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Why do green spaces matter for mental health in urban environments?

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ABSTRACT

BACKGROUND AND OBJECTIVES: Urban green spaces play a vital role in promoting the mental and physical well-being of city residents. While their benefits are widely acknowledged, understanding how demographic factors and travel behaviors influence this green space usage remains limited. This study aims to explore the relationship between urban green space use, user demographics, and perceived mental health benefits within urban environments.

METHODS: A quantitative survey was conducted involving 420 urban green space users. The study assessed participants' health status, physical activities, and emotional responses using structured questionnaires. Statistical analyses such as Analysis of Variance and Principal Component Analysis were employed to evaluate relationships between variables. All analyses were conducted using the Statistical Package for Social Sciences software (version 27).

FINDINGS: Stress levels were found to be moderate to high, with a mean score of 3.22 on a 5-point Likert scale. Emotional well-being showed a positive correlation with reduced stress, with those experiencing emotional distress reporting higher stress levels (mean score of 4.13). Regular physical activity was associated with lower anxiety levels, with individuals engaging in physical exercise reporting an average anxiety score of 2.85 compared to 4.12 for those with minimal activity. Additionally, emotional health improved significantly, as participants reported higher confidence and peace of mind, with scores increasing from 2.75 to 4.10 after engaging in stress-reducing activities. Demographic factors influenced stress levels, with younger participants (ages 18-25) having a mean stress score of 3.45, compared to older participants (ages 45-60) who reported a mean stress score of 2.89.

CONCLUSION: Urban green space provides a significant mental health benefit by reducing stress and enhancing emotional well-being. This study highlights the critical role of UGS in urban planning for fostering resilience and promoting sustainable community development, aligning with the Sustainable Development Goals.

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INTRODUCTION

Urban Green Spaces (UGSs), including parks and gardens, are essential elements of urban environments designed to incorporate vegetation (Hanson *et al.*, 2021). Historically rooted in 18th and 19th-century European gardens, these spaces were initially exclusive to the elite, showcasing elaborate designs like those found in Versailles and Central Park (Loughran, 2020). The industrialization of the 19th century highlighted urban issues such as overcrowding and pollution, prompting advocates for public parks to address these challenges (Platt, 2018). This period birthed expansive public parks, exemplified by London's Hyde Park and the designs of Frederick Law Olmsted (Jones, 2022). The late 19th and early 20th centuries saw the City Beautiful Movement, which prioritized aesthetic values in urban planning, leading to grand boulevards and landscaped parks (Krueckeberg, 2018). The 20th century marked a shift towards accessible recreational spaces for all demographics (Contesse, Van Vliet, and Lenhart, 2018). In recent decades, the focus has increasingly shifted to the environmental benefits of green spaces, highlighting sustainability and ecological preservation (Dushkova and Haase, 2020). Community parks have become vital local gathering places, and the concept of urban green spaces continues to evolve, incorporating adaptive reuse of industrial sites and new technologies for education. These spaces are crucial for enhancing urban life, improving environmental quality, and supporting resident well-being amid urban growth and challenges (Lehmann, 2021). By 2050, seven out of ten people around the world will live in cities (De Neve and Krekel, 2020). This rapid urbanization presents numerous challenges, including increased stress, anxiety, and depression, largely stemming from environmental stressors such as noise, pollution, and social isolation (Rahaman, Kalam, and Al-Mamun, 2023). In this context, the integration of green spaces into urban planning is not merely an aesthetic consideration but a vital component of public health strategy. The benefits of UGSs align closely with the United Nations Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-Being) and SDG 11 (Sustainable Cities and Communities). Theories such as New Urbanism, Eco-City, Social Capital, and Healthy Cities emphasize their importance in

creating vibrant, sustainable urban areas (Giacovelli, 2022). UGSs are crucial for enhancing urban livability by positively affecting the environment, public health, and community well-being. Studies indicate significant mental health benefits, with Houlden *et al.*, (2021) showing that individuals near green areas experience lower psychological distress. This supports the "biophilia hypothesis," which suggests that humans have an inherent connection to nature, enhancing emotional well-being through interactions with green environments (Kellert, Heerwagen, and Mador, 2011). Additionally, Bratman *et al.*, (2021) found that even brief exposure to nature can improve mood and cognitive functioning, highlighting nature's restorative role. Attention Restoration Theory (ART) further explains these benefits, suggesting that natural environments replenish cognitive resources depleted by urban stressors, thereby enhancing focus, creativity, and emotional resilience, all vital for mental health in fast-paced urban settings (Kaplan and Kaplan, 1989). UGSs also promote physical activity, an important factor linked to improved mental health (Callaghan *et al.*, 2021). Kaczynski and Henderson (2007) highlighted that environments conducive to physical activity can lead to reduced symptoms of anxiety and depression. Moreover, Motomura *et al.*, (2024) found that proximity to parks correlates with higher rates of physical activity among residents, further emphasizing the mental health benefits associated with active lifestyles. Social interaction facilitated by green spaces is another key factor in promoting mental health. Parks and community gardens provide venues for socialization, fostering community ties and reducing feelings of loneliness. A study by Ruijsbroek *et al.*, (2017) indicated that stronger social connections, enhanced by communal green spaces, are associated with improved mental health outcomes. UGSs in India, including public parks, botanical gardens, urban forests, and community gardens, are influenced by the historical gardens of Mughal and Rajput rulers (Sharma, Upadhyay, and Chani, 2019). The colonial era established the framework for public parks, while post-independence efforts improved urban living conditions through green area development (Mell, 2018). Current trends emphasize ecological sustainability, native plant species, and community engagement, with initiatives like community gardens gaining traction (Mumtaz,

2021). However, challenges such as maintenance, encroachment, and pollution persist due to rapid urbanization and competing land uses (Turaga *et al.*, 2020). Urban planners are increasingly integrating green spaces into development plans, exploring solutions like green roofs and vertical gardens, supported by initiatives such as the Swachh Bharat Mission and Smart Cities Mission (Shruti, Singh, and Ohri, 2020). Examining local UGSs is crucial for general management, especially as their significance grows amid urbanization challenges and the need for environmental sustainability. The objectives of this study are to investigate the relationship between UGS utilization and perceived stress, emotional responses, and overall mental well-being among urban residents. To achieve these objectives, the research survey was conducted in the residential areas of Midnapore town, West Bengal, India, in 2024.

MATERIALS AND METHODS

Research design

This study employed a cross-sectional research design to investigate the utilization patterns and perceptions of UGS among residents of Midnapore town, West Bengal, India. The design aimed to capture a snapshot of visitor experiences across different times of day, focusing on the morning (5:00 am to 8:00 am) and afternoon (5:00 pm to 7:00 pm) periods, which were identified as peak hours for UGS visits. The research was conducted from March 2024 to May 2024.

Selection of the study area

Midnapore town (Fig. 1) was selected for its diverse urban and semi-urban settings, varied population densities, and unique environmental and health challenges. This localized approach aimed to provide insights into how different types of UGS, including public parks, community gardens, and

peri-urban forested areas, contribute to the well-being and recreational needs of its residents. Two UGS locations were selected for primary survey data collection, detailed in Table 1.

Population and sample

The study targeted users of UGS in Midnapore town, West Bengal, India, with a total participant pool of 420 respondents. This diverse population was selected to reflect the town's varied demographics, including different age groups, genders, socio-economic statuses, and educational backgrounds. To gather participants efficiently, convenience sampling was employed, allowing for the rapid recruitment of individuals who frequented UGS during peak visiting hours (morning and evening). This method was chosen for its time and resource efficiency, enabling the collection of genuine experiences in a natural setting while capturing a wide range of user motivations for visiting UGS. Participants were required to be at least 18 years old and to have visited a UGS at least once in the past month, ensuring they could provide relevant insights based on recent interactions. According to the 2011 census data, the total population of Midnapore municipality was 169,264. To determine an appropriate sample size for interviews, Eq. 1 was applied, which considered a 95% confidence level and a 5% margin of error.

$$n = \frac{Z^2 \cdot p \cdot (1 - p)}{E^2} \quad (1)$$

Where: n is the sample size needed, Z is the Z-score corresponding to the desired confidence level (approximately 1.96 for 95% confidence), and p is the estimated proportion of the population that possesses the attribute in question (assumed as 0.5 to maximize the sample size), E is the margin of error

Table 1: Selected urban green spaces in Midnapore town for primary survey

Name of the UGS	No. of Respondents	Percent	Remarks
Police Line Park (PLP), also known as Sukumar Sengupta Smriti Udyan	196	46.67	Public amusement park with recreational facilities
Tetultala Play Ground (TPG)	224	53.33	Public open space without recreational facilities
Total	420	100.0	-

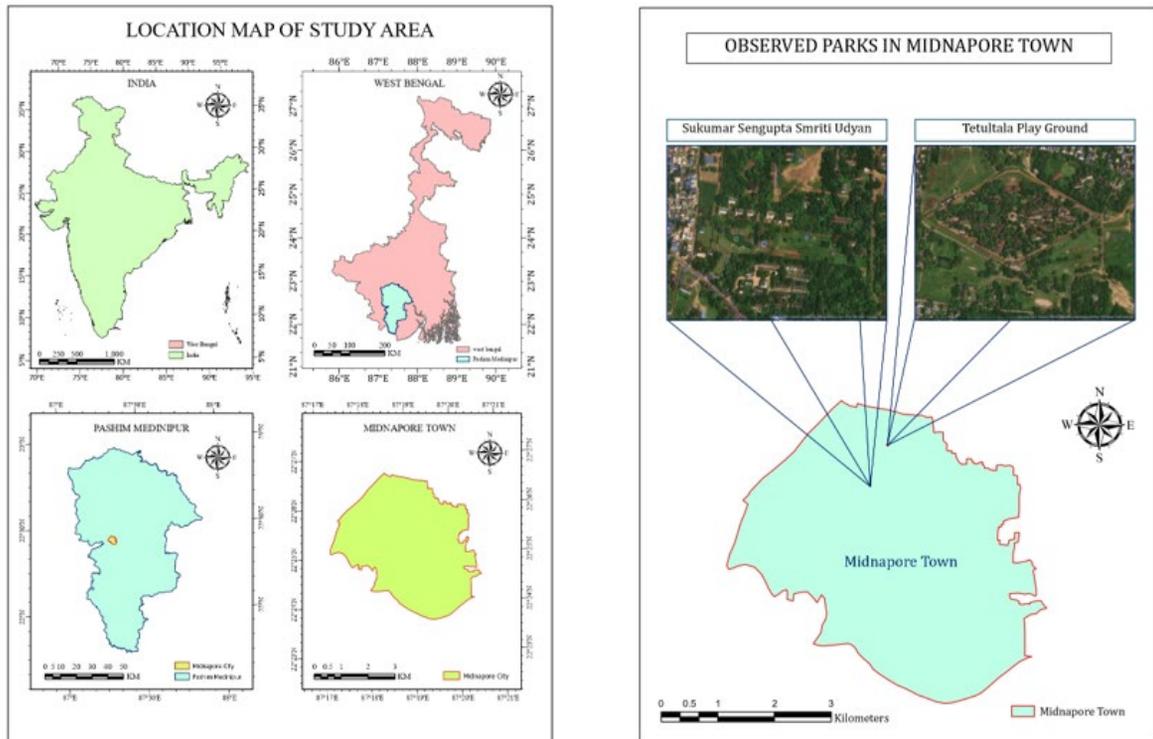


Fig. 1: Geographic location of the observed urban green spaces in the study area

(0.05). Based on this calculation, the sample size required for conducting interviews in the Midnapore municipality was determined to be approximately 385 respondents. Adjustments were made based on specific research goals and conditions, leading to the inclusion of 420 respondents, all of whom were users of urban green spaces.

Data collection methods

The study employed a structured questionnaire as its primary data collection instrument, specifically tailored to measure the mental well-being of UGS users. The first section gathered demographic information, such as age, gender, marital status, educational attainment, household income, and family size, to contextualize the findings. Following this, the questionnaire included a section on travel behavior, where participants reported the frequency of their UGS visits, mode of travel, and travel time, providing insights into how these factors might

influence mental well-being. Health metrics were also assessed through self-reported measures of height, weight, and existing health conditions. Crucially, the Perceived Stress Scale, consisting of 10 items measured on a 5-point Likert scale, evaluated the levels of stress associated with UGS experiences.

Reliability and validity assessment

The study rigorously evaluated the reliability and validity of measurement instruments for assessing perceived stress and mental well-being among UGS users. Internal consistency was confirmed with Cronbach's Alpha values of 0.869 for the perceived stress scale and 0.882 for the mental well-being scale, indicating high reliability. The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy was 0.843, indicating an adequate sample size for factor analysis. Bartlett's Test of Sphericity revealed significant correlations among variables, with a chi-square of 1775.502 ($p < 0.001$), confirming meaningful relationships between constructs.

Data analysis

Data analysis for the study employed several statistical methods to explore the relationship between UGS usage and mental well-being outcomes. Descriptive statistics summarized participants' demographic characteristics and survey responses. One-way ANOVA assessed differences in perceived stress and mental well-being across demographic factors, with significance set at $p < 0.05$. Additionally, Principal Component Analysis (PCA) identified underlying factors related to perceived stress and mental well-being among UGS users.

RESULTS AND DISCUSSION

Socio-demographic profile of the sample respondents

The demographic profile of UGS users, presented in [Table 2](#), reveals a diverse user base predominantly aged 18-30 (41.7%) and over 60 (20.0%), with a majority being male (65.0%). Most respondents identify as Hindu (93.3%) and are married (60.0%), indicating UGS as a family-friendly space. Educationally, many are graduates (31.7%) or have postgraduate degrees (30.0%), suggesting a correlation between education and UGS usage. Employment status is fairly balanced, with 53.3% unemployed, highlighting UGS as a valuable recreational option for job seekers. Income levels primarily fall between 20,001-40,000 rupees (38.3%), indicating UGS's accessibility for lower to middle-income families. Most users reside within the Midnapore Municipality (81.7%) and are homeowners (78.3%), often living in their current residence for over ten years (66.7%), which emphasizes UGS as a significant community asset that fosters engagement and accessible recreation across diverse demographic groups. The demographic profile of UGS users highlights key mental health considerations in urban planning. The prominence of young adults indicates a need for UGS that support their recreational and social activities, which are vital for mental health ([Bressane et al., 2024](#)). The higher percentage of male users points to a gender gap, stressing the importance of inclusive environments for psychological well-being. Additionally, the prevalence of married individuals and joint families suggests that UGS are crucial for family-oriented activities, enhancing emotional support and intergenerational bonding, factors important for mental resilience. For many educated yet unemployed users, UGS serve as essential spaces

for relaxation and stress relief, underscoring the need for equitable access to these resources ([Xiong, Xu, and Zhao, 2024](#)).

Travel behavior of the sample respondents

[Table 3](#) reveals key insights into the travel patterns and expenditures of Urban Green Space (UGS) users. A significant majority (73.3%) travel primarily from home, with walking being the predominant mode of transport (53.3%), followed by cycling (31.7%). Most users visit UGS daily (43.3%), and a substantial portion (56.7%) incur no transportation costs for these visits, underscoring the accessibility of these spaces. Travel times are generally short, with 36.7% reaching UGS in under 15 minutes. During their visits, 43.3% spend nothing, while 30% spend between 10-20 rupees, indicating low-cost leisure options. The primary expenditure during visits is on food and beverages (31.7%), but 40% report no spending at all. These findings highlight a trend toward affordable and accessible recreation, emphasizing the role of walkable urban environments and budget-friendly leisure activities in enhancing community engagement with UGS. The findings related to travel behavior to Urban Green Spaces highlight their crucial role in supporting mental health within urban environments. The significant number of users walking to UGS suggests that easy access to these spaces encourages physical activity, which is known to enhance mood and reduce symptoms of anxiety and depression ([Maury-Mora, Gómez-Villarino, and Varela-Martínez, 2022](#)). Daily visits indicate that UGS serve as essential mental health refuges for urban residents, providing opportunities for relaxation and social interaction, which are vital for emotional well-being ([Naghbi, Farrokhi, and Faizi, 2024](#)). The low transportation costs and short travel times further enhance the appeal of UGS as an accessible mental health resource, particularly for marginalized communities ([Liu, Kwan, and Kan, 2021](#)). By facilitating frequent, low-cost access to nature, UGS can help mitigate the stressors associated with urban living, promoting resilience and psychological recovery ([Robillard et al., 2023](#)).

Physical health of the sample respondents

[Table 4](#) highlights the health and physical activity profiles of UGS users. A significant 73.3%

Table 2: Socio-demographic profile of sample respondents

Demographic variable	Category	Frequency	Percent
Age group (in years)	Under 18	14	3.3
	18-30	175	41.7
	31-45	70	16.7
	46-60	77	18.3
	Over 60	84	20.0
Gender	Female and others	147	35.0
	Male	273	65.0
Religion	Hindu	392	93.3
	Muslim	21	5.0
	Others	7	1.7
Marital status	Others	168	40.0
	Married	252	60.0
	Primary	21	5.0
Educational status	Upper primary	14	3.3
	Secondary	49	11.7
	Higher secondary	77	18.3
	Graduate	133	31.7
	Postgraduate and above	126	30.0
Employment status	Unemployed	224	53.3
	Employed	196	46.7
Household income (in INR)	Up to 20,000	105	25.0
	20,001-40,000	161	38.3
	40,001-60,000	112	26.7
	60,001-80,000	21	5.0
	Above 80,000	21	5.0
	Nuclear	168	40.0
Nature of family	Joint	252	60.0
	3-4	189	45.0
Number of family members	5-6	161	38.3
	7-8	35	8.3
	Above 8	35	8.3
	Outside Midnapore Municipality	77	18.3
Residence	Inside Midnapore Municipality	343	81.7
	Renter	91	21.7
Type of residence	Homeowner	329	78.3
	Less than 1 year	7	1.7
Duration of ownership/rental (in years)	1-5 years	84	20.0
	5-10 years	49	11.7
	More than 10 years	280	66.7

Table 3: Travel patterns and expenditures of sample respondents:

Travel behaviours	Variable	Frequency	Percent
Origin of travel	Home	308	73.3
	Work	21	5.0
	Shops	14	3.3
	School	14	3.3
	College/University	56	13.3
	Others	7	1.7
	Total	420	100.0
Mode of travel	Walk	224	53.3
	Bicycle	133	31.7
	Drive (motorbike/car)	42	10.0
	Public transportation	14	3.3
	Others	7	1.7
Frequency of visits	Total	420	100.0
	Daily	182	43.3
	Several times a week	119	28.3
	Once a week	91	21.7
	Rarely/Never	28	6.7
Transportation cost to visit UGS (in INR)	Total	420	100.0
	Nil	238	56.7
	Less than 5	28	6.7
	5-10	42	10.0
	10-20	98	23.3
	More than 20	14	3.3
	Total	420	100.0
Travel time to visit UGS (in minutes)	Less than 15 minutes	154	36.7
	15-30 minutes	105	25.0
	30-60 minutes	112	26.7
	More than 60 minutes	49	11.7
	Total	420	100.0
Accompanying persons during the UGS visit	Alone	105	25.0
	Friends	182	43.3
	Partner	70	16.7
	Children	56	13.3
	Others	7	1.7
	Total	420	100.0
	None	182	43.3
Spending per visit to UGS	Less than 10 rupees	21	5.0
	10-20	126	30.0
	21-50	84	20.0
	More than 50	7	1.7
	Total	420	100.0
Primary expenditures during visits to UGS	Nothing	168	40.0
	Food/beverages	133	31.7
	Equipment (e.g., sports gear)	7	1.7
	Entry fees (if applicable)	105	25.0
	Others	7	1.7
Total	420	100.0	

Green spaces matter and mental health

reported no disease history, indicating that UGS may attract healthier individuals, while 26.7% face health challenges, especially diabetes (16.7%) and hypertension (11.7%). Walking is the primary activity for 66.7% of users, underscoring UGS's role

in promoting physical activity; however, 35.0% engage in only low to moderate physical activity (30-60 minutes), suggesting room for increased participation. Half of the users' average moderate step counts (501-2000 steps) demonstrate UGS's

Table 4: Status of health and physical activity of UGS users

	Category	Subcategory	Frequency	Percent	
Status of health	Disease history	Haven't disease history	308	73.3%	
		Have disease history	112	26.7%	
	Physical activities at UGS	Walking	280	66.7%	
		Jogging	28	6.7%	
		Cycling	28	6.7%	
		Sports	84	20.0%	
	Disease types	No specific diseases	273	65.0%	
		Diabetes (Diabetes Mellitus)	70	16.7%	
		Blood pressure (Hypertension)	49	11.7%	
		Thyroid disorders	14	3.3%	
		Arthritis	7	1.7%	
	Height	Others	Arthritis	7	1.7%
			Others	7	1.7%
			Short (4.00 - 5.40 feet)	200	47.6%
	Weight	Medium (5.41 - 5.80 feet)	Medium (5.41 - 5.80 feet)	112	26.7%
			Tall (5.81 - 6.20 feet)	108	25.7%
			Underweight (20 - 54 kg)	153	36.4%
	BMI categories	Normal weight (55 - 69 kg)	Normal weight (55 - 69 kg)	217	51.7%
			Overweight (70 - 85 kg)	50	11.9%
			Underweight (mild thinness)	7	1.7%
Overweight (pre-obese)			35	8.3%	
Nature of physical activity	Physical activities at UGS	Obese (Class I)	126	30.0%	
		Obese (Class II)	168	40.0%	
		Obese (Class III)	84	20.0%	
	Physical activity duration	Walking	280	66.7%	
		Jogging	28	6.7%	
		Cycling	28	6.7%	
	Average step count	Sports	84	20.0%	
		Low (30 - 45 minutes)	147	35.0%	
		Moderate (60 minutes)	147	35.0%	
	Average step count	High (70 minutes and above)	126	30.0%	
Low (0 - 500)		147	35.0%		
Moderate (501 - 2000)		210	50.0%		
		High (2001 and above)	63	15.0%	

potential for facilitating exercise. Nevertheless, the 40.0% classified as Obese Class II raises concerns about UGS's effectiveness in addressing obesity. Overall, while UGS users generally display a healthy profile, targeted interventions may be necessary to boost activity levels and tackle obesity in this population. The physical health findings among UGS users highlight the critical interplay between mental health and urbanism. While a significant majority of respondents report no disease history, the presence of health issues like diabetes and hypertension underscores the necessity for UGS to promote holistic well-being (Bressane et al., 2024). Regular activities such as walking, engaged in by a notable portion of users, contribute to mental health benefits, including reduced anxiety and improved mood (Keenan et al., 2021). However, the observed low to moderate levels of physical activity indicate an opportunity for urban planners to enhance engagement through targeted programs that encourage active lifestyles within these spaces. Additionally, the prevalence of obesity among users highlights the importance of designing UGS that not only support physical activity but also foster community interactions, which are vital for

enhancing self-esteem and mental resilience (Kanelli et al., 2023).

Cognitive and emotional responses related to stress about UGS

The item statistics reveal perceptions and emotional responses related to stress about UGS, categorized into cognitive appraisal and emotional response statements presented in Table 5. Respondents generally reported moderate to high levels of agreement with statements reflecting their cognitive appraisal of stress when in UGS, presented in Table 59. For instance, they expressed feeling confident in their ability to handle problems (Mean = 3.1833, SD = 0.886) and believing they can control irritations better (Mean = 3.0500, SD = 0.992) in these environments. However, there was more variability in feeling overwhelmed (Mean = 2.4667, SD = 1.057) and feeling on top of things (Mean = 3.1167, SD = 1.113). In terms of emotional responses, respondents generally reported positive experiences in UGS. They often felt less anxious and more peaceful (Mean = 3.2167, SD = 1.052) and experienced relief and relaxation (Mean = 3.1833, SD = 1.058) after spending time in

Table 5: Perceptions and emotional responses related to stress about UGS

		Item Statistics		
Perceived stress types	Statements related to perceived stress about UGS	Mean	Std. Deviation	N
Cognitive appraisal of stress statements (Xiong, Xu, and Zhao, 2024)	I feel confident about my ability to handle my problems when I spend time in urban green spaces.	3.1833	.88596	420
	I often feel that things are going my way when I immerse myself in green environments.	3.0167	.94083	420
	I rarely find that I cannot cope with all the things that I have to do when I connect with nature in the city.	2.4667	1.05746	420
	I believe I can control irritations in my life better when I spend time in urban green spaces.	3.0500	.99155	420
	I generally feel that I am on top of things when I engage with greenery in urban settings.	3.1167	1.11326	420
Emotional responses to stress statements (Xu et al., 2024)	I feel less anxious and more at peace when I'm surrounded by green landscapes in the city.	3.2167	1.05152	420
	I often experience a sense of relief and relaxation after spending time in urban green spaces.	3.1833	1.05785	420
	I seldom feel overwhelmed by stress when I immerse myself in the tranquility of urban parks.	2.9500	.82611	420
	I believe that being in nature within the city helps me manage my emotions more effectively.	2.9000	.96205	420
	I rarely feel tense or worried when I take leisurely walks in urban green areas.	2.9500	1.05680	420

The Cronbach's Alpha coefficient of 0.869 indicates a high level of reliability among the items measuring the constructs. The Cronbach's Alpha based on standardized items is 0.867, further confirming the consistency of the measurements.

these settings. However, there was some variability in feeling overwhelmed by stress (Mean = 2.9500, SD = 0.826) and managing emotions effectively (Mean = 2.9000, SD = 0.962) in urban green spaces. Leisurely walks were less consistently associated with reduced tension or worry (Mean = 2.9500, SD = 1.057). The finding that users generally feel confident in managing problems while in UGSs underscores the psychological benefits of natural environments in urban settings. This sense of confidence can be linked to several psychological theories that highlight the restorative effects of nature. Kaplan and Kaplan (1989) propose the "Attention Restoration Theory," which posits that natural environments facilitate mental recovery and enhance cognitive functioning, leading individuals to feel more equipped to tackle life's challenges. Moreover, UGS provides a space for reflection and emotional regulation. Being in nature can promote mindfulness and increase self-awareness, which are crucial for effective problem-solving (Borges *et al.*, 2024). Research indicates that exposure to green environments can reduce cognitive overload and enhance mood, contributing to improved mental resilience (Vella-Brodrick and Gilowska, 2022). This is particularly relevant in urban contexts, where residents often face stressors related to rapid urbanization, noise, and social pressures. Users of Urban Green Spaces report feeling less anxious and more at peace, highlighting the significant emotional benefits associated with natural environments in urban settings. This aligns with the growing body of research indicating that interaction with green spaces can lead to improved mental health outcomes, including reduced anxiety and enhanced feelings of tranquility (Xu *et al.*, 2024). Nature has a unique ability to induce relaxation and mitigate stress. Studies show that exposure to green environments can lower cortisol levels, a physiological marker of stress, promote a sense of calmness, improve overall life satisfaction, and reduce feelings of anxiety among urban residents (McSweeney *et al.*, 2021). The concept of "biophilia," proposed by Wilson (2017), suggests that humans have an innate affinity for nature, and this connection can lead to positive emotional responses when engaging with natural settings. UGS can act as a buffer against urban stressors, offering residents a refuge from the hustle and bustle of city life. The restorative effects of nature

can facilitate emotional regulation and promote mental resilience, particularly in densely populated urban areas where individuals may experience high levels of stress (Lencastre *et al.*, 2024).

Factors influencing perceived stress levels: insights from ANOVA analysis

The ANOVA analysis in Table 6 reveals significant factors influencing perceived stress levels among respondents. Age is a key determinant ($F(33, 386) = 14.788, p < .001$), with stress experiences varying across age groups. Gender differences are evident ($F(1, 418) = 6.162, p = .013$), as males and females exhibit distinct stress levels. Religious affiliation also significantly affects stress perceptions ($F(2, 417) = 11.901, p < .001$). Marital status strongly influences stress, with married individuals reporting lower levels ($F(1, 418) = 161.406, p < .001$). Educational attainment ($F(5, 414) = 9.866, p < .001$) and household income ($F(25, 394) = 17.853, p < .001$) are critical factors, indicating that higher education and financial stability contribute to lower stress levels. Family size ($F(8, 411) = 6.765, p < .001$) and type of residence ($F(1, 418) = 12.482, p < .001$) further influence stress perceptions. Additionally, travel-related factors such as frequency of visits to urban green spaces ($F(3, 416) = 9.195, p < .001$) and transportation costs ($F(4, 415) = 4.785, p = .001$) significantly impact perceived stress. Finally, health metrics like BMI ($F(49, 370) = 19.275, p < .001$) highlight the relationship between physical health and mental well-being, illustrating the complex factors shaping stress perceptions in urban populations. Socio-demographic factors such as age, gender, marital status, educational attainment, and household income significantly affect perceived stress levels among UGS users. Research indicates that marital status enhances psychological well-being; married individuals benefit from social support and companionship, which can buffer stress (Dasgupta *et al.*, 2022). Age also influences stress perception, with younger individuals facing higher stress due to life transitions, while older adults often employ coping strategies (Lyu, Wang, and Fan, 2024). Educational attainment correlates with stress levels, as those with higher education typically have better access to resources, leading to reduced stress (Burger and Strassmann Rocha, 2024). Gender differences are notable, with women often reporting higher stress

due to social expectations and coping styles (Giurgiu *et al.*, 2024). Lastly, household income is crucial, as financial stability is linked to lower stress and better access to health and recreational resources (Wdowicka *et al.*, 2024).

Analysis of commonalities in urban green space user perceptions

The commonalities presented in Table 7 offer a nuanced perspective on how urban green space users perceive stress and emotional responses, as analyzed through Principal Component Analysis (PCA). Initially, all survey items start with a commonality of 1.000, indicating complete independence and full variance explanation by each variable. After extraction, the commonalities reveal how closely each item aligns with the underlying factors. For example, statements reflecting confidence and emotional stability, such as

feeling capable of handling problems (communality = 0.750) and feeling in control within green environments (communality = 0.800), demonstrate significant retained variance. Conversely, items like rarely feeling overwhelmed by stress (communality = 0.218) indicate weaker alignment, suggesting these may capture more specific or nuanced aspects of the user experience that are less broadly represented by the extracted factors.

The component matrix in Table 8, derived from Principal Component Analysis (PCA) with two extracted components, reveals important insights into how survey statements relate to perceived stress and emotional responses among urban green space users. Component 1, labeled positive engagement and emotional well-being, includes high-loading statements such as “I feel confident about my ability to handle my problems” (.663), “I often feel that

Table 6: ANOVA analysis of factors influencing perceived stress levels

	Factors	Sum of Squares	df	Mean Square	F-value	p-value
Socio-demographic factors	Age in years	10701.017	33	324.273	14.788	.000
	Gender	278.405	1	278.405	6.162	.013
	Religion	1034.867	2	517.433	11.901	.000
	Marital status	5338.978	1	5338.978	161.406	.000
	Educational status	2040.592	5	408.118	9.866	.000
	Household income (rupees/month)	10179.433	25	407.177	17.853	.000
	Number of family members	2230.036	8	278.755	6.765	.000
	Type of residence	555.730	1	555.730	12.482	.000
	Nature of family	239.575	1	239.575	5.291	.022
	Duration of ownership/rental of property (years)	13152.767	27	487.140	31.759	.000
	Origin of travel	3857.170	5	771.434	20.863	.000
	Mode of travel	6041.581	4	1510.395	47.761	.000
	Frequency of visits	1191.830	3	397.277	9.195	.000
Travel behaviours	Transportation cost (rupees)	844.906	4	211.226	4.785	.001
	Travel time (minutes)	1257.989	3	419.330	9.741	.000
	Accompanying persons	2668.292	4	667.073	16.781	.000
	Spending per visit	6985.623	4	1746.406	59.504	.000
	Primary expenditures during visits	5289.467	4	1322.367	39.549	.000
Physical health	Diseases types	2514.218	5	502.844	12.502	.000
	Height (feet)	2797.453	17	164.556	4.041	.000
	BMI (kg/m ²)	13770.867	49	281.038	19.275	.000

Table 7: Communalities before and after extraction through Principal Component Analysis

Communalities		
	Initial	Extraction
I feel confident about my ability to handle my problems when I spend time in urban green spaces.	1.000	.750
I often feel that things are going my way when I immerse myself in green environments.	1.000	.655
I rarely find that I cannot cope with all the things that I have to do when I connect with nature in the city.	1.000	.434
I believe I can control irritations in my life better when I spend time in urban green spaces.	1.000	.649
I generally feel that I am on top of things when I engage with greenery in urban settings.	1.000	.800
I feel less anxious and more at peace when I'm surrounded by green landscapes in the city.	1.000	.552
I often experience a sense of relief and relaxation after spending time in urban green spaces.	1.000	.598
I seldom feel overwhelmed by stress when I immerse myself in the tranquility of urban parks.	1.000	.218
I believe that being in nature within the city helps me manage my emotions more effectively.	1.000	.585
I rarely feel tense or worried when I take leisurely walks in urban green areas.	1.000	.489

Extraction Method: Principal Component Analysis.

Table 8: Component Matrix on survey statements related to perceived stress and emotional responses in urban green spaces

Component Matrix ^a		
	Component	
	1	2
I feel confident about my ability to handle my problems when I spend time in urban green spaces.	.663	-.557
I often feel that things are going my way when I immerse myself in green environments.	.774	-.235
I rarely find that I cannot cope with all the things that I have to do when I connect with nature in the city.	.628	-.199
I believe I can control irritations in my life better when I spend time in urban green spaces.	.558	.581
I generally feel that I am on top of things when I engage with greenery in urban settings.	.845	.293
I feel less anxious and more at peace when I'm surrounded by green landscapes in the city.	.731	.134
I often experience a sense of relief and relaxation after spending time in urban green spaces.	.698	.333
I seldom feel overwhelmed by stress when I immerse myself in the tranquility of urban parks.	.440	.157
I believe that being in nature within the city helps me manage my emotions more effectively.	.738	-.202
I rarely feel tense or worried when I take leisurely walks in urban green areas.	.664	-.220

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

things are going my way" (.774), "I generally feel that I am on top of things" (.845), and "I feel less anxious and more at peace" (.731). These findings indicate that users view urban green spaces as significantly enhancing their confidence, positivity, and emotional calmness. Additionally, items like "I rarely feel overwhelmed by stress" (.440) and "I

seldom feel tense or worried" (.664) support this notion, suggesting that reduced stress and relaxation are integral to positive engagement with these environments. Component 2, labeled emotional management and relaxation, includes statements such as "I believe I can control irritations in my life better" (.581) and "I often experience a sense of

relief and relaxation” (.333), indicating that users see urban green spaces as beneficial for emotional management and relaxation. However, the statement “I believe that being in nature helps me manage my emotions effectively” (.738) shows a negative loading on Component 2, suggesting that this belief may not align strongly with the emotional management factors identified, highlighting a complex relationship between nature and users’ emotional responses.

Integrating UGS into urban planning is essential for community well-being, ecological sustainability, and achieving SDGs. Research shows that UGS significantly enhances mental health by reducing stress and promoting emotional well-being. Notable examples like Central Park in New York City and Griffith Park in Los Angeles provide visitors with rejuvenation and improved mood through activities such as walking and mindfulness (Jacobson, 2017). The Royal Botanic Gardens in Melbourne fosters social interactions, enhancing users’ confidence and sense of community belonging (Ward, Truong, and Gray, 2022). Additionally, UGS supports ecological functions like air quality improvement and stormwater management, aligning with SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action) (Orsetti *et al.*, 2022). Involving local communities in the planning process encourages ownership and social equity (Grabowski, McPhearson, and Pickett, 2023). Furthermore, developing data-driven smart eco-city models can identify areas needing UGS, ensuring effective resource allocation (Wu *et al.*, 2022). Ultimately, integrating UGS into urban design enhances individual well-being while contributing to ecological and social sustainability.

CONCLUSION

This study addressed the critical research problem of how UGSs influence perceived stress and emotional well-being, focusing on Midnapore town as a representative yet underexamined urban setting. It contributes to theory-building by illuminating the complex interrelationships between UGS, perceived stress, and emotional well-being, offering valuable insights for environmental psychology and urban studies. The study emphasizes the importance of considering demographic, health-related, and environmental variables in understanding mental health dynamics within urban settings. Findings from

the study suggest that future theoretical frameworks should integrate such multifaceted determinants to better address the psychological impacts of urban living. From a policy perspective, the study holds significant implications for achieving Sustainable Development Goals, particularly SDG 3 (Good Health and Well-Being) and SDG 11 (Sustainable Cities and Communities). By evidencing that access to and engagement with quality green spaces can alleviate stress and foster emotional resilience, the research reinforces the necessity of embedding UGS into urban planning and governance. Such integration supports not only public health and psychological well-being but also broader goals of inclusivity, environmental sustainability, and community resilience. These insights suggest actionable strategies such as designing inclusive green spaces in densely populated areas, integrating green prescriptions into public health programs, and encouraging participatory planning to reflect community needs. However, the study is limited by its reliance on self-reported data, a cross-sectional design, and a geographically constrained sample, which may not fully capture causal relationships or allow for broader generalization. Future research should incorporate longitudinal approaches, physiological and behavioral indicators of stress, and comparative studies across diverse urban regions to validate and extend these findings. In the long run, urban green spaces emerge as essential infrastructural elements in the pursuit of holistic, sustainable urban development that prioritizes mental well-being.

AUTHOR CONTRIBUTIONS

A. Baitalik performed the literature review and research design, analyzed and interpreted the data, prepared the manuscript text, and manuscript. T. Bhattacharjee performed the literature review, compiled the data, and manuscript.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy, have been completely witnessed by the authors.

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ABBREVIATIONS (NOMENCLATURE)

ANOVA	Analysis of Variance
ART	Attention Restoration Theory
BMI	Body Mass Index
KMO	Kaiser-Meyer-Olkin
UGS	Urban Green Spaces
PCA	Principal Component Analysis
SDGs	Sustainable Development Goals

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