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Positive body image is a pathway between nature contact and life satisfaction across 58 nations

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ABSTRACT

Time spent in nature benefits human mental and physical well-being. However, much of the variance in outcomes of nature contact remains unexplained, suggesting that new mechanistic pathways need to be considered. Here, we tested a novel conceptual model linking nature contact with life satisfaction via pathways involving positive experiences of living in and experiencing the world through the physical self. Using data from the Body Image in Nature Survey (BINS; $N = 50{,}363$), representing respondents from 58 nations and speaking 36 different languages, we find that nature contact is associated with greater self-compassion and greater perceived restoration in nature, which in turn are associated with more positive body image. In addition, more positive body image is associated with greater life satisfaction. These associations were robust to sensitivity tests, generalised to all gender identities and age groups, and held individually in almost all national groups and languages. Although replications are needed, we propose that the materialities of natural environments help to link bodily experiences to the production and experience of well-being, a process that is largely stable across national groups.

1. Introduction

As global rates of urbanisation continue to grow (Zhou et al. 2019), scholars and policymakers have expressed concerns about human detachment and alienation from nature (Beery et al., 2023; Swami et al., 2024c). These concerns, in turn, have galvanised efforts to (re-)establish positive connections between nature and humanity, particularly in urban spaces (Beatley, 2010; Kowarik et al., 2025). Driving much of the contemporary enthusiasm for such "biophilic efforts" (Milliken et al., 2023) is the well-established finding that contact with natural environments is associated with more positive physical and mental health in adults (e.g., Barragan-Jason et al., 2023; Cuijpers et al., 2023; Gaekwad et al., 2023) and children (Moll et al., 2023), with the link being strongest in urban areas (Browning et al., 2022).

In terms of mental health, one robust finding (Bratman et al., 2021; Bratman and Gross, 2026; Capaldi et al., 2014) is a positive association between nature contact and subjective well-being (i.e., the multifaceted ways in which individuals think about and experience their lives; Diener et al., 2018). For example, people who more frequently visit natural environments report greater affective and evaluative well-being (i.e., life satisfaction), believe their lives are more worthwhile, and feel happier (Alcock et al., 2025; Fian et al., 2024; White et al., 2017). Similarly, people report greater levels of state happiness (Stieger et al., 2022) and express more positive sentiments (e.g., in social media posts) when in nature compared to when in built environments (Li et al., 2022). Importantly, the positive association between nature contact and life satisfaction is relatively stable across national groups (Dougall et al., 2024).

This positive association has primarily been explained in terms of the instorative (e.g., facilitating social cohesion) and restorative (e.g., attention restoration, stress recovery) capacities of nature (Hartig et al., 2014; Kuo, 2015; Markevych et al., 2017). However, the pathways between nature contact and mental health are likely complex and multitudinous (Dzhambov et al., 2020). One under-researched pathway involves the ways in which nature contact promotes positive experiences of living in and experiencing the world through the physical self (Swami, 2024). That is, nature contact may promote greater bodily agency and comfort, responsiveness to the physical and relational needs of the body, and appreciation for the functions of the body (Swami, 2024), all of which in turn promote greater subjective well-being (Swami et al., 2022a).

In fact, growing evidence (for a review, see Swami, 2024) shows that nature contact is reliably associated with more positive body image (i.e., an overarching love and respect for the body; Tylka, 2018). Cross-sectional studies have reported moderate-to-large, positive associations between nature contact and facets of positive body image, including body appreciation and functionality appreciation (Swami et al., 2019, 2020a). Additionally, spending time in nature elevates state

positive body image (Czepczor-Bernat et al., 2022, 2024; Swami et al., 2020b) and results in more positive body image relative to time spent in built environments (Harriger et al., 2024; Liu et al., 2024; Swami et al., 2018). Even exposure to "simulated" or digitised nature can elicit these effects on positive body image (Rygal and Swami, 2021; Swami et al., 2018, 2024c).

In turn, positive body image is robustly associated with greater subjective well-being. Cross-sectional studies have established a link between these constructs both within (Swami et al., 2018b, 2024b) and across national groups (Swami et al., 2023), while prospective studies have found that baseline positive body image predicts future improvements to subjective well-being (Linardon et al., 2023; Urke et al., 2021). Thus, it stands to reason that nature contact may be linked with greater subjective well-being via a pathway that involves positive body image. While such a mediational triangle may seem intuitive (Swami et al., 2022a), it has not been empirically tested and is complicated by several issues.

First, the link between nature contact and positive body image is likely complex and itself mediated by other factors (Swami, 2024). Relevant research has focused primarily on the constructs of connectedness to nature (i.e., a sense of oneness with nature; Mayer and Frantz, 2004) and self-compassion (i.e., the ability to be kind to oneself at times of despair; Neff, 2003). Thus, studies have shown that higher connectedness to nature is significantly associated with more positive body image (Swami et al., 2016a) and mediates the relationship between nature contact and positive body image (Baceviciene et al., 2021; Swami et al., 2020a; Swami et al., 2016b). Likewise, self-compassion mediates the relationship between nature contact and positive body image (Swami et al., 2019).

Second, little research has considered the extent to which properties of natural environments shape body image outcomes. For instance, some natural environments have stronger impacts on body image experiences than others (e.g., blue- versus greenspaces) (Rygal and Swami, 2021; Stieger et al., 2022), which may reflect the fact that some natural environments are perceived as more restorative than others (Menardo et al., 2021; Pasanen et al., 2018). However, the relationship between perceived restoration during nature visits and body image is equivocal, with evidence of both positive associations (Baceviciene et al., 2021) and null effects (Czepczor-Bernat et al., 2022). Thus, testing the extent to which perceived restoration mediates any association between nature contact and body image outcomes remains an important task.

Third, much of the existing evidence is limited to English-speaking, Western, educated, highly industrialised, rich, and democratic (WEIRD) societies (Holland et al., 2021; Swami, 2024). This is important because, although the benefits of nature in terms of health are unlikely to be impeded by national boundaries (Dougall et al., 2024; Elliot et al., 2023; Patwary et al., 2024; White et al., 2017), it may be that the processes involved in embodied contact with nature vary across national groups (Swami, 2024). This would reflect not only epistemologies and values about the natural world that can vary across nations (Capaldi et al., 2017; Fox and Xu, 2017), but also the different ways in which the flow of capital, colonisation, and ongoing inequalities affect the nature-health link (Berdejo-Espinola et al., 2024; Mahanty et al., 2023). As such, it is necessary to consider the possibility of cross-national variations and, in so doing, effectively respond to repeated calls to look beyond WEIRD communities (Jimenez et al., 2021; Marvier et al., 2023).

1.1. The present study

To address some of these issues, we report on the results of the Body Image in Nature Survey (BINS; Swami et al., 2022a), a collaborative, researcher-crowdsourced, international project that gathered cross-sectional data between 2020 and 2022. Ours is the most comprehensive multinational study of the associations between nature contact, positive body image, and subjective well-being to date, including more than 50,000 participants from 58 nations (see Fig. 1). Here, we tested a novel conceptual model (see Fig. 2) linking nature contact with subjective well-being (operationalised as life satisfaction) via positive body image (operationalised via its core facet of body appreciation). Additionally, we tested the hypothesis that the link between nature contact and body appreciation would be mediated by three parallel mediators: self-compassion (operationalised as compassionate self-responding),

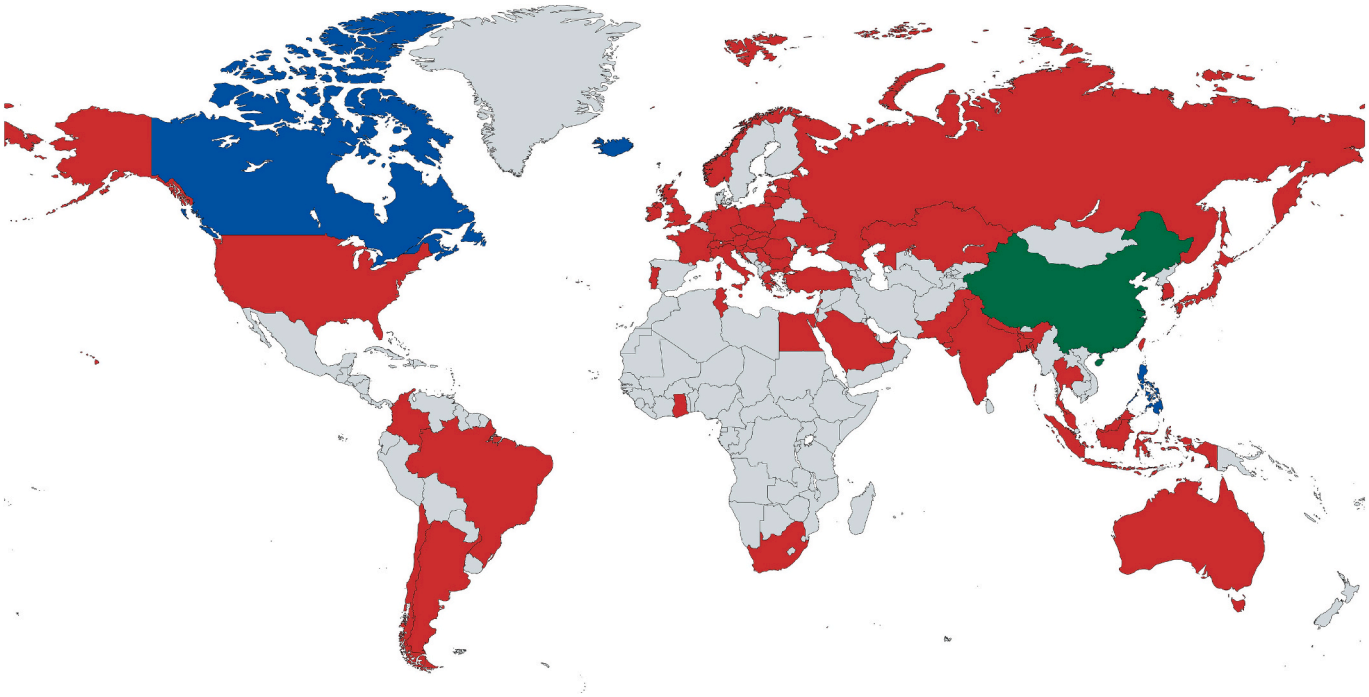

Fig. 1. World map indicating data from nations that were retained for analysis from the Body Image in Nature Survey (BINS) dataset. Nations in red indicate that the survey was presented in a single language, blue indicates two languages, and green indicates three languages. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

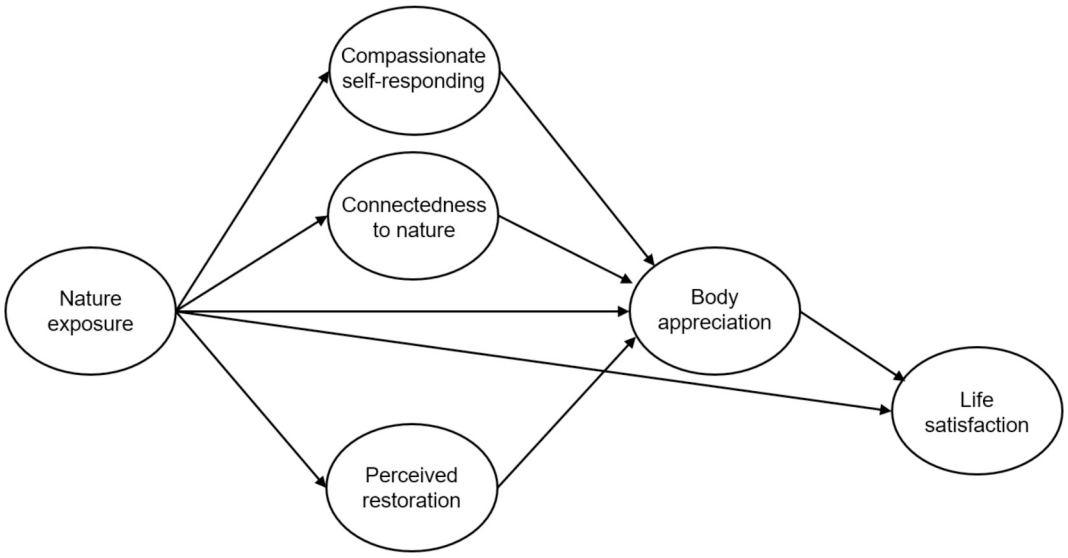

Fig. 2. Conceptual model of the direct and indirect relationships between nature contact and body appreciation and life satisfaction, respectively.

connectedness to nature, and perceived restoration during participants' most recent visit to a natural environment.

Drawing on the BINS dataset, we first estimated the hypothesised model in the full sample (i.e., across all participants treated as a single community) to determine whether it yielded a stable and acceptable solution or whether structural adjustments were necessary. Next, we tested whether an optimised model would be invariant across gender identities and age groups (i.e., emerging adults: 18–24 years; young adults: 25–44 years; middle-age and older adults: ≥ 45 years). Multigroup models were also used to examine whether an optimised model would be invariant across the 63 distinct samples (including linguistic variation) from 58 nations represented in the BINS. Finally, we subjected the optimised model to robustness and sensitivity checks by adding three sets of covariates, namely proxies of socioeconomic status (financial security, education), sociodemographic factors (racialised status, urbanicity), and personality (the Big Five personality traits).

2. Method

2.1. Overview of the body image in nature Survey

The Body Image in Nature Survey (BINS) was a researcher-crowdsourced project involving 253 scientists working collaboratively across 65 nations (Swami et al., 2022a). All cross-sectional data were collected between November 2020 and February 2022 with community sampling, with the majority of recruitment taking place online. The overall project received ethics approval from the School Research Ethics Panel at the first author's institution (approval code: PSY-S19-015) and, unless exempt by national laws, all collaborating teams additionally obtained ethics approval from local institutional ethics committees or review boards. A list of nations, associated sample sizes for the total BINS dataset, data collection methods, ethics approvals, and survey languages is presented in Supplementary Table S1.

2.2. Participants

The original BINS dataset consists of 56,968 respondents, representing 72 distinct samples from 65 nations (or "national groups"; see Fig. 1). However, prior related work has shown that it is not possible to extract factor scores for all variables included in the BINS for all collected samples (Swami et al., 2023, 2024c, 2025a, 2025b). Individual measured variables did not evidence measurement invariance in some samples, which means that the data from these samples did not conform to the measurement models that otherwise applied in all other samples and that were used to extract factor scores. Measurement invariance is a prerequisite of score comparisons across samples. Without it, cross-sample comparisons typically yield biased and misleading results, even if invariance does not necessarily address all potential cross-cultural variation (e.g., residual cultural nuances, response styles) in item interpretation and responding (Guenole and Brown, 2014; Swami and Barron, 2019). Because we did not want to impute values for variables that were missing for these samples, we instead retained for analysis only samples for which estimates for all predictors were available. This resulted in omitting data from participants in Bosnia and Herzegovina, Ecuador, Iran, Iraq, Israel, Nigeria, and Spain, as well as Arabic speakers in the United Arab Emirates and Tamil speakers in India.

The final, retained sample for analysis consisted of 50,363 participants, representing 63 distinct samples from 58 nations and speaking 36 different languages. Of this retained sample, 59.9% were women, 39.4% were men, and 0.7% reported another gender identity. Ages ranged from 18 to 99 years (M = 33.05, SD = 13.93) and, among participants who provided self-reported height and weight within a reasonable range (n = 48,498), body mass indices (BMIs) ranged from 12.17 to 60.00 kg/m^2 (M = 24.43, SD = 5.03). In terms of financial security compared to others of their age in their country, 25.7% and 50.1% felt more or equally secure, respectively, with 24.2% feeling less secure. Most (84.0%) lived in an urban rather than a rural (16.0%) area, and the majority reported at least completing secondary education (72.3%). In total, 53.1% were in a committed relationship, including marriage. The majority (74.6%) self-identified as being part of a racialised majority in their nation, whereas 10.5% identified as part of a racialised minority group (13.8% were uncertain and data on racialised status were not collected in France due to prohibition of the collection and storage of race-related data). Table 1 presents detailed sample description data for all individual nations. In four countries, data was collected in either two (Canada, Iceland, the Philippines) or three (China) languages.

2.3. Measures

2.3.1. Nature contact

Contact with the natural environments was measured using the 4-item Nature Exposure Scale (NES; Kamitsis and Francis, 2013), which measures an individual's level of contact with nature in everyday life and activities (two items), as well as levels of contact with nature outside of everyday environments (two items). Response anchors varied

Table 1
Sample Descriptions of Data from the Body Image in Nature Survey (BINS).

Nation	Sample size	Mean age (*SD*)	% Women	Mean financial security (*SD*)	%Urban residence	%Secondary/ tertiary education	%In committed relationship or married	%Racialised minority
Argentina	670	35.36 (13.6)	57	2.13 (0.7)	98	81	50	9
Australia	1,038	35.23 (13.1)	71	1.90 (0.8)	93	77	55	18
Austria	1,279	41.99 (16.5)	54	2.08 (0.7)	67	62	63	9
Bahrain	441	30.47 (9.8)	74	1.98 (0.6)	98	87	51	8
Bangladesh	460	29.30 (8.6)	42	1.78 (0.8)	88	80	51	13
Brazil	1,462	36.77 (12.0)	58	2.21 (0.7)	99	86	66	12
Bulgaria	248	33.52 (14.1)	62	2.16 (0.6)	92	54	52	4
Canada (English)	336	24.61 (10.0)	83	2.10 (0.7)	82	36	48	14
Canada (French)	806	38.22 (12.8)	88	2.29 (0.7)	78	95	72	7
Chile	422	36.14 (13.6)	79	2.28 (0.8)	94	73	41	8
China (Cantonese)	409	20.50 (5.9)	58	2.18 (0.7)	100	96	2	2
China (English)	349	21.93 (5.3)	65	1.79 (0.7)	97	62	26	6
China (Mandarin)	1,231	35.00 (7.3)	69	1.82 (0.6)	95	92	86	4
Colombia	793	27.15 (11.5)	60	2.01 (0.8)	96	57	22	7
Croatia	898	39.10 (12.1)	59	2.08 (0.7)	71	91	69	2
Cyprus	363	34.31 (9.6)	65	2.09 (0.7)	87	69	64	4
Czechia	700	38.10 (17.0)	66	2.29 (0.6)	82	75	62	2
Egypt	1,627	23.62 (8.7)	72	2.06 (0.6)	98	86	27	6
Estonia	449	38.93 (14.1)	63	2.10 (0.7)	80	64	58	2
France	562	36.01 (14.2)	76	2.08 (0.7)	64	67	47	NA
Germany	620	31.01 (11.9)	62	2.18 (0.8)	83	64	58	12
Ghana	434	21.97 (4.5)	41	2.08 (0.8)	84	72	32	26
Greece	556	31.49 (11.8)	65	2.03 (0.7)	91	63	55	5
Hungary	654	32.80 (13.4)	69	2.07 (0.6)	72	69	63	2
Iceland (English)	1,149	38.50 (17.5)	50	2.27 (0.7)	92	61	65	11
Iceland (Icelandic)	432	54.91 (15.5)	54	2.05 (0.6)	75	81	78	3
India (Hindi)	1,664	32.07 (11.8)	45	2.14 (0.8)	73	78	45	13
Indonesia	292	19.79 (3.2)	72	1.76 (0.5)	87	43	14	3
Ireland	351	33.73 (12.4)	50	2.11 (0.8)	76	80	62	5
Italy	2,307	33.17 (14.0)	62	1.95 (0.6)	81	67	61	6
Japan	360	49.44 (16.6)	100	1.79 (0.6)	90	81	61	8
Kazakhstan	380	30.07 (11.3)	53	2.04 (0.6)	94	76	48	11
Latvia	827	41.04 (12.8)	66	2.02 (0.7)	74	82	69	4
Lebanon	1,295	25.74 (12.3)	67	1.93 (0.7)	70	63	33	16
Lithuania	491	40.34 (12.8)	51	2.05 (0.6)	72	84	74	3
Malaysia	1,193	27.81 (8.7)	69	1.74 (0.6)	76	84	29	30

(*continued on next page*)

Table 1 (*continued*)

Nation	Sample size	Mean age (*SD*)	% Women	Mean financial security (*SD*)	%Urban residence	%Secondary/ tertiary education	%In committed relationship or married	%Racialised minority
Malta	347	35.52 (15.4)	72	2.10 (0.7)	78	71	60	7
Nepal	353	25.78 (6.0)	50	1.77 (0.7)	82	98	28	5
Netherlands	1,004	46.81 (16.3)	53	2.05 (0.6)	61	98	69	9
Norway	360	41.24 (11.6)	77	2.17 (0.7)	78	92	77	4
Pakistan	267	20.59 (2.7)	28	2.16 (0.9)	100	47	83	49
Palestine	401	27.64 (9.5)	25	2.01 (0.6)	81	90	42	7
Philippines (English)	350	24.87 (11.2)	0	2.03 (0.7)	97	56	24	13
Philippines (Tagalog)	504	37.43 (11.9)	73	1.83 (0.7)	97	89	65	16
Poland	1,954	30.51 (11.9)	62	1.99 (0.7)	74	63	56	3
Portugal	363	36.53 (17.9)	68	2.05 (0.7)	85	81	37	5
Romania	1,819	26.94 (10.8)	53	2.05 (0.7)	80	49	60	5
Russia	206	39.94 (11.8)	71	1.84 (0.5)	97	84	67	8
Saudi Arabia	380	28.02 (9.7)	55	2.03 (0.7)	94	83	33	20
Serbia	650	30.72 (11.3)	56	2.20 (0.7)	95	65	65	10
Slovakia	814	37.79 (14.7)	54	1.92 (0.6)	65	75	67	4
Slovenia	452	36.84 (14.9)	59	2.16 (0.7)	49	87	66	2
South Africa	318	35.15 (16.1)	53	1.74 (0.8)	78	73	45	31
South Korea	381	27.60 (9.7)	48	1.89 (0.6)	98	54	43	52
Switzerland	377	46.48 (15.2)	52	1.98 (0.7)	62	51	66	5
Taiwan	529	41.36 (13.6)	60	2.48 (0.7)	90	92	67	7
Thailand	3,275	25.85 (10.8)	62	1.76 (0.6)	87	45	23	6
Tunisia	374	41.62 (15.2)	55	2.10 (0.6)	96	90	63	0
Türkiye	2,518	31.63 (11.5)	57	1.98 (0.8)	97	61	57	14
Ukraine	141	39.00 (11.7)	59	1.74 (0.6)	95	87	71	9
United Arab Emirates (English)	904	27.50 (11.8)	36	2.13 (0.8)	98	73	43	31
United Kingdom	1,243	37.99 (13.9)	54	2.03 (0.7)	84	87	68	23
United States of America	2,531	35.35 (12.7)	62	1.93 (0.7)	85	82	61	20

Note. *SD* = standard deviation.

depending on the item, but all included 5-point scales. In the BINS dataset, the NES has been shown to have a unidimensional factor structure that is invariant across most represented nations, languages, gender identities, and age groups (Swami et al., 2024c). Although the NES ostensibly measures "exposure" to natural environments, following recent recommendations (Browning et al., 2025; White et al., 2023), we instead use the term "nature contact" when referring to NES scores as this term implies a more active relationship with nature.

2.3.2. Connectedness to nature

As part of the BINS survey package, participants completed the 14-item Connectedness to Nature Scale (CNS; Mayer and Frant, 2004) using a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The CNS measures participants' affective and experiential connection to nature. In the BINS dataset, a truncated 7-item version of the CNS was found to have optimal fit and evidenced measurement invariance across most represented nations, languages, gender identities, and age groups (Swami et al., 2024c).

2.3.3. Compassionate self-responding

Participants were also asked to complete the 12-item Self-Compassion Scale–Short Form (SCS–SF; Raes et al., 2011), which measures aspects of self-kindness, common humanity, and mindfulness. All items were rated on a 5-point scale, ranging from 1 (almost never) to 5 (almost always). In the BINS dataset, the SCS–SF was found to have a 2-dimensional factor structure, with subscales reflecting compassionate (6 items) and uncompassionate self-responding (5 items), respectively (Swami et al., 2025b). To provide the purest assessment of self-compassion, only compassionate self-responding scores were used in the present study.

2.3.4. Restorative experiences

To measure perceived restorative experiences during participants' most recent nature-based visit, we used the Restoration Outcomes Scale (ROS; Korpela and Ylén, 2009; Korpela et al., 2014). This is a 9-item instrument that measures the degree of restorative outcomes in terms of relaxation, calmness, attention restoration, clarity of thought, subjective vitality, and self-confidence. All items were rated on a 7-point scale ranging from 1 (not at all) to 7 (completely). As the invariance of this instrument across nations has not been previously tested, we did so here. As reported in the Supplementary Materials, it was possible to derive a unidimensional model of the ROS that was invariant across all nations represented in the analyses.

2.3.5. Body appreciation

Body appreciation was measured using the 10-item Body Appreciation Scale-2 (BAS-2; Tylka and Wood-Barcalow, 2015), which measures the degree to which individuals accept, hold favourable opinions toward, and respect the body, while also rejecting media-promoted appearance ideals as the only form of human beauty. All items were rated on a 5-point scale (1 = never, 5 = always). In the BINS dataset, the BAS-2 has been shown to have a unidimensional factor structure that is invariant across all represented nations, languages, gender identities, and age groups (Swami et al., 2023).

2.3.6. Life satisfaction

To measure a facet of subjective well-being, we asked participants to complete the 5-item Satisfaction with Life Scale (SWLS; Diener et al., 1985), which assesses an individual's global judgement of their life satisfaction based on their own subjective criteria. All items were rated on a 7-point response scale (1 = strongly disagree, 7 = strongly agree). In the BINS dataset, the SWLS has been shown to have a unidimensional factor structure that is invariant across most represented nations, languages, gender identities, and age groups (Swami et al., 2025a).

2.3.7. Personality

Participants were asked to complete the Five-Item Personality Inventory (FIPI; Gosling et al., 2003), which measures the Big Five personality facets of Openness to Experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism, with one item for each facet. All items were rated on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). Scores on the FIPI have been shown to have adequate levels of convergent validity and adequate test–retest reliability up to two weeks (Gosling et al., 2003).

2.3.8. Urbanicity

To assess urbanicity, participants were asked about their current place of residence, with response options adapted from a previous study (Pedersen and Mortensen, 2001) as follows: capital city, capital city suburbs, provincial city (more than 100,000 residents), provincial town (more than 10,000 residents), and rural areas. Response options were assigned values 1 to 5 (in the above order) for statistical analysis and collapsed into urban versus rural for descriptive purposes. This measure of urbanicity has been used in previous cross-national work (Swami et al., 2020a).

2.3.9. Financial security

Following previous cross-national work (Swami et al., 2020a), participants were asked to self-report how financially secure they felt relative to others of their own age in their country of residence (1 = *less secure*, 2 = *same*, 3 = *more secure*).

2.3.10. Body mass index

Participants self-reported their height and weight, which we used to compute self-reported BMI as kg/m^2. Following previous work (Swami et al., 2018b), data for participants with improbable BMI values (< 12 or > 60 kg/m^2) were recoded as missing values. We have in hindsight elected not to include BMI in analyses because of concerns that its use perpetuates weight stigma (Bailey et al., 2025), and only report it here for sample descriptive purposes.

2.3.11. Demographics

Highest educational qualification was assessed as follows: 1 = *no formal education*, 2 = *primary education*, 3 = *secondary education*, 4 = *still in full-time education*, 5 = *undergraduate degree*, 6 = *postgraduate degree*, 7 = *other*; marital status was assessed as: 1 = *single*, 2 = *single but in a committed relationship*, 3 = *married*, 4 = *other*; and racialised status relative to their country of residence was assessed as: 1 = *ethnic/racial majority*, 2 = *ethnic/racial minority*, 3 = *not sure*. The latter item provides a common metric of categorising ethnicity/racialised identity across diverse nations (Swami et al., 2020a). For descriptive purposes at the national level and for analyses, response options for highest educational qualification were collapsed into *secondary/tertiary* (secondary education, undergraduate degree, postgraduate degree) versus *other* (all remaining categories) and response options of racialised status were collapsed into *racialised minority* (racial minority) versus *other* (all remaining categories).

2.4. Procedures, Ethics, and data Sharing

Full procedural information about the BINS is provided in the study protocol (Swami et al., 2022a). The BINS project was conducted in accordance with the principles of the Declaration of Helsinki and following all local institutional guidelines. In brief, once local ethics approval had been obtained or collaborators confirmed that approval was not required as per national laws (see Supplementary Table S1), researchers recruited participants from the community in their respective nations between November 2020 and February 2022. Inclusion criteria were being ≥ 18 years of age, a resident and citizen of the particular nation in which recruitment took place, and being able to complete the survey in the language in which it was presented. In all but nine locales (see Supplementary Table S1), data collection was conducted online. All participants were presented with a standardised information sheet and provided (digital or written) informed consent before completing an anonymous version of the BINS package. Upon completion, participants received debriefing information, which included contact information for the first author as well as a local researcher. The BINS data and our analytic codes are available on the Open Science Framework at https://osf.io/ubewk/overview?view_only = 8fd5b1323f1c41fe992e976e21eecbd1.

2.5. Analytic Strategy

The hypothesised model was investigated with structural equation modeling (SEM), utilizing Mplus 8.8 (Muthén and Muthén, 2017) and factor scores of the NES, CNS, the compassionate self-responding subscale of the SCS–SF, the BAS-2, and the SWLS from previous analyses of the BINS data (Swami et al., 2023, 2024c; Swami et al., 2025a, 2025b), as well as factor scores of the ROS from the present study (see Supplementary Materials). To arrive at overall estimates and account for the clustered nature of the BINS data, the "complex" function of Mplus with national groups as a grouping variable was used in all analyses, except where stated otherwise. A first analysis tested the originally hypothesised model as depicted in Fig. 2 (also allowing for covariances between the parallel mediators of compassionate self-responding, connectedness to nature, and perceived restoration). Building on indices of model fit and modification indices, direct paths of the mediators to life satisfaction were then added, if and where required. All total, direct, and indirect effects of nature contact and of the mediators to life satisfaction were then evaluated with this main model. In subsequent analyses, the main model was reinvestigated using languages as a grouping variable to examine the robustness of results regarding this alternative BINS clustering variable. Multigroup models were fitted to the data to

examine the robustness of results with regards to gender identities and age groups, comparing the fit of unconstrained and constrained models, wherein the unstandardised parameters of all direct paths were constrained to equality across groups. Multigroup models were also fitted for national groups and languages to explore whether the associations in the main model were invariant across these groups.

A final set of analyses tested the sensitivity of the main model results against three sets of covariates (socioeconomic status: financial security, education; sociodemographic factors: racialised status, urbanicity; personality: the Big Five personality traits), using these as background variables with paths to all other variables in the main model. As this necessitated the estimation of a larger number of extra parameters (also including the covariances between all pairs of background variables), three sensitivity analyses were conducted to make this analysis feasible, investigating the three sets of covariates in separate models.

Robust maximum likelihood (MLR) estimation was employed in all analyses and model fit was evaluated using CFI, TLI, RMSEA (alongside its 90% confidence interval), and SRMR values (using cutoffs of 'good' and 'acceptable' fits of 0.95/.90 for CFI and TLI values, and for a 'good' fit of 0.06 and 0.08 for RMSEA and SRMR values; Hu and Bentler, 1999). In addition, χ^2 tests of model fit are reported. For comparisons of the unconstrained to the constrained multigroup models, $\Delta\chi^2$ tests are reported as well. However, as χ^2 and $\Delta\chi^2$ tests were mostly overpowered due to the large sample size, readily detecting small and negligible deviations, fit indices were preferred in the evaluation of (comparative) model fit.

3. Results

3.1. Association between nature contact and life satisfaction

Our hypothesised model, represented in Fig. 2, included a direct path between nature contact and life satisfaction, as well as a mediated pathway via body appreciation. Additionally, the hypothesised model allowed for mediations of the link between nature contact and body appreciation via compassionate self-responding, connectedness to nature, and perceived restoration, respectively. When we tested fit of this model to our total dataset, we found that it had less-than-optimal fit (see Table 2). To rectify this, we added direct paths from compassionate self-responding and perceived restoration, respectively, to life satisfaction. This revised model had good fit to the data (see Table 2).

Fig. 3 presents this revised model along with standardised regression coefficients (see Fig. S1 for a traditional path diagram). This model included five pathways of relevance, namely: (a) a direct path from nature contact to life satisfaction; (b) an indirect path between nature contact and life satisfaction via body appreciation; (c) an indirect path between nature contact and life satisfaction through compassionate self-responding and body appreciation; (d) an indirect path between nature contact and life satisfaction through connectedness to nature and body appreciation, and; (e) an indirect path between nature contact and life satisfaction through perceived restoration and body appreciation. This model also included mediated pathways between nature contact and life satisfaction via compassionate self-responding and perceived restoration, respectively, that did not flow via body appreciation.

Table 2
Results of the Structural Equation Modeling Analyses Indicating Fit of the Hypothesised, Original Model and Final, Retained Model, and Stability of the Latter in National Groups, Gender Identities, and Age Groups.

	χ^2 (*df*)	CFI	TLI	RMSEA	90%-CI	SRMR	$\Delta\chi^2$ (*df*)
Hypothesised model (Fig. 2)	121.73 (3)	0.759	0.000	0.028	0[.024, 0.032]	0.043	
Retained model with additional paths (Fig. 3)							
With cluster variable national group	1.57 (1)	0.999	0.983	0.003	0[.000, 0.013]	0.002	
With cluster variable language	22.18 (1)	0.995	0.331	0.021	0[.014, 0.028]	0.002	
Multigroup models (Fig. 3)							
Gender identities (unconstrained)	8.55 (3)	1.000	0.998	0.010	0[.002, 0.019]	0.002	
Gender identities (constrained)	187.20 (25)	0.996	0.992	0.020	0[.017, 0.022]	0.012	209.76 (22)
Age group (unconstrained)	20.02 (3)	1.000	0.993	0.018	0[.011, 0.026]	0.003	
Age group (constrained)	467.13 (25)	0.988	0.979	0.032	0[.030, 0.035]	0.023	518.98 (22)
National groups (unconstrained)	82.87 (63)	1.000	0.994	0.020	0[.002, 0.031]	0.007	
National groups (constrained)	6389.60 (745)	0.879	0.847	0.097	0[.095, 0.100]	0.117	7190.36 (682)
National groups (constrained), without India (Hindi), Brazil, Taiwan, Pakistan, and Latvia	2798.51 (685)	0.950	0.936	0.063	0[.060, 0.065]	0.059	
Languages (unconstrained)	44.82 (36)	1.000	0.997	0.013	0[.000, 0.024]	0.005	
Languages (constrained)	5634.90 (421)	0.888	0.856	0.094	0[.092, 0.096]	0.120	6382.24 (385)
Languages (constrained), without Hindi, Portuguese, and Latvian	2044.36 (385)	0.961	0.949	0.056	0[.053, 0.058]	0.047	
Sensitivity analyses (Fig. 3)							
Socioeconomic status	1.03 (1)	1.000	0.999	0.001	0[.000, 0.012]	0.001	
Sociodemographic factors	1.44 (1)	0.9990	0.986	0.003	0[.000, 0.013]	0.002	
Personality	0.89 (1)	1.000	1.000	0.000	0[.000, 0.012]	0.001	

Note. In the constrained multigroup models all direct effects in the main model were constrained to equality across groups, whereas estimated freely in the unconstrained models. $\Delta\chi^2$ test are provided for the comparisons of constrained vs. unconstrained models for which the number of groups were equal. All *p* values of the χ^2 and $\Delta\chi^2$ tests were less than 0.001, except for the main model with national group as cluster variable ($p = 0.21$); the unconstrained multigroup models of gender identities ($p = 0.036$), national groups ($p = 0.047$), and languages ($p = 0.15$); and the sensitivity analyses (*p*s = 0.31, 0.23, and 0.35).

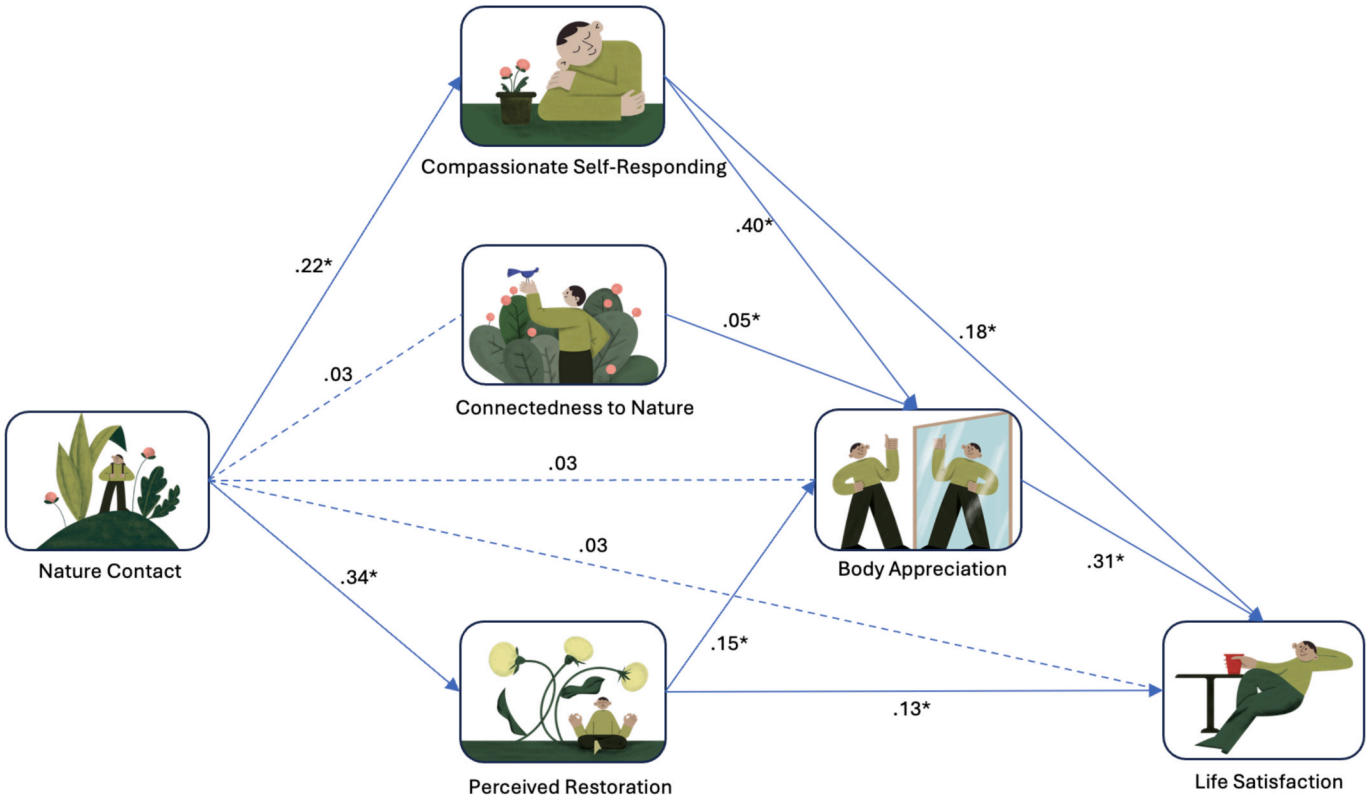

Fig. 3. Final model that fit the data best. Numbers are standardised regression coefficients. * $p < 0.001$. Figure credit: Logan Vuong.

Across all national groups, the direct paths from nature contact to, respectively, life satisfaction and body appreciation were not significant (see Fig. 3). Conversely, the indirect pathways involving compassionate self-responding and perceived restoration, respectively, and body appreciation were both significant. The indirect pathway involving connectedness to nature and body appreciation, however, was not, but only because the direct path from nature contact to connectedness to nature was broken (i.e., not significant and negligible in size). Of the three parallel mediators, compassionate self-responding had the strongest direct path to body appreciation, which, in turn, had the strongest direct path to life satisfaction; these were stronger than the direct paths of self-compassion and perceived restoration to life satisfaction.

Total effects, total indirect effects, and specific indirect effects are reported in Table 3. The total effects capture the overall associations of each variable with life satisfaction. The total indirect effects capture the totality of the associations of the variables with life satisfaction (i.e., both the mediated and unmediated effects). The specific indirect effects capture the associations of the variables with life satisfaction over each individual path involving other variables in between. The use of the term "effect" does not imply that relationships between these variables are causal or that we considered them as such.

The bulk of the total effect of nature contact on life satisfaction was, as predicted, via the mediating variables. Only the path that went directly via body appreciation and the path that went via connectedness to nature were not relevant for the indirect association. Among the mediators themselves, compassionate self-responding had the largest total effect on life satisfaction. The strength of the association was explained about equally by the indirect and direct paths. Perceived restoration had the second largest total effect on life satisfaction, with most of this association accounted for by the direct path. The two indirect effects of nature contact via body appreciation to life satisfaction and via perceived restoration to life satisfaction were of a similar size. Together with the other indirect effects that went via self-compassion, this made compassionate self-responding the single most salient mediator of the link between nature contact and life satisfaction, besides body appreciation. The total effect of connectedness to nature on life satisfaction was statistically significant, but negligible in size.

Table 3
Total Effects, Total Indirect Effects, and Specific Indirect Effects in the Main Analysis.

Predictor →(mediator[s]) → outcome	Standardized regression coefficient [95%-CI]
Total effects and total indirect effects	
Total effect: Nature contact → life satisfaction	**0.17 [.05, 0.29]**
Total indirect effect via all intervening mediators	**0.14 [.08, 0.20]**
Total effect: Compassionate self-responding → life satisfaction	**0.31 [.27, 0.35]**
Total indirect effect via body appreciation	**0.13 [.10, 0.16]**
Total effect: Connectedness to nature → life satisfaction (via body appreciation)	**0.02 [.01, 0.02]**
Total effect: Restoration during last visit → life satisfaction	**0.18 [.10, 0.25]**
Total indirect effect via body appreciation	**0.04 [.04, 0.06]**
Specific indirect effects of nature contact → life satisfaction	
Nature contact → body appreciation → life satisfaction	0.01 [-0.003, 0.02]
Nature contact → compassionate self-responding → life satisfaction	**0.04 [.02, 0.06]**
Nature contact → restoration during last visit → life satisfaction	**0.04 [.02, 0.07]**
Nature contact → compassionate self-responding → body appreciation → life satisfaction	**0.03 [.02, 0.04]**
Nature contact → connectedness to nature → body appreciation → life satisfaction	0.001 [.000, 0.001]
Nature contact → restoration during last visit → body appreciation → life satisfaction	**0.02 [.01, 0.03]**

Note. CI = confidence interval. Boldface signifies significance ($p < 0.05$).

3.2. Robustness of results and sensitivity tests

Fit of the main model in Fig. 3 remained good both when using language, instead of national groups, as a cluster variable in analyses and when controlling for covariates (see Table 3). Additionally, the main model applied equally well to all gender identities and age groups represented in the BINS, and all direct effects in the main model were also invariant across (i.e., did not differ between) these groups. Further, all total and indirect effect estimates remained robust when changing these analytic options or controlling for covariates (see Table 4; see Table 5 for the path coefficients of the covariates on the main analysis variables in the sensitivity analyses). Estimates only diminished slightly in size when controlling for personality (see Table 4). As a final test of robustness, we also reversed the directionality of relationships as depicted in Fig. 3. This model had poorer fit compared to the original model, $\chi^2(1) = 4.37$, $p < 0.001$, CFI = 0.993, TLI = 0.897, RMSEA = 0.009 (90% *CI* = 0.002, 0.017), SRMR = 0.005, which suggests that the model with our preferred (theoretical) order provides better fit to the data.

3.3. Invariance of the direct effects in the main model across national groups and languages

The direct effects in the main model were not invariant across all national groups and languages (see Table 3). To identify national groups and languages that appeared to deviate most from all other groups and languages in their estimates of direct effects, we investigated the relative contributions of all national groups and languages to their respective overall χ^2 values of the constrained models. To control for differences in sample size, χ^2 contributions were divided by the sample sizes of the respective groups and languages.

For national groups, five groups emerged whose relative contributions to the χ^2 model fit test appeared to be markedly larger than those of all other groups. Table 6 presents the standardised direct effects (from the unconstrained model) in these five national groups in descending order of their relative contributions to the overall χ^2 value. Compared to the overall estimates (see Fig. 3), nature contact had stronger associations with the downstream constructs in India (Hindi), but associations with life satisfaction were either negative (nature contact, body appreciation) or null (compassionate self-responding, restorative outcomes). In Brazil, associations of nature contact with compassionate self-responding and restorative outcomes were negative.

In Taiwan, there were stronger associations of nature contact with restorative outcomes and of restorative outcomes with body appreciation, but no associations of body appreciation, compassionate self-responding, and restorative outcomes with life satisfaction. Similar to India (Hindi), associations of nature contact were stronger with compassionate self-responding and restorative outcomes in Pakistan, but there were no associations between compassionate self-responding and body appreciation, and restorative outcomes and life satisfaction. In Latvia, there were no associations between nature contact and restorative outcomes, restorative outcomes and body appreciation, and restorative outcomes and life satisfaction; however, there was a stronger association between nature contact and life satisfaction. Excluding all of these groups from analysis, an acceptable fit of an invariant model could be obtained for all remaining national groups.

For languages, three languages matching three of the above identified national groups emerged (again in descending order): Hindi, Portuguese, and Latvian. Deviating direct effects (Table 7) were identical (Hindi, Latvian) to those of the respective national groups or largely similar (Portuguese and Brazil; see Table 6). When excluding these languages from analyses, acceptable fit of an invariant model was obtained for all other languages as well (for further details, see Tables 6 and 7).

Taken together, these results suggest that the associations presented in Fig. 3 generalised to gender identities and age groups represented in the BINS, remained robust when controlling for covariates, and held individually in most national groups and languages. This speaks to the broad generalisability of the present cross-sectional results to different nations, languages, and sociodemographic groups represented in the present study.

4. Discussion

Spending time in nature can be good for us, including in terms of improved subjective well-being (e.g., Alcock et al., 2025; Dougall et al., 2024; Fian et al., 2024; White et al., 2017), but explanations for this link continue to be explored and debated (Kuo, 2015; Markevych et al., 2017). In this study, we considered a potentially important but underresearched pathway, namely that contact with natural environments is associated with higher life satisfaction via improved experiences of living in and interacting with the world through the physical self (Swami, 2024). To explore this theorising, as well as further potential

Table 4
Total Effects, Total Indirect Effects, and Specific Indirect Effects in the Robustness and Sensitivity Analyses.

Predictor →(mediator[s]) → outcome	Standardized regression coefficient [95%-CI] controlling for					
	Languages	Gender identities	Age groups	Socioeconomic status	Sociodemo-graphic factors	Personality
Total effects and total indirect effects						
Total: NC → LS	**0.17 [.05, 0.29]**	**0.17/.16/.15**	**0.15/.17/.18**	**0.15 [.06, 0.23]**	**0.17 [.07, 0.27]**	**0.09 [.002, 0.17]**
Total ind. via all intervening mediators	**0.14 [.08, 0.20]**	**0.14/.14/.12**	**0.12/.14/.14**	**0.13 [.09, 0.17]**	**0.14 [.10, 0.19]**	**0.07 [.04, 0.10]**
Total: CS → LS	**0.31 [.27, 0.34]**	**0.31/.30/.30**	**0.32/.30/.30**	**0.29 [.25, 0.32]**	**0.31 [.27, 0.35]**	**0.23 [.20, 0.27]**
Total ind. via BA	**0.13 [.09, 0.16]**	**0.13/.12/.12**	**0.13/.12/.12**	**0.11 [.09, 0.14]**	**0.12 [.09, 0.15]**	**0.08 [.06, 0.10]**
Total: CN → LS (via BA)	**0.02 [.01, 0.03]**	**0.02/.02/.02**	**0.02/.02/.02**	**0.02 [.01, 0.02]**	**0.02 [.01, 0.02]**	**0.01 [.005, 0.02]**
Total: RE → LS	**0.18 [.11, 0.24]**	**0.18/.18/.19**	**0.18/.18/.18**	**0.17 [.11, 0.24]**	**0.18 [.10, 0.25]**	**0.14 [.07, 0.21]**
Total ind. via BA	**0.04 [.03, 0.06]**	**0.05/.05/.05**	**0.05/.05/.05**	**0.04 [.03, 0.05]**	**0.05 [.04, 0.06]**	**0.03 [.02, 0.04]**
Specific indirect effects of NC → LS						
NC → BA → LS	0.01 [-0.004, 0.02]	**0.01/.01/.01**	**0.01/.01/.01**	0.01 [-0.01, 0.02]	0.01 [-0.003, 0.02]	0.001 [-0.01, 0.01]
NC → CS → LS	**0.04 [.02, 0.06]**	**0.04/.04/.04**	**0.04/.04/.04**	**0.04 [.02, 0.05]**	**0.04 [.03, 0.06]**	**0.02 [.01, 0.03]**
NC → RE → LS	**0.04 [.02, 0.07]**	**0.04/.04/.04**	0.04/.04/.05	**0.04 [.02, 0.07]**	**0.05 [.02, 0.07]**	**0.03 [.01, 0.05]**
NC → CS → BA → LS	**0.03 [.01, 0.04]**	**0.03/.03/.03**	**0.03/.03/.03**	**0.03 [.02, 0.03]**	**0.03 [.02, 0.04]**	**0.01 [.01, 0.02]**
NC → CN → BA → LS	0.001 [.000, 0.001]	0.001/.000/ .000	0.000/.000/ .000	0.000 [.000, 0.001]	0.000 [.000, 0.001]	0.000 [.000, 0.001]
NC → RE → BA → LS	**0.02 [.01, 0.03]**	**0.02/.02/.02**	**0.02/.02/.02**	**0.02 [.01, 0.02]**	**0.02 [.01, 0.03]**	**0.01 [.002, 0.01]**

Note. CI = confidence interval, NC = nature contact, LS = life satisfaction, CS = compassionate self-responding, BA = body appreciation, CN = connectedness with nature, RE = restoration during last nature visit. For gender identities and age groups point estimates for each of the three groups are provided. In the multigroup analyses of these groups, unstandardized regression coefficients were constrained to equality. The standardized regression coefficients may still differ due to differences in dispersion between the respective groups. Boldface indicates significance ($p < 0.05$).

Table 5
Standardised Direct Effects of the Covariates to the Variables in the Main Model in the Sensitivity Analyses.

Covariate	NC	CS	CN	RE	BA	LS
Controlling for socioeconomic status						
Financial security	**0.07 [.01, 0.12]**	**0.07 [.04, 0.11]**	0.01 [-0.01, 0.03]	0.04 [-0.003, 0.08]	**0.08 [.05, 0.11]**	**0.25 [.22, 0.28]**
Secondary/tertiary education	0.01 [-0.05, 0.07]	0.02 [-0.02, 0.06]	**0.05 [.02, 0.08]**	0.02 [-0.03, 0.06]	−0.01 [-0.04, 0.02]	0.03 [-0.004, 0.07]
Controlling for sociodemographic factors						
Racialised minority	**−0.05 [-0.08, −0.02]**	0.01 [-0.03, 0.04]	−0.02 [-0.04, 0.01]	−0.02 [-0.05, 0.00]	0.02 [-0.01, 0.05]	**−0.03 [-0.06, −0.001]**
Urbanicity	**−0.17 [-0.22, −0.12]**	**0.04 [.01, 0.06]**	0.01 [-0.02, 0.03]	**0.05 [.02, 0.08]**	0.01 [-0.03, 0.04]	0.01 [-0.01, 0.04]
Controlling for personality						
Openness	**0.15 [.08, 0.21]**	**0.14 [.08, 0.20]**	0.01 [-0.03, 0.04]	**0.11 [.05, 0.17]**	0.06 [-0.004, 0.12]	−0.01 [-0.06, 0.04]
Conscientiousness	**0.15 [.10, 0.20]**	**0.13 [.07, 0.18]**	0.02 [-0.002, 0.05]	**0.06 [.01, 0.12]**	**0.13 [.08, 0.18]**	**0.08 [.06, 0.11]**
Extraversion	**−0.07 [-0.12, −0.02]**	**0.07 [.01, 0.14]**	**0.05 [.03, 0.07]**	**0.09 [.05, 0.13]**	**0.18 [.13, 0.23]**	**0.11 [.06, 0.16]**
Agreeableness	**0.07 [.03, 0.12]**	**0.11 [.06, 0.16]**	0.01 [-0.01, 0.03]	**0.12 [.06, 0.19]**	0.004 [-0.05, 0.06]	0.001 [-0.03, 0.04]
Neuroticism	**−0.09 [-0.15, −0.03]**	**−0.20 [-0.28, −0.12]**	−0.02 [-0.04, 0.01]	−0.05 [-0.09, 0.003]	**−0.08 [-0.14, −0.03]**	**−0.09 [-0.13, −0.05]**

Note. CI = confidence interval, NC = nature contact, CS = compassionate self-responding, CN = connectedness with nature, RE = restoration during last nature visit, BA = body appreciation, LS = life satisfaction. Boldface indicates significance ($p < 0.05$).

Table 6
Standardised Direct Effect Estimates in the Five Groups Deviating Strongest from the Other National Groups.

Direct effect	India (Hindi)	Brazil	Taiwan	Pakistan	Latvia
NC → CS	**0.51 [.47, 0.55]**	**−0.28 [-0.32, −0.23]**	**0.28 [.20, 0.36]**	**0.41 [.30, 0.52]**	**0.18 [.10, 0.25]**
NC → CN	**0.05 [.004, 0.10]**	**−0.06 [-0.11, −0.01]**	0.02 [-0.07, 0.11]	0.08 [-0.06, 0.21]	**0.07 [.004, 0.14]**
NC → RE	**0.53 [.50, 0.57]**	**−0.43 [-0.48, −0.39]**	**0.58 [.51, 0.64]**	**0.50 [.40, 0.59]**	0.03 [-0.05, 0.10]
CS → BA	**0.28 [.24, 0.33]**	**0.50 [.45, 0.54]**	**0.31 [.23, 0.39]**	−0.01 [-0.18, 0.16]	**0.42 [.34, 0.49]**
CN → BA	0.03 [.000, 0.06]	−0.02 [-0.07, 0.02]	**0.08 [.002, 0.15]**	0.10 [-0.01, 0.22]	0.01 [-0.05, 0.07]
NC → BA	**0.15 [.11, 0.19]**	**−0.07 [-0.12, −0.02]**	0.02 [-0.07, 0.12]	0.06 [-0.09, 0.21]	**0.08 [.01, 0.16]**
RE → BA	**0.45 [.40, 0.49]**	**0.06 [.01, 0.11]**	**0.27 [.18, 0.37]**	**0.20 [.04, 0.36]**	**−0.08 [-0.16, −0.02]**
BA → LS	**−0.20 [-0.28, −0.13]**	**0.30 [.23, 0.35]**	−0.01 [-0.12, 0.11]	**0.35 [.24, 0.45]**	**0.31 [.24, 0.39]**
NC → LS	**−0.16 [-0.23, −0.10]**	−0.01 [-0.07, 0.04]	0.06 [-0.04, 0.17]	0.03 [-0.09, 0.16]	**0.14 [.07, 0.20]**
CS → LS	0.01 [-0.06, 0.08]	**0.21 [.15, 0.27]**	−0.10 [-0.22, 0.03]	**0.18 [.03, 0.33]**	**0.25 [.16, 0.33]**
RE → LS	0.03 [-0.04, 0.10]	**0.10 [.05, 0.16]**	0.00 [-0.09, 0.10]	0.03 [-0.16, 0.21]	0.06 [-0.01, 0.12]

Note. NC = nature contact, CS = compassionate self-responding, CN = connectedness with nature, LS = life satisfaction, RE = restoration during last nature visit, BA = body appreciation. Numbers are standardized regression coefficients alongside their 95% confidence intervals. Boldface indicates significance ($p < 0.05$).

Table 7
Standardised Direct Effect Estimates in the Three Languages Deviating Strongest from the Other Languages.

Direct effect	Hindi	Portuguese	Latvian
NC → CS	**0.51 [.47, 0.55]**	**−0.19 [-0.24, −0.15]**	**0.28 [.20, 0.36]**
NC → CN	**0.05 [.004, 0.10]**	**−0.18 [-0.23, −0.13]**	0.02 [-0.07, 0.11]
NC → RE	**0.53 [.50, 0.57]**	**−0.29 [-0.34, −0.24]**	**0.58 [.51, 0.64]**
CS → BA	**0.28 [.24, 0.33]**	**0.50 [.46, 0.53]**	**0.31 [.23, 0.39]**
CN → BA	0.03 [.000, 0.06]	−0.04 [-0.08, 0.000]	**0.08 [.002, 0.15]**
NC → BA	**0.15 [.11, 0.19]**	**0.11 [.07, 0.15]**	0.02 [-0.07, 0.12]
RE → BA	**0.45 [.40, 0.49]**	**0.13 [.09, 0.18]**	**0.27 [.18, 0.37]**
BA → LS	**−0.20 [-0.28, −0.13]**	**0.29 [.24, 0.34]**	−0.01 [-0.12, 0.11]
NC → LS	**−0.16 [-0.23, −0.10]**	**−0.12 [-0.16, −0.08]**	0.06 [-0.04, 0.17]
CS → LS	0.01 [-0.06, 0.08]	**0.20 [.15, 0.25]**	−0.10 [-0.22, 0.03]
RE → LS	0.03 [-0.04, 0.10]	**0.14 [.10, 0.19]**	0.00 [-0.09, 0.10]

Note. NC = nature contact, CS = compassionate self-responding, CN = connectedness with nature, LS = life satisfaction, RE = restoration during last nature visit, BA = body appreciation. Numbers are standardized regression coefficients alongside their 95% confidence intervals. Boldface indicates significance ($p < 0.05$).

mediating pathways, we utilised data from the Body Image in Nature Survey (Swami et al., 2022a), which included responses to a purpose-designed, cross-sectional survey from over 50,000 respondents in 58 nations.

Broadly speaking, our results indicated that greater nature contact is cross-sectionally linked to higher life satisfaction via a number of pathways, each of which involves, at least in part, experiences of body appreciation. Importantly, our final model – as depicted in Fig. 3 – was robust to sensitivity tests and stable across all age groups and gender identities represented in our sample. This model was also invariant across most (i.e., all but a handful) of national and linguistic groups retained for analyses from the BINS. In short, we present evidence of a robust link between nature contact and life satisfaction via several mediating pathways, with our model remaining stable across a range of respondent characteristics.

One important contribution of the present work was our finding that nature contact was not directly linked with either life satisfaction or body appreciation. Although we should expect these constructs to be significantly associated based on previous work (e.g., Fian et al., 2024; Stieger et al., 2022; Swami et al., 2019, 2020; White et al., 2017), it is possible that these links were attenuated because of the manner in which nature contact was measured in the BINS (see more below).

Alternatively, it is possible that previously reported direct associations were inflated because of the reliance on relatively small and homogeneous sample sizes, especially *vis-à-vis* the nature contact and body appreciation link (Swami, 2024). A more realistic explanation, however, is that much of most of the total effect of nature contact on life satisfaction occurred via mediating variables (see also Liao et al., 2025). That is, these mediating relationships appear to be offer stronger explanatory power than the direct associations.

More specifically, our results showed that greater nature contact was indirectly associated with body appreciation via two possible pathways, the stronger of which involved compassionate self-responding. A similar mediational pathway has been reported previously (Swami et al., 2019) and it seems likely that opportunities for "cognitive quiet" (Kaplan and Kaplan, 1989) – or rumination that does not require effortful attention – in nature facilitate more compassionate self-responding (Kaufman, 2015). That is, the gentle stimuli and tranquillity of natural environments often promote deliberation-without-attention (Kaufman, 2018), which effortlessly allows for mindful approaches to distressing emotions or thoughts, self-kindness, and a feeling of connection with others who may also be suffering (van Gordon et al., 2018). As one example, attaining cognitive quiet involves eliminating cognitive clutter, which permits recovery of affective faculties that may allow individuals to experience compassionate self-responding.

In turn, compassionate self-responding was found in our analyses to be associated with greater body appreciation. The association between compassionate self-responding and body appreciation is robust, with one *meta*-analysis (Turk and Waller, 2020) reporting a combined effect across 20 studies of $r = 0.52$ (95% $CI = 0.46, 0.57$). Activating, experiencing, or practising compassionate self-responding may allow individuals to cultivate and safeguard body appreciation even amidst threats to body image experienced in everyday life (Siegel et al., 2020; Tylka and Kroon Van Diest, 2015). Compassionate self-responding may also mean that body image threats are less likely to be perceived as threatening and provide individuals with safeguarded (cognitive) space to challenge those threats (Tylka and Kroon Van Diest, 2015). In fact, the effects of compassionate self-responding may be broader, directly affecting life satisfaction, possibly by reducing negative thinking and emotions or enhancing emotional regulation skills (Neff, 2023).

A second mediational pathway involved perceived restoration (i.e., short-term improvements to affective, physiological, and attention restoration outcomes) during respondents' last visit to a natural environment. This link is widely supported in the extant literature. Attention Restoration Theory (Kaplan, 1995; Kaplan and Berman, 2010; Kaplan and Kaplan, 1989), for instance, suggests that urban environments require top-down, goal-directed attention to process attention-demanding stimuli, which can result in mental fatigue, failure to maintain goal-directed behaviour, and impaired self-regulation. Conversely, natural environments are able to support recovery from states of cognitive depletion (i.e., attention restoration), precisely because they contain stimuli that capture attention effortlessly and thereby stimulate involuntary attention, allow directed attention to rest, aid the ability to adopt mindful states, and ultimately achieve cognitive restoration and optimal self-regulation (Ohly et al., 2016; Stevenson et al., 2018).

In turn, perceived restoration appears to be associated with greater body appreciation, a link that has only been reported once previously in Lithuanian adults (Baceviciene et al., 2021). Theories of restoration have traditionally focused on cognitive and physiological outcomes (Kaplan, 1995; Kaplan and Kaplan, 1989), but the construct is also multifaceted and includes components of vitality (an energetic, positive state) and self-confidence (Korpela and Ylén, 2009; Pasanen et al., 2018) that likely contribute to higher body appreciation. Restorative experiences may also promote improved everyday coping (Hartig et al., 2014), particularly when contact with nature occurs repetitively. Such coping strategies may also extend to adaptive affect regulation styles when exposed to body image challenges (Cash et al., 2005), such as being teased about one's weight, which provides a "protective filter" that facilitates that development of body appreciation (Swami et al., 2022b). Importantly, perceived restoration also had a direct impact on life satisfaction, possibly by boosting self-efficacy, positive emotions, and mental recovery (Bai et al., 2025).

Our results also showed a robust association between body appreciation and life satisfaction, which is consistent with the evidence that facets of positive body image are reliably linked with more adaptive well-being (Swami et al., 2018b, 2024b). For instance, one *meta*-analysis of 72 studies reported that body appreciation was positively associated with indices of general well-being ($r = 0.47$, 95% CI = 0.46, 0.48), including life satisfaction (Linardon et al., 2022). It seems likely that, when individuals have the capacity to love, respect, and care for their bodies, they also begin to develop greater respect and care for their mental health more generally (Iannantuono and Tylka, 2012). Individuals with greater body appreciation may also be more likely to engage in forms of self-care or be more attuned to their bodily needs (e.g., eating adaptively, engaging in physical activity), which in turn promotes greater life satisfaction (Linardon et al., 2022, 2023).

In the present work, we also tested a third possible mediational pathway involving connectedness to nature. While some previous studies have reported that connectedness to nature mediates the relationship between nature contact and body appreciation (Baceviciene et al., 2021; Swami et al., 2016b, 2022a), we were not able to corroborate this mediational link in the present study. Specifically, the association between nature contact and connectedness to nature was not significant and, while the mediational pathway from connectedness to nature to life satisfaction via body appreciation was significant, its effects were negligible. Thus, while it is clear that connectedness to nature plays an important role in promoting various forms of well-being (Pritchard et al., 2020; Zeng et al., 2025), it may be that its impact on experiences of inhabiting the body are relatively weak.

Overall, our findings show that greater nature contact is associated with higher body appreciation, which in turn is linked with greater life satisfaction. These associations were robust to sensitivity tests and remained stable across all adult age groups and gender identities that were represented in the BINS dataset. Notably, these associations were also robust across all but five national groups and three languages. Where the model diverged, it was typically because singular direct paths were non-significant (e.g., the path between compassionate self-responding and body appreciation in India and Pakistan) or in the contra-indicated direction (e.g., a negative association between nature contact and compassionate self-responding in Brazil).

It is difficult to know precisely what caused these divergent effects in singular nations without additional data. However, one possibility is that epistemologies about the natural world and its outcomes vary across national and cultural contexts (Swami et al., 2022a), which in turn affected the strength of particular pathways in our model in specific national groups. Alternatively, it may simply be the case that these effects were spurious or artefactual. Nevertheless, when these handful of cases were excluded, we achieved a well-fitting model in the remaining national groups and languages. It might be suggested, therefore, that the processes involved in how embodied engagement with nature translates into health-related outcomes may be relatively common across cultures. Largely irrespective of the specific national site, it appears that the materialities of natural environments help to link external and internal bodily experiences to the production of life satisfaction.

Our study has several potential limitations, which are important to acknowledge. First, our assessment of nature contact was based on self-report, and there has been some recent criticism of the specific instrument we used in terms of what it captures (i.e., different forms of nature contact in a single metric;Swami et al., 2024c). This may be one reason why the relationship between nature contact and connectedness to nature was non-significant, and it may also explain why the links with life satisfaction and body appreciation were unexpectedly non-significant. For instance, it may be that our brief measure of nature contact

masked the complexities of repeated engagement with different types of natural environment (Dougall et al., 2024). To better understand the impact of nature contact, it will be helpful in future work to more carefully distinguish between its different forms, such as the amount of everyday nature around the home or work, deliberative contact with nature (e.g., leisure visits to natural settings), and psychological awareness of exposure to nature (Browning et al., 2025; Dougall et al., 2024). Relatedly, future work should also consider the mediational routes through which nature exposure may be associated with other indices of positive body image, such as functionality appreciation (Alleva et al., 2017), which may be important given suggestions that nature exposure facilitates an appreciation for what the body is capable of doing rather than what it looks like (Swami et al., 2018).

Additionally, the BINS dataset primarily represents samples that were recruited opportunistically and, as such, the experiences of specific samples may not be representative of its nation. For instance, many of the subsamples from individual nations were relatively highly educated and there may also have been limited diversity in terms of socioeconomic status. We also did not ask participants about possible disabilities or neurodiversity, which may affect outcomes of nature contact (see Swami et al., 2025). In a similar vein, because the BINS dataset was researcher-crowdsourced, there were practical difficulties in reaching all world regions and we acknowledge that the dataset was underrepresented in Africa, Central Asia, the Caribbean, and Central America. It should also be noted that the BINS data were collected over a 15-month period that took place in the context of the COVID-19 pandemic. It is difficult to know how this might have impacted our results, but it seems likely that there would have been some cross-national variation in post-pandemic policies that affected citizens' abilities to spend time in nature, as well as broader indices of well-being.

Further research is also needed to translate our cross-sectional findings into causational conclusions. In spite of these limitations, in this study, we validated a conceptual model demonstrating the benefits of nature contact on life satisfaction via more body appreciation. Our findings highlight the ways in which nature contact can lead to better life satisfaction, largely irrespective of one's gender identity, age, nationality, or language. As populations worldwide seek effective ways to promote better subjective well-being, our findings serve as a timely reminder of the invaluable role that is and can be played by natural environments. Indeed, our findings support calls to use scientific evidence as the foundation on which urban planning, educational systems, and international governance prioritises the natural environment as an effective route toward promoting positive mental health for populations worldwide.

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Declaration of competing interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.envint.2026.110277.

Data availability

The link to the data is available in the manuscript

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