



Universidade Estadual Paulista
"Júlio de Mesquita Filho"
Programa Interunidades



Mestrado

Engenharia Civil e Ambiental

MIRELA BEATRIZ SILVA

EFEITOS DO CONTATO COM A NATUREZA
SOBRE INDICADORES DE ESTRESSE, ANSIEDADE E DEPRESSÃO:
O GRAU DE NATURALIDADE IMPORTA?

Bauru
2023

MIRELA BEATRIZ SILVA

**EFEITOS DO CONTATO COM A NATUREZA
SOBRE INDICADORES DE ESTRESSE, ANSIEDADE E DEPRESSÃO:
O GRAU DE NATURALIDADE IMPORTA?**

Dissertação apresentada como requisito para a obtenção do título de Mestre em Engenharia Civil e Ambiental da Universidade Estadual Paulista “Júlio de Mesquita Filho”, Área de Concentração Saneamento.

Orientador: Prof. Dr. Adriano Bressane

Coorientadora: Profa. Dra. Líliam César de Castro Medeiros

Bauru
2023



Silva, Mirela Beatriz.

Efeitos do contato com a natureza sobre indicadores de estresse, ansiedade e depressão : o grau de naturalidade importa? / Mirela Beatriz Silva, 2023

70 p. : il.

Orientador: Adriano Bressane

Coorientadora: Lílíam César de Castro
Medeiros

Dissertação (mestrado) - Universidade Estadual Paulista (Unesp), Faculdade de Engenharia, Bauru, 2023

1. Infraestrutura urbana. 2. Área verde. 3. Saúde pública. I. Título.

ATA DA DEFESA PÚBLICA DA DISSERTAÇÃO DE MESTRADO DE MIRELA BEATRIZ SILVA, DISCENTE DO PROGRAMA DE PÓS-GRADUAÇÃO EM ENGENHARIA CIVIL E AMBIENTAL, DA FACULDADE DE ENGENHARIA - CÂMPUS DE BAURU.

Aos 24 dias do mês de novembro do ano de 2023, às 10:00 horas, por meio de Videoconferência, realizou-se a defesa de DISSERTAÇÃO DE MESTRADO de MIRELA BEATRIZ SILVA, intitulada **CIDADES SAUDÁVEIS E SUSTENTÁVEIS: A INFLUÊNCIA DA NATURALIDADE DOS ESPAÇOS VERDES URBANOS SOBRE O BEM-ESTAR DA POPULAÇÃO**. A Comissão Examinadora foi constituída pelos seguintes membros: Prof. Dr. ADRIANO BRESSANE (Orientador(a) - Participação Virtual) do(a) Departamento de Engenharia Ambiental / Universidade Estadual Paulista UNESP Instituto de Ciência e Tecnologia de São José dos Campos, Prof. Dr. RODRIGO CUSTODIO URBAN (Participação Virtual) do(a) Departamento de Engenharia Ambiental / Instituto de Ciência e Tecnologia do Câmpus de São José dos Campos - UNESP, Profa. Dra. ELISA ESPOSITO (Participação Virtual) do(a) Departamento de Ciência e Tecnologia / Universidade Federal De São Paulo - UNIFESP / São José dos Campos. Após a exposição pela mestranda e arguição pelos membros da Comissão Examinadora que participaram do ato, de forma presencial e/ou virtual, a discente recebeu o conceito final: APROVADA. Nada mais havendo, foi lavrada a presente ata, que após lida e aprovada, foi assinada pelo(a) Presidente(a) da Comissão Examinadora.

Prof. Dr. ADRIANO BRESSANE



**DEFESA DE DISSERTAÇÃO DE MESTRADO DO PROGRAMA DE PÓS-GRADUAÇÃO EM ENGENHARIA
CIVIL E AMBIENTAL**

DISCENTE: MIRELA BEATRIZ SILVA

TÍTULO CIDADES SAUDÁVEIS E SUSTENTÁVEIS: A INFLUÊNCIA DA NATURALIDADE DOS ESPAÇOS
VERDES URBANOS SOBRE O BEM-ESTAR DA POPULAÇÃO

Data: 24 de novembro de 2023 às 10:00

Local: Via sistemas de videoconferência e outras ferramentas para comunicação a distância

APROVADO (X)

REPROVADO ()

PARECER CIRCUNSTANCIADO:

A dissertação destaca-se pela relevância e contribuição para o campo de estudos. Durante a arguição, a candidata demonstrou notável capacidade em responder as questões. Diante dos expostos, a comissão considera a candidata apta para obtenção do título de mestre em Engenharia Civil e Ambiental.

Bauru, 24 de novembro de 2023


Prof. Dr. Adriano Bressane

Resumo

Vários estudos têm mostrado os efeitos positivos do contato com a natureza na saúde pública. No entanto, a maioria das pesquisas tem sido realizada no exterior, o que limita a generalização dos resultados, especialmente em países em desenvolvimento como o Brasil. Para preencher essa lacuna, foi realizado um estudo no Brasil para investigar o impacto do grau de naturalidade no bem-estar mental. Uma pesquisa foi conduzida com 2136 participantes, avaliando seu contato com a natureza e níveis de depressão, ansiedade e estresse. Os resultados revelaram que indivíduos que interagiam ativamente com a natureza tinham melhores resultados de saúde mental em comparação com aqueles que não o faziam. Além disso, os benefícios foram mais significativos quando os indivíduos eram expostos a ambientes com maior grau de naturalidade. Os achados mostraram que a exposição a ambientes mais naturais teve um efeito maior na redução da depressão em comparação com espaços verdes antropizados. O impacto na ansiedade foi mais pronunciado quando os indivíduos se envolviam com ambientes com maior grau de naturalidade. Os efeitos sobre o estresse também variaram com base no grau de naturalidade, com um impacto mais substancial observado ao comparar indivíduos que não tiveram contato com a natureza com aqueles que interagiram com ambientes mais naturais. No geral, o estudo destacou a importância da interação com a natureza para promover o bem-estar mental. Aumentar a exposição a ambientes naturais teve um efeito positivo e estabilizador nos resultados de saúde mental. Esses achados contribuem para a compreensão da relação entre ambientes naturais e promoção da saúde em ambientes urbanos e enfatizam a necessidade de mais pesquisas em países em desenvolvimento.

Palavras-chave: infraestrutura urbana; área verde; saúde pública.

Abstract

Numerous studies have shown the positive effects of contact with nature on public health. However, most of the research has been conducted abroad, limiting the generalizability of the findings, especially in developing countries like Brazil. To address this gap, a study was conducted in Brazil to investigate the impact of the degree of naturalness on mental well-being. A survey was conducted with 2136 participants, assessing their contact with nature and levels of depression, anxiety, and stress. The results revealed that individuals who actively interacted with nature had better mental health outcomes compared to those who did not. Moreover, the benefits were more significant when individuals were exposed to wilder environments. The findings showed that exposure to wild natural environments had a larger effect on reducing depression compared to designed green spaces. The impact on anxiety was more pronounced when individuals engaged with wild natural environments. The effects on stress also varied based on the degree of naturalness, with a more substantial impact observed when comparing individuals who had no nature interaction to those who interacted with wild natural environments. Overall, the study highlighted the importance of nature interaction for promoting mental well-being. Increasing exposure to natural environments, especially wilder ones, had a positive and stabilizing effect on mental health outcomes. These findings contribute to the understanding of the relationship between natural environments and health promotion in urban settings and emphasize the need for further research in developing countries.

Keywords: urban infrastructure; green spaces; public health.

Índice de Figuras

Minuta de artigo

Figure 1. Sociodemographic profile of respondents: (a) age grouped by gender and
(b) income grouped by education.....38

Figure 2. Association between degree of naturalness and depression, anxiety and
stress level.....41

Índice de Tabelas

Artigo publicado

Table 1. Association between frequency of contact with nature and occurrence of stress, anxiety, and depression symptoms.....	13
Table 2. Significance of frequency of contact with nature on the occurrence of anxiety, stress, and depression symptoms.....	14

Minuta de artigo

Table 1. Sociodemographic profile of respondents (n = 2136).....	37
Table 2. Effect of the degree of naturalness on depression, anxiety and stress level.	39

SUMÁRIO

RESUMO	I
ABSTRACT.....	II
ÍNDICE DE FIGURAS.....	III
ÍNDICE DE TABELAS.....	IV
SUMÁRIO.....	V
1 INTRODUÇÃO.....	1
2 OBJETIVOS	5
2.1 OBJETIVO GERAL	5
2.2 OBJETIVOS ESPECÍFICOS	5
3 ARTIGO PUBLICADO	6
4 MINUTA DE ARTIGO.....	32
5 CONCLUSÕES E RECOMENDAÇÕES	55
5.1 PRINCIPAL	55
5.2 ESPECÍFICAS.....	55
5.3 RECOMENDAÇÕES	57
6 REFERÊNCIAS BIBLIOGRÁFICAS	58

1 INTRODUÇÃO

O surgimento das cidades proporcionou melhorias significativas em várias dimensões da vida humana, contribuindo para o bem-estar dos cidadãos por meio de serviços de saneamento, segurança, educação, energia, saúde e transporte, por exemplo (WANG et al., 2021; BRESSANE et al., 2022).

Por outro lado, quando as áreas construídas se espalham e sua expansão invade os espaços verdes urbanos (EVU), suprimindo os ambientes naturais, pode ter um impacto negativo severo na qualidade ambiental, no bem-estar público e na qualidade de vida nas cidades (XU et al., 2018; LEDDA e de MONTIS, 2019; YANG et al., 2021).

Embora as EVU possam contribuir com funções ecológicas como conservação da biodiversidade, fluxo gênico (troca de material genético entre populações de fauna e flora, por exemplo) e proteção de recursos naturais, elas também cumprem um papel social como locais privados e públicos de lazer e recreação (HANSEN et al., 2019; TIAN et al., 2020; DEROSE et al., 2021; CHALMIN-PUI et al., 2021; CHENG et al., 2021).

Assim, as EVU podem representar uma abordagem promissora para a gestão do solo urbano, promovendo a educação ambiental e estratégias de políticas públicas de saúde, ou seja, para alcançar cidades sustentáveis e saudáveis, principalmente por sua capacidade multifuncional (RIGOLON et al., 2018; KROLL et al., 2019).

Várias interpretações da EVU podem ser encontradas na literatura acadêmica (NIEUWENHUIJSEN et al., 2021). No geral, uma EVU pode ter vários graus de naturalidade (artificial ou selvagem), mas normalmente se refere a áreas com poucas ou nenhuma edificação, com cobertura vegetal e comumente equipadas com instalações destinadas ao lazer e recreação dos cidadãos. Assim, o EVU pode ser uma estratégia chave essencial para alcançar cidades e comunidades resilientes, sustentáveis e saudáveis (KROLL et al., 2019).

Neste sentido, um número crescente de estudos tem mostrado os efeitos positivos do EVU na saúde pública. Melhora na pressão arterial, na qualidade do sono, nos sistemas cardiovascular e respiratório, bem como na saúde mental, principalmente pela redução dos sintomas de estresse, depressão e ansiedade, que estão entre os principais benefícios revelados nas últimas décadas em todo o mundo (ULRICH et al. , 1991; PARSONS et al., 1998; TOPPER et al., 2010; FAN et al., 2011; BEYER et al. 2014; NEWBY et al., 2014; SONG et al., 2014; PRETTY et al., 2014 ; COX et al., 2018; RAUTIO et al. 2018; SPINHOVEN et al., 2018; BARRETO et al. 2019; OWENS e BUNCE, 2022; BRESSANE et al., 2022).

Usando medidas fisiológicas como frequência cardíaca e tensão muscular, Ulrich et al. (1991) investigaram os impactos da exposição ambientes naturais e urbanos em pessoas residentes em cidades dos Estados Unidos da América (EUA), submetidas a situações estressantes. Em conclusão, o estudo constatou que o tempo de recuperação do estresse foi menor quando os indivíduos foram expostos a ambientes naturais em comparação aos urbanos.

Também desenvolvido nos EUA, o estudo de Parsons et al. (1998) avaliou a recuperação do estresse em motoristas que percorreram uma das quatro rotas: floresta/rural, fora dos campos de golfe, urbana e cenários mistos. Os autores verificaram que motoristas em percursos com cenários mais naturais recuperavam-se do estresse mais rapidamente do que aqueles expostos a cenários projetados, ou seja, espaços dominados por edificações.

Estudos realizados em outros países, como Austrália, Holanda, Coreia do Sul, Japão e Reino Unido, também relataram uma associação inversa entre contato com a natureza e problemas comuns de saúde mental, como depressão e ansiedade (Fan et al., 2011; Beyer et al. 2014; Rautio et al. 2018; Cox et al., 2018). Por exemplo, Cox et al. (2018) observaram que indivíduos que residem em áreas rurais com maior acesso à natureza apresentam melhor saúde mental, medida por escalas de depressão, ansiedade e estresse, do que aqueles que vivem em áreas urbanas com falta de vegetação.

Estudos também verificaram que atividades na natureza, como banhos na floresta e caminhadas na natureza, podem reduzir a frequência de pensamentos negativos repetitivos e contribuir positivamente para os sintomas de depressão e ansiedade, mais do que atividades internas, como academia e clubes esportivos (TOPPER et al., 2010; NEWBY et al., 2014; SPINHOVEN et al., 2018). Além disso, foi revelado que as atividades realizadas em áreas naturais reduziram mais os sintomas de estresse e ansiedade do que aquelas realizadas em áreas construídas (SONG et al., 2014).

Apesar das evidências crescentes nos últimos anos, a grande maioria dos estudos foi realizada no exterior, limitando a validação de resultados empíricos para outras regiões (ROSA et al., 2018), especialmente para países em desenvolvimento como o Brasil (ROSA et al., 2019).

Na revisão desenvolvida por Nawrath et al. (2021), apenas um estudo foi realizado no Brasil naquela época, investigando a associação entre a exposição a UGS no entorno das residências e a saúde mental dos moradores (BARRETO et al., 2019). Recentemente, outro estudo realizado no Brasil por Bressane et al. (2022) trouxe análises exploratórias voltadas para o entendimento inicial de uma população pouco estudada. Os resultados indicaram que pessoas com maior contato com a natureza têm cerca de 3 a 5 vezes menos ocorrência de sintomas associados a estresse, ansiedade e depressão. No entanto, o estudo não avaliou como variações na forma desse contato podem afetar seus benefícios.

2 OBJETIVOS

2.1 Objetivo Geral

Analisar como variações no contato humano com a natureza afetam indicadores do estado emocional de estresse, ansiedade e depressão, que constituem os transtornos mentais mais comuns na população em todo o mundo (HAJEBI et al., 2018).

2.2 Objetivos específicos

- verificar se os efeitos do contato com a natureza sobre o estado emocional de estresse, ansiedade e depressão são dependentes do grau de naturalidade da área; e
- verificar se há prevalência associada a variáveis demográficas, em relação aos efeitos do contato com a natureza sobre o estado emocional de estresse, ansiedade e depressão;

3 ARTIGO PUBLICADO

Association between Contact with Nature and Anxiety, Stress and Depression Symptoms: A Primary Survey in Brazil

Abstract

Mental health benefits have been linked to human interaction with nature. However, most studies have been carried out in developed countries, limiting the generalizability of empirical findings to other parts of the world. To address this gap, this study was conducted in Brazil. The objective of the study was to assess whether the frequency of contact with nature affects the occurrence of anxiety, stress, and depression. Data were collected between June and July 2022 through an online survey ($n = 1186$, $1 - \alpha = 0.95$, $p = 0.05$, $1 - \beta = 0.85$, $\rho = 0.1$). Thus, the public online survey made it possible to carry out voluntary response sampling suitable for an exploratory study, with the purpose of an initial understanding of an under-researched population. First, a logistic regression was performed for quantifying the association between contact with nature and mental symptoms. In addition, three groups of people having different frequencies (low, medium, and

high) of contact with nature and a reference group, comprised of those who reported no contact, were compared using Kruskal–Wallis and Dwass–Steel–Crichtlow–Fligner tests. This study employs a cross-sectional design and relies on retrospective recall. As a result, the research hypothesis was confirmed. People who very rarely have contact with nature had a 97.95% probability of moderate occurrence of stress, which decreases to 20.98% for people who have contact with nature frequently. Furthermore, in the same comparison, the probability of occurrence was 3.6 times lower for anxiety and 4.8 times lower for depression. In conclusion, the evidence indicates that the greater the frequency of contact with nature, the lower the occurrence of stress, anxiety, and depression symptoms. Nevertheless, the benefits of this contact were significant only when its frequency was moderate (about once or twice a week) or higher.

Keywords: nature contact; mental health; primary survey; Brazil

Introduction

Humankind has undergone great transformations, with several impacts on its habitat and lifestyle. Early civilizations lived as nomads in direct contact with nature, but the emergence of agriculture allowed the growth of cities, and the increase in built-up environments and respective suppression of natural areas has intensified in the most recent period of human history [1]. Humankind's distance from the adversities of the natural environment has brought benefits in many fields, such as sanitation, transport, and medicine. On the other hand, modern

society's increasing focus on the built environment and designed entertainment, such as social networks in digital medias, has raised concerns about higher rates of mental health problems associated with the fact that people spend less time in contact with nature [2-7].

Among the studies that seek to explain the process by which contact with nature brings benefits to human health, Kellert [8] analyzed the biophilia hypothesis developed by Wilson [9]. According to this thesis, survival of humankind throughout the evolutionary process was dependent on the physical, mental, and intellectual improvement developed from the direct relationship with nature. Thus, humankind's ancestors would have perpetuated an attraction, biologically encoded, to the natural environment [10].

According to McMahan and Estes [11], the fact that humankind's ancestors lived amid nature, taking advantage of the availability of resources such as water and food, would have produced a beneficial association that contributes to well-being and quality of life. The mental health benefits of contact with nature have also been linked to its effect on the right hemisphere of the brain and the parasympathetic nervous system, which contributes to the restoration of physical energy, to calm excess brain activity after stressful events [12].

From the perspective of Attention Restoration Theory (ART) [13-15], nature acts on the improvement of mental fatigue and, in this way, contributes to the recovery of associated mental health problems. According to ART, mental fatigue is related to voluntary attention (concentration), which tends to increase

over time. Contact with nature activates involuntary attention (distraction), which does not require effort, allowing rest and restoration of brain functioning.

As pointed out by Owens and Bunce [16, p. 2], “the idea that contact with nature is positive for human health is not new”. Several studies have revealed evidence on the effects of contact with nature in different dimensions of human health [17]. Reductions in stress, anxiety, and depression symptoms are among the mental health benefits studied over the years [8, 18-27].

Notwithstanding, most studies have been carried out in developed countries, thus limiting the generalizability of empirical findings to other parts of the [28]. Responding to ongoing calls for more studies in developing countries [29], especially in Latin America, where there is a dearth of primary research [7], this study was conducted in Brazil. The objective was to evaluate the research hypothesis that the frequency of contact with nature affects the occurrence of anxiety, stress, and depression symptoms.

Method

Initially, data collection was performed by the application of an online survey between June and July 2022. This process is according to Brazil’s ethical requirements for studies involving human beings (Process #58149622.3.0000.0077). As inclusion criteria, we considered participants who are at least 18 years old and resident in Brazil. There are no further distinctions such as gender, region, social strata, education level, etc. The sample size of 1186 respondents provided a test

power ($1 - \beta$) of 0.85 for a significance level (α) of 0.05 and a minimum detectable effect size (ρ) of 0.1. The effect size observed in the study was calculated from the variances, using Pearson's test.

Thus, the public online survey enabled voluntary response sampling suitable for an exploratory study, with the purpose of an initial understanding of an under-researched population. Filling out an online self-report, respondents were asked about the occurrence of anxiety, stress, and depression symptoms in the last month, considering [30]: (i) stress symptoms: nervousness, overreaction, agitation, intolerance, feeling very sensitive; (ii) anxiety symptoms: fatigue, wheezing, shakiness, racing thoughts, increased heart rate; and (iii) depression symptoms: sadness, negative thoughts, hopelessness, discouragement, low self-esteem.

The symptoms were scored using a discrete six-point scale: 1, very rarely (less than once a month); 2, rarely (about once a month); 3, sometimes (about twice a month); 4, moderately (about once a week); 5, frequently (about twice a week); and 6, very often (more than twice a week). It is worth mentioning that only symptoms based on the Depression, Anxiety, and Stress Scale (DASS) were used as a reference, to support the respondents in the retrospective recall of such symptoms. Therefore, as the purpose of the study was to measure the frequency of this occurrence, without classifying the severity of symptoms, cut-offs and any other psychometric properties of the DASS were not used.

In the second question, respondents stated the frequency with which they usually have contact with nature, considering: (i) nature: natural areas, such as gardens, forests, grassland, reserves, woods, parks, beaches, mountains, or similar environments; and (ii) contact with nature: recreational or leisure activity in natural areas, such as contemplating, walking, running, cycling, horseback riding, camping, fishing, swimming, surfing, meditating, or similar activities.

This study employs a cross-sectional design and relies on retrospective recall. For the comparative analysis, four groups of respondents were formed, according to the frequency of nature contact: reference group (G0), hardly ever (less than once a month); low frequency group (G1), sometimes (about once or twice a month); medium frequency group (G2), moderately (about once or twice a week); and high frequency group (G3), frequently (more than twice a week). Aiming to verify the reliability of this scale of grouping, the Cronbach's alpha was calculated, which resulted in 0.736, indicating an acceptable internal consistency.

As the data collected are not continuous, a non-parametric approach was used for statistical analysis. First, we performed a logistic regression analysis aimed at quantifying the association between events: (e1) contact with nature; and (e2) occurrence of anxiety, stress, and depression symptoms. If $p < 0.05$ in the regression, and the odds ratio (OR) is < 1 (95% CI), then the events are negatively associated [31]. In this case, the presence of event e1 (contact with nature) reduces the chances of event e2 (occurrence of symptoms).

Once the hypothesis of dependence between events has been verified, the responses given by the groups (G0, G1, G2, and G3) were compared using two-sided Kruskal–Wallis and Dwass–Steel–Chritchlow–Fligner (DSCF) tests. All analyses considered a confidence level ($1 - \alpha$) of 95%.

Whereas stress, anxiety, and depression problems can lead to reduced contact with nature, there may well be bi-directional effects, so a review of the current literature was undertaken, identifying which studies are longitudinal and which are cross-sectional, to help towards disentangling the direction of causality. To search for the most reliable, relevant, and up-to-date literature, we use the Scopus database, in which the following query was applied: title-abs-key (“nature” and (“green” or “contact” or “disorder” or “depression” or “anxiety”) and (“longitudinal” or “transversal” or “cross-sectional”)) and (limit-to (pubstage, “final”)) and (limit-to (doctype, “ar”)) and (limit-to (subjarea, “psyc”) or limit-to (subjarea, “envi”)) and (limit-to (pubyear, 2023) or limit-to (pubyear, 2022) or limit-to (pubyear, 2021) or limit-to (pubyear, 2020) or limit-to (pubyear, 2019) or limit-to (pubyear, 2018) or limit-to (pubyear, 2017) or limit-to (pubyear, 2016) or limit-to (pubyear, 2015) or limit-to (pubyear, 2014) or limit-to (pubyear, 2013) or limit-to (pubyear, 2012)) and (limit-to (language, “English”)). Considering the publications of the last 10 years (from 2012), the 200 most recent articles were preliminarily screened. After excluding those outside the scope, only 20.6% used longitudinal designs, with results that were compared to those of the present study.

Results

Considering the cases with goodness-of-fit of the data to the model and a significant regression coefficient (δ), the OR was <1 for all associations under analysis (Table 1). This finding indicates that the likelihood of occurrence of the symptoms (anxiety, stress, and depression) tends to decrease when the frequency of nature contact increases, corroborating the research hypothesis.

Table 1. Association between frequency of contact with nature and occurrence of stress, anxiety, and depression symptoms.

	Event	p		OR (95% CI)	Likelihood of Occurrence (%)			
		GoF	δ		G0 (e_1^1)	G1 (e_1^2)	G2 (e_1^3)	G3 (e_1^4)
Stress	(e_2^1)	<0.001	<0.001	0.638	75.99	66.90	56.34	45.17
	(e_2^2)	<0.001	<0.001	0.177	97.95	89.45	60.00	20.98
	(e_2^3)	0.043	0.038	0.635	26.28	18.88	12.88	8.58
Anxiety	(e_2^1)	0.214	0.216	*	*	*	*	*
	(e_2^2)	<0.001	<0.001	0.258	95.51	84.60	58.64	26.80
	(e_2^3)	0.001	<0.001	0.424	46.64	27.04	13.58	6.25
Depression	(e_2^1)	0.038	0.037	0.764	36.63	30.63	25.23	20.49
	(e_2^2)	<0.001	<0.001	0.510	41.75	26.78	15.73	8.70
	(e_2^3)	0.001	0.0082	0.586	20.66	13.23	8.20	4.97

G0: reference group; G1: low frequency group; G2: medium frequency group; G3: high frequency group; e_2^1 : sometimes; e_2^2 : moderately; e_2^3 : frequently; OR: odds ratio; GoF: goodness-of-fit (χ^2); δ : regression coefficient; * non-adequacy of adjustment of the data to the model or non-significant regression.

Participants who very rarely have contact with nature (G0) have a 97.95% probability of moderate occurrence of stress (e_2^2). This probability decreases to 20.98% for people who have contact with nature frequently (G3), which is 4.7 times lower. For the same comparison (i.e., considering a moderate occurrence of the symptoms for both G0 and G3), the probability of occurrence was 3.6 times lower for anxiety (from 95.5% in G0 to 26.8% in G3) and 4.8 times lower for depression (from 41.75% to 8.7%). As can be seen in Table 2, the null hypothesis can be rejected at a confidence level of 99.9% ($p \leq 0.001$) for almost all multiple paired comparisons, except in the comparison between G0 and G1.

Table 2. Significance of frequency of contact with nature on the occurrence of anxiety, stress, and depression symptoms.

	Kruskal–Wallis *	DSCF *		
		G0 × G1	G0 × G2	G0 × G3
Stress	<0.001	0.197	<0.001	<0.001
Anxiety	<0.001	0.607	0.001	<0.001
Depression	<0.001	0.070	<0.001	<0.001

* p value: probability of rejecting the null hypothesis (H_0 : the frequency of contact with nature does not affect the occurrence of anxiety, stress, and depression symptoms) when it is true.

In other words, the research hypothesis that the frequency of contact with nature affects the occurrence of anxiety, stress, and depression symptoms was confirmed. The effect size observed in the study was 0.230 for anxiety, 0.203 for stress, and 0.196 for depression, considered as a medium-sized effect. However, it

is important to highlight that there was no statistically significant effect ($p > 0.05$) on the occurrence of symptoms when the frequency of contact with nature was only sometimes, that is, about once or twice a month ($G0 \times G1$). Therefore, the benefits of this contact were significant only when its frequency was moderate (about once or twice a week) or higher.

Discussion

Effects on Anxiety, Stress, and Depression Symptoms

In agreement with our results, previous studies have also verified that contact with nature, which includes environments, such as forests, being near trees (or other vegetation) and water features (such as rivers and lakes), grassland, reserves, woods, or parks, had positive impacts on stress, anxiety, and depression.

Ulrich et al. [18] analyzed the effects of natural and urban settings on people who had been subjected to a stressful condition (watching a horror movie). Based on physiological measures such as heart rate and muscle tension, the authors verified that the stress recovery time was shorter when people were exposed to natural rather than urban environments.

Parsons et al. [19] evaluated stress recovery in drivers who had traveled one of the following four routes: forest/rural scenery, outside golf courses, urban scenes, and mixed scenarios. The results showed that drivers on routes dominated by natural scenes experienced faster recovery from stress than participants who saw environments dominated by artificial scenes (buildings) while driving.

Cox et al. [32] found that residents of rural areas, with higher “doses of nature”, had better mental health (measured on scales of depression, anxiety, and stress) than people who live in urban areas characterized by predominantly built environments. Similarly, other studies, such as Fan et al. [23], Beyer et al. [24], Rautio et al. [26], and Barreto et al. [27], have shown an inverse association between the presence of green areas around the home and the occurrence of more common mental health problems such as anxiety and depression.

Mackay and Neil [22] related physical exercise in natural areas with a considerable decrease in anxiety levels. Song et al. [25] compared the effect of physical activities in natural (greener) and artificial (more built) environments. The authors verified a more significant decrease in anxiety and stress levels in people who walk in natural areas, such as parks, compared to people who walk on urban roads (artificial, built, or designed areas). Pretty et al. [20] found that those who walked daily around a natural park, with woods and lakes, experienced significantly less depression than people who walked in a shopping mall.

Regarding the mechanisms involved in explaining the association between contact with nature and the mental health benefits, Owens and Bunce [16] argue that there are several potential candidates. Among them, the authors highlight mechanisms related to stress, rumination (repetitive thinking), mindfulness, sleep, and exercise (physical activity). Some evidence supports that contact with nature is capable of mitigating cortisol hypersecretion and, consequently, of reducing stress, which is also a risk factor for depression [33, 34].

Studies have also found that walking in nature and forest bathing [35] were able to reduce the frequency of repetitive negative thoughts (rumination), contributing positively to the improvement of depression and anxiety symptoms [36-39].

Meta-analyses have confirmed evidence that mindfulness practice provides a non-judgmental level of awareness, which is heightened when performed in contact with nature, becoming even more beneficial for mental health, in terms of a reduction in stress, anxiety, and depression [40-44].

Upon performing a literature review, Shin et al. [45] reported a positive association between green walking and better night-time indices of autonomic nervous system functioning. Thus, by contributing to good sleep, contact with nature can also mitigate the deleterious effects of poor sleep on mood and well-being [46].

By improving emotional regulation [47] and self-esteem [48] and reducing obesity [49] and inflammatory processes [50], exercise (physical activity) has been shown by several studies to be beneficial for mental health, especially under conditions of exposure to nature, and be more beneficial than engaging in similar activities in a non-forested urban area [29, 51-52].

Whereas it is entirely possible for the hypothetical direction to be reversed, that is, mental problems may lead to reduced contact with nature, to help towards disentangling the direction of causality, the results of recent studies with longitudinal designs are highlighted below, corroborating the results of the present study.

Das and Gailey [53] longitudinally assessed whether physical activities (walking or running) in contact with nature (green exercise) provided a decline in adverse mental health symptoms (anxiety and depression) during the COVID-19 pandemic lockdown. The authors found fewer adverse symptoms due to green exercise. Moreover, they found that green exercise, as opposed to indoor exercise, corresponds with a decrease in anxiety and depression symptoms.

Yang et al. [54] performed a multilevel analysis to determine the longitudinal effects of therapeutic gardening on mental health and well-being during the COVID-19 pandemic. The results showed that mental health improved significantly over time as the therapeutic gardening program progressed. The authors concluded that therapeutic gardening is a promising nature-based intervention for improving mental health.

Klein et al. [55] investigated associations between residential green space and mental health, including depression, through a longitudinal survey. Their conclusion was that residing amid greater green spaces was associated with lower levels of depressive symptoms.

Colléony et al. [56] conducted a longitudinal study to quantify the effects of nature deprivations on health and well-being. The results confirmed that the frequency, duration, and quality of contact with nature dropped during the COVID-19 pandemic lockdown, particularly for people living in less green neighborhoods, where a significant decrease in well-being was also found.

Perrins et al. [57] developed a longitudinal survey to assess whether the presence of natural elements in workers' day-to-day environments can improve workers' psychological well-being. The authors found that contact with nature in everyday life is significantly associated with decreased level of anxiety.

Maes et al. [58] used longitudinal data to examine associations between types of the natural environment and adolescent mental health. The study showed that greater daily exposure to forest areas, but not pastures, was associated with a lower risk of emotional problems.

Olszewska-Guizzo et al. [59] investigated longitudinal changes in depressed mood from before COVID-19 to immediately after the national lockdown in Singapore ended. The results showed that greater exposure to nature during the lockdown did not help mitigate depressive symptoms, as previous research suggests. The authors argue that this may be due to the lower quality of exposure to nature during the lockdown.

As a practical implication, recognition of the benefits of contact with nature has become increasingly relevant in healthcare (nature-based therapeutics). Although such an implication is not the focus of this study, a brief summary is presented here.

Nature-Based Therapeutics

Nature-based therapies seek to provide health benefits through interactions with plants, animals, and natural landscapes: for example, therapeutic horticulture [60], adventure therapy [61], wilderness therapy [62-63], green exercise [64], and forest bathing [65].

Hechter and Fife [66] point out that therapies based on contact with nature have helped patients to face fears and insecurities, with significant improvements in anxiety. Brown and Grant [67] found that therapies based on a high level of interaction with nature provide several benefits to groups of psychiatric patients, especially those with chemical dependency.

Greenleaf et al. [64] found that green exercise was able to reduce the deterioration of mental abilities in patients with Alzheimer's disease. Similarly, McCaffrey [68] assessed that walking in garden areas, such as urban parks, had a positive effect on older adults diagnosed with mild to moderate depression. Detweiler et al. [69] evaluated the effect of walking in a garden in a psychiatric facility on the behavior of patients with dementia. The authors found that residents who used the garden more frequently started to have less agitated behavior and an improvement in mood and quality of life.

The use of plants through horticulture has also been promising in treating people with dementia. Son et al. [60] found that therapeutic horticulture was beneficial for the self-esteem and sociability of patients with progressive neurodegeneration.

Gigliotti and Jarrott [70] found that horticultural activities carried out once a week for just half an hour favored higher levels of engagement and affection among psychiatric patients.

Kam and Siu [71] investigated the effect of horticulture on people with psychiatric illnesses. The study found that horticulture was effective in reducing levels of anxiety, depression, and stress among participants in the pilot study.

Wichrowski et al. [72] evaluated the effects of horticulture on mood and heart rate in patients on a cardiac rehabilitation program. The results indicated an improvement in the mood state, which is beneficial for reducing stress. To the extent that stress contributes to coronary heart disease, it was concluded that horticulture is an effective therapy for cardiac rehabilitation.

Exposure to nature based on adventure therapy can lead to changes in the cognitive-behavioral pattern of adolescents with obesity, and Jelalian et al. [61] found that there was a significant difference in the percentage of participants who maintained minimal weight loss, concluding that this type of therapy is a promising strategy, especially in older adolescents.

Wilderness therapy has shown promise in improving delinquent behavior; Wilson and Lipsey [73] evaluated that it had a positive impact on the behavior of young people, reducing antisocial behavior and the carrying out of crimes. Russell [62] also noted the effectiveness of wilderness therapy in reducing behavioral and emotional problems in adolescents.

Furthermore, the effectiveness of wilderness therapy as a form of rehabilitation for individuals with schizophrenia was assessed by Voruganti et al. [63], with patients showing improvement in cognitive skills and self-esteem, in addition to significant weight loss, along with relevant occupational and social gains.

Conclusions

The present study evaluated the association between interaction with nature and the hypothetical reduction in stress, anxiety, and depression symptoms through primary research in Brazil. The research hypothesis was confirmed and evidence indicates that the greater the frequency of contact with nature, the lower the occurrence of symptoms (from 3.6 to 4.8 times lower). Nevertheless, the benefits of this contact were significant only when its frequency was moderate (about once or twice a week) or higher.

With regard to limitations, the research did not take into account influencing factors associated with the form of contact (contemplating, walking, running, etc.) or the type of nature (gardens, forests, woods, parks, etc.). Moreover, in order to contribute to an initial understanding of an under-researched population, the influence of potential confounding factors (age, gender, income, education, etc.) was not considered. Other limitations of this study are that it is cross-sectional, it relies on retrospective recall, and there are no randomized components. Considering that the vast majority of studies have used cross-sectional designs, another recommendation for future studies is to employ longitudinal designs and assess how other factors affect the health benefits of contact with nature.

References

1. Keys, P.W.; Galaz, V.; Dyer, M.; Matthews, N.; Folke, C.; Nyström, M.; Cornell, S.E. Anthropocene risk. *Nat. Sustain.* 2019, 2, 667–673.
2. Frumkin, H.; Bratman, G.N.; Breslow, S.J.; Cochran, B.; Kahn, P.H.; Lawler, J.J.; Levin, P.S.; Tandon, P.S.; Varanasi, U.; Wolf, K.L.; et al. Nature contact and human health: A research agenda. *Environ. Health Perspect* 2017, 125, e075001.
3. Silverman, J.; Corneau, N. From nature deficit to outdoor exploration: Curriculum for sustainability in Vermont's public schools. *J. Adventure Educ. Outdoor Learn.* 2017, 17, 258–273.
4. Ewert, A.; Chang, Y. Levels of Nature and Stress Response. *Behav. Sci.* 2018, 8, 49–62.
5. Bratman, G.N.; Hamilton, J.P.; Hahn, K.S.; Daily, G.C.; Gross, J.J. Nature experience reduces rumination and subgenual prefrontal cortex activation. *Proc. Natl. Acad. Sci. USA* 2015, 112, 8567–8572.
6. Colding, J.; Gren, Å.; Barthel, S. The incremental demise of urban green spaces. *Land* 2020, 9, 1–11.
7. Alvarez, E.N.; Garcia, A.; Le, P. A review of Nature Deficit Disorder (NDD) and its disproportionate impacts on Latinx populations. *Environ. Dev.* 2022, in press, e100732.
8. Kellert, S.R. *Kinship to Mastery: Biophilia in Human Evolution and Development*; Island Press: Washington, DC, USA, 1997.
9. Wilson, E.O. Biophilia. In *The Human Bond with Other Species*; Harvard University Press: Cambridge, UK, 1984.
10. Tidball, K.G. *Urgent biophilia: Human-nature interactions and biological*

attractions in disaster resilience. *Ecol. Soc.* 2012, 17, 1–18.

11. McMahan, E.A.; Estes, D. The Effect of Contact with Natural Environments on Positive and Negative Effect: A Meta-Analysis. *J. Posit. Psychol.* 2015, 10, 1–43.
12. Furnass, B. Health values. In *The Value of National Parks to the Community: Values and Ways of Improving the Contribution of Australian National Parks to the Community*; Messer, J., Mosley, J.G., Eds.; University of Sydney, Australian Conservation Foundation: Sydney, Australia, 1979; pp. 60–69.
13. Kaplan, R.; Kaplan, S. *The Experience of Nature: A Psychological Perspective*; Cambridge University Press: Cambridge, UK; New York, NY, USA, 1989.
14. Kaplan, S. The restorative benefits of nature: Toward an integrative framework. *J. Environ. Psychol.* 1995, 15, 169–182.
15. Kaplan, S.; Berman, M.G. Directed attention as a common resource for executive functioning and self-regulation. *Perspect. Psychol. Sci.* 2010, 5, 43–57.
16. Owens, M.; Bunce, H.L.I. The Potential for Outdoor Nature-Based Interventions in the Treatment and Prevention of Depression. *Front. Psychol.* 2022, 13, e740210.
17. White, A.P.; Elliott, L.R.; Gascon, M.; Roberts, B.; Fleming, L.E. Blue space, health and well-being: A narrative overview and synthesis of potential benefits. *Environ. Res.* 2020, 191, e110169.
18. Ulrich, R.S.; Simons, R.F.; Losito, B.D.; Fiorito, E.; Miles, M.A.; Zelson, M. Stress recovery during exposure to natural and urban environments. *J. Environ. Psychol.* 1991, 11, 231–248.
19. Parsons, R.; Tassinary, L.G.; Ulrich, R.S.; Hebl, M.R.; Grossman-Alexander, M. The view from the road: Implications for stress recovery and immunization. *J.*

Environ. Psychol. 1998, 18, 113–140.

20. Pretty, J.; Hine, R.; Peacock, J. Green exercise: The benefits of activities in green places. *Biologist* 2006, 53, 143–148.

21. Kellert, S.R. *Dimensions, elements and attributes of biophilic design*. In Biophilic Design; Kellert, S., Heerwagen, J.H., Mador, M.L., Eds.; John Wiley & Sons: Hoboken, NJ, USA, 2008.

22. Mackay, G.J.; Neill, J.T. The effect of “green exercise” on state anxiety and the role of exercise duration, intensity, and greenness: A quasi-experimental study. *Psychol. Sport Exerc.* 2010, 11, 238–245.

23. Fan, Y.; Das, K.V.; Chen, Q. Neighborhood green, social support, physical activity, and stress: Assessing the cumulative impact. *Health Place* 2011, 17, 1202–1213.

24. Beyer, K.M.M.; Kaltenbach, A.; Szabo, A.; Bogar, S.; Javier Nieto, F.; Malecki, K.M. Exposure to neighborhood green space and mental health: Evidence from the survey of the health of Wisconsin. *Int. J. Environ. Res. Public Health* 2014, 11, 3453–3472.

25. Song, C.; Ikei, H.; Igarashi, M.; Miwa, M.; Takagaki, M.; Miyazaki, Y. Physiological and psychological responses of young males during spring-time walks in urban park. *J. Physiol. Anthropol.* 2014, 33, 2–7.

26. Rautio, N.; Filatova, S.; Lehtiniemi, H.; Miettunen, J. Living environment and its relationship to depressive mood: A systematic review. *Int. J. Soc. Psychiatry* 2018, 64, 92–103.

27. Barreto, P.; Lopes, C.S.; Silveira, I.H.; Faerstein, E.; Junger, W. Is living near green areas beneficial to mental health? *Rev. Saúde Pública*. 2019, 53, 55–75.

28. Rosa, C.D.; Profice, C.C.; Collado, S. Nature experiences and adults' self-reported pro-environmental behaviors: The role of connectedness to nature and childhood nature experiences. *Front. Psychol.* 2018, 32, 355–381.
29. Rosa, C.D.; Larson, L.R.; Collado, S.; Profice, C.C. Forest therapy can prevent and treat depression: Evidence from meta-analyses. *Urban For. Urban Green.* 2021, 57, 1–11.
30. Sinclair, S.J.; Siefert, C.J.; Slavin-Mulford, J.M.; Stein, M.B.; Renna, M.; Blais, M.A. Psychometric evaluation and normative data for the Depression, Anxiety, and Stress Scales in a nonclinical sample of U.S. adults. *Eval. Health Prof.* 2012, 35, 259–279.
31. Szumilas, M. Explaining Odds Ratios. *J. Can. Acad. Child. Adolesc. Psychiatry* 2010, 19, 227–229.
32. Cox, D.T.C.; Shanahan, D.F.; Hudson, H.L.; Fuller, R.A.; Gaston, K.J. The impact of urbanisation on nature dose and the implications for human health. *Landscape Urban Plan* 2018, 179, 72–80.
33. Antonelli, M.; Barbieri, G.; Donelli, D. Effects of forest bathing (shinrin-yoku) on levels of cortisol as a stress biomarker: A systematic review and meta-analysis. *Int. J. Biometeorol.* 2019, 63, 1117–1134.
34. Hunter, M.C.R.; Gillespie, B.W.; Chen, S.Y. Urban Nature Experiences Reduce Stress in the Context of Daily Life Based on Salivary Biomarkers. *Front. Psychol.* 2019, 10, 1–16.
35. McEwan, K.; Giles, D.; Clarke, F.J.; Kotera, Y.; Evans, G.; Terebenina, O.; Minou, L.; Teeling, C.; Basran, J.; Wood, W.; et al. A pragmatic controlled trial of forest bathing compared with compassionate mind training in the UK: Impacts on self-reported wellbeing and heart rate variability. *Sustainability* 2021, 13, 1380.

36. Topper, M.; Emmelkamp, P.M.G.; Ehring, T. Improving prevention of depression and anxiety disorders: Repetitive negative thinking as a promising target. *Appl. Prev. Psychol.* 2010, 14, 57–71.
37. Newby, J.M.; Williams, A.D.; Andrews, G. Reductions in negative repetitive thinking and metacognitive beliefs during transdiagnostic internet cognitive behavioural therapy (iCBT) for mixed anxiety and depression. *Behav. Res. Ther.* 2014, 59, 52–60.
38. Spinhoven, P.; van Hemert, A.M.; Penninx, B.W. Repetitive negative thinking as a predictor of depression and anxiety: A longitudinal cohort study *J. Affect. Disord.* 2018, 241, 216–225.
39. Monterege, S.; Tsagkalidou, A.; Cuijpers, P.; Spinhoven, P. The effects of different types of treatment for anxiety on repetitive negative thinking: A meta-analysis. *Clin. Psychol. Sci. Pract.* 2019, 27, e12316.
40. Hofmann, S.G.; Sawyer, A.T.; Witt, A.A.; Oh, D. The effect of mindfulness-based therapy on anxiety and depression: A meta-analytic review. *J. Consult. Clin. Psychol.* 2010, 78, 169–183.
41. Hofmann, S.G.; Gómez, A.F. Mindfulness-Based Interventions for Anxiety and Depression. *Psychiatr. Clin.* 2017, 40, 739–749.
42. Schutte, N.S.; Malouff, J.M. Mindfulness and connectedness to nature: A meta-analytic investigation. *Personal. Individ. Differ.* 2018, 127, 10–14.
43. Choe, E.Y.; Jorgensen, A.; Sheffield, D. Does a natural environment enhance the effectiveness of mindfulness-based stress reduction (MBSR)? Examining the mental health and wellbeing, and nature connectedness benefits. *Landsc. Urban Plan.* 2020, 202, e103886.
44. Bishop, S.R. What do we really know about mindfulness-based stress

reduction? *Psychosom. Med.* 2002, 64, 71–83.

45. Shin, J.C.; Parab, K.V.; An, R.; Grigsby-Toussaint, D.S. Greenspace exposure and sleep: A systematic review. *Environ. Res.* 2020, 182, e109081.

46. Gladwell, V.F.; Kuoppa, P.; Tarvainen, M.P.; Rogerson, M. A lunchtime walk in nature enhances restoration of autonomic control during night-time sleep: Results from a preliminary study. *Int. J. Environ. Res. Public Health* 2016, 13, e280.

47. Richardson, M.; McEwan, K.; Maratos, F.; Sheffield, D. Joy and calm: How an evolutionary functional model of affect regulation informs positive emotions in nature. *Evol. Psychol. Sci.* 2016, 2, 308–320.

48. Fiorilli, C.; Capitello, T.G.; Barni, D.; Buonomo, I.; Gentile, S. Predicting adolescent depression: The interrelated roles of self-esteem and interpersonal stressors. *Front. Psychol.* 2019, 10, 1–6.

49. Luo, Y.N.; Huang, W.Z.; Liu, X.X.; Markevych, I.; Bloom, M.S.; Zhao, T.; Heinrich, J.; Yang, B.-Y.; Dong, G.-H. Greenspace with overweight and obesity: A systematic review and meta-analysis of epidemiological studies up to 2020. *Obes. Rev.* 2020, 21, e13078.

50. Stier-Jarmer, M.; Throner, V.; Kirschneck, M.; Immich, G.; Frisch, D.; Schuh, A. The psychological and physical effects of forests on human health: A systematic review of systematic reviews and meta-analyses. *Int. J. Environ. Res. Public Health* 2021, 18, 1770.

51. Ashdown-Franks, G.; Firth, J.; Carney, R.; Carvalho, A.F.; Hallgren, M.; Koyanagi, A.; Rosenbaum, S.; Schuch, F.B.; Smith, L.; Solmi, M.; et al. Exercise as medicine for mental and substance use disorders: A meta-review of the benefits for neuropsychiatric and cognitive outcomes. *Sports Med.* 2020, 50, 151–170.

52. Hu, M.X.; Turner, D.; Generaal, E.; Bos, D.; Ikram, M.K.; Ikram, M.A.;

- Cuijpers, P.; Penninx, B.W.J.H. Exercise interventions for the prevention of depression: A systematic review of meta-analyses. *BMC Public Health* 2020, 20, 1–11.
53. Das, A.; Gailey, S. Green exercise, mental health symptoms, and state lockdown policies: A longitudinal study. *J. Environ. Psychol.* 2022, 82, 101848.
54. Yang, Y.; Ro, E.; Lee, T.-J.; An, B.-C.; Hong, K.-P.; Yun, H.-J.; Park, E.-Y.; Cho, H.-R.; Yun, S.-Y.; Park, M.; et al. The Multi-Sites Trial on the Effects of Therapeutic Gardening on Mental Health and Well-Being. *Int. J. Environ. Res. Public Health* 2022, 19, 8046.
55. Klein, Y.; Lindfors, P.; Osika, W.; Magnusson Hanson, L.L.; Stenfors, C.U.D. Residential Greenspace Is Associated with Lower Levels of Depressive and Burnout Symptoms, and Higher Levelsof Life Satisfaction: A Nationwide Population-Based Study in Sweden. *Int. J. Environ. Res. Public Health* 2022, 19, 5668.
56. Colléony, A.; Clayton, S.; Shwartz, A. Impacts of nature deprivations during the COVID-19 pandemic: A pre-post comparison. *Biol. Conserv.* 2022, 268, 109520.
57. Perrins, S.P.; Varanasi, U.; Seto, E.; Bratman, G.N. Nature at work: The effects of day-to-day nature contact on workers' stress and psychological well-being. *Urban For. Urban Green* 2021, 66, 127404.
58. Maes, M.J.A.; Pirani, M.; Booth, E.R.; Shen, C.; Milligan, B.; Jones, K.E.; Toledano, M.B. Benefit of woodland and other natural environments for adolescents' cognition and mental health. *Nat. Sustain.* 2021, 4, 851–858.
59. Olszewska-Guizzo, A.; Fogel, A.; Escoffier, N.; Ho, R. Effects of COVID-19-related stay-at-home order on neuropsychophysiological response to urban

spaces: Beneficial role of exposure to nature? *J. Environ. Psychol.* 2021, 75, 101590.

60. Son, K.C.; Um, S.J.; Kim, S.Y.; Song, J.E.; Kwack, H.R. Effect of horticultural therapy on the changes of self-esteem and sociality of individuals with chronic schizophrenia. *Acta Hort.* 2004, 639, 185–191.

61. Jelalian, E.; Mehlenbeck, R.; Lloyd-Richardson, E.E.; Birmaher, V.; Wing, R.R. Pediatric highlight: “adventure therapy” combined with cognitive-behavioral treatment for overweight adolescents. *Int. J. Obes.* 2006, 30, 31–39.

62. Russell, K. An assessment of outcomes in outdoor behavioral healthcare treatment. *Child Youth Care Forum* 2003, 9, 1–10.

63. Voruganti, L.N.P.; Whatham, J.; Bard, E.; Parker, G.; Babbey, C.; Ryan, J. Going beyond: An adventure-and recreation-based group intervention promotes well-being and weight loss in schizophrenia. *Can. J. Psychiatry* 2006, 51, 575–580.

64. Greenleaf, A.T.; Bryant, R.M.; Pollock, J.B. Nature-Based Counseling: Integrating the Healing Benefits of Nature into Practice. *Int. J. Adv. Couns.* 2013, 36, 162–174.

65. Antonelli, M.; Donelli, D.; Carlone, L.; Maggini, V.; Firenzuoli, F.; Bedeschi, E. Effects of forest bathing (shinrin-yoku) on individual well-being: An umbrella review. *Int. J. Environ. Health Res.* 2022, 32, 1842–1867.

66. Hechter, S.A.; Fife, S.T. Children and Nature. *Eco-Inf. Pract.* 2019, 1, 45–57.

67. Brown, C.; Grant, M. Biodiversity and Human Health: What Role for Nature in Healthy Urban Planning? *Built Environ.* 2005, 31, 326–338.

68. McCaffrey, R. The effect of healing gardens and art therapy on older adults with mild to moderate depression. *Holist. Nurs. Pract.* 2007, 21, 79–84.

69. Detweiler, M.B.; Murphy, P.F.; Myers, L.C.; Kim, K.Y. Does a wander

garden influence inappropriate behaviors in dementia residents? *Am. J. Alzheimer Dis. Other Demen.* 2008, 23, 31–45.

70. Gigliotti, C.M.; Jarrott, S.E. Effects of horticulture therapy on engagement and affect. *Can. J. Aging* 2005, 24, 367–377.

71. Kam, M.C.Y.; Siu, A.M.H. Evaluation of a horticultural activity programmed for persons with psychiatric illness. *Hong Kong J. Occup. Ther.* 2010, 20, 80–86.

72. Wichrowski, M.; Whiteson, J.; Haas, F.; Mola, A.; Rey, M.J. Effects of horticultural therapy on mood and heart rate in patients participating in an inpatient cardiopulmonar rehabilitation program. *J. Cardiopulm. Rehabil.* 2005, 25, 270–274.

73. Wilson, S.J.; Lipsey, M.W. Wilderness challenge programs for delinquent youth: A meta-analysis of outcome evaluations. *Eval. Prog. Plan.* 2000, 23, 1–12.

4 MINUTA DE ARTIGO

Understanding How Green Space Naturalness Impacts Wellbeing: Prospects for Designing Greener and Healthier Cities

Abstract

While studies have verified the health benefits of nature engagement, limited research explores the potential impact of varying levels of naturalness, especially in the context of developing countries. This study aims to enhance our understanding of how the naturalness of green spaces (closer to wild or man-made settings) affects wellbeing. Data collected from an online survey, involving 2136 residents in metropolitan urban regions in Brazil, underwent analysis using Welch's ANOVA and Games-Howell post-hoc tests, revealing significant effects on symptoms of depression, anxiety, and stress. Our findings not only align with but also extend the results of previous studies, providing evidence-based insights for designing greener and healthier cities. In conclusion, urban planners and policymakers should prioritize incorporating wilder settings into green spaces, fostering environments that enable and support health.

Keywords. urban infrastructure; green spaces; public health.

Introduction

The rise of cities has ushered in substantial enhancements across several facets of human life. These improvements have been instrumental in enhancing the wellbeing of urban dwellers, encompassing areas such as sanitation, security, education, energy access, healthcare provisions, and transportation services, among others (Wang et al., 2021; Bressane et al., 2022). On the other hand, when built-up areas sprawl encroaches on urban green spaces (UGS), suppressing the natural areas, it can have a severe detrimental impact on the environmental quality, public wellbeing, and quality of life in cities (Xu et al., 2018; Ledda and de Montis, 2019; Yang et al., 2021).

Research by Xu et al. (2018) highlights that the depletion of UGS not only diminishes urban biodiversity but also exacerbates issues such as air pollution and heat island effects, which are detrimental to public health. Furthermore, Ledda and Montis (2019) highlight the cascading effects on public wellbeing. Reduced access to green spaces has been linked to increased stress levels, decreased physical activity, and diminished mental health among urban residents (Jennings et al., 2019). Yang et al. (2021) reinforce this perception by emphasizing the resultant decline in overall quality of life within cities.

UGS play a pivotal role in urban landscapes, serving a dual function that encompasses ecological and social dimensions. While the UGS can contribute to ecological functions, and natural resources protection, they also serve a social role

as private and public places for leisure and recreation (Hansen et al., 2019; Tian et al., 2020; Deroose et al., 2021; Chalmin-Pui et al., 2021; Cheng et al., 2021).

On the ecological front, UGS contribute substantially to biodiversity conservation and gene flow, as demonstrated by the research of Hansen et al. (2019) and Tian et al. (2020). These vital green spaces within the urban matrix provide refuge for various species, fostering genetic diversity and supporting the health of urban ecosystems. Additionally, they serve as critical shields for safeguarding natural resources, preventing soil erosion, and mitigating the impacts of climate change, as indicated by Deroose et al. (2021).

In the realm of social wellbeing, UGS hold an equally vital position as private and public spaces for leisure and recreation. Chalmin-Pui et al. (2021) emphasize the contribution of UGS in enhancing the quality of urban life. These spaces serve as oases of relaxation and tranquility amid the hustle and bustle of city life. Residents and visitors alike find respite in UGS, engaging in physical activities and social interactions. Moreover, the research by Cheng et al. (2021) delves into the far-reaching health benefits of urban forests. Their findings substantiate that regular contact with nature in urban settings is associated with reduced stress levels, improved mental health, and increased physical activity, contributing to overall wellbeing.

Thus, the UGS can represent a promising approach to managing urban land, promoting environmental education, and public health policy strategies, that is for achieving sustainable and healthy cities, mainly because of its

multifunctional capacity (Rigolon et al., 2018; Kroll et al., 2019). In this sense, a growing number of studies have shown the positive effects of UGS on public health. Improvement in blood pressure, sleep quality, cardiovascular and respiratory systems, as well as mental health, among the main benefits revealed over the last decades (Ulrich et al., 1991; Parsons et al., 1998; Topper et al., 2010; Fan et al., 2011; Beyer et al. 2014; Newby et al., 2014; Song et al., 2014; Pretty et al., 2014; Cox et al., 2018; Rautio et al. 2018; Spinhoven et al., 2018; Barreto et al. 2019; Owens and Bunce, 2022; Bressane et al., 2022).

Studies carried in other countries such as Australia, Netherlands, South Korea, Japan, and United Kingdom, have also reported an inverse association between contact with nature and common mental health problems such as depression and anxiety (Fan et al., 2011; Beyer et al. 2014; Rautio et al. 2018). Despite a growing body of evidence in recent years, the majority of studies have primarily taken place in higher-income countries, thereby constraining the generalizability of empirical findings to other regions (Rosa et al., 2018). This limitation is particularly noteworthy for developing countries like Brazil (Rosa et al., 2019). In the review conducted by Nawrath et al. (2021), only one study was reported to have been carried out in Brazil at that time, investigating the association between exposure to UGS surrounding houses and the mental health of residents (Barreto et al., 2019). Recently, another study conducted in Brazil by Bressane et al. (2022) brought exploratory analyses aimed at the initial understanding of an understudied population. The results indicated that people

with greater contact with nature have about 3 to 5 times less occurrence of symptoms associated with stress, anxiety, and depression. However, the study did not evaluate how variations in the form of this contact, can affect its benefits.

Brazil's unique environmental, cultural, and lifestyle factors may differ from those in previous studies conducted elsewhere. Given the global concern surrounding mental health, understanding the relationship between urban naturalness and wellbeing in developing countries is crucial for tailoring public health policies and urban planning. In response to this gap, this article presents a study conducted in Brazilian metropolitan regions, aimed at fulfilling the growing need for more research in developing nations.

Concerning the concept of naturalness, it is worth noting that the academic literature presents various interpretations of UGS. (Nieuwenhuijsen et al., 2021). Overall, an UGS refer to areas partly or completely covered by vegetation, which can be equipped with facilities designed for leisure and recreation of citizens, such as parks and community gardens (Haas et al., 2021). In this sense, references to "naturalness" are present in several studies, including those carried out by Hartig et al. (2014), van den Bosch et al. (2017), Maller et al. (2019), Hedblom et al. (2019), Jennings et al. (2019), and Geary et al. (2021). Notwithstanding, Hoyle et al. (2018) argue that defining this concept in the context of urban design and management is a complex task. Taking into account this literature, in this present study we assume "naturalness" in the context of UGS as the degree to which an environment resembles or exhibits characteristics

associated with natural ecosystems. Thus, the "degree of naturalness" refers to how closely an environment aligns with natural ecosystems, considering the extent of human manipulation within a given space. Higher naturalness suggest that an area closely resembles natural landscapes, while lower naturalness is associated with human-made spaces, including gardens, and parks.

Material and method

Data were collected from an online public survey, with a total sample size of 2136 respondents residing in metropolitan urban regions in Brazil (Table 1, Figure 1), adhered to the ethical requirements for human studies in Brazil (Process #58149622.3.0000.0077). The survey form was structured into some main sections.

Table 1. Sociodemographic profile of respondents (n = 2136).

gender [identity]	age group [years old]	income [min. wage]	education [level]	marital status
male 40%	young [18, 25[15.7%	lower) [0, 2[16.2%	elementary 0.3%	single 46.1%
female 59.6%	adult [25, 45[55.2%	lower-middle [2, 4] 21.9%	high-school 16.2%	married 45.3%
non-binary 0.4%	middle-age [45, 60[21.0%	middle [4, 10] 37.0%	university 83.5%	widower 0.9%
	elderly [60, +∞[8.1%	higher-middle [10, 20] 17.7%		divorced 7.7%
		higher [20, +∞[7.1%		

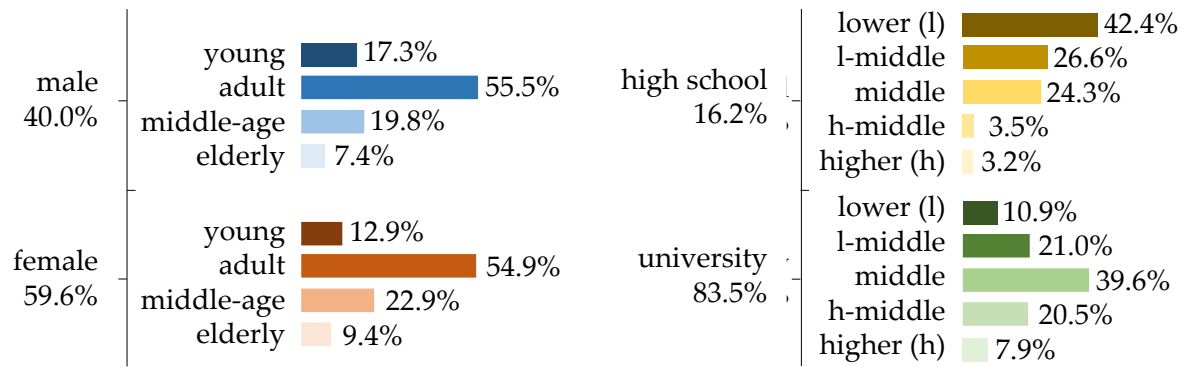


Figure 1. Sociodemographic profile of respondents: (a) age grouped by gender and (b) income grouped by education.

To evaluate the level of wellbeing, opening section required participants to complete questions based on the Depression, Anxiety and Stress Scale (DASS-21) form, which has been widely utilized in clinical and non-clinical populations across numerous countries (Bibi et al., 2020b). In the second section the participants were required to reveal the locations where they had engaged with nature in the past week, as the DASS 21 form also evaluates variables related to mental well-being within the same timeframe. Subsequently, areas closer to wild settings were categorized as having higher naturalness. Otherwise, they were classified as having lower naturalness.

Before evaluating the fixed and main effects of the naturalness on wellbeing, its potential interaction with sociodemographic profile factors were rejected, as shown in Table 2.

Table 2. Potential interaction between naturalness and sociodemographic profile.

interaction	depression	p-value*	
		anxiety	stress
naturalness x gender	0.481	0.639	0.570
naturalness x age	0.231	0.370	0.527
naturalness x marital status	0.579	0.309	0.185
naturalness x income	0.426	0.221	0.532
naturalness x education	0.395	0.100	0.224

* nonsignificant for p-value > 0.05.

From the above, the subsequent analyzes were performed using one-factor Welch's ANOVA and Games-Howell post-hoc tests, by assuming a sample size sufficiently large to meet means approximately normally distributed, as stated by Central Limit Theorem (Mwiti et al., 2019). Then, the effect size (d_{Cohen}) was assessed using:

$$d_{Cohen} = \frac{\mu_{before} - \mu_{after}}{\sqrt{\frac{(n_{before} - 1)\sigma_{before}^2 + (n_{after} - 1)\sigma_{after}^2}{n_{before} + n_{after} - 2}}} \quad (1)$$

where, μ and σ are the mean and standard deviation of the i^{th} group, respectively. According to Funder e Ozer (2019), an effect around 5% ($\rho \leq d < 7.5\%$) indicates a very small effect, around 10% small ($7.5 \leq d < 15\%$), 20% medium ($15 \leq d < 25\%$), and around 30% or greater ($d \geq 25\%$) a large effect size. All analyzes considered a test power ($1 - \beta$) of 0.8 for a significance level (α) of 0.05, and a minimum detectable effect size (ρ) of 6%.

Results

The findings confirm the research hypothesis. The degree of environmental naturalness has a significant impact on well-being, as evidenced by the observed reduction in depression, anxiety, and stress, which becomes increasingly greater in engagement with wilder settings (Table 3, and Figure 2). It is worth noting that "none," "lower," and "higher" relate to the naturalness of the environment in which the respondents had engaged.

Table 3. Effect of the degree of naturalness on depression, anxiety and stress level.

			none	higher
depression	lower	mean difference	-1.450***	1.190***
		d_{Cohen}	16.5%	15.7%
	none	mean difference	-----	2.640***
		d_{Cohen}	-----	30.5%
anxiety	lower	mean difference	-0.325	0.615***
		d_{Cohen}	5.07%	9.96%
	none	mean difference	-----	0.940***
		d_{Cohen}	-----	15.1%
stress	lower	mean difference	-1.120**	0.977***
		d_{Cohen}	12.3%	11.9%
	none	mean difference	-----	2.098***
		d_{Cohen}	-----	23.7%

* $p < 0.05$; ** $p < 0.01$; *** $p < .001$; gray = nonsignificant; yellow = small; green = medium; blue = large.

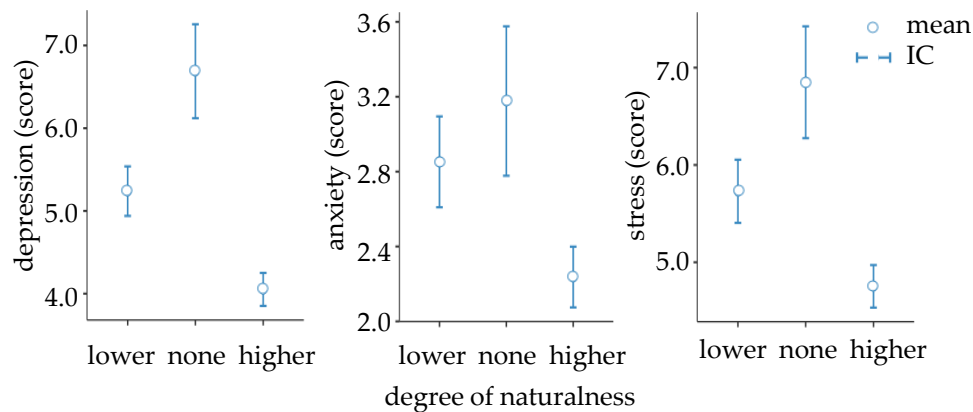


Figure 2. Association between degree of naturalness and mental health.

Discussion

Previous studies have also found that engaging in nature-related activities, such as forest bathing and walking in natural settings, can positively impact depression and anxiety symptoms more than indoor activities like gym workouts and sports clubs (Topper et al., 2010; Newby et al., 2014; Spinhoven et al., 2018). Consistent with our results, it has been revealed that activities conducted in natural areas reduce stress and anxiety symptoms more than those performed in built-up areas (Song et al., 2014).

Although the studies reported in the literature converge on evidence supporting greater benefits from activities in natural areas, there is limited evidence on how the variation in the degree of naturalness affects these benefits, even among recent studies, such as Liu et al. (2022). The authors verified that both urban parks and blue spaces positively impact mental health, primarily reducing depression and anxiety. However, differentiating the effects of various degrees of naturalness was not considered in the study.

Regarding anxiety, no significant effect was observed ($p\text{-value} > 0.05$) when comparing individuals without contact with nature (none degree) to those engaging in environments with some nature (lower degree). Significance emerged only when contrasting individuals without nature engagement to those engaged in environments with more naturalness (closer to natural ecosystems), revealing a moderate effect size of 15.1%. Similarly, Yigitcanlar et al. (2020) verified positive effects on mental health associated with visits to urban parks. Nevertheless, the authors also did not compare the benefits arising from engagement in settings with different degrees of naturalness.

In the context of stress, the effect size exhibits a significant shift, ranging from 12.3% (none vs. lower) to 23.7% (none vs. higher), corresponding to the increasing degree of naturalness. When comparing the intermediate groups (lower vs. higher), the effect size displays less difference (11.9%). In consonance, a comparative study examining the impact of nature exposure versus its absence, investigated the psychological relaxation effects of observing a landscape with a green façade vs. gray infrastructure (Elsadek et al., 2019). The findings reveal that the presence of natural elements in the green façade significantly enhanced human relaxation levels compared to viewing the conventional built-up area.

Another interesting aspect to note is that the group of individuals interacting with wilder, more natural environments exhibits a lower dispersion of mental distress symptom scores, signifying greater stability concerning mental well-being. Indeed, some studies have begun to explore variations in urban green

spaces and their effects on health, albeit in smaller quantities. For instance, Mears et al. (2020) assert that the connections between greenspace attributes and health indicators are intricate. The authors encompassed quality aspects related to the quality of greenspaces, including features like signage, the availability of amenities such as trash bins, seating, and restrooms, path maintenance, safety measures, plant-related aspects, and cleanliness. Notwithstanding, it's important to note that their study also did not consider the degree of naturalness in greenspaces as a contributing factor.

In turn, the findings from Allard-Poesi et al. (2022) closely align with the results of our present study, providing further support for our evidence. The authors verified the relationship between different types of urban nature and the wellbeing of city residents. The results show that the perceived characteristics of nature close to urban residences have direct and indirect influences on the psychological and resource-related dimensions of citizens' wellbeing. Specifically, they observed that less domesticated nature, such as forests, fields and thickets, contributes to wellbeing by favoring light or calm activities in nature. On the other hand, small points of nature, such as balconies, patios or roof gardens, also contribute to wellbeing, although to a lesser extent. In turn, more domesticated nature, such as urban gardens and parks, makes a marginal contribution to the physical and resource-related dimensions of wellbeing. The study was carried out based on a sample of 2,500 French urban residents. Thus, to the best of our knowledge, this is one of the first studies to address this issue, especially in

developing countries.

In contrast, the findings from Marques et al. (2021) reveal another interesting perspective. They found that, during the COVID-19 pandemic, home gardens (less natural) were more efficient than visits to urban parks in reducing mental distress. This observation might be attributed to the practice of self-isolation during the pandemic, which led residents to find solace and wellbeing in their houses. These contrasting results underscore the importance of considering local contexts and unique circumstances when assessing the impact of nature on well-being. Factors such as the type of urban nature, cultural practices, and external events like a pandemic can all influence this relationship.

Among other studies, Liu et al. (2018) also verified a positive association between the perception of naturalness in university campuses and students' wellbeing. This study, in consonance with our findings, underscores the significance of engaging with green spaces to meet health needs. Similarly, Noe and Stolte (2023) investigated residents' views on nature in UGS, particularly lawn parks and bush parks. Like our study, they noted that different spaces fulfill distinct community needs and offer varying degrees of nature engagement. Additionally, Jarvis et al. (2020) confirmed the connection between exposure to diverse urban natural environments and health outcomes, also aligning with our study. In summary, these studies collectively support our findings regarding the effects of nature on wellbeing, reinforcing the importance of considering such aspects in designing greener and healthier cities.

Prospects for Designing Greener and Healthier Cities

Like many other parts of the world, urbanization process in Brazil have been characterized by extensive gray infrastructure. However, our findings underscore the need to prioritize the integration of more natural settings into landscape and city planning, like urban green infrastructure, to support wellbeing through nature engagement. To contribute to this, the following prospects are introduced, tailored to the Brazilian setting but applicable in similar geographic contexts worldwide.

Encouraging architects and city planners to seamlessly incorporate natural features like green roofs and vertical gardens into building designs is essential for urban architecture. The integration of these elements should be a central focus. São Paulo's Eco-Courtyard project serves as a successful example, demonstrating how urban buildings can effectively incorporate green spaces for the benefit of residents. A notable case where natural features have been successfully incorporated into building designs is Copenhagen, Denmark. Copenhagen has gained international recognition for its innovative and sustainable urban planning strategies, including a strong focus on integrating green elements into the urban landscape

Additionally, urban planners should prioritize the preservation and expansion of urban forests and biodiversity-rich areas within Brazilian cities is crucial. This involves safeguarding existing natural habitats, promoting native vegetation, and implementing reforestation initiatives. A successful example can

be found in Curitiba, a Brazilian city that has seamlessly integrated green spaces, parks, and extensive tree canopies into its urban planning, resulting in a more sustainable and nature-rich environment, such as the implemented actions at Portland, Oregon, in the United States. The city's authorities have implemented a range of initiatives aimed at promoting biodiversity and enhancing the wellbeing of its residents through a focus on natural environments.

Another strategic is design nature-infused urban environments, incorporating natural elements into the built environment. The integration of green infrastructure, including parks, greenways, and urban forests, into city planning across Brazil is vital. These green spaces should be accessible to residents of all backgrounds. Belo Horizonte, a Brazilian city, has led the way in embracing green infrastructure by developing an extensive network of urban parks and green corridors. A prominent real-world example of a city that has implemented the strategic action of designing nature-infused urban environments by incorporating natural elements into the built environment is Singapore, often referred to as the "City in a Garden," has become a global exemplar of green urban planning and sustainable city development.

Furthermore, it is essential to promote equitable access. Ensuring that nature-rich urban environments are accessible to individuals from all socio-economic groups in Brazil is a priority. Creating green spaces and natural areas in underserved communities can help reduce disparities in access to nature. Initiatives like the "Green Doors" project in Rio de Janeiro focus on making green

spaces accessible to all residents, regardless of their origin or socio-economic background. One city where efforts have been made to promote equitable access to nature-rich urban environments is Vancouver, Canada, with a focus on reducing disparities and democratizing the mental health benefits of nature, making them available to everyone regardless of its origin.

Launching public awareness campaigns throughout Brazil is essential to educate urban residents about the mental health benefits of nature. These campaigns should also stress the importance of conserving and maintaining natural areas. Promoting community engagement in nature-related activities, such as community gardening and nature walks, can foster a sense of ownership and responsibility among participants. Rio de Janeiro's "Nature Guardians" program, which involves local communities in the conservation and monitoring of urban natural areas, serves as an inspiring model. A city that has implemented public awareness campaigns to educate urban residents about the mental health benefits of nature and promote the conservation of natural areas is Melbourne, Australia. For instance, Melbourne encourages residents to participate in citizen science programs focused on monitoring and conserving local natural areas. These programs not only provide valuable data but also create a sense of ownership and responsibility among participants.

In addition, advocating for greater collaboration between urban planning and health policies in Brazil is key. Nature-based interventions should be incorporated into mental health promotion strategies. Exploring the potential for

nature prescription programs in Brazil, where healthcare providers encourage patients to spend time in nature as part of their treatment plans, can be highly beneficial. A tangible case is San Francisco, California, in the United States, which has initiated nature prescription programs, often referred to as "Park Rx," where healthcare providers encourage patients to spend time in nature as part of their treatment plans. Physicians and healthcare professionals prescribe time in parks and green spaces as a complementary approach to improving mental health and overall wellbeing.

In summary, incorporating the insights from this study into landscape and urban planning can contribute to more resilient and healthier cities in Brazil. Prioritizing naturalness in urban environments, ensuring equitable access, and promoting awareness of the mental health benefits of nature interaction are key steps toward enhancing the wellbeing of Brazilian urban populations.

Final remarks

This study explores how environmental naturalness impacts wellbeing, providing prospects for planners and policymakers to design greener and healthier cities. As wilder settings provided larger reductions in depression, anxiety, and stress symptoms, our results provide evidence-based recommendations for designing UGS with features closer to natural ecosystems to function as health-supporting environments. This includes prioritize the preservation and integration of areas, such as nature reserves, waterfronts, and

green corridors, within cities. Subsequent research directions may delve into the intricate mechanisms and long-lasting impacts of extended involvement with nature, providing an avenue for a more comprehensive understanding of how UGS can be optimized to provide enduring mental and emotional support.

References

- Allard-Poesi, F., Matos, L. B., Massu, J. (2022) Not all types of nature have an equal effect on urban residents' wellbeing: A structural equation model approach. *Health & Place*, 74, 102759.
- Barreto, P., Lopes, C.S., Silveira, I.H., Faerstein, E., Junger, W. (2019) Is living near green areas beneficial to mental health? *Rev. Saúde Publica*. 53, 55–75.
- Beyer, K.M.M., Kaltenbach, A., Szabo, A., Bogar, S., Javier Nieto, F., Malecki, K.M. (2014) Exposure to neighborhood green space and mental health: Evidence from the survey of the health of Wisconsin. *Int. J. Environ. Res. Public. Health*, 11, 3453–3472.
- Bibi, A., Lin, M., Zhang, X. C., Margraf, J. (2020b) Psychometric properties and measurement invariance of Depression, Anxiety and Stress Scales (DASS-21) across cultures. *International Journal of Psychology*, 55(6), 916-925.
- Bibi, A., Lin, M., Margraf, J. (2020a) Salutogenic constructs across Pakistan and Germany: A cross sectional study. *International Journal of Clinical and Health Psychology*, 20(1), 1–9.
- Bressane, A., Negri, R. G., de Brito Junior, I., Medeiros, L. C. D. C., Araújo, I. L. L., Silva, M. B., Rosa, G. C. S. D. (2022) Association between contact with nature and anxiety, stress and depression symptoms: a primary survey in Brazil. *Sustainability*, 14(17), 10506.
- Chalmin-Pui, L.S., Griffiths, A., Roe, J., Heaton, T., Cameron, R. (2021) Why garden?

Attitudes and the perceived health benefits of home gardening. *Cities*, 112, 103118.

Cheng, X., Liu, J., Liu, H., Lu, S. (2021) A systematic review of evidence of additional health benefits from forest exposure. *Landsc. Urban Plan.* 212, 104123,

Cox, D.T.C., Shanahan, D.F., Hudson, H.L., Fuller, R.A., Gaston, K.J. (2018) The impact of urbanisation on nature dose and the implications for human health. *Landsc Urban Plan*, 179, 72-80.

Elsadek, M., Liu, B., Lian, Z. (2019). Green façades: Their contribution to stress recovery and wellbeing in high-density cities. *Urban Forestry & Urban Greening*, 46, 126446.

Fan, Y., Das, K.V., Chen, Q. (2011) Neighborhood green, social support, physical activity, and stress: Assessing the cumulative impact. *Health Place*, 17, 1202–1213.

Funder, D. C., Ozer, D. J. (2019) Evaluating effect size in psychological research: Sense and nonsense. *Advances in Methods and Practices in Psychological Science*, 2(2), 156-168.

Geary, R. S., Wheeler, B., Lovell, R., Jepson, R., Hunter, R., Rodgers, S. (2021) A call to action: Improving urban green spaces to reduce health inequalities exacerbated by COVID-19. *Preventive Medicine*, 145, 106425.

Hansen, R., Olafsson, A. S., van der Jagt, A.P.N., Rall, E., Pauleit, S. (2019) Planning multifunctional green infrastructure for compact cities: What is the state of practice? *Ecological Indicators*, 96, 99-110.

Haas, W., Hassink, J., Stuiver, M. (2021) The role of urban green space in promoting inclusion: Experiences from the netherlands. *Frontiers in Environmental Science*, 9, 618198.

Hedblom, M., Gunnarsson, B., Iravani, B., Knez, I., Schaefer, M., Thorsson, P., Lundström, J. N. (2019) Reduction of physiological stress by urban green space in a

multisensory virtual experiment. *Scientific reports*, 9(1), 10113.

Hartig, T., Mitchell, R., de Vries, S., Frumkin, H. (2014) Nature and health. *Annual Review of Public Health*, 35, 207–28.

Hoyle, H., Jorgensen, A., Hitchmough, J. D. (2019). What determines how we see nature? Perceptions of naturalness in designed urban green spaces. *People and Nature*, 1(2), 167-180.

Jarvis, I., Koehoorn, M., Gergel, S. E., van den Bosch, M. (2020) Different types of urban natural environments influence various dimensions of self-reported health. *Environmental Research*, 186, 109614.

Jennings, V., Bamkole, O. (2019) The relationship between social cohesion and urban green space: An avenue for health promotion. *International journal of environmental research and public health*, 16(3), 452.

Kellert, S.R. (2008) Dimensions, elements and attributes of biophilic design. In *Biophilic Design*, Kellert, S., Heerwagen, J.H., Mador, M.L., Eds., John Wiley Sons: Hoboken, NJ, USA.

Kroll, C., Warchold, A, Pradhan, P. (2019) Sustainable Development Goals (SDGs): Are we successful in turning trade-offs into synergies? *Palgrave Commun*, 5, 1-11.

Ledda, A., De Montis, A. (2019) Infrastructural landscape fragmentation versus occlusion: A sensitivity analysis. *Land Use Policy*, 83, 523–531

Liu, H., Ren, H., Remme, R. P., Nong, H., Sui, C. (2021) The effect of urban nature exposure on mental health—a case study of Guangzhou. *Journal of Cleaner Production*, 304, 127100.

Liu, Q., Zhang, Y., Lin, Y., You, D., Zhang, W., Huang, Q., ... Lan, S. (2018) The relationship between self-rated naturalness of university green space and students' restoration and health. *Urban Forestry Urban Greening*, 34, 259-268.

Maller, C., Mumaw, L., Cooke, B. (2019) Health and social benefits of living with 'wild' nature. In *Rewilding* (9, 165-181). Cambridge: Cambridge University Press.

Marques, P., Silva, A. S., Quaresma, Y., Manna, L. R., de Magalhães Neto, N., Mazzoni, R. (2021) Home gardens can be more important than other urban green infrastructure for mental wellbeing during COVID-19 pandemics. *Urban Forestry Urban Greening*, 64, 127268.

Mears, M., Brindley, P., Jorgensen, A., Maheswaran, R. (2020) Population-level linkages between urban greenspace and health inequality: The case for using multiple indicators of neighbourhood greenspace. *Health & Place*, 62, 102284.

Mwiti, M., Wanyonyi, S., Marangu, D. (2019) Central Limit Theorem and Its Applications in Determining Shoe Sizes of University Students.

Nawrath, M., Guenat, S., Elsey, H., Dallimer, M. (2021) Exploring uncharted territory: Do urban greenspaces support mental health in low- and middle-income countries? *Environ Research*, v. 194, p. 1-21, 2021.

Newby, J. M., Williams, A.D., Andrews, G. (2014) Reductions in negative repetitive thinking and metacognitive beliefs during transdiagnostic internet cognitive behavioural therapy (iCBT) for mixed anxiety and depression. *Behav. Res. Ther.* 59, 52–60.

Nieuwenhuijsen, N. J. (2021) Green Infrastructure and Health. *Annu. Rev. Public Health*, 42, 317–328.

Noe, E. E., Stolte, O. (2023) Dwelling in the city: A qualitative exploration of the human-nature relationship in three types of urban greenspace. *Landscape and Urban Planning*, 230, 104633.

Owens, M., Bunce, H.L.I. (2022) The Potential for Outdoor Nature-Based Interventions in the Treatment and Prevention of Depression. *Front. Psychol.* 13, e740210.

- Parsons, R., Tassinary, L.G., Ulrich, R.S., Hebl, M.R., Grossman-Alexander, M. (1998) The view from the road: Implications for stress recovery and immunization. *J. Environ. Psychol.* 18, 113–140.
- Pretty, J., Hine, R., Peacock, J. (2006) Green exercise: The benefits of activities in green places. *Biologist*, 53, 143–148.
- Rautio, N., Filatova, S., Lehtiniemi, H., Miettunen, J. (2018) Living environment and its relationship to depressive mood: A systematic review. *Int. J. Soc. Psychiatry*, 64, 92–103.
- Rigolon, A., Browning, M.H.E.M., Lee, K., Shin, S. (2018) Access to Urban Green Space in Cities of the Global South: A Systematic Literature Review. *Urban Sci.*, 2, 1-25.
- Rosa, C.D., Larson, L.R., Collado, S., Profice, C.C. (2021) Forest therapy can prevent and treat depression: Evidence from meta-analyses. *Urban For. Urban Green.* 57, 1–11.
- Rosa, C.D., Profice, C.C., Collado, S. (2018) Nature experiences and adults' self-reported pro-environmental behaviors: The role of connectedness to nature and childhood nature experiences. *Front. Psychol.* 32, 355–381.
- Song, C., Ikei, H., Igarashi, M., Miwa, M., Takagaki, M., Miyazaki, Y. (2014) Physiological and psychological responses of young males during spring-time walks in urban park. *J. Physiol. Anthropol.*, 33, 2–7.
- Tian, Y., Wu, H., Zhang, G., Wang, L., Zheng, D., Li, S. (2020) Perceptions of ecosystem services, disservices and willingness-to-pay for urban green space conservation. *Journal of Environmental Management*, 260, 110140.
- Topper, M., Emmelkamp, P.M.G., Ehring, T. (2010) Improving prevention of depression and anxiety disorders: Repetitive negative thinking as a promising target. *Appl. Prev. Psychol.* 14, 57–71.
- Ulrich, R.S., Simons, R.F., Losito, B.D., Fiorito, E., Miles, M.A., Zelson, M. (1991) Stress

recovery during exposure to natural and urban environments. *J. Environ. Psychol.*, 11, 231–248.

van den Bosch, M., Sang, Å. O. (2017) Urban natural environments as nature-based solutions for improved public health—A systematic review of reviews. *Environmental Research*, 158, 373–384.

Wang, S., Bai, X., Zhang, X. (2021) Urbanization can benefit agricultural production with large-scale farming in China. *Nat Food*, 2, 183–191.

Xu, X., Xie, Y., Qi, K., Luo, Z., Wang, X. (2018) Detecting the response of bird communities and biodiversity to habitat loss and fragmentation due to urbanization. *Sci. Total Environ*, 624, 1561–1576.

Yang, Y., Tang, D., Yang, X. (2021) Investigating the spatio-temporal variations of the impact of urbanization on haze pollution using multiple indicators. *Stoch Environ Res Risk Assess*, 35, 703–717.

Yigitcanlar, T., Kamruzzaman, M., Teimouri, R., Degirmenci, K., Alanjagh, F. A. (2020) Association between park visits and mental health in a developing country context: The case of Tabriz, Iran. *Landscape and Urban Planning*, 199, 103805.

5 CONCLUSÕES E RECOMENDAÇÕES

5.1 Principal

Com base nas evidências reveladas, verifica-se que existem diferenças significativas na saúde mental entre indivíduos que interagem ativamente com a natureza e aqueles que não o fazem. Os dados corroboram ainda mais a noção de que essas diferenças se tornam mais pronunciadas quando os indivíduos são expostos a ambientes com maior grau de naturalidade.

5.2 Específicas

Os resultados indicam que a natureza tem um impacto substancial na redução da depressão, com efeitos maiores observados nas interações com ambientes naturais selvagens em comparação com espaços verdes projetados ou falta de interação com a natureza. Além disso, embora os efeitos sobre ansiedade e estresse possam apresentar magnitudes menores com o aumento do grau de naturalidade, eles se tornam mais significativos ao comparar indivíduos sem interação com a natureza com aqueles que interagem com ambientes mais naturais

Os dados também revelam que os resultados de saúde mental para indivíduos que interagem com ambientes naturais selvagens exibem menos dispersão, indicando maior confiabilidade nos efeitos da natureza nesse grupo. Por outro lado, os resultados de saúde mental para indivíduos sem interação com a natureza mostram uma faixa mais ampla, sugerindo uma relação menos consistente e mais imprevisível com a natureza. Essas descobertas destacam a importância da interação com a natureza na promoção do bem-estar mental.

À medida que os indivíduos interagem com graus mais elevados de natureza, há uma tendência para resultados de saúde mental mais estáveis e positivos, ressaltando os efeitos benéficos e estabilizadores do aumento da exposição a ambientes naturais. Em conclusão, a pesquisa enfatiza a importância de integrar a natureza em nossas vidas para o benefício da saúde mental. Ela destaca o impacto substancial da natureza na depressão e revela que o grau de naturalidade desempenha um papel crucial na redução de problemas de saúde mental.

As descobertas também demonstram que a interação com a natureza tem um efeito mais pronunciado no bem-estar mental quando os indivíduos interagem com ambientes naturais selvagens. Assim, incorporar e promover conexões com a natureza pode contribuir significativamente para promover o bem-estar mental geral e a estabilidade.

A importância dessas descobertas para o planejamento de cidades mais saudáveis e sustentáveis é significativa. A pesquisa destaca o impacto positivo da natureza na saúde mental, especialmente na redução da depressão. Essas informações podem orientar urbanistas e formuladores de políticas na criação de ambientes que priorizem e incorporem elementos naturais. Em primeiro lugar, os resultados enfatizam a necessidade de fornecer acesso à natureza em ambientes urbanos.

5.3 Recomendações

Em estudos futuros, recomenda-se verificar se outras variações na forma de contato com a natureza tem efeito sobre os benefícios para a saúde, em particular: (1) verificar se a duração e a frequência do contato com a natureza têm efeito sobre benefícios para a saúde; (3) verificar se a intensidade da atividade física em contato com a natureza tem efeito sobre tais benefícios; (4) verificar se a percepção dos benefícios do contato com a natureza tem efeito sobre a disposição da população em pagar por áreas verdes urbanas.

6 REFERÊNCIAS BIBLIOGRÁFICAS

BARRETO, P.A.; LOPES, C.S.; SILVEIRA, I.H. DA; FAERSTEIN, E.; JUNGER, W.L. Is living near green areas beneficial to mental health? *Rev. Saúde Pública*, v.53, n.75, p. 1-10, 2019, <https://doi.org/10.11606/s1518-8787.2019053001008>

BEYER, K.M.M.; KALTENBACH, A.; SZABO, A.; BOGAR, S.; JAVIER NIETO, F.; MALECKI, K.M. Exposure to neighborhood green space and mental health: Evidence from the survey of the health of Wisconsin. *Int. J. Environ. Res. Public. Health*, v.11, p.3453–3472, 2014. <https://doi.org/10.3390/ijerph110303453>

BRESSANE, A.; NEGRI, R. G.; DE BRITO JUNIOR, I.; MEDEIROS, L. C. D. C.; ARAÚJO, I. L. L.; SILVA, M. B.; ROSA, G. C. S. D. Association between contact with nature and anxiety, stress and depression symptoms: a primary survey in Brazil. *Sustainability*, v.14, n.17, p.10506, 2022. <https://doi.org/10.3390/su141710506>

FAUL, F.; ERDFELDER, E.; LANG, A.-G.; BUCHNER, A. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, v.39, p.175-191, 2007. <https://doi.org/10.3758/BF03193146>

CHALMIN-PUI, L.S.; GRIFFITHS, A.; ROE, J.; HEATON, T.; CAMERON, R. Why garden? Attitudes and the perceived health benefits of home gardening. *Cities*, v.112, p.103118, 2021. <https://doi.org/10.1016/j.cities.2021.103118>

CHENG, X.; LIU, J.; LIU, H.; LU, S. A systematic review of evidence of additional health benefits from forest exposure. *Landsc. Urban Plan.* v.212, p. 104123, 2021. <https://doi.org/https://doi.org/10.1016/j.landurbplan.2021.104123>

COX, D.T.C.; SHANAHAN, D.F.; HUDSON, H.L.; FULLER, R.A.; GASTON, K.J. The impact of urbanisation on nature dose and the implications for human health. *Landsc Urban Plan*, v.179, p.72-80, 2018. <https://doi.org/10.1016/j.landurbplan.2018.07.013>

DEROSE, K.P.; WALLACE, D.D.; HAN, B.; COHEN, D.A. Effects of park-based interventions on health-related outcomes: A systematic review. *Prev. Med.* v.147, p. 106528. 2021. <https://doi.org/10.1016/j.ypmed.2021.106528>

FAN, Y.; DAS, K.V.; CHEN, Q. Neighborhood green, social support, physical activity, and stress: Assessing the cumulative impact. *Health Place*, v.17, p.1202–1213, 2011. <https://doi.org/10.1016/j.healthplace.2011.08.008>

FUNDER, D. C.; OZER, D. J. Evaluating effect size in psychological research: Sense and nonsense. *Advances in Methods and Practices in Psychological Science*, n.2, v.2, p. 156-168, 2019. <https://doi.org/10.1177/2515245919847202>

HANSEN, R.; OLAFSSON, A. S.; VAN DER JAGT, A.P.N.; RALL, E.; PAULEIT, S. Planning multifunctional green infrastructure for compact cities: What is the state of practice? *Ecological Indicators*, v.96, p.99-110, 2019. <https://doi.org/10.1016/j.ecolind.2017.09.042>.

JAMOVI PROJECT. 2022. Jamovi Version 2.3 [Computer Software]. Disponível em: <<https://www.jamovi.org>>. Acessado em: 02 de Janeiro de 2023.

KROLL, C.; WARCHOLD, A; PRADHAN, P. Sustainable Development Goals (SDGs): Are we successful in turning trade-offs into synergies? *Palgrave Commun*, v.5, p.1-11, 2019. <https://doi.org/10.1057/s41599-019-0335-5>

LEDDA, A.; DE MONTIS, A. Infrastructural landscape fragmentation versus occlusion: A sensitivity analysis. *Land use policy*, v. 83, 523–531, 2019. <http://dx.doi.org/10.1016/j.landusepol.2019.02.035>

MWITI, M.; WANYONYI, S.; MARANGU, D. Central Limit Theorem and Its Applications in Determining Shoe Sizes of University Students. *Asian-European Journal of Mathematics*, n. 3, v.1, p. 1-9 2019. <https://doi.org/10.9734/AJPAS/2019/v3i130082>

NAWRATH, M.; GUENAT, S.; ELSEY, H.; DALLIMER, M. Exploring uncharted territory: Do urban greenspaces support mental health in low- and middle-income countries? *Environ Research*, v. 194, p. 1-21, 2021. <http://dx.doi.org/10.1016/j.envres.2020.110625>

NEWBY, J. M.; WILLIAMS, A.D.; ANDREWS, G. Reductions in negative repetitive thinking and metacognitive beliefs during transdiagnostic internet cognitive behavioural therapy (iCBT) for mixed anxiety and depression. *Behav. Res. Ther.* v.59, p.52–60, 2014. <https://doi.org/10.1016/j.brat.2014.05.009>

NIEUWENHUIJSEN, N. J. Green Infrastructure and Health. *Annu. Rev. Public Health*, v.42, p.317–328, 2021. <https://doi.org/10.1146/annurev-publhealth090419-102511>

OWENS, M.; BUNCE, H.L.I. The Potential for Outdoor Nature-Based Interventions in the Treatment and Prevention of Depression. *Front. Psychol.* v.13, p.e740210, 2022. <https://doi.org/10.3389/fpsyg.2022.740210>

PARSONS, R.; TASSINARY, L.G.; ULRICH, R.S.; HEBL, M.R.; GROSSMAN-ALEXANDER, M. The view from the road: Implications for stress recovery and immunization. *J. Environ. Psychol.* v.18, p.113–140, 1998. <https://doi.org/10.1006/jevp.1998.0086>

PRETTY, J., PEACOCK, J., SELLENS, M., GRIFFIN, M. The mental and physical health outcomes of green exercise. *International Journal of Environmental Health Research*, v.15 p.319-337, 2005. <http://dx.doi.org/10.1080/09603120500155963>.

RAUTIO, N.; FILATOVA, S.; LEHTINIEMI, H.; MIETTUNEN, J. Living environment and its relationship to depressive mood: A systematic review. *Int. J. Soc. Psychiatry*, v. 64, p. 92–103, 2018. <https://doi.org/10.1177/0020764017744582>

RIGOLON, A.; BROWNING, M.H.E.M.; LEE, K.; SHIN, S. Access to Urban Green Space in Cities of the Global South: A Systematic Literature Review. *Urban Sci.*; v.2, p.1-25, 2018. <https://doi.org/10.3390/urbansci2030067>

ROSA, C., D., PROFICE, C. C., COLLADO, S. Nature experiences and adults' self-reported pro-environmental behaviors: the role of connectedness to nature and

childhood nature experiences. *Frontiers in Psychology*, v.32, n.6, p.355–81, 2018.
<https://doi.org/10.3389/fpsyg.2018.01055>

ROSA, C., D., COLLADO, S., PROFICE, C. C., LARSON, L. R. Nature-based recreation associated with connectedness to nature and leisure satisfaction among students in Brazil. *Leisure Studies*, v. 38, n.5, p.1-9, 2019.
<https://doi.org/10.1080/02614367.2019.1620842>

SONG, C., IKEI, H., IGARASHI, M., MIWA, M., TAKAGAKI, M., MIYAZAKI, Y. Physiological and psychological responses of young males during spring-time walks in urban park. *Journal of Physiological Anthropology*, v.33, n.8, p. 2-7, 2014.
<https://doi.org/10.1186/1880-6805-33-8>

TIAN, Y.; WU, H.; ZHANG, G.; WANG, L.; ZHENG, D.; LI, S. Perceptions of ecosystem services, disservices and willingness-to-pay for urban green space conservation. *Journal of Environmental Management*, n.260, p.110140, 2020.
<https://doi.org/10.1016/j.jenvman.2020.110140>

TOPPER, M.; EMMELKAMP, P.M.G.; EHRING, T. Improving prevention of depression and anxiety disorders: Repetitive negative thinking as a promising target. *Appl. Prev. Psychol.* v.14, p.57–71, 2010.
<https://doi.org/10.1016/j.appsy.2012.03.001>

ULRICH, R.S.; SIMONS, R.F.; LOSITO, B.D.; FIORITO, E.; MILES, M.A.; ZELSON, M. Stress recovery during exposure to natural and urban environments. *J. Environ. Psychol.* v.11, p.231–248, 1991. [https://doi.org/10.1016/S0272-4944\(05\)80184-7](https://doi.org/10.1016/S0272-4944(05)80184-7)

VIGNOLA, R. C. B.; TUCCI, A. M. Adaptation and validation of the Depression, Anxiety and Stress Scale (DASS) to Brazilian portuguese. *J Affect Disord.* v.155, p.104-9, 2014. <https://doi.org/10.1016/j.jad.2013.10.031>

WANG, S.; BAI, X.; ZHANG, X. Urbanization can benefit agricultural production with large-scale farming in China. *Nat Food*, v.2, p.183–191, 2021. <https://doi.org/10.1038/s43016-021-00228-6>

XU, X.; XIE, Y.; QI, K.; LUO, Z.; WANG, X. Detecting the response of bird communities and biodiversity to habitat loss and fragmentation due to urbanization. *Sci. Total Environ*, v. 624, 1561–1576, 2018. <https://doi.org/10.1016/j.scitotenv.2017.12.143>

YANG, Y.; TANG, D.; YANG, X. Investigating the spatio-temporal variations of the impact of urbanization on haze pollution using multiple indicators. *Stoch Environ Res Risk Assess*, v.35, p.703–717, 2021. <https://doi.org/10.1007/s00477-020-01937-3>