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Factors influencing likelihood of participation in green social prescriptions in an international sample

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Abstract

Green social prescriptions (GSPs) include interventions designed to combat sedentary behavior and preventable diseases by leveraging the benefits of nature-based physical activity. As these programs are still evolving, there is limited data regarding the likelihood of participation from an international perspective. This study examined factors influencing participation likelihood in GSPs across various geographic contexts, levels of greenness, nature-relatedness, well-being, and socio-demographic variables. We conducted an online, cross-sectional survey with 2,467 participants from Australia, India, Singapore, the United Kingdom, and the United States in September 2022. Participants reported their likelihood of participating in GSPs with four distinct outcomes, and we calculated an aggregate participation likelihood score. We used linear regression models to analyze associations between variables and participation likelihood, including models stratified by gender and country. Results showed that a more positive attitude towards nature was the strongest predictor of participation likelihood. Positive associations were found with educational attainment, financial comfort, and time spent in greenspace, while male gender and better well-being were linked to lower participation likelihood. Some differences in associations were revealed when stratified by country. An interaction between urban setting and greenness indicated that individuals in greener urban areas, particularly males, were less likely to feel the need for GSPs. These findings highlight that GSPs are likely to reach people who already share positive attitudes towards nature. Results indicate targeted interventions may be useful for individuals with less favorable attitudes towards nature, and males in particular, to increase likelihood of participation. Further research should explore cultural differences and the impact of health status on GSP participation. Understanding these factors can inform more equitable and effective GSP implementation.

Keywords*: Green social prescriptions, NR-6, NDVI, urban greenness, well-being*

Green Social Prescriptions (GSPs), also known as park prescriptions or nature prescriptions, are gaining popularity as interventions to address the high burden of chronic disease and to increase physical activity (Kondo et al., 2020). These programs are typically designed in collaboration with public land agencies, health care providers, and community partners to improve individual and community health. GSPs are an accessible and low-cost supplement to routine medical care, usually involving a physician or other healthcare provider giving patients a written recommendation for visits to natural settings such as a local park or garden for recreation (Ivers & Astell-Burt, 2023). Activities prescribed can include forest bathing (Ideno et al., 2017), community gardening (Howarth et al., 2020), and nature walking groups (Olcoń et al., 2023), among others.

Emerging evidence indicates that contact with nature can have a multifaceted positive impact on health by promoting healthy behaviors such as physical activity and social interaction (Bowler et al., 2010, Kondo et al., 2018, Nguyen et al., 2021). Being in nature has beneficial effects on cardiovascular health and is linked to a reduced risk of anxiety, loneliness, and depression (Astell-Burt et al., 2022; Nguyen et al., 2023). GSPs align with well-established frameworks for restorative and therapeutic environments, as natural environments can enhance mental health and offer a respite from the demands and stressors of daily life (Kaplan & Kaplan, 1989; Roe & McCay, 2021). Integrating nature-based activities into healthcare strategies provides an opportunity to improve overall population well-being and aids in the prevention and management of various health issues.

However, patient uptake or adherence to GSPs is not necessarily a given; there can be various influences on engagement in prescribed nature activities. Two theories, the Health Belief Model (HBM) and the Theory of Planned Behavior (TPB) provide useful guidance on factors that may affect participation in GSPs. The Health Belief Model (HBM) was developed to explain and predict preventative health behavior by considering individual actor perceptions, potentially modifying behaviors, and likelihood of action (Hochbaum et al., 1952). According to the HBM, perceived benefits are predictors of health behaviors. Prior research has found that for patients to enroll in a GSP they must first believe that the intervention will benefit them (Husk et al., 2020). Therefore, the HBM suggests that those with better subjective health or well-being may perceive a GSP to be less beneficial than those with poorer health, which is worthy of further exploration.

The Theory of Planned Behavior (TPB) (Ajzen, 1991) holds that attitudes, subjective norms, and perceived behavioral control are primary factors in the intention to engage in a desired behavior. In the context of GSPs, prior research has found that those more connected with nature are more likely to seek out opportunities to be in nature (Flowers et al., 2016, Nisbet et al., 2009), and therefore attitudes towards nature, or nature-relatedness, may contribute to willingness to participate in a GSP.

According to both models, subjective norms and cues to action, for example, others around you engaging in certain actions and one's surroundings, can influence health behaviors. Urban environments are considered less green than rural environments, and urban greening and the associated health benefits receive much attention (Gianfredi et al., 2021). To the contrary, rural environments, which are often considered as having ample access to greenspace, often have poor population health (Dong et al., 2024). Therefore, one's location of residence (for example in an urban, suburban, or rural setting), and proximity to or exposure to greenspace, may influence their participation in a GSP.

As GSPs are being implemented in many countries (e.g., the NHS Green Social Prescribing in England and ParkRx in the United States), examining these programs from an international perspective provides a broader understanding of the contextual and cultural factors influencing participation. For instance, studies exploring perceptions and use of urban greenspace in India and South Africa each highlight that such perceptions and use vary by age, income, and employment status (Lahoti et al., 2023, Shackleton & Blair, 2013). By exploring if these findings also translate into the demographics of those more and less inclined to engage in GSPs, providers can tailor programs more effectively.

Because GSPs are growing in popularity across the globe, there is a need for research on the factors that promote the success of these programs, including factors relating to participation. This study sought to gain additional insight into GSPs by exploring the likelihood of participation in relation to geographic context, proximal greenness, attitudes towards nature, and well-being, along with socio-demographic variables. We further tested interaction effects between local greenness and setting to determine if participation likelihood differs by setting-dependent greenness. Associations were explored across genders and different cultural contexts in Australia, India, Singapore, the United Kingdom, and the United States.

Methods

Study Design

A survey of cross-sectional design was administered to English-speaking adults (over 18 years of age) residing in Australia, India, Singapore, the United Kingdom (UK), and the United States (USA) via a Qualtrics XM (Salt Lake City, UT, USA) panel. This project was initiated via international seed funding from universities in three of the five countries (Australia, UK, and USA). Singapore was added due to well-known greening and nature prescription efforts (Müller-Riemenschneider et al., 2020) and a high proportion of English speakers. India was added for a low and middle-income country context and availability of an English-speaking Qualtrics panel. Participants were recruited by Qualtrics through email, text messages, in-app notifications, and via a Qualtrics panel portal. Potential

respondents were notified that the survey was for research purposes, but not specific content details to limit self-selection bias. Qualtrics XM maintains an incentive program for participants, which includes any of the following: cash, gift cards, charitable donations, vouchers, redeemable points, sweepstakes entrance, and airline miles. Qualtrics facilitated a ten percent sample pilot test of the survey and inclusion criteria (i.e., over the age of 18 years and English speaking). The survey was conducted for ten days during September 2022 and obtained a total of 2625 responses, with nearly equal representation from each country. Further details are published elsewhere (Astell-Burt et al., 2024). The North Carolina State University ethics review board approved the study.

Measures

Participation likelihood

Our outcome variable of interest was participation likelihood in nature prescriptions. GSPs were defined to respondents as "programs where a trusted health or wellness professional recommends or prescribes time or activities in green, natural spaces such as parks, forests, or gardens for human health and wellness benefits." Participants were then asked to rank their likelihood of participating in nature prescriptions across four different outcomes: physical well-being, psychological well-being, social well-being, and diet/nutrition on a Likert scale from 1 to 5, with 1 being extremely unlikely and 5 being extremely likely. These questions were phrased as: *"If provided a green social prescription for your physical well-being, by your primary care physician, how likely are you to participate?*" Similar questions were asked about the three additional outcomes. We then calculated a composite participation likelihood score from the sum of responses (range 4-20). This participation likelihood score was a newly created measure and chosen as a general measure of how likely someone is to participate in a green social prescription of any type, with higher values indicating a greater stated likelihood of participating in GSPs.

Normalized Difference Vegetation Index (NDVI)

Normalized Difference Vegetation Index (NDVI) was used as a measure of greenness for where each participant lived. It is a commonly used measure in studies examining associations between greenness and health outcomes (Dadvand & Nieuwenhuijsen, 2018; Huang et al., 2021; Paoin et al., 2023; Rhew et al., 2011). To calculate NDVI for each respondent, postal codes were first geocoded and then a 5km buffer was drawn around the centroid of each postal code. Methods adapted from Stowell et al. (2023) were used to calculate mean annual NDVI values for each postal code for the full calendar year of 2021 using Sentinel-2 10m-resolution satellite data and Google Earth Engine (Gorelick et al., 2017). NDVI values range from -1 to 1, with higher values representing healthier and more green vegetation. Per Stowell et al. (2023), negative values, which typically indicate water, were converted to zeros. Missing NDVI values, often due to extensive cloud cover, were not included in the analysis.

Self-reported well-being

Self-reported well-being was assessed using the WHO-5 Well-Being Index (Topp et al., 2015). Participants were asked to report on how they were feeling in the last two weeks on a 1 to 6 scale, with 1 being all the time and 6 being none of the time.

1. I have felt cheerful and in good spirits
2. I have felt calm and relaxed
3. I have felt active and vigorous
4. I woke up feeling fresh and rested
5. My daily life has been filled with things that interest me

Responses were then reverse coded to a 0 - 5 scale (e.g., 6 coded as 0 and 1 coded as 5) and summed for each participant, resulting in Well-Being Index scores ranging from 0 to 100. Scores were then categorized as poor (0-25), low (26-50), good (51-75), and excellent (76-100).

Attitudes towards nature

To examine attitudes towards nature, the six-question NR-6 nature relatedness scale (Nisbet & Zelenski, 2013) was included. Respondents were asked to rate how much they agreed with each statement:

1. My ideal vacation spot would be a remote, wilderness area
2. I always think about how my actions affect the environment
3. My connection to nature and the environment is a part of my spirituality
4. I take notice of wildlife wherever I am
5. My relationship to nature is an important part of who I am
6. I feel very connected to all living things and the earth

Participants rated each statement on a scale from 1 (strongly disagree) to 5 (strongly agree). The mean of responses for each participant was calculated, with higher values indicating a higher level of connection to nature. They were also asked "Approximately how many hours did you spend in greenspaces and/or blue spaces in total over the last 7 days?" to capture existing behavior with respect to natural spaces. The response options were integers ranging from 0 to 20. Higher responses on the NR-6 have been shown to correlate with higher numbers of hours spent in, and more frequent visitation to preferred, greenspaces (Astell-Burt & Feng, 2021).

Demographic and socioeconomic variables

Several demographic and socioeconomic variables were collected. The age of respondents was collected as birth year and converted to estimated age in 2022. The ages were then categorized into three levels - ages 19-34, 35-54, and 55 and above. Gender was reported as male, female, non-binary, and prefer not to say, but only the genders of male and female were included due to small numbers (n = 12) of the other responses. Education was collected in three categories 1) Did not graduate college, 2) University/college degree, and 3)

Masters/PhD/MD/Equivalent. These responses were dichotomized into no college degree and college degree and higher categories because education past high school is a strong indicator of socioeconomic status that might affect GSP participation. As income level is not easy to compare across countries and may not be an indicator of financial security. Measures of perceived financial security are a component of broader financial well-being scales (Vieira et al., 2023). We collected financial security as 'living comfortably', 'doing alright', 'just about getting by', 'finding it quite difficult', and 'finding it very difficult' (Astell-Burt & Feng, 2021). Quite difficult and very difficult were combined into 'difficult' and living comfortably and doing alright were combined into a 'comfortable' category. These categories were combined because we were not attempting to understand the differences between the two most secure groups and the two least secure groups. Geography (rural, suburban, and urban) was also reported, with 36 responses being excluded due to the respondents selecting multiple categories.

Statistical Analysis

To explore the associations of GSP participation likelihood and our study variables, we ran two multiple linear regression models for the entire sample, first with all the variables and then with a setting*NDVI interaction variable. As nature-relatedness, greenspace hours, and NDVI were continuous variables, they were standardized in the regression model to allow for a more meaningful interpretation of the results. The following reference categories were used: Country - Australia, age - 19-34, gender - female, education - no college degree, financial security - difficult, setting - rural, and well-being - poor. We used the full model with setting*NDVI interaction with the stratified data (gender and country). Statistical analyses were run with the stats package in R version 4.3.2.

Results

Descriptives of survey data

A total of 2625 responses were received after screening responses for year of birth and country of residence. The average response time was 7 minutes 35 seconds. As the Qualtrics Panel recruits from a variety of sources, we were not able to calculate a response rate. After excluding missing NDVI data, and gender and geography data as described above, we were left with a total sample of 2467 responses for analysis: Australia (n = 480), India (n = 501), Singapore (n = 470), United Kingdom (n = 505) and the United States (n = 511). The sample was predominantly female (n = 1455), between the ages of 19 and 34 (n = 1333), and college-educated (n = 1647). The majority lived in urban (n = 1097) and suburban (n = 1023) settings. Well-being scores were distributed as poor (n = 321), low (n = 701), good (n = 870), and excellent (n = 575).

Participation likelihood scores ranged from 4 to 20 with a mean value of 14.93 (SD = 3.80). The mean nature-relatedness score was 3.64 (SD = 0.87), and respondents reported spending an average of 5.22 hours (SD = 4.19) in a green or blue space in the week before completing the survey. The table of results and stratified data are reported in Table 1.

Postal codes represented a variety of regions in each country and mean annual NDVI values (M = 0.445, SD = 0.141) ranged from 0 (least green) to 0.859 (most green). The United Kingdom was the most green (M = 0.516, SD = 0.111) and India the least (M = 0.349, SD = 0.132). NDVI values are also reported in Table 1.

Table 1. Descriptive statistics of survey sample and sample stratification by country and gender. Data are reported as n (%) or mean (sd).

	Full sample (n=2467)	Australia (n=480)	India (n=501)	Singapore (n=470)	United Kingdom (n=505)	United States (n=511)	Male (n=1012)	Female (n=1455)
Country								
Australia	480 (19.5)	-	-	-	-	-	115 (11.4)	365 (25.1)
India	501 (20.3)	-	-	-	-	-	281 (27.8)	220 (15.1)
Singapore	470 (19.1)	-	-	-	-	-	250 (24.7)	220 (15.1)
UK	505 (20.5)	-	-	-	-	-	195 (19.3)	310 (21.3)
USA	511 (20.7)	-	-	-	-	-	171 (16.9)	340 (23.4)
Gender								
Male	1012 (41.0)	115 (24.0)	281 (56.1)	250 (53.2)	195 (38.6)	171 (33.5)	-	-
Female	1455 (59.0)	365 (76.0)	220 (43.9)	220 (46.8)	310 (61.4)	340 (66.5)	-	-
Age								

19-34	1333 (54.0)	309 (64.4)	379 (75.6)	235 (50.0)	241 (47.7)	169 (33.1)	537 (53.1)	796 (54.7)
35-54	860 (34.9)	118 (24.6)	117 (23.4)	197 (41.9)	206 (40.8)	222 (43.4)	370 (36.6)	490 (33.7)
55+	274 (11.1)	53 (11.0)	5 (1.0)	38 (8.1)	58 (11.5)	120 (23.5)	105 (10.4)	169 (11.6)
Education								
No college degree	820 (33.2)	203 (42.3)	49 (9.8)	129 (27.4)	155 (30.7)	284 (55.6)	291 (28.8)	529 (36.4)
College degree or higher	1647 (66.8)	277 (57.7)	452 (90.2)	341 (72.6)	350 (69.3)	227 (44.4)	721 (71.2)	926 (63.6)
Financial Security								
Finding it difficult	472 (19.1)	105 (21.9)	58 (11.6)	61 (13.0)	134 (26.5)	114 (22.3)	167 (16.5)	305 (21.0)
Getting by	782 (31.7)	156 (32.5)	113 (22.6)	163 (34.7)	183 (36.2)	167 (32.7)	300 (29.6)	482 (33.1)
Comfortable	1213 (49.2)	219 (45.6)	330 (68.8)	246 (52.3)	188 (37.2)	230 (45.0)	545 (53.9)	668 (45.9)
Setting								
Rural	347 (14.1)	56 (11.7)	58 (11.6)	30 (6.4)	72 (14.3)	131 (25.6)	109 (10.8)	238 (16.4)
Suburban	1023 (41.5)	323 (67.3)	78 (15.6)	155 (33.0)	259 (51.3)	208 (40.7)	337 (33.3)	646 (44.4)

Urban	1097 (44.5)	101 (21.0)	365 (72.8)	285 (60.6)	174 (34.4)	172 (33.7)	526 (52.0)	571 (39.2)
Well-being Index								
Poor	321 (13.0)	79 (16.5)	32 (6.4)	49 (10.4)	75 (14.9)	86 (16.8)	95 (9.4)	226 (15.5)
Low	701 (28.4)	163 (24.0)	91 (18.2)	158 (33.6)	160 (31.7)	129 (25.2)	263 (26.0)	438 (30.1)
Good	870 (35.3)	167 (34.8)	157 (31.3)	171 (36.4)	189 (37.4)	186 (36.4)	369 (36.5)	501 (34.4)
Excellent	575 (23.3)	71 (14.8)	221 (44.1)	92 (19.6)	81 (16.0)	110 (21.5)	285 (28.2)	290 (19.9)
NR-6	3.64 (0.86)	3.44 (0.85)	4.03 (0.87)	3.58 (0.74)	3.57 (0.79)	3.57 (0.89)	3.71 (0.86)	3.59 (0.85)
Hours in Greenspace	5.22 (4.19)	4.27 (3.60)	7.53 (4.96)	5.08 (3.76)	5.17 (3.67)	4.05 (3.85)	5.81 (4.37)	4.82 (4.06)
NDVI	0.44 (0.14)	0.47 (0.14)	0.35 (0.13)	0.40 (0.09)	0.52 (0.11)	0.49 (0.16)	0.43 (0.14)	0.45 (0.14)
Physical well-being likelihood	3.73 (1.09)	3.63 (0.98)	4.02 (1.23)	3.69 (0.91)	3.37 (1.05)	3.63 (1.19)	3.74 (1.12)	3.73 (1.07)
Psychological well-being likelihood	3.78 (1.08)	3.69 (1.00)	4.01 (1.17)	3.74 (0.92)	3.76 (1.06)	3.69 (1.16)	3.74 (1.11)	3.80 (1.05)
Social well-being likelihood	3.69 (1.08)	3.57 (1.04)	3.96 (1.15)	3.60 (0.97)	3.70 (1.02)	3.59 (1.17)	3.69 (1.12)	3.69 (1.05)
Diet/nutrition likelihood	3.73 (1.08)	3.37 (1.03)	4.00 (1.15)	3.70 (0.93)	3.70 (1.06)	3.60 (1.15)	3.71 (1.13)	3.74 (1.05)

Total likelihood	14.93 (3.80)	14.53 (3.52)	15.99 (4.12)	14.73 (3.13)	14.86 (3.66)	14.51 (4.22)	14.88 (3.88)	14.96 (3.73)

Regression Results

The first regression model included all variables but no setting*NDVI interaction term. Results from this model were significant ($F(18, 2448) = 57.64$, $R^2_{adj} = 0.293$, $p < .001$), meaning at least one of our variables had a statistically significant relationship with GSP participation likelihood. The covariates with statistically significant ($p < .05$) and positive associations with participation likelihood were having a college degree or higher ($\beta = 0.333$, $p < .05$), being financially comfortable ($\beta = 0.475$, $p < .05$), nature relatedness ($\beta = 1.83$, $p < .001$), and hours spent in greenspace ($\beta = 0.238$, $p < .001$). Statistically significant variables negatively associated with participation likelihood were being male ($\beta = -0.443$, $p < .01$) and having good well-being ($\beta = -0.640$, $p < .01$). Annual NDVI was negative in direction, but very close to zero and not statistically significant.

The second regression model with the setting*NDVI interaction term added to the model to examine how greenness may impact those in different settings was also significant, and there was no substantial change in model fit ($F(20, 2446) = 52.46$, $R^2_{adj} = 0.294$). The Urban*NDVI interaction term was significant ($\beta = -0.394$, $p < .05$). The Annual NDVI variable, which now represents Annual NDVI for rural respondents, changed direction to positive and increased in magnitude, though it was still not statistically significant. The regression model results of the full sample are shown in Table 2. Next, we report our results after stratifying by gender and by country.

Table 2. Linear regression models for green social prescription participation likelihood. Coefficients are reported with standard errors.

		Participation Likelihood	
		Model 1	Model 2
Country (ref: Australia)			
	India	-0.278 (0.237)	-0.343 (0.238)
	Singapore	-0.269 (0.221)	-0.239 (0.221)
	United Kingdom	0.010 (0.211)	0.003 (0.211)
	United States	-0.283 (0.213)	-0.298 (0.213)
Age (ref: 19-34)			
	35 - 54	0.267 (0.145)	0.239 (0.145)
	55+	-0.055 (0.224)	-0.092 (0.224)
Gender (ref: female)			
	Male	-0.443** (0.136)	-0.435** (0.136)
Education (ref: no college degree)			

	College degree	0.333* (0.149)	0.326* (0.148)
Financial Security (ref: Difficult)			
	Getting by	-0.138 (0.194)	-0.168 (0.194)
	Comfortable	0.475* (0.192)	0.450* (0.192)
Setting (ref: Rural)			
	Suburban	0.045 (0.205)	0.069 (0.225)
	Urban	0.355 (0.213)	0.339 (0.225)
Well-being (ref: Poor)			
	Low	-0.292 (0.221)	-0.296 (0.221)
	Good	-0.604** (0.222)	-0.604** (0.222)
	Excellent	-0.125 (0.250)	-0.134 (0.249)
NR-6		1.831*** (0.071)	1.825*** (0.071)
Greenspace hours		0.238*** (0.072)	0.231** (0.071)
Annual NDVI		-0.025 (0.075)	0.124 (0.166)
Suburban*NDVI		-	0.041 (0.199)
Urban*NDVI		-	-0.395* (0.196)
Constant		14.923*** (0.306)	14.896*** (0.314)
Observations		2,467	2,467

R^2	0.298	0.300
Adjusted R^2	0.293	0.294
Residual Std. Error	3.193 (df=2448)	2.188 (df=2446)
F Statistic	57.643*** (df=18;2448)	52.461*** (df=20; 2446)

Note: *p<0.05; **p<0.01; ***p<0.001

Gender

We stratified our data by gender to compare associations between gender among the variables. For females, being financially comfortable was associated with a greater participation likelihood ($\beta = 0.794$, $p < .01$). Good well-being was associated with a lower likelihood of participation index ($\beta = -0.681$, $p < .05$) in females. Nature relatedness was significant for females ($\beta = 1.72$, $p < .001$) and males ($\beta = 1.98$, $p < .001$), as was greenspace hours in females ($\beta = 0.201$, $p < .05$) and males ($\beta = 0.268$, $p < .05$). The Urban*NDVI interaction term was significant only for males ($\beta = -0.973$, $p < .01$). Full gender regression results are presented in Table 3.

Table 3. Gender-stratified linear regression model of green social prescription participation likelihood. Coefficients are reported with standard errors.

		Participation Likelihood by Gender	
		Female	Male
Country (ref: Australia)			
	India	-0.489 (0.317)	-0.018 (0.395)
	Singapore	-0.368 (0.287)	0.027 (0.375)
	United Kingdom	0.046 (0.255)	0.049 (0.390)
	United States	-0.392 (0.260)	-0.025 (0.395)
Age (ref: 19-34)			
	35 - 54	0.244 (0.189)	0.278 (0.230)
	55+	-0.173 (0.289)	-0.108 (0.365)
Education (ref: no college degree)			

	College degree	0.255 (0.191)	0.459 (0.239)
Financial Security (ref: Difficult)			
	Getting by	-0.099 (0.245)	-0.194 (0.322)
	Comfortable	0.794** (0.246)	-0.001 (0.310)
Setting (ref: Rural)			
	Suburban	-0.093 (0.277)	0.227 (0.389)
	Urban	0.316 (0.283)	0.360 (0.377)
Well-being (ref: Poor)			
	Low	-0.343 (0.269)	-0.117 (0.395)
	Good	-0.681* (0.273)	-0.357 (0.388)
	Excellent	-0.277 (0.320)	0.160 (0.413)
NR-6		1.716*** (0.092)	1.978*** (0.110)
Greenspace hours		0.201* (0.094)	0.268* (0.110)
Annual NDVI		-0.092 (0.204)	0.570 (0.293)
Suburban*NDVI		0.260 (0.250)	-0.409 (0.339)

Urban*NDVI	-0.059 (0.250)	-0.973** (0.328)
Constant	14.892*** (0.370)	14.212*** (0.608)
Observations	1,455	1,012
R^2	0.283	0.335
Adjusted R^2	0.274	0.322
Residual Std. Error	3.183 (df=1435)	3.197 (df=992)
F Statistic	29.865*** (df=19;1435)	26.312*** (df=19; 992)

Note: *p<0.05; **p<0.01; ***p<0.001

Country

To examine differences across countries, we stratified the sample by country using the full regression model with the interaction term. The results by country can be found in Table 4. Most notable is that nature-relatedness was significant across all countries at the p <.001 level and coefficients ranged from 1.39 (Singapore) to 2.27 (India). The male gender was only significant for Australia (β = -0.702, p<.05) and the United Kingdom (β = -0.748, p<.05). Being college educated and the financial status of getting by were only significant for India (β = 1.938, p<.001 and β = -1.05, p<.05, respectively). Good well-being status was only significant for the United States (β = -1.357, p<.05). Hours spent in greenspace in the last week were significant only for India (β = 0.439, p<.01) and the United Kingdom (β = 0.373, p<.05). There was no statistically significant result for setting, NDVI, or setting-greenness interactions after stratification by country.

Table 4: Country-stratified regression results of green social prescription participation likelihood. Coefficients are reported with standard errors.

		Australia	India	Singapore	UK	US
Age (ref: 19-34)						
	35 - 54	0.267 (0.349)	0.411 (0.326)	0.282 (0.270)	0.353 (0.310)	-0.379 (0.386)
	55+	0.812 (0.498)	-0.813 (1.340)	0.501 (0.494)	0.061 (0.486)	-0.850 (0.464)
Gender (ref: female)						
	Male	-0.702* (0.356)	0.053 (0.273)	-0.323 (0.238)	-0.748* (0.296)	-0.208 (0.359)
Education (ref: no college degree)						

		Australia	India	Singapore	UK	US
College degree		0.372 (0.301)	1.938*** (0.461)	0.495 (0.299)	0.476 (0.325)	-0.189 (0.348)
Financial Security (ref: Difficult)						
Getting by		0.215 (0.418)	-1.047* (0.491)	-0.287 (0.425)	0.144 (0.380)	0.070 (0.489)
Comfortable		0.488 (0.412)	-0.114 (0.447)	0.202 (0.415)	0.357 (0.394)	0.867 (0.488)
Setting (ref: Rural)						
Suburban		0.823 (0.494)	0.097 (0.558)	-0.429 (0.564)	0.190 (0.479)	-0.333 (0.471)
	Urban	0.786 (0.574)	0.432 (0.448)	0.288 (0.542)	0.644 (0.511)	-0.224 (0.503)
Well-being (ref: Poor)						
	Low	-0.320 (0.450)	-0.713 (0.610)	-0.247 (0.461)	0.705 (0.459)	-0.916 (0.540)
	Good	-0.633 (0.469)	-0.704 (0.585)	-0.031 (0.464)	-0.515 (0.467)	-1.357* (0.537)
Excellent		-0.781 (0.568)	-0.144 (0.588)	0.333 (0.543)	0.323 (0.548)	-0.948 (0.607)
NR-6		1.544*** (0.153)	2.272*** (0.149)	1.390*** (0.140)	1.561*** (0.153)	1.877*** (0.177)
Greenspace hours		0.063 (0.155)	0.439** (0.139)	-0.122 (0.138)	0.373* (0.151)	0.171 (0.177)

	Australia	India	Singapore	UK	US
Annual NDVI	-0.134 (0378)	0.314 (0.345)	0.560 (0.560)	0.539 (0.388)	-0.039 (0.378)
Suburban*NDVI	0.216 (0.424)	0.115 (0.454)	-0.780 (0.609)	0.039 (0.448)	-0.0005 (0.487)
Urban*NDVI	-0.305 (0.488)	-0.664 (0.391)	-0.707 (0.582)	-0.335 (0.462)	-0.408 (0.473)
Constant	13.749*** (0.627)	14.415*** (0.843)	14.373*** (0.709)	13.889*** (0.616)	15.688*** (0.621)
Observations	480	501	470	505	511
R^2	0.223	0.506	0.271	0.261	0.252
Adjusted R^2	0.196	0.489	0.245	0.241	0.288
Residual Std. Error	3.156 (df=463)	2.931 (df=484)	2.726 (df=453)	3.188 (df=488)	3.705 (df=494)
F Statistic	8.293*** (df=16; 463)	30.964*** (df=16; 484)	10.533*** (df = 16; 453)	11.024*** (df = 16; 488)	10.414*** (df = 16; 494)

Note: *p<0.05; **p<0.01; ***p<0.001

Discussion

We examined factors influencing the likelihood of participating in GSPs in an international sample using a multiple linear regression model that included factors related to nature attitudes and behaviors, geography, and socio-demographic situations. We also performed stratified analyses to gain further insights into potential differences between gender and country. Our findings indicated that positive attitudes towards nature (as measured using the Nature-Relatedness Scale) were the dominant factor influencing participation likelihood across all regression models. Local greenness was associated with participation likelihood for males in urban environments. Good subjective well-being was an important factor for females, particularly in the United States. In the following sections, we will discuss the factors related to nature, location, and social characteristics, respectively.

Nature-related variables

Our results showed that for a one standard deviation increase in nature relatedness score (0.87), the participation likelihood score increased by over 1.8 points. This significant and positive relationship was consistent across all stratifications, suggesting that individuals with more positive attitudes towards nature are more likely to participate in GSPs. This finding is supported by perceived benefits of the HBM, and consistent with existing research on nature-based recreation, which demonstrates a positive association between a sense of connection to nature and participation in nature-based recreation (Flowers et al., 2016, Lin et al., 2014, Rosa et al., 2023). Although we did not test for gender-specific statistical differences, our stratified analysis suggests that this effect may be stronger in males compared to females, corroborating a previous

study indicating males engage more in nature-based recreation despite potentially lower nature connection scores than females (Rosa et al., 2023). These gender differences in attitudes towards nature highlight the need for further exploration of possible determinants, including cultural and structural factors.

Furthermore, our findings also revealed a positive relationship between the amount of time recently spent in greenspace and likelihood of participation, supporting the previously discussed link between nature-relatedness scores and behavior, and aligns with TPB. However, this was only a small association, suggesting that positive attitudes towards nature primarily drive participation likelihood. Although the relationship between time spent in greenspace and participation likelihood was consistent across genders, it was statistically significant only in India and the United Kingdom in our country stratification. This indicates that while current nature-visitation behavior plays a role, positive attitudes towards nature are likely more influential in determining participation in GSPs. We do note, however, that we did not collect context around the time recently spent in greenspace, which highlights the need for future research to explore perceived behavioral control and its role in GSP participation.

Given the strong association between attitudes towards nature and participation likelihood in GSPs, it is crucial to consider the value of these programs for individuals who may have more negative perceptions or less familiarity with natural environments. In this case, the type of prescription provided may be important. Individuals with lower nature-relatedness scores may benefit from guided participation in structured activities that indirectly increase familiarity with natural environments, such as nature walking groups or community gardens, to gradually develop a more positive attitude toward nature. Evidence suggests that GSP interventions can enhance one's connection to nature (Razani et al., 2019), and according to TPB, these shifts in attitude may facilitate positive behavioral changes, such as increased time spent in nature.

Overall, our findings underscore the importance for providers to assess a patient's connection to nature, alongside their access to safe, quality spaces when designing an appropriate prescription model (Williams et al., 2020). Future research should explore whether actual participation (as compared to likelihood of participation) is consistent with nature-based recreation research, as well as further explore the cultural differences observed in our stratified analysis.

Location characteristics

To assess the influence of location characteristics on GSP participation likelihood, we included country, urban-suburban-rural setting, and local greenness via NDVI in our model. Individually, none of these variables were statistically significant. However, when the setting*NDVI interaction was added to the model, the Urban*NDVI interaction term emerged as statistically significant. We interpret this result to suggest that participation likelihood in GSPs tends to be lower for those living in more green urban areas compared to less green urban areas. As our gender-stratified analysis found this relationship to be statistically significant only for males, it is again consistent with the findings of Rosa et al. (2023), indicating that males are more likely to participate in nature-based recreation. This interaction effect, along with the gender differences observed, warrants further investigation. Nonetheless, the primary finding that setting is not a significant factor in GSP participation likelihood suggests a broad geographic relevance for these programs. Furthermore, while we believe our sample is reasonably representative of diverse green characteristics, a more nuanced understanding of the green environment and how it impacts potential GSP participation is warranted.

Social characteristics

Our model included several socio-economic variables to control for potential differences in access to care. Having a college education and being financially comfortable were both significant and positively associated with participation likelihood. Individuals with a college education and financial stability may have improved access to care and may have more capacity to participate in such programs as noted by health equity concerns (Rigolon et al., 2021). However, after stratifying by country, education level was only significant for India. Furthermore, being financially stable was no longer significant for any country, and getting by financially was now statistically significant for India only, showing a negative relationship with participation likelihood. This suggests that individuals in India with modest financial stability are less likely to participate in a GSP. These differences observed in India indicate the need for further research, potentially influenced by the high proportion of individuals with a college degree or higher, which was just over 90% in the Indian sample.

Our findings related to subjective well-being conclude our discussion on factors influencing GSP participation. Individuals reporting good self-reported well-being (51-75 on the WHO-5 Well-being Index) tend to have lower participation likelihood scores compared to those with poor well-being, supporting the HBM. As the WHO-5 Well-being Index was the only proxy for respondents' health, it suggests that the better someone feels, the less likely they will want to participate in a GSP intervention. Similarly,

both low and excellent well-being levels also showed negative associations. This finding also varied between males and females in our stratified analysis. Poor well-being was the reference category, with subsequent categories showing negative coefficients. On average, as well-being increases, the stated likelihood of participation in GSPs decreases, but more significantly so for those with good well-being. This trend may be driven by our responses from the US, as it was the only country with a significant finding for well-being, with a relatively large coefficient (-1.36). These non-uniform findings highlight possible cultural or contextual factors influencing this relationship. For instance, in cultures where nature is less integrated into health practices, individuals with good well-being might perceive less need for GSPs. The divergent results between the US and other countries point to the need for further research to explore how cultural attitudes towards nature and well-being impact GSP participation. Understanding these dynamics could help tailor GSP programs to better meet the needs of diverse populations and enhance their effectiveness as a health intervention.

Limitations and strengths

There are some limitations to our study that warrant acknowledgement. The cross-sectional design restricts our observations to a single point in time, precluding insights into changes over time and causal inference. The use of the Qualtrics Panel format and English-speaking requirement may have introduced some degree of sampling bias, potentially limiting the representativeness of our findings. Despite that limitation, our study benefited from a large sample size and equivalent representation from each country, enabling high-level comparisons across countries, and we note that post hoc power analysis found that we were sufficiently powered to detect small-to-medium effects (G*Power 3.1.7.9; Feng et al., 2009). However, we acknowledge that while annual NDVI measure of greenness provided a practical measure of greenness for broad comparisons, it may not capture nuanced details of immediate surroundings, such as type, quality, or accessibility, that could be relevant at the individual level (Astell-Burt & Faul, 2022). Our findings describe participation likelihood for any type of GSP, but future work should explore associations with GSPs of specific prescriptive focus. Moreover, we did not capture access, perceived quality, or safety contexts in our time spent in nature variable, which are known to influence behavior (Cardinali et al., 2024; Nguyen et al., 2021). This gap highlights an area for future research to better understand how these elements of perceived behavioral control impact engagement with greenspaces.

Conclusions

This study explored factors related to the likelihood of participation in GSPs to support their use. We found that positive attitudes towards nature were the most prominent factor for participation likelihood, aligning with existing research on nature-based recreation. Our findings suggest that efforts to promote nature connectedness from an early age may aid in willingness to engage in GSPs. Additional research should test if early life exposure and engagement with nature leads to later life engagement with GSPs. The differences observed across genders and at the international level also suggest that GSPs may require adaptation across various social and cultural contexts. Future research should explore the link between nature-relatedness scores and GSP participation, optimal intervention formats, and long-term health outcomes. Understanding the role of healthcare providers in promoting GSPs and their scalability to reach underserved populations is essential for informing policy and practice.

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Conflict of Interest

The authors have no conflicts of interest to declare.

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