd & Stodolska, 2019), should also include gender. Our work highlights the need to address prominent constraints and develop interventions that help women to enjoy positive experiences in the outdoors.

## **Conflict of interest**

The authors declare they have no conflict of interest.

## **Data availability statement**

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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