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RESEARCH AND THEORY

Measuring and modeling the association between human psychological well-being and urban green spaces of Lahore, Pakistan

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Abstract

The ongoing process of urbanization has led to a concerning reduction in the accessibility and availability of green spaces within urban areas. Concurrently, the sedentary and fast-paced lifestyles commonly associated with urban living have created significant barriers between urban residents and green spaces. This study aims to comprehensively assess and model the impact of urban green spaces on the psychological well-being of residents in Lahore. To achieve this objective, a questionnaire-based survey was conducted, involving a substantial sample of 1050 respondents. The study employed regression analysis to gauge the extent to which residents interacted with urban green spaces. A structural model was generated using Smart PLS to provide a more nuanced understanding of the relationships between these variables. The findings of the study were and provided considerable information, ultimately revealing a strongly positive and statistically significant relationship between urban green spaces and the promotion of human well-being (beta = 0.717, $p < 0.000$, and $R^2 = 0.514$). As such, it can be concluded that the residents' interaction with urban green spaces in Lahore exerts a favorable impact on their psychological well-being. Considering these findings, this study demonstrates the vital importance of ensuring the accessible availability of urban green spaces within Lahore. It also highlights the urgent need to raise awareness among residents about the positive contributions that green spaces make to their psychological well-being. By prioritizing the preservation and expansion of urban green spaces, policymakers can ultimately take proactive steps to enhance the quality of life for urban residents.

Keywords Proximity · Modeling · Psychological well-being · Urban green spaces · Urbanization

Introduction

Urban green spaces (UGS) have been extensively researched for their positive effects on human psychological well-being in fields including environmental psychology, public health, and urban ecology over the past few decades. This research has been supported and reinforced by data acquired from a growing number of empirical investigations (Zhang and Tan 2019). Urban green spaces encompass urban land that is partially or fully covered by grass, trees, bushes, or other forms of vegetation. Examples of urban green spaces include parks, community gardens, cemeteries, rooftop and vertical gardens, meadows, and wooded areas (Haase et al. 2017). The forms of urban green spaces may range from green surfaces, open and burying spaces, sports fields, private gardens, road verges, vacant land, and urban horticulture. One of the central aspects of urban settings is urban greenery because it encourages physical activity, psychological and mental relaxation, and the removal of air pollutants that promote human life events (Wang & Akbari 2016; Duan et al. 2018). Urban green areas provide a healthy and safe environment for activities like running, jogging, and walking that improve human well-being (Jabbar et al. 2021; *WHO | Urban Green Spaces*, n.d.). These green spaces have a positive environmental and socio-economic effect in metropolitan settings by improving the surrounding environment and residents' health. Urban greenness accelerates physio-psychological and emotional calmness and social cohesion (Mensah et al. 2016). Green spaces in urban land are a key component of a sustainable and livable city (Dhingra & Chattopadhyay 2016). According to several studies, urban greenery also actively enhances human life by reducing urban heat islands in heavily inhabited regions and is essential for enhancing

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human life (Jabbar and Yusoff 2022a). Urban greenness provides the residents' needs for ecosystem services on a large scale (Campagnaro et al. 2020). The presence and easy access to green areas were also beneficial to life satisfaction and human well-being. Focusing on ecosystem services, the connections between socio-ecological settings and urban green spaces enhance socio-environmental justice (Enssle and Kabisch 2020).

Psychological well-being can include the need for a sense of accomplishment and personal improvement on both an intra- and inter-individual level of human psychological health (Ryff & Keyes 1995; "What is Psychological Well-being 2018). Feelings of happiness, contentment, and life satisfaction characterize psychological well-being. However, it is challenging to completely determine whether human psychology is favorably related to the interaction of urban greenness. The associations between urban green spaces and residents' psychological well-being may vary due to the greenery's varying form and quality. Although all psychological problems cannot be resolved by nature, they can be reduced by enhancing a person's connection to open and green spaces. For instance, meadows have just a little impact on human psychology, while the abundance of trees significantly impacts psychological health (Southon et al. 2018). The proximity of green spaces to one's home or employment also has favorable consequences and various advantages for human well-being that are intimately linked to nature. For example, visitors relieve their tension and improve their mental and psychological health in such ways. In Sydney, green areas were favorably connected with psychological well-being (Taylor et al. 2018). A natural setting has been demonstrated to have beneficial effects on psychological well-being. Human psychological well-being is maintained and strengthened through interactions with nature and the proximity to green spaces reduces psychological problems. As a result, it can be argued that a crucial component of urban living and human psychological recovery is urban greenery (White et al. 2017).

For human well-being, urban green elements are equally important. Urban green areas are a source of enjoyment, a place to unwind, and a means of healing from physical and mental stress as demonstrated by areas such as Hangzhou, China. People are drawn to green landscapes because of their abundance of trees, clean water, and vibrant flowers, which can help with mental and psychological stress recovery (Wang et al. 2019). The richness of biodiversity in urban greenery does not affect the population negatively (Chang et al. 2020). UGSs have a substantial role in psychological well-being in densely populated areas; however, the degree of relevance may vary for various socio-economic levels (Scopelliti et al. 2016). Urban green areas also encourage social connection, contributing to psychological well-being (Jennings & Bamkole 2019). Human well-being and natural features such as biodiversity and forest canopy are intimately related. The diversity of green landscapes is strongly correlated with the recovery of human psychology. The impact of urban green spaces on psychological health may change depending on species' differences. The composition and arrangement of the green landscape have also been found to correlate with psychological recovery in Rennes, France. Consequently, the composition and arrangement diversity in urban green spaces improve psychological well-being (Meyer-Grandbastien et al. 2020). Although there may not be a substantial correlation between naturalness and biodiversity, a high correlation between psychological well-being and vegetation cover may exist. Positive but weak relationships exist between natural parks, improved mood, and stress reduction (Schebella et al. 2019). Four diverse, well-kept public parks in Delhi were the subject of a study to determine the advantages to human well-being. It was observed that visitors' interactions with parks are beneficial to their psychological well-being (Paul & Nagendra 2017). Therefore, it can be determined that urban green spaces are beneficial for residents' psychological recovery and well-being.

Urban green spaces, such as parks, wetlands, and green belts, can serve as natural buffers against flooding. They absorb excess rainwater, reducing the volume and speed of surface runoff during heavy rainfall events. This natural flood control can help mitigate the risk of urban flooding (Escobedo et al. 2011). Green spaces act as natural stormwater management systems, as vegetation and soil in these areas absorb rainwater, allowing it to infiltrate into the ground. This reduces the load on stormwater drainage systems and can prevent overwhelmed drains from causing flooding in urban streets (Ahern et al. 2014). Vegetation in urban green spaces stabilizes soil and reduces erosion. This is especially important in hilly or sloped urban areas where runoff can lead to soil erosion and landslides during heavy rainfall events (Livesley et al. 2016). Urban green spaces contribute to overall climate resilience by moderating temperature extremes and reducing the urban heat island effect. Cooler urban areas are less susceptible to extreme weather events, including heavy rainfall and associated flooding (Kabisch et al. 2017; Nasar-u-Minallah 2020).

Similarly, the positive associations between urban green spaces and psychological well-being are well documented in the various studies highlighting their significance for urban residents. However, rapid urbanization and a sedentary lifestyle are creating a rift between urban greenness and the residents (Nasar-u-Minallah et al. 2021). So, urbanization is reducing accessibility and easy access to green spaces (Bhalli and Ghaffar 2015). Moreover, the urban sedentary and busy lifestyles also create obstacles between urban greenery and the residents. The lack of comprehensive studies on the impacts of urban green spaces on inhabitants' psychological well-being is also a cause of human

psychological issues, especially in developing countries like Pakistan. Therefore, this study aims to investigate and understand, measure, and model such a relationship between urban green spaces and human psychological well-being in the city of Lahore, Pakistan. The study incorporates the use of quantitative modeling techniques, such as structural equation modeling and other comprehensive analysis, offering valuable insights into how the relationship between green spaces and well-being evolves. Overall, the significance of the study lies in its systematic and data-driven exploration of the intricate relationship between urban green spaces and human psychological well-being, potentially uncovering insights that can inform urban policies and practices to enhance residents' quality of life.

Materials and methods

Study area description

Lahore is an urban metropolis boasting the second largest population in Pakistan. It is located on the river Ravi from 31° 15′ 0″ N to 31° 45′ 0″ N and 74° 01′ 0″ E to 74° 39′ 0″ E, as shown in Fig. 1. Generally, the study area is situated in the Upper Indus Plain on the left bank of the river Ravi. It is also known as the "heart of Pakistan" due to its cultural, and academic activities, and socioeconomic importance in the country. According to the population census report of 2017, the city has an 11,126,285 population in 1772 km^2 along with a 6278.94/km^2 density (GOP 2017). Previously, 82% of the population was urbanized, but the 2017 census data confirms that the whole district is now urbanized (Nasar-u-Minallah and Ghaffar 2020). Therefore, the increasing proportion of urban residents calls for a better way of life and puts pressure on green places to sustainably provide ecosystem services. There are 276 green belts and 828 parks in Lahore, according to the Parks and Horticulture Authority Lahore, as depicted in Fig. 1 (Hanif et al. 2022). According to published data, the majority of studies saw parks as a sign of urban green space. According to studies, Lahore only has 3% of its land covered in green space—an extremely low percentage by global standards. Given that, between 25 and 30% of the metropolitan area must have green space. Though it is referred to as the "City of Gardens," it is currently having problems due to the reduction in green areas (Alam et al. 2014; Nasar-u-Minallah 2018; 2019). As a result, Lahore is

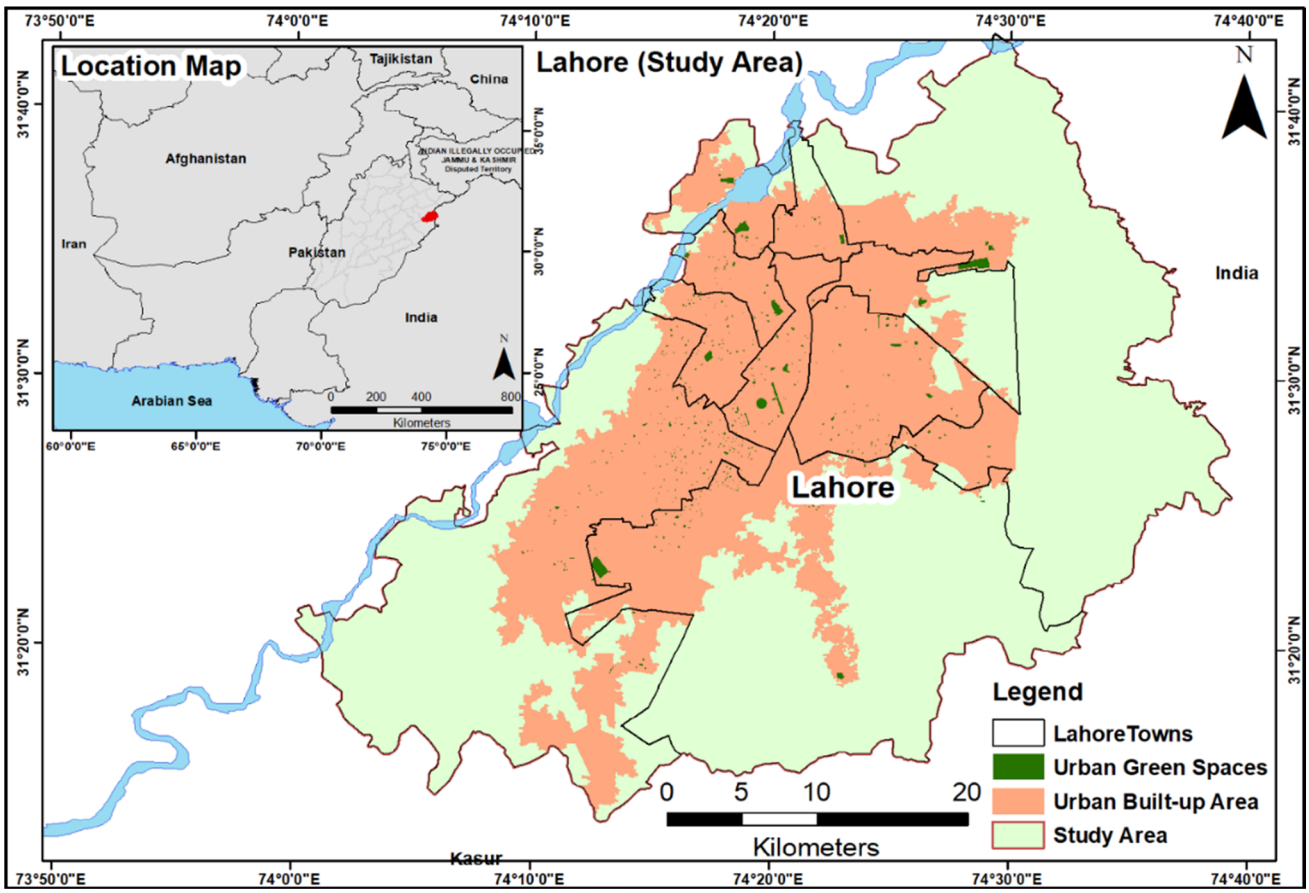

Fig. 1 Location of Lahore and distribution of urban green spaces

beginning to experience various environmental problems, such as wintertime smog and air pollution and urban heat islands (Nasar-u-Minallah et al. 2023) and urban flooding (Zia et al. 2022).

Data collection and analysis

A field survey was conducted in which 1050 residents were examined by using a simple random sampling technique in Lahore, providing the data that was used for this research study. The study prepared a questionnaire (shown in Appendix – B) for data collection to measure and model the role of urban green spaces in the psychological well-being of people living in urban environments. The primary goal of the study was to examine the contribution of urban green areas, particularly parks, to the psychological well-being of those who live in urban areas. For this reason, the study asked several questions about how people use parks and how they view their surroundings. Demographic and socio-economic information about the respondents was also covered in the survey. A field survey of the respondents' demographic profile is given in Appendix – A. After that, the collected data was inputted into Microsoft Excel, where measurement of urban green spaces for psychological well-being was performed. Similarly, a structural model was generated by using the Smart PLS (version 4). Further details of data analysis are given below. Further details regarding the methodological framework of the study area are given in Fig. 2.

Measurement of urban green spaces interaction

To evaluate the way residents interact with urban green spaces, the study assessed their (i) visiting routine (VR), (ii) spending hours (TS), and (iii) distance (DIST) from the green spaces. The interaction was measured using the UGSI scale, which assigns scores to different responses, as given in Table 1.

Measurement of psychological well-being

The residents' psychological well-being was quantified by applying Ryff's psychological well-being scale (Ryff 1989; Ryff & Keyes 1995). The study used the shortest version (18 items) of the scale, based on six theoretically motivated constructs. To measure the psychological well-being of the residents, Ryff's psychological well-being scale (Ryff 1989; Ryff & Keyes 1995) was employed. The study utilized the

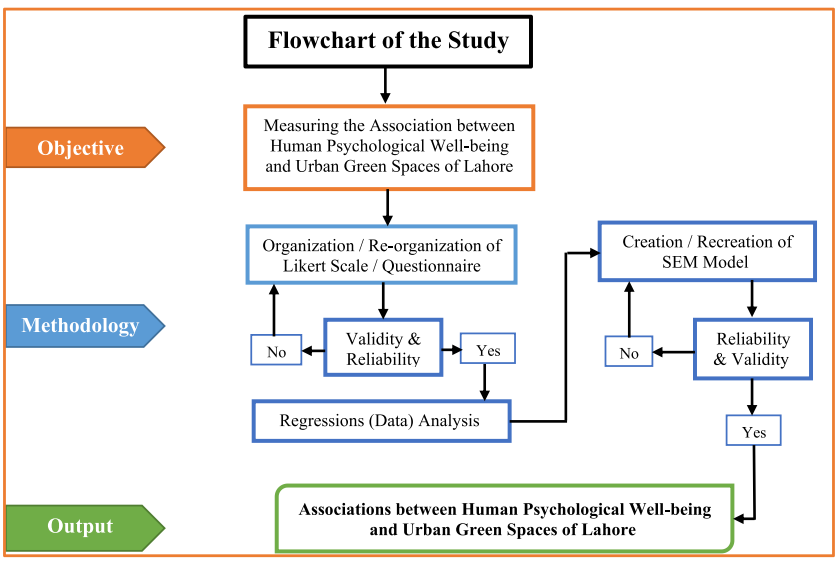

Fig. 2 Flowchart of the study

Table 1 Scale for measurement of urban green spaces interaction

Variables	Visiting routine	Score	Spending hours	Score	Distance (km)	Score
Response and offered scores	Daily	5	One	1	Within 0.5	6
	Weekly	4	Two	2	0.5–1	5
	Monthly	3	Three	3	1–2	4
	Often	2	Four	4	2–3	3
	Rarely	1	Five and above	5	3–4	2
					Above 4	1

briefest version of the scale, consisting of 18 items. This version focuses on six constructs that are theoretically driven and are described in detail in Table 2.

Factor analysis

Factor analysis of the scale was conducted in which all six factors gained an adequate level of Cronbach's alpha reliability (above 70) which is detailed in Table 2.

Reliability and validity

Table 3 presents the assessment of the reliability and validity of the psychological well-being scale. The composite reliability of the different measures ranged from 0.75 to 0.93, exceeding the recommended threshold value of 0.70 (Nunnally & Nunnally, 1978). These values, which fall within the suitable range of 0.50 to 0.90, demonstrate the scale's appropriateness for structural modeling. Furthermore, Cronbach's alpha coefficients were calculated and ranged from 0.511 to 0.889, further supporting the scale's suitability for analysis (Taber 2018). The average variance extracted (AVA) for each measure was examined using Fornell and Larcker's recommendations to establish discriminant validity. The AVA values ranged from 0.507 to 0.814, surpassing the minimum acceptable value of 0.50. These findings provide statistical evidence of the scale's reliability and validity across all measures.

Inter-constructs correlation

The inter-construct correlation of the psychological well-being scale was quantified in which all the constructs were found to significantly correlate according to the suggested adequate value of 0.70 (Cohen 1977, p. 83). However, the correlation was found between 0.837 and 0.930 at $p < 0.01$, which is shown in Table 4.

Table 2 Factor analysis of psychological well-being scale

Sr. No	Factor	Abbreviation	Item	Mean	Minimum	Maximum	Cronbach's alpha
1	Autonomy		1	4.953	4.914	4.993	0.943
		AU	7				
			13				
2	Environmental mastery		2	4.989	4.977	4.995	0.942
		EM	8				
			14				
3	Personal growth		3	4.981	4.958	4.993	0.956
		PG	9				
			15				
4	Positive relations		4	5.033	4.985	5.066	0.948
		PR	10				
			16				
5	Purpose in life		*5*	4.966	4.997	5.038	0.934
		PL	*11*				
			17				
6	Self-acceptance		*6*	4.964	4.919	5.004	0.932
		SA	*12*				
			18				

Table 3 Construct reliability and validity for psychological well-being

Sr.#	Constructs	Cronbach's alpha	rho_A	Composite reliability	AVE
1	Autonomy	0.885	0.887	0.929	0.813
2	Environmental mastery	0.886	0.887	0.929	0.814
3	Personal growth	0.886	0.888	0.93	0.815
4	Positive relation	0.862	0.862	0.916	0.784
5	Purpose in life	0.889	0.891	0.931	0.819
6	Self-acceptance	0.893	0.894	0.933	0.824
7	UGSI	0.511	0.52	0.753	0.506

Table 4 Inter-construct correlation for psychological well-being

	AU	EM	PG	PR	PL	SA
AU	1					
EM	0.927**	1				
PG	0.918**	0.930**	1			
PR	0.924**	0.904**	0.901**	1		
PL	0.837**	0.852**	0.869**	0.873**	1	
SA	0.856**	0.883**	0.893**	0.888**	0.925**	1

**Correlation is significant at the 0.01 level (2-tailed)

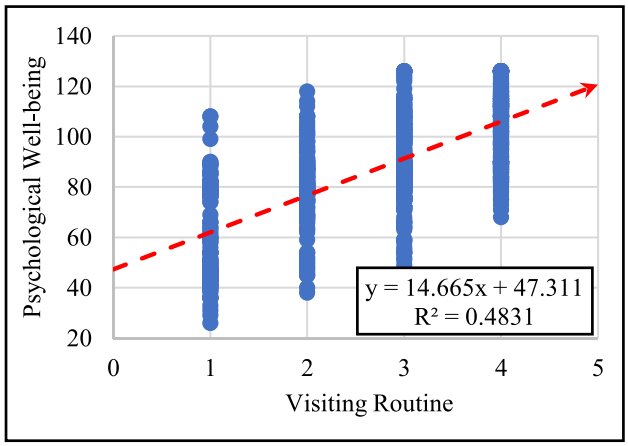

Fig. 3 Effects of visiting routine on psychological well-being

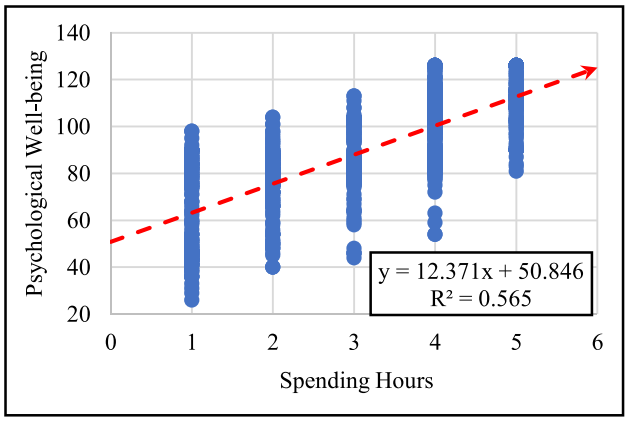

Fig. 4 Effects of spending hours on psychological well-being

Results

Measuring the urban green spaces for psychological well-being

The effects of visiting routine in urban green spaces on residents' psychological well-being were analyzed by applying linear regression in which the equation was found (F (1, 1048) = 979.524, $P < 0.000$) with an R^2 of 0.483. Therefore, the residents' predicted score will equal 47.311 + 14.665 when the visiting routine to urban green spaces is measured. Consequently, psychological well-being increased by 14.665 for 47.311 for each score of visiting routine, which is detailed in Fig. 3. So, residents' psychological well-being increased with the increase in their visits to green spaces.

The impact of spending hours in urban green spaces on respondents' psychological well-being was examined using linear regression analysis. The equation obtained was significant (F (1, 1048) = 1361.454, $P < 0.000$), and the coefficient of determination (R^2) was found to be 0.565. This may suggest that spending hours in UGSs substantially influences residents' psychological well-being. These findings are further illustrated in Fig. 4, confirming that residents' psychological well-being is positively associated with their time spent in green spaces.

A linear regression analysis was conducted to examine the impact of distance from green spaces on residents' psychological well-being. The results revealed a significant relationship between the two variables (F (1, 1048) = 1396.703, $P < 0.000$), with an R^2 value of 0.235. The equation derived from the analysis indicates that the predicted score of respondents' psychological well-being can be estimated by adding 7.1632 for every unit increase in distance from green spaces, starting from a baseline score of 117.2. These findings demonstrate that as the distance from green spaces increases, residents' psychological well-being tends to decrease. This relationship is further illustrated in Fig. 5.

The effects of UGSI on residents' psychological well-being were analyzed by applying a linear regression in which the equation was found (F (1, 1048) = 4006.346, $P < 0.000$) with an R^2 of 0.792. Therefore, the residents' predicted score will equal 31.961 + 6.035 when urban green spaces interaction is measured. Consequently, psychological well-being increased by 6.035 for 31.961 for each UGSI score, detailed in Fig. 6. Therefore, residents' psychological well-being increased with the increase in their interaction with green spaces.

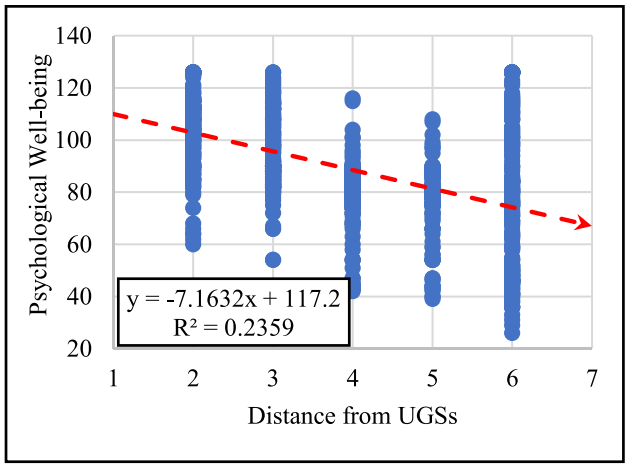

Fig. 5 Effects of distance on psychological well-being

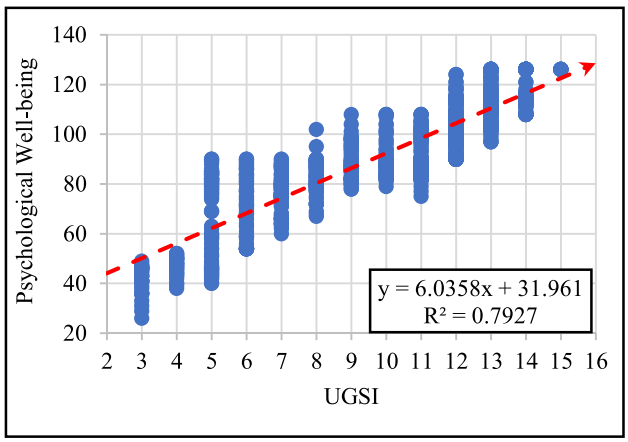

Fig. 6 Effects of UGSI on psychological well-being

Modeling urban green spaces for psychological well-being

The study measured residents' interaction with urban green spaces by examining their visiting routine, the time spent in green spaces, and the distance of their residence from these areas. The measurement model, presented in Fig. 7, demonstrated the contribution of each variable. Visiting routine had a beta coefficient of 0.647, explaining 41.8% of the variance ($R^2 = 0.418$). Spending hours in green spaces had a beta coefficient of 0.773, accounting for 59.8% of the variance ($R^2 = 0.598$). Distance from UGSs had a beta coefficient of 0.708, explaining 50.1% of the variance ($R^2 = 0.501$). All three variables exhibited statistically significant and adequate contributions to the residents' urban green space interaction (UGSI) based on the analysis.

A structural model is a statistical representation of the relationships between different independent and dependent

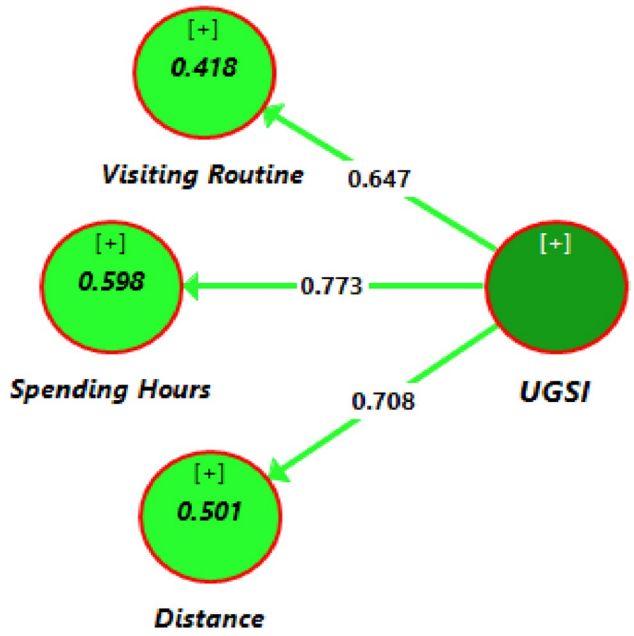

Fig. 7 Urban green spaces interaction by the respondents

variables in a system. In other words, it is a form of regression analysis which helps to compute the effects of independent variables on dependent variables. In this context, it likely represents how urban green space interaction (as an independent variable) affects residents' psychological well-being (dependent variable). A structural model of the effects of urban green spaces interaction on residents' psychological well-being is given in Fig. 8, in which the path coefficients (beta = 0.717) were found positive and significant at $p < 0.000$, with an R^2 of 0.514. Path coefficients "beta" (β), represent the strength and direction of the relationships between variables in a structural model. Each path coefficient indicates how much one variable influences another. Positive coefficients indicate a positive relationship (an increase in one variable leads to an increase in another), while negative coefficients indicate a negative relationship (an increase in one variable leads to a decrease in another). The magnitude of the coefficient indicates the strength of the relationship. Similarly, *R*-squared is a statistic that measures the goodness-of-fit of a model. In the context of structural modeling, R^2 values help you understand how well the model explains the variance in the dependent variable (residents' psychological well-being). It tells you the proportion of the variability in the dependent variable (psychological well-being) that can be accounted for by the independent variables (urban green spaces interaction) in the model.

All 18 outer loading values of six constructs were found between 0.881 and 0.927. In structural equation modeling (SEM), the outer loading values of constructs refer to the relationships between the observed variables (urban green

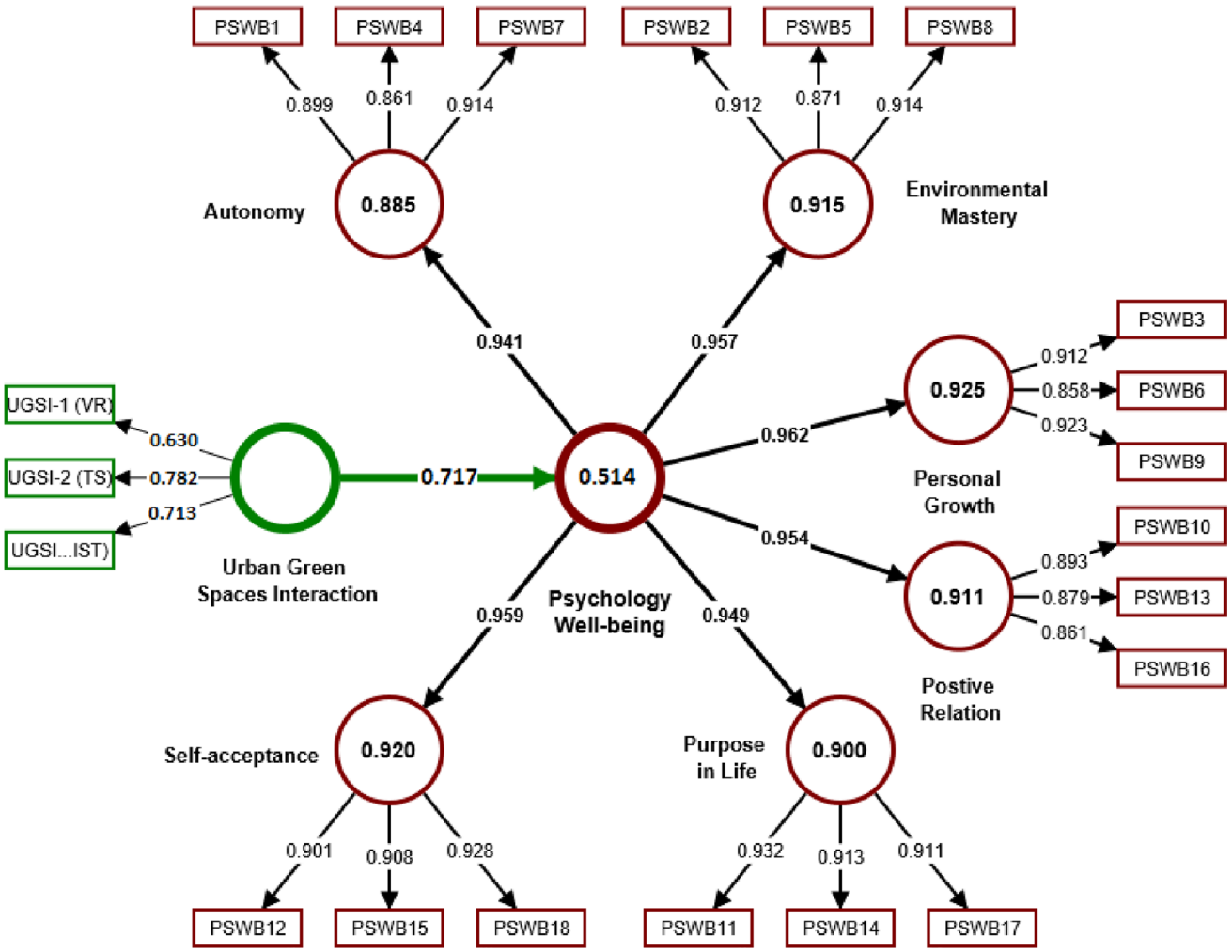

Fig. 8 Associations between residents' psychological well-being and green spaces of Lahore

spaces interaction and psychological well-being) and the latent constructs (outer loadings) they are intended to measure. The range of outer loading values between 0.881 and 0.927 in the structural model suggests that the indicators are well correlated with their respective latent constructs. The values in the range of 0.881 to 0.927 describe that these indicators are reliable measures of the constructs they are intended to represent. High outer loading values contribute to a well-fitting measurement model, which is a crucial component of the structural equation model. When indicators have strong loadings, it suggests that they effectively capture the variation in their respective latent constructs. This enhances the overall fit of the measurement model, indicating that the model adequately reflects the relationships between urban green spaces and psychological well-being. Similarly, psychological well-being loads its path; (i) autonomy reflecting 0.951 with R^2 of 0.904, (ii) environmental mastery reflecting 0.959 with R^2 of 0.92, (iii) personal growth reflecting 0.962 with R^2 of 0.925, (iv) positive relations reflecting 0.957 with R^2 of 0.916, (v) purpose in life reflecting 0.94 with R^2 of 0.883, and (vi) self-acceptance reflecting 0.954 with R^2 of 0.909. So, all the structural model's inner and outer loadings are positive and statistically significant.

In the second part of the model, the study examined the impact of urban green space interaction on residents' psychological well-being. This was assessed using three indicators: visiting routine, spending hours, and distance. The frequency or routine of visiting urban green spaces can impact psychological well-being. For instance, regular visits may provide a sense of continuity and stability in one's life. It can also facilitate a stronger connection with nature and the local community (Enssle and Kabisch 2020; Schebella et al. 2019). Residents who have a consistent visiting routine, such as daily or weekly visits to urban green spaces, experience improved psychological well-being. They reported lower levels of stress, anxiety, and depression, and higher levels of happiness and life satisfaction. Similarly, the amount of time

spent in urban green spaces can also influence psychological well-being. Longer durations of exposure to nature and green environments can provide more significant opportunities for relaxation, stress reduction, physical activity, and social interactions (Pietilä et al. 2015). In this way, residents who spend more hours in urban green spaces experience greater benefits for their psychological well-being. They reported improved mood, reduced symptoms of mental distress, and an overall enhanced sense of well-being. Likewise, the proximity or distance of urban green spaces from residents' homes plays a role in accessibility. Closer proximity makes it easier for individuals to visit these spaces regularly, promoting a sense of convenience and integration of green spaces into daily life (Houlden et al. 2019). Therefore, the residents who live closer to urban green spaces might be more likely to visit them regularly. This proximity led to improved psychological well-being, as it reduces the effort and time required to access nature. They reported higher levels of psychological health which were examined on the Likert scale. The analysis revealed that all three indicators positively and statistically significantly influenced psychological well-being. This implies that a more frequent visiting routine, longer hours spent in green spaces, and shorter distances from urban green spaces were associated with higher levels of psychological well-being. Visiting routine contributes positively by reflecting 0.630, spending hours by reflecting 0.782, and distance by reflecting 0.713. In this way, the total effect of urban green spaces is positive (beta = 0.717, at $p < 0.000$) with an R^2 of 0.514) and statistically significant on psychological well-being. The structural model demonstrates a significant and positive relationship between urban green spaces and residents' psychological well-being in Lahore. These findings indicate that urban green spaces play a crucial and beneficial role in enhancing the psychological well-being of the residents in the city.

To mitigate sampling bias, the study employs random sampling techniques to ensure a more representative and diverse participant pool. This approach enhanced the external validity of the findings. Similarly, to address omitted variable bias, the study conducted more extensive literature reviews and included a broader set of control variables in the analysis. This helped account for potential confounding factors that may influence both green space exposure and well-being.

Discussion

Human psychology is positively associated with the interaction of urban green infrastructure. The residents of the study area who interact with urban green landscapes are frequently found psychologically stronger, as Southon et al. (2018) analyzed that connectivity with nature and green landscapes affects human psychological well-being positively. However, the green spaces with the maximum number of trees were found more beneficial in enhancing psychological well-being (Southon et al. 2018). In this study, the residents of Lahore were found to be highly beneficial to the interaction of urban green spaces. Almost similar results were found in a study which was conducted in four cities in New Zealand (Auckland and Willington) and Australia (Melbourne and Sydney), where it was evaluated that the nearness of green spaces to one's home or place of employment provides advantages. Residents in urban areas experience stress, but when green spaces or naturally green landscapes are close by and they spend as much time there as possible, they feel better and more at ease. In Sydney, it was discovered that green areas had a more favorable relationship with psychological well-being (Taylor et al. 2018). The results of these studies support the findings of the current study, and the same results were achieved (in Figs. 3, 4, and 5). It has resulted that the closeness of green spaces boosts the office working ability and leaves positive impacts on human psychology as White et al. (2017) recommended urban greenery is crucial to restoring human psychological health (White et al. 2017). Similarly, the study found that a higher level of interaction of urban green spaces in Lahore caused higher psychological well-being among the respondents.

The study area is a highly populated area with the second-highest population in the country, where urban green areas have been discovered to considerably affect human psychological well-being. The result is also supported by the studies of Scopelliti et al. (2016) and Jennings and Bamkole (2019). They recommended that UGSs are essential to psychological health in thickly populated urban land; however, the significance level may differ. Urban green spaces promote enhanced psychological well-being (Jennings & Bamkole 2019). In various parts of the world, it has been analyzed that urban green spaces help the restoration of human psychology, which endorses the present study results. It has been noted that awareness of a green environment is favorably correlated with psychological recovery in Rennes, France (Meyer-Grandbastien et al. 2020). The findings of the study indicate a positive relationship between urban vegetation and human psychological well-being (Schebella et al. 2019). Similarly, research on four separate, well-kept public parks in Delhi found that 68% of visitors visit for a positive effect on human psychological well-being (Paul & Nagendra 2017). The current study and numerous studies conducted in India have established the highly significant role of urban green spaces in promoting human psychological well-being. These findings not only reinforce the recommendations but also endorse the importance of UGSs in improving the psychological well-being of individuals (Paul & Nagendra 2017), France (Meyer-Grandbastien et al. 2020), New Zealand and Australia (Taylor et al. 2018), and

Pakistan (Jabbar and Yusoff 2022b). As such, the study findings are also found in alignment with the studies cited in this paragraph.

Recent research, as demonstrated by Van den Bosch and Sang (2017), has shown that green spaces, particularly those incorporating natural elements, substantially reduce stress and restore well-being, leading to improved mental health (Van den Bosch and Sang 2017). Additionally, it has been found that spending time in urban green spaces is associated with improved mood, decreased negative emotions, and increased positive affect. Campagnaro et al. (2020) discovered that exposure to urban green spaces is also linked to lower depressive symptoms, with specific benefits observed among women and older adults (Campagnaro et al. 2020). Moreover, Dadvand et al. (2019) demonstrated that individuals residing in areas with more green spaces experience better cognitive development in children, including enhanced attention and working memory (Dadvand et al. 2019). Roe et al. (2017) further supported these findings by indicating that engaging in physical activities within urban green spaces promotes attention restoration and cognitive advantages, such as improved executive function and attentional control (Hanif et al. 2022). These recent references highlight the beneficial effects of urban green spaces on human psychological well-being. These effects encompass various aspects such as stress reduction, mood enhancement, cognitive function improvement, and social interaction facilitation (Roe et al. 2017).

Furthermore, it has been discovered that individuals who had access to urban green spaces reported lower stress levels and exhibited reduced symptoms of anxiety and depression (Shanahan et al. 2016). Similarly, it has been recommended that spending 90 min walking in natural environments significantly decreased rumination, a repetitive negative thinking pattern, compared to walking in urban settings (Bratman et al. 2019). Berman et al. (2008) demonstrated that exposure to nature, including urban green spaces, can enhance cognitive function, attention, and memory performance. Moreover, a systematic review indicated that spending time in natural environments, such as urban parks, positively influenced cognitive health, including attention restoration and improved academic performance in children (Twohig-Bennett & Jones 2018). These studies collectively highlight the significance of green spaces in promoting psychological well-being.

Limitations of the study

The limitations of the study include potential biases due to a simple random sampling technique with a sample size of 1050 residents in Lahore, impacting the overall generalizability. Self-reported data collection poses a risk of social desirability bias, as respondents may provide socially acceptable answers rather than answers which reflect genuine, personal experiences. The cross-sectional design restricts establishing causation or inferring directionality in the relationship. While established scales were used, inherent limitations may exist in fully capturing residents' nuanced experiences and opinions. The study's focus on Lahore suggests limited generalizability to diverse cultural or geographic contexts, acknowledging variations in urban green spaces' impact on psychological well-being. Recognizing these limitations enhances transparency, aiding readers and future researchers in interpreting findings within the study's constraints.

Conclusion and suggestions

In conclusion, it can determine that the significance of urban green spaces for human psychological well-being is highly prominent. Green spaces offer avenues for restoring human psychology and feelings, enhancing mental strength and working efficiency. Furthermore, urban green spaces recover human psychological well-being by relieving mental anxiety and reviving human attention. A positive association between human psychology and urban green spaces exist but is not a comprehensive fix for all psychological problems. However, green spaces' interaction may work similarly to medication and improve human psychology by boosting attention. Green spaces may work as a safety net against depression and other psychological illnesses. Thus, human psychological issues can be reduced by increasing interaction with nature, and green spaces are one of the most significant sources of interaction with nature in urban areas. Therefore, the urban planner suggests the role of urban green spaces for psychological well-being as well as the resident's awareness of the benefits of urban greenness for psychological well-being. In developing countries like Pakistan, the younger generation may display a greater presence of psychological problems due to the less availability of, and interaction with green spaces. Moreover, the availability of green spaces is necessary to maintain human psychological well-being with easy access. More research is required in this field to understand how urban green areas affect people's psychological health. The novelty of this study stems from its holistic and methodologically rigorous approach to investigating the intricate relationship between urban green spaces and human psychological well-being. By employing advanced quantitative modeling techniques, such as structural equation modeling, the study transcends traditional observational methods, adding a layer of precision and depth to the analysis. One key aspect of novelty lies in the systematic incorporation of various factors that contribute to the relationship between urban green spaces and psychological well-being. For instance, the study takes into account the proximity of green spaces to residential areas, recognizing that the spatial distribution of these spaces may play a crucial role in influencing residents' well-being.

This nuanced exploration enables a more comprehensive understanding of how different elements interconnect and impact the overall psychological well-being of individuals in urban settings.

Finally, upon examining such data and considerations on the role of urban green spaces in promoting human well-being, several recommendations can be made. First, leaders should take adequate measures to ensure there is equitable access to urban green spaces, particularly in underserved communities. This provides equal opportunities for all individuals to benefit from the positive effects of UGSs on well-being. Next urban planning and development professionals in particular should prioritize the preservation and enhancement of current green spaces. They should promote and incentivize physical activity within urban green spaces to enhance both physical and mental health. Furthermore, leaders and experts should conduct public awareness campaigns to educate the public about the significance of urban green spaces for well-being. Such campaigns highlight the mental health benefits and encourage responsible use and conservation of these spaces. In conjunction, green spaces should also be utilized as community gathering places to foster social interaction and community engagement. Incorporating nature into urban designs by integrating green roofs, vertical gardens, and pocket parks are excellent example of doing so. These various methods of raising awareness of and integrating urban green spaces into communities bring nature closer to people's daily lives, ultimately enhancing their well-being.

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Declarations

Competing interests The authors declare no competing interests.

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