Urban Green Spaces and Quality of Life Among Young Adults: Moderating Effects of Loneliness

Miguel Ortiz Diaz [1] , Asad Abbas [2*]

[1] *School of Architecture, Art and Design, Tecnologico de Monterrey, Monterrey, NL 64700, Mexico.*

[2] *Writing Lab, Institute for the Future of Education, Tecnologico de Monterrey, Monterrey, NL 64700, Mexico.*

Abstract

This research study aims to explore whether urban green spaces (UGS) correlate with the quality of life (QOL) and whether loneliness (LL) can influence this relationship among young adults in the Monterrey metropolitan area of Mexico. The study employed quantitative methods, using both online and paper surveys in Spanish and English to collect 182 valid responses, which were analyzed through statistical techniques such as reliability, validity, correlation, and moderation analysis. The results indicated that UGS are significantly and positively related to QOL (β=0.20, p≤0.01). Furthermore, the study found that LL has a significant negative related to QOL (β=-0.09, p≤0.05). Results also demonstrate a significant negative moderation effect of LL on UGS and QOL (β=-0.13, p≤0.05). With the findings, we propose that urban planners and policymakers prioritize developing and maintaining UGS to enhance citizens' QOL. Furthermore, efforts should be made to reduce LL by involving citizens in community participation to increase a sense of community and place attachment. This study offers new insights into the relationship between UGS, LL, and QOL, highlighting the significance of social connections in maximizing the benefits of green spaces on quality of life.

Keywords: Urban Green Spaces; Urbanization; Urban Policy; Social Interaction; Mental Health; Educational Innovation; Higher Education.

1. Introduction

The world's population reached 8.0 billion in 2022 [1], with 56% residing in urban settlements. This trend is expected to continue, with an estimated doubling by 2050, when 7 out of 10 people are expected to live in urban areas [2]. This research, like the work of Elmqvist et al. [3], considers urbanization a multidimensional process that manifests rapidly changing human populations and land cover. Work opportunities and leisure comprise essential patterns for understanding urban development in cities because of their variety, eventfulness, the possibility of choice, and stimulation [4]. However, these patterns have complex dynamics, including traffic jams, pollution, health impacts, diseases, crime, inequality, and informal settlements. Still, cities remain attractive to people despite these downsides [5]. In 2015, the United Nations published seventeen Sustainable Development Goals (SDGs) to address the adverse effects of urban growth, calling for collective efforts to create an inclusive, sustainable, and resilient future for people and the planet [6]. SDG-11, "*Sustainable cities and communities*," aims to make cities more "inclusive," "safe," "resilient," and "sustainable." Latin America's urban transition relies on diverse metropolitan and regional development plans that expand public policies and urban planning tools to support sustainable growth. However, these development plans are generally not integrated [7]. In Mexico, urban development has continued to expand since

1950, when only 49% of the population resided in urban areas. By the 1990s, this percentage had risen to 71%, and the latest reports from 2020 indicated that 79% of the population lived in urban areas [8]. Thus, Mexico's National Plan focuses on improving city conditions through several objectives and actions. The Urban Improvement and Housing Program (Programa de mejoramiento urbano y Vivienda) aims to bridge the gaps between high-luxury areas and exclusive urban developments with marginalized neighborhoods through rehabilitation and improvement projects for public spaces [9]. Moreover, Article 115 of Mexico's Constitution establishes that municipalities are primarily responsible for urban development [10]. As a result of the decentralization policies, direct community involvement in planning and development programs has become a central concern at the local level for achieving both national and global urban goals. At the local level, community participation most effectively contributes to improving the overall quality of life (QOL) in urban areas [11]. One notable example of community participation in the Global South is the 2001 initiative by the World Bank, which adopted a community-based poverty reduction strategy to enhance the quality of life in impoverished communities. The initiative aimed to build the capacity of communities to develop and maintain microprojects that would identify problems and propose and implement sustainable solutions. At the end of the initiative, significant improvements in the quality of life were evident, as reflected in the increased number of educational and healthcare facilities [12].

Despite ongoing efforts to improve urban development, current urbanization practices, driven by the prioritization of land value, have led governments to reduce further the quantity and size of urban green spaces (UGS), progressively deepening the disconnection between people and the natural environment [13, 14]. Moreover, UGS also faces serious issues of inequitable distribution, which disproportionately affect marginalized communities and limit their access to social and environmental benefits [15]. Previous research has revealed that some of the predominant benefits of UGS, besides physical and mental health benefits [16], are community participation, place attachment, and a sense of community [17, 18]; those with strong correlations are social constructs that develop through social interactions [19-21]. However, the decline or lack of UGS means that social interactions and entertainment occur through social media [22]. In this context, Hatamleh [23] noted that young adults often feel obligated to sustain their social connections through platforms like Facebook and Twitter. This practice can inadvertently weaken the depth and authenticity of those relationships. Supporting this conclusion, several studies have indicated that an increased dependence on social media is associated with a decline in face-to-face interactions, particularly in urban environments where social infrastructure is already under pressure, negatively impacting overall QOL [24, 25].

One of the central challenges to fostering QOL in such contexts is the growing prevalence of loneliness (LL), which disproportionately affects adolescents and adults in urban areas [26, 27]. This issue becomes even more concerning when estimates suggest that nearly one-third of individuals in industrialized cities report feeling lonely, with one in twelve experiencing loneliness at a clinically significant level [28]. Loneliness emerged as a growing concern during the early stages of the COVID-19 pandemic and was identified as part of a broader behavioral epidemic [29]. The global disruption during COVID-19 exposed the fragility of social bonds, as the widespread reduction in in-person interactions intensified psychological stress and feelings of loneliness, even in contexts where the direct health impacts of the pandemic were relatively limited [30, 31].

This study examined the growing concern about LL and its impact on social interactions. Specifically, we aimed to explore how this issue reshapes urban green spaces (UGS) and influences the overall QOL among young adults. Our primary objective was to provide new insights into LL and its attenuation among adults, specifically examining the correlation between urban green spaces and quality of life. We focused our investigation on the Monterrey, Mexico metropolitan area. This city has experienced rapid urban growth over the past three decades, driven by its economic development and industrial activity. The city's size increased by 2.6 times from 1990 to 2019, while the population grew 1.8 times, from 2.6 million to approximately 4.8 million in 2019, resulting in a decrease in population density by more than 30% per hectare [32]. To achieve the study's objective, we conducted an online and paper-pencil survey among adults living in the metropolitan area of Monterrey; after data collection, we statistically analyzed the data and concluded the study.

This paper is structured as follows: The next section presents the theoretical background, conceptual framework, and development of hypotheses, which describe findings from key literature on UGS, LL, and QOL. It thoroughly presents the conceptual framework and hypotheses to demonstrate the moderating role of loneliness in the relationship between green spaces and quality of life. The Methodology section covers research design, data collection procedures, instruments, and statistical analyses. The Results section presents statistical findings, including demographic characteristics, reliability, validity, correlation matrix, and moderation effects. The Discussion section interprets the findings, supported by state-of-the-art literature. Finally, the paper outlines the research's theoretical contributions and practical implications, addresses the study's limitations, suggests future research directions, and states the study's findings in the Conclusion section.

2. Theoretical Background, Conceptual Framework, and Hypotheses Development

2.1. Theoretical Background

The Evolutionary Theory of Loneliness (ETL), developed by Cacioppo & Cacioppo [33], conceptualizes loneliness as an evolved biological alarm system that alerts individuals to threats to their need for social connections, which is fundamental to survival in social species. According to ETL, the absence or perceived lack of supportive social relationships triggers loneliness, activating behavioral and neurobiological responses such as heightened vigilance and stress that promote self-preservation, often through unconscious processes and with long-term consequences for health and quality of life. In urban contexts, this framework helps explain why individuals may feel lonely even when surrounded by others. UGS is widely acknowledged for improving mental health and quality of life (QOL), partly by fostering social interactions [34]. However, from the ETL perspective, loneliness may alter how individuals engage with UGS. For instance, the Implicit Vigilance Postulate suggests that lonely individuals may perceive green spaces, especially unfamiliar or crowded ones, as unsafe, thereby limiting their potential benefits, such as fostering community participation or place attachment. Additionally, the Repair Postulate posits that loneliness may drive efforts to reconnect to social roles that UGS could support. However, chronic loneliness, as described by the Selfishness Postulate, may instead foster avoidance or self-protective behaviors that undermine these restorative opportunities. Thus, ETL provides a valuable lens for examining loneliness as both an outcome and a moderator in the relationship between UGS and QOL, potentially weakening or reshaping the positive effects typically associated with access to UGS.

2.2. Urban Green Spaces

Urban areas continue to expand with no pause in the stages of transformation. New UGS are needed due to these transformations and climate change. UGS are areas within the urban environment that offer greenery, such as grass, trees, and shrubs, in public or private parks and greenways. These spaces provide numerous benefits to the environment and society, including serving as meeting and gathering points and providing significant cooling [35, 36]. However, urbanization's varied spatiality produces challenges that correlate with historical and ecological factors [37]. Urban sprawl and densification are the main spatial detriments of urbanization. Habibi & Asadi [38] note that urban sprawl arises from a lack of centralized planning, leading to unrestricted development expansion and the exponential growth of low-density residential and commercial settlements, as well as the dominance of transportation by private automotive vehicles. Thus, urban sprawl destroys and fragments natural or semi-natural vegetation on the outskirts of cities, preserving or increasing the spatial disparities between rural and urban areas [39, 40]. Geographical information system simulations demonstrate that these patterns do not adequately distribute UGS in the intermediate areas of a city [41]. In contrast, urban densification aims for high-density housing, mixed-use spaces, efficient public transportation, and encourages cycling and walking. However, a key concern is the insufficient availability of UGS in these areas and the loss of green space during city densification [39].

UGS are essential in improving the quality of life in cities. Housing and infrastructure close to UGS (e.g., public transportation systems and healthcare facilities) increase the benefits to adults, facilitating physical activities, recreation, and social interactions. They improve air quality and humidity, mitigating climate change by reducing air temperature and serving as controls during floods and hurricanes in urban areas [37, 42, 43]. Nevertheless, it is essential to recognize that ongoing urban development will continue to present challenges. Urban and landscape planners must prioritize green spaces in their development plans to enhance the quality of life in urban areas.

2.3. Loneliness

Developing suitable urban green spaces to improve social interactions yields various advantages in urban development and should be prioritized. In the book "*Life Between Buildings,*" Gehl [44] argues the importance of well-designed spaces for people and social interactions. Additionally, studies have examined how the frequency of public space usage affects the connection between public spaces and a sense of community [45]. The latter can enhance face-to-face interactions and community participation in urban development. Improving the shared emotional connections helps maintain a sense of community and facilitates problem-solving processes [17, 46]. Acknowledging the harmful effects of urbanization is imperative, as traffic congestion, air pollution, and urban sprawl pose significant challenges to urban planning [47]. The American urban planner Lynch [48], in the 1996 book "*The Image of the City*," argued the importance of a semiotic approach to assessing a city. He emphasized that cities' denominations, such as streets, buildings, and walls, can be real or perceived. These "edges," plus the housing and mobility problems in contemporary cities, create difficult-to-access and isolated areas. The socio-spatial tendencies of the area are associated with residential living and a high risk of loneliness (LL) among young adults, where social isolation occurs due to their weak links with the community, friends, and family [49].

Another factor in the increase in LL is the nature of social relationships [50]. As a subjective issue, some researchers have found contradictions in different perspectives and typologies, such as social LL, which refers to connectedness with a small number of people in one's social network, and emotional LL, resulting from a lack of understanding and association in relationships [25].

In the last few years, the situation has worsened due to the impact of the COVID-19 pandemic. According to Bonsaksen et al. [25], higher levels of LL were observed in mixed population subsets during the COVID-19 pandemic. Furthermore, LL was considered a significant mental health issue during that time. Lim et al. [50] and Twenge et al. [51] highlighted that some studies found that the probability of early mortality associated with LL was 26% among adults, and also a significant risk factor for depression. Furthermore, Khalaf et al. [52] reported that social media could generate mental health problems, increasing the risks of self-harm, loneliness, and loss of empathy. Urban policymakers aware of the city's conditions should prioritize the design and creation of new social interaction spaces (e.g., urban green spaces). Efforts should focus on community-based solutions, with community cooperation to create local opportunities, leisure activities, and mental health support for people of all ages by sharing ideas and identifying and mobilizing existing community resources [53].

2.4. Quality of Life

In the contemporary urbanized world, cities must have adaptive capacities to adjust urban plans [54]. As urbanization increases worldwide, a diverse range of transformations in cities and green spaces plays a role in maintaining and enhancing the public's general health, increasing citizen happiness, and providing services that mitigate the effects of climate change [55, 56]. Planners must consider the two dimensions of QOL, as argued by Das [57], namely objective and subjective. The subjective dimension refers to an individual's perceived well-being, primarily based on their satisfaction with their contextual environment. The objective dimension focuses on managing external life conditions, such as mitigating high summer temperatures and improving air quality [58, 59]. An individual's QOL must depend on both objective and subjective dimensions [60]. LL increased during and after the pandemic due to its impact on interpersonal and community interactions, as well as reduced personal social interactions among adults. Some authors have also pointed to social media use as a factor contributing to a decrease in in-person social interactions, which affects the QOL of urban citizens [61, 62]. Consequently, the better quality of life associated with urban green spaces can attenuate LL.

2.5. The Moderating Role of Loneliness on Urban Green Spaces and Quality of Life

LL plays a significant role in moderating the relationship between UGS and QOL among adults due to associated parameters. For instance, Shankar et al. [63] found correlations between loneliness and poorer well-being. Although studies have found that visits to urban green spaces are associated with better mental health, the different urban patterns can directly and indirectly influence the assessment [64] (See Figure 1).

Hypotheses

H1: UGS have a significant relationship with QOL.

H2: LL has a significant negative relationship with QOL.

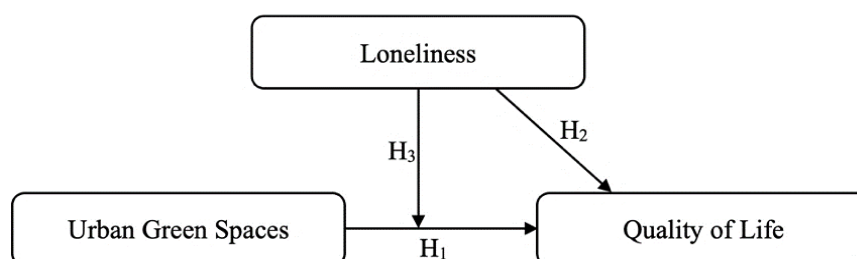*H3:* LL negatively moderates the relationship between UGS and QOL

Figure 1. Proposed conceptual framework for the hypotheses

3. Materials and Methods

3.1. Flowchart of Research Methodology

Figure 2 illustrates the flowchart of materials and methods utilized to achieve the research objectives of this empirical study. The research process begins with brainstorming, based on a review of the literature, and ends with implications and a conclusion.
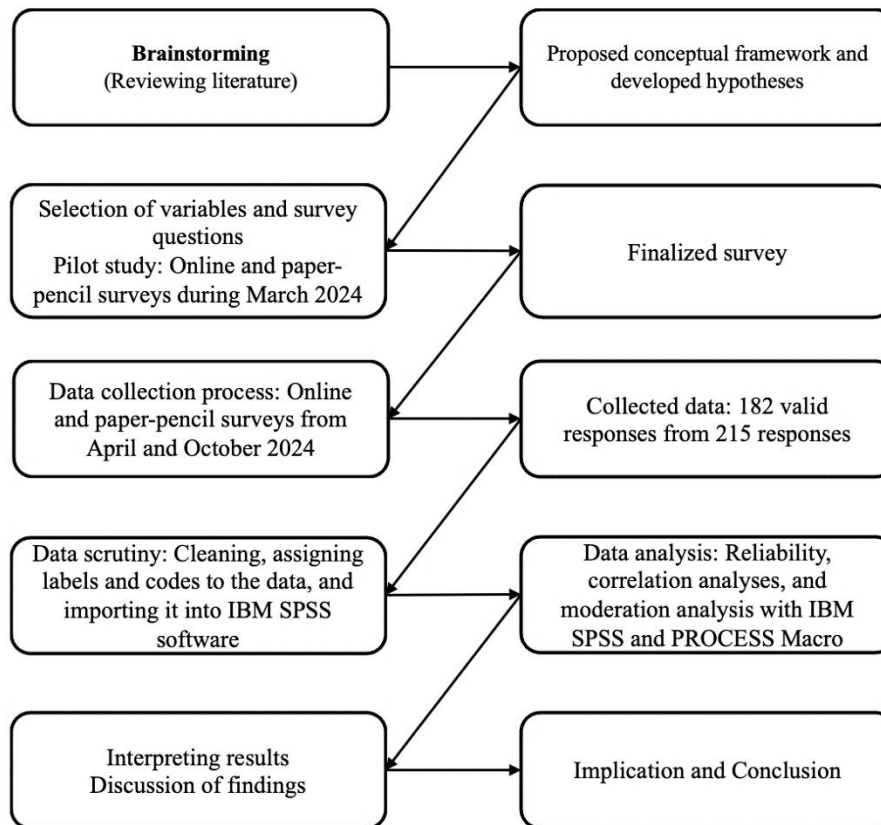
Figure 2. Flowchart of the research methodology

3.2. Data Collection Procedure

This project was part of a research stay at a leading private university in Nuevo Leon, Mexico. In late February 2024, the research began with establishing the research hypothesis and the structure of the dependent and moderating variables. To collect data from adults, we designed online and paper-pencil surveys. The surveys were provided in English and Spanish because the research instructions were in English, and the students were native Spanish speakers. According to the university's research guidelines, all participants were required to provide informed consent. The consent statements explained confidentiality for both types of surveys, emphasizing the privacy and security of individual respondents. All participating students were anonymous, volunteer respondents. In April and October 2024, we distributed a Google Forms online survey via WhatsApp to voluntary students enrolled at Tecnologico de Monterrey (TEC) and Universidad Autonoma de Nuevo Leon (UANL). We also conducted a paper-pencil survey with students in the Monterrey Metropolitan Area, receiving 215 responses, of which 182 were deemed valid for the research analysis.

3.3. Pilot Survey

The initial data collection was conducted through a pilot study involving a single group. To begin, the supervisor reviewed the survey and approved the layout and survey questions. Subsequently, we verified the survey's layout, reliability, and readability. In the first week of March 2024, we distributed twenty bilingual surveys to the target group, comprising university students enrolled in Tecnologico de Monterrey (TEC) and Universidad Autonoma de Nuevo Leon (UANL). These surveys conformed to the research instructions and were provided in both Spanish and English. We explicitly asked the students to complete the online and paper-pencil surveys voluntarily. The pilot study was segmented into five sections: confidentiality notes, demographic information, LL, UGS, and QOL. It is important to note that we did not include the data from the initial survey in the study's final analysis.

3.4. Instruments

- *Control variables and confidentiality note*

The first part contained a confidentiality notice and requested volunteer participation. We added this section to ensure that participants were aware of the research survey process. The second section included information on control variables. It asked participants for their demographic information (i.e., age, gender, marital status, housing accompaniment, qualification, and municipality where they lived). It also requested information about the university where they studied, their economic family support (per month), and their favorite type of green space (i.e., public, private, or both).

- *Urban green spaces*

The second section adapted the work of Conedera et al. [65] and consisted of six items related to urban green spaces. The adaptation asked about their favorite green space in the Monterrey Metropolitan Area and the municipality where it is located. (The Monterrey metropolitan area comprises several municipal governments.) It asked for the degree of agreement with statements containing green space factors, such as getting away from distractions, extent, fascination, and compatibility (e.g., Do you feel free from daily responsibilities, problems, and routine? Can you easily adapt to this place?).

- *Loneliness*

The loneliness section adapted the work of Wang et al. [66]. The scale comprised eleven items measuring the absence of confidence in social relations and the degree of a social network (e.g., "I often feel rejected," "There is always someone I can talk to about my day-to-day problems").

- *Quality of life*

The fourth section adapted eight items about the quality of life from the work of Das [57], asking the participants how satisfied they were with their lives to measure their satisfaction with their physical, economic, and social environments (e.g., satisfaction with their financial condition, conditions of housing, and availability of parks and green areas).

3.5. Data Scrutiny and Statistical Analysis

After completing the data collection process, we downloaded the online data from Google Forms into an Excel file (CSV format). We reviewed the paper-pencil surveys individually to ensure they were correctly completed, and we removed any incomplete or biased responses from the study. After that, we manually entered the survey data into the Excel file. Next, we assigned a code to each response, converting them from text to numbers, and then imported the Excel data file into the IBM SPSS file format (.csv file) for the final analysis.

Once the data were imported into IBM SPSS, we performed demographic analyses. We used descriptive statistics (frequencies) to summarize the survey data, providing a comprehensive overview of the participants' demographic characteristics and responses. We also conducted reliability analyses of each variable to determine their correlations. The correlation analyses aimed to find a linear approximation of the results. Finally, we used PROCESS Macro version 4.0 in IBM SPSS to conduct a moderation analysis to determine the research results.

4. Results

4.1. Demographic Information

We sent the online and paper-pencil surveys to 235 young adults. Of the 215 responses, 33 were excluded due to bias or incompletion, leaving 182 (84.6%) usable responses. Eighty survey participants were male 80 (43.9%), and 102 (56%) were female. Ninety-seven (53.8%) were aged 20 years and under, 67 (36.8%) were 20 to 24 years, and the remaining 18 (9.9%) were older than 24. Seventeen (9.3%) held high school diplomas, 127 (69.7%) were university undergraduates, and 38 (20.9%) were postgraduates. Twenty respondents (11%) lived alone, 69 (37.9%) lived with a roommate, and 93 (51.1%) lived with family (see Table 1).

Table 1. Demographic information

Variables	Number	Percentage
Gender		
Male	80	43.9%
Female	102	56%
Age		
20 years and below	97	53.8%
21 to 24 years	67	36.8%
25 years and above	18	9.9%
Academic qualifications		
High school	17	9.3%
University undergraduates	127	69.7%
Postgraduates	38	20.9%
Household composition		
Lived alone	20	11%
Lived with a roommate	69	37.9%
Lived with family	93	51.1%

4.2. Reliability and Validity

Before the formal analysis, we verified the reliability of the information. In the LL section, the reliability resulted in an α (Cronbach's alpha) of 0.93. According to Cronbach [67], a valid reliability for α is greater than 0.7; thus, there was internal consistency regarding the interrelatedness of the sample test items. The UGS also scored high in validity with Cronbach's alpha (α) of .91, considered sufficiently reliable for further analysis. The Cronbach's α for the QOL section was .83. Therefore, the scales used to measure variables in the research model were confirmed as valid and reliable for testing the hypotheses (see Table 2).

Table 2. Reliability

Instrument	Cronbach's Alpha (α)	Reliability Range [67]
Loneliness (LL)	0.93	> 0.7
Urban Green Spaces (UGS)	0.91	> 0.7
Quality of Life (QOL)	0.83	> 0.7

We also performed confirmatory factor analysis to assess the discriminant validity of the measurement model. Results showed that the three-factors hypothesized model fit the data (χ^2 = 165.77, df = 116, comparative fit index (CFI) = 0.97, and root mean square error of approximation (RMSEA) = 0.05) better than an alternative single factor model in which all constructs were added to single factor (χ^2 = 1174.37, df = 119, CFI = 0.39, and RMSEA = 0.22). These findings provide evidence of discriminant validity and suggest that our data was not affected by common method bias.

4.3. Correlation Matrix

Correlation coefficients describe the linear relationship between two quantitative variables. We required an approximately linear relationship based on the form, direction, and variation of the variables. Pearson's correlation coefficient r describes the strength and direction of an association between two variables [68]. The results show that the Pearson's correlation coefficient r=-0.71 for LL correlated with urban green spaces. The quality of life was found to be more significant than loneliness (LL) in relation to urban green spaces, as indicated by a Pearson's correlation coefficient of r=0.26. Additionally, the results of the QOL correlation with LL yielded a Pearson's correlation coefficient of r=-0.20 (see Table 3).

Table 3. Correlation matrix

	Urban green spaces (UGS)	Loneliness (LL)	Quality of life (QOL)
Urban green spaces (UGS)	**0.91**	---	---
Loneliness (LL)	-0.71*	**0.93**	---
Quality of life (QOL)	0.26**	-0.20**	**0.83**

Note: Level of significance *p<0.05; **p<0.01; Note: Cronbach's alpha diagonal cells (**bold**)

4.4. Moderation Effects

Hypothesis H1 proposed that UGS have a statistically significant relationship with QOL. Accordingly, the results show that UGS significantly affected QOL (β=0.20, p≤0.01). These results support H1. H2 suggested that LL has a significant negative relationship with QOL. Results indicated that LL significantly influenced QOL (β=-0.09, p≤0.05). Thus, the results support H2.

A moderation test was conducted with UGS as the predictor, QOL as the dependent variable, and LL as the moderator. As predicted, results demonstrate a negative significant interaction effect of LL and UGS on QOL (β=-0.13, p≤0.05), providing support for H3 (see Table 4).

Table 4. Results of moderation analysis

Outcome variable	Quality of life (QOL)			
	β	SE	t	*p*
Urban green spaces (UGS)	0.20	0.07	2.98	0.00
Loneliness (LL)	-0.09	0.04	-2.03	0.04
Interaction	-0.13	0.06	-2.10	0.04

Note: Level of significance *p≤0.05; **p<0.01; ***p≤0.001

Note: Interaction = Urban green spaces (UGS) × Loneliness (LL)

To further validate the moderation effect, we performed a simple slope analysis. Figure 3 demonstrates the interaction effect. The slope analysis reveals that at a high level (one standard deviation above the mean) of LL, the effect of UGS on QOL becomes insignificant ($\beta=0.05$, SE = ns). Compared with a high level of LL, the effect of UGS on QOL becomes strongly positive at the mean level of LL [($\beta=0.20$, SE=0.07, $p\leq0.05$], and at the low level of LL (one standard deviation below the mean) [($\beta=0.34$, SE = 0.09, $p\leq0.001$]. These results further support Hypothesis 3.
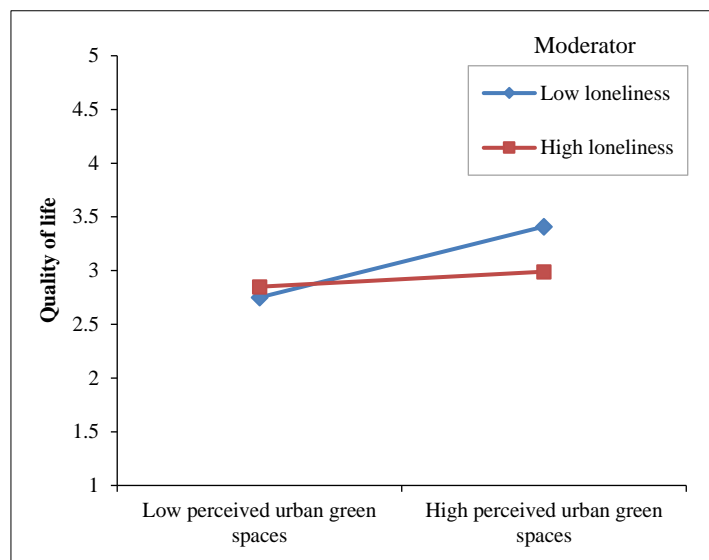

Figure 3. Results of slope analysis

5. Discussion

The objective of this empirical study was to investigate the moderating role of LL on UGS and QOL among young adults. We developed a theoretical research model and proposed hypotheses to achieve this objective. Furthermore, this paper presents statistical results analyzed in conjunction with the support of published literature.

This study confirms that UGS significantly correlates with perceived QOL. Previous studies found significant and positive relationships [69] and argued that increases in greenness could substantially improve the lives of urban citizens. Moreover, Budruk et al. [19] suggested that a strong connection to green spaces is linked to better mental health and overall well-being. This connection in adults' daily lives is usually developed through regularly experiencing positive and healthy interactions with green spaces. Therefore, the circumstances in which adults are raised and the surroundings in which they live and interact are significant factors in forming this attachment. Regarding environmental and spatial features, Akpinar [70] found that the most essential factor in urban green spaces is the proximity of the home to green space. In addition, Zhang et al. [71] highlighted that neighborhoods with higher-quality green spaces did not provide more beneficial affordances to health, quality of life, recreation, and social interactions. The perceived quality of UGS was more closely related to the proximity and usability of the green space, rather than its quantity.

This study found a significant negative relation between LL and QOL among young adults. This finding aligns with existing literature highlighting the detrimental impact of LL on QOL. However, much of the existing literature, as emphasized by Bartlett et al. [72] and Terkelsen et al. [73], highlights the impact of LL on QOL in adults, focusing on factors such as declining mobility, retirement, and the loss of close relationships. As a result, Li et al. [74] mention that QOL appears to be more significantly affected by loneliness in older populations compared to younger adults. Our findings draw attention to a growing concern among younger adults, where there is comparatively less focus. This may be due to generational assumptions that younger adults are more socially connected and where relational support from friends and family plays a key role in alleviating feelings of loneliness [75]. However, traditional ideals of adulthood, such as stable employment, long-term relationships, and parenthood, are increasingly delayed, contributing to uncertainty in social roles and a diminished sense of belonging [76]. This prolonged phase of emerging adulthood can increase vulnerability to loneliness, which in turn undermines emotional well-being and overall quality of life [77]. Given that approximately 75% of all mental health conditions emerge before the age of 24 [78], addressing loneliness at this life stage is crucial not only to enhance present QOL but also to prevent longer-term mental health consequences.

The results confirmed the hypothesis about the negative moderating role of loneliness between UGS and QOL. Only a few studies have looked into the impact of LL on UGS and QOL using the same approach. LL is often

accompanied by impairments in vision, hearing, and mobility, which affect social connectedness, limiting the ability to feel comfortable driving, walking, or engaging in conversations [79]. This informs us about the importance that LL can represent in this relationship. For example, Bergefurt et al. [80] studied the correlations between urbanization features, such as mobility and social neighborhood, and their influence on public space use, life satisfaction, and LL. The findings indicated that a lack of social connectedness is associated with a decrease in the frequency of visits to green spaces. Additionally, a correlation was found between loneliness and life satisfaction, suggesting that individuals who feel lonely tend to be less satisfied with their lives.

In addition, van den van den Berg et al. [81] indicated that UGS do not directly facilitate social contact, but they do enhance the sense of community by fostering feelings of trust, acceptance, and a sense of belonging. According to Jones & Comfort [82], the connection between a place and a sense of community cannot be established quickly because it takes time to develop emotional and mental health associations. Additionally, Cacioppo & Cacioppo [33] mention that LL operates primarily through nonconscious processes and functions as an aversive biological signal rather than a rational behavior. There is no straightforward way to design environments that directly mitigate LL. However, Cardinali et al. [83] propose the PRIGSHARE framework, which helps align UGS design with specific health outcomes by identifying dominant pathways such as restoration, instauration, and mitigation. While not focused on LL, the framework provides urban planners with spatial tools (e.g., vegetative assessments, isochrones, buffered service areas) to evaluate and design environments that may indirectly buffer the effects of loneliness through calm, accessible, and socially supportive settings. Similarly, proximity was found to be more critical than the availability of UGS in terms of QOL [59].

5.1. Theoretical Contribution and Practical Implication

This study expands the theoretical understanding of loneliness by positioning it as a psychological mechanism triggered by material and spatial urban conditions. Drawing on the Evolutionary Theory of Loneliness (ETL), it highlights how urbanization transformed cities during the Industrial Revolution, where access to public transportation was limited, fragmented, disconnected, or made difficult due to the scarcity of green spaces. This can reduce individuals' autonomy, safety, and opportunities for social interactions. Loneliness becomes both a result and a filter: it not only weakens the positive impact of UGS on QOL but also reshapes how individuals perceive and engage with their environments. These structural limitations can transform material barriers into psychological ones, leading to feelings of disconnection even in densely populated areas. This conceptualization reframes loneliness not solely as a mental health outcome but as a moderator of quality of life (QOL), which alters how individuals benefit from UGS, particularly in highly urbanized metropolitan contexts.

Improving the QOL through green infrastructure requires more than expanding green areas; it demands understanding who feels welcomed in these spaces and why others avoid them. While this study offers practical insights, future research should aim for broader and more diverse participation from neighborhoods to capture a wider range of experiences related to access, safety, and socio-economic conditions. This is particularly critical in fragmented metropolitan areas like Monterrey in Mexico, where disparities in public transportation, urban safety, and green space connectivity often limit usage. Policymakers must balance UGS expansion with pressing urban needs such as housing and mobility by prioritizing integration, not merely addition. UGS should be embedded within walkable, mixed-use areas, supported by reliable public transportation, and co-designed with communities to ensure they are safe, inclusive, and context-responsive. Municipal and state governments must begin treating mental health and loneliness as a fundamental lens for evaluating urban spaces. Digital platforms and social media, which are often mentioned as contributing to increased loneliness, can instead be strategically repurposed to coordinate community-led activities, promote the co-creation of green spaces, and engage populations typically excluded from formal participation processes.

5.2. Limitations and Future Directions

This research has limitations due to its scope and the nature of the study. The first limitation is due to the focus on young adults. Second, its geographical size and dense population make it the largest metropolitan city in Nuevo Leon, Mexico. Third, the research design relies on a quantitative survey. To extend this work, we propose possible future research directions to overcome the current limitations of this research. First, we will expand our scope to include K-12 students and older adults to gain more insights into loneliness and the roles of UGS and QOL. Furthermore, a comparative study should be conducted by considering other metropolitan cities in the state of Nuevo Leon or by comparing different states in Mexico. Finally, the avenue for expansion of this work is a future study to design a mixed-methods research approach to gather the opinions of individuals in the form of text and conduct text analysis to highlight the sentiments of the broader population. This will enhance our understanding of the role of LL and its impact on UGS and QOL across various social and age groups, as well as different patterns of cultural and urban differences.

6. Conclusion

Our findings provide a clearer understanding of the interconnectedness between UGS, LL, and QOL. Understanding related variables, such as urbanization and social interactions, facilitates comprehension and the identification of correlations. This study suggests that living in urban areas contributes significantly to QOL; this can help policymakers and city planners update and rethink the spatial features of urbanization and their impact on mental health, including LL, as a serious concern. Integrating community-building activities within green spaces to positively impact residents' QOL is vital. Prioritizing the expansion of urban green areas and their protection is crucial for enhancing adults' social and recreational needs and their responses to climate change. This study's statistical analysis concludes that LL negatively moderates individuals' perceptions of UGS and QOL. LL can be caused by urbanization and its negative spatial consequences (e.g., traffic jams, pollution, health issues, inequality, as well as a lack of green spaces). These create borders that prevent social interactions among citizens. Another cause is the decline in social interactions since the COVID-19 pandemic and the increase in social media usage.

7. Declarations

7.1. Author Contributions

Conceptualization, M.O.D. and A.A.; methodology, M.O.D.; software, M.O.D.; validation, M.O.D.; formal analysis, M.O.D.; investigation, M.O.D. and A.A.; resources, M.O.D.; data curation, M.O.D.; writing—original draft preparation, M.O.D.; writing—review and editing, A.A.; visualization, M.O.D.; supervision, A.A.; project administration, M.O.D. All authors have read and agreed to the published version of the manuscript.

7.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

7.3. Funding and Acknowledgments

7.4. Institutional Review Board Statement

All procedures performed in this study adhered to the ethical standards of the institution and the 1964 Declaration of Helsinki and its subsequent amendments, or comparable ethical standards.

7.5. Informed Consent Statement

All participants in the study provided informed consent.

7.6. Declaration of Competing Interest

The authors declare that there are no conflicts of interest concerning the publication of this manuscript. Furthermore, all ethical considerations, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

8. References

[1] Ritchie, H., Rodés-Guirao, L., Mathieu, E., Gerber, M., Ortiz-Ospina, E., Hasell, J., & Roser, M. (2023). Population growth. Our World in Data, Global Change Data Lab, University of Oxford, Oxford, United Kingdom. Available online: https://ourworldindata.org/population-growth?insight=the-rapid-progress-seen-in-many-countries-shows-an-end-to-poverty-is-possible#article-citation (accessed on August 2025).

[2] World Bank Group. (2015). Urban Development. World Bank Group, Washington, United States. Available online: https://www.worldbank.org/en/topic/urbandevelopment/overview#1 (accessed on August 2025).

[3] Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P. J., McDonald, R. I., Parnell, S., Schewenius, M., Sendstad, M., Seto, K. C., & Wilkinson, C. (2013). Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities. Springer, Dordrecht, Netherlands. doi:10.1007/978-94-007-7088-1.

[4] Milgram, S. (1970). The experience of living in cities. Science, 167(3924), 1461–1468. doi:10.1126/science.167.3924.1461.

[5] Rybski, D., & González, M. C. (2022). Cities as complex systems—Collection overview. PLoS One, 17(2), 262964. doi:10.1371/journal.pone.0262964.

[6] UNESA. (2015). the 17 Goals. Department of Economic and Social Affairs, Sustainable Development, United Nations, New York, united States. Available online: https://sdgs.un.org/goals (accessed on August 2025).

[7] Sette Whitaker Ferreira, J., Rojas, E., De Souza Carvalho, H. R., Rago Frignani, C., & Santi Lupo, L. (2020). Housing policies and the roles of local governments in Latin America: recent experiences. Environment and Urbanization, 32(2), 333–350. doi:10.1177/0956247820935699.

[8] Instituto Nacional de Estadística y Geografía (INEGI). (2023). Use statistics and geography to discover Mexico. Instituto Nacional de Estadística y Geografía (INEGI), Aguascalientes, Mexico. Available online: https://cuentame.inegi.org.mx/poblacion/rur_urb.aspx?tema=P (accessed on August 2025). (In Spanish).

[9] Diario Oficial de la Federación (DOF). (2023). Rules of Operation of the Urban Improvement Program for Fiscal Year 2024. Diario Oficial de la Federación (DOF), Cuauhtémoc, Mexico. Available online: https://www.dof.gob.mx/nota_detalle.php?codigo=5713381&fecha=30/12/2023 (accessed on August 2025). (In Spanish).

[10] Political Constitution of the United Mexican States. (2024). Chamber of Deputies of the H. Congress of the Union. Political Constitution of the United Mexican States, Santiago de Querétaro, Mexico. Available online: https://www.diputados.gob.mx/LeyesBiblio/pdf/CPEUM.pdf (accessed on August 2025). (In Spanish).

[11] Ismail, W. A. W., & Said, I. (2015). Integrating the Community in Urban Design and Planning of Public Spaces: A Review in Malaysian Cities. Procedia - Social and Behavioral Sciences, 168, 357–364. doi:10.1016/j.sbspro.2014.10.241.

[12] Muhammad, Z. (2016). Improving Quality of Life through Community-based Participatory Development in Nigeria: Explanatory Factors for Success and Failure. Procedia - Social and Behavioral Sciences, 222, 151–159. doi:10.1016/j.sbspro.2016.05.206.

[13] van Bommel, M. N. C., Derkzen, M. L., & Vaandrager, L. (2025). Greening for meaning: Sense of place in green citizen initiatives in the Netherlands. Wellbeing, Space and Society, 8(100240), 100240. doi:10.1016/j.wss.2025.100240.

[14] Hu, J., Zhang, F., Qiu, B., Zhang, X., Yu, Z., Mao, Y., Wang, C., & Zhang, J. (2024). Green-gray imbalance: Rapid urbanization reduces the probability of green space exposure in early 21st century China. Science of the Total Environment, 933(173168), 173168. doi:10.1016/j.scitotenv.2024.173168.

[15] Jamalishahni, T., Turrell, G., Foster, S., Davern, M., & Villanueva, K. (2023). Neighbourhood socio-economic disadvantage and loneliness: the contribution of green space quantity and quality. BMC Public Health, 23(1), 598. doi:10.1186/s12889-023-15433-0.

[16] Villeneuve, P. J., Gill, G. K., Cottagiri, S. A., Dales, R., Rainham, D., Ross, N. A., Dogan, H., Griffith, L. E., Raina, P., & Crouse, D. L. (2024). Does urban greenness reduce loneliness and social isolation among Canadians? A cross-sectional study of middle-aged and older adults of the Canadian Longitudinal Study on Aging (CLSA). Canadian Journal of Public Health, 115(2), 282–295. doi:10.17269/s41997-023-00841-x.

[17] Chavis, D. M., & Wandersman, A. (1990). Sense of community in the urban environment: A catalyst for participation and community development. American Journal of Community Psychology, 18(1), 55–81. doi:10.1007/BF00922689.

[18] Manzo, L. C., & Perkins, D. D. (2006). Finding common ground: The importance of place attachment to community participation and planning. Journal of Planning Literature, 20(4), 335–350. doi:10.1177/0885412205286160.

[19] Budruk, M., Thomas, H., & Tyrrell, T. (2009). Urban green spaces: A study of place attachment and environmental attitudes in India. Society & Natural Resources, 22(9), 824–839. doi:10.1080/08941920802628515.

[20] Dinnie, E., Brown, K. M., & Morris, S. (2013). Community, cooperation and conflict: Negotiating the social well-being benefits of urban greenspace experiences. Landscape and Urban Planning, 112(1), 1–9. doi:10.1016/j.landurbplan.2012.12.012.

[21] Li, J., Koohsari, M. J., Kaczynski, A. T., Tanimoto, R., Watanabe, R., Nakaya, T., Luo, Y., Zhao, J., Yasunaga, A., Oka, K., & Hanibuchi, T. (2025). The built environment and place attachment: Insights from Japanese cities. Preventive Medicine Reports, 50(102969), 102969. doi:10.1016/j.pmedr.2025.102969.

[22] Avalle, M., Di Marco, N., Etta, G., Sangiorgio, E., Alipour, S., Bonetti, A., Alvisi, L., Scala, A., Baronchelli, A., Cinelli, M., & Quattrociocchi, W. (2024). Persistent interaction patterns across social media platforms and over time. Nature, 628(8008), 582–589. doi:10.1038/s41586-024-07229-y.

[23] Hatamleh, I. H. M. (2024). Exploring the Multifaceted Influences of Social Media Motivation on Online Relationship Commitment among Young Adults in Jordan: An Empirical Study. Human Behavior and Emerging Technologies, 2024, 1–16. doi:10.1155/2024/2510500.

[24] Askarizad, R., & Safari, H. (2020). The influence of social interactions on the behavioral patterns of the people in urban spaces (case study: The pedestrian zone of Rasht Municipality Square, Iran). Cities, 101(102687), 102687. doi:10.1016/j.cities.2020.102687.

[25] Bonsaksen, T., Ruffolo, M., Price, D., Leung, J., Thygesen, H., Lamph, G., Kabelenga, I., & Geirdal, A. Ø. (2023). Associations between social media use and loneliness in a cross-national population: do motives for social media use matter? Health Psychology and Behavioral Medicine, 11(1), 2158089. doi:10.1080/21642850.2022.2158089.

[26] Sasaki, N., Tabuchi, T., Okubo, R., & Nishi, D. (2023). Association of living condition using urbanisation level and neighbourhood deprivation with loneliness and social isolation during COVID-19 pandemic: a cross-sectional study of the nationwide data in Japan. BMJ Public Health, 1(1), e000341. doi:10.1136/bmjph-2023-000341.

[27] Twenge, J. M., Haidt, J., Blake, A. B., McAllister, C., Lemon, H., & Le Roy, A. (2021). Worldwide increases in adolescent loneliness. Journal of Adolescence, 93(1), 257–269. doi:10.1016/j.adolescence.2021.06.006.

[28] Surkalim, D. L., Luo, M., Eres, R., Gebel, K., Van Buskirk, J., Bauman, A., & Ding, D. (2022). The prevalence of loneliness across 113 countries: Systematic review and meta-analysis. The BMJ, 376, 67068. doi:10.1136/bmj-2021-067068.

[29] Jeste, D. V., Lee, E. E., & Cacioppo, S. (2020). Battling the Modern Behavioral Epidemic of Loneliness: Suggestions for Research and Interventions. JAMA Psychiatry, 77(6), 553–554. doi:10.1001/jamapsychiatry.2020.0027.

[30] Ahuja, P., Syal, G., & Kaur, A. (2021). Psychological stress: Repercussions of COVID-19 on gender. Journal of Public Affairs, 21(4). doi:10.1002/pa.2533.

[31] Ernst, M., Niederer, D., Werner, A. M., Czaja, S. J., Mikton, C., Ong, A. D., Rosen, T., Brähler, E., & Beutel, M. E. (2022). Loneliness Before and During the COVID-19 Pandemic: A Systematic Review With Meta-Analysis. American Psychologist, 77(5), 660–677. doi:10.1037/amp0001005.

[32] Carpio, A., Ponce-Lopez, R., & Lozano-García, D. F. (2021). Urban form, land use, and cover change and their impact on carbon emissions in the Monterrey Metropolitan area, Mexico. Urban Climate, 39, 100947. doi:10.1016/j.uclim.2021.100947.

[33] Cacioppo, J. T., & Cacioppo, S. (2018). Loneliness in the modern age: An evolutionary theory of loneliness (ETL). Advances in experimental social psychology, Academic press, Cambridge, United States. doi:10.1016/bs.aesp.2018.03.003.

[34] Xu, Z., Marini, S., Mauro, M., Maietta Latessa, P., Grigoletto, A., & Toselli, S. (2025). Associations Between Urban Green Space Quality and Mental Wellbeing: Systematic Review. Land, 14(2), 381. doi:10.3390/land14020381.

[35] Reyes-Riveros, R., Altamirano, A., De La Barrera, F., Rozas-Vásquez, D., Vieli, L., & Meli, P. (2021). Linking public urban green spaces and human well-being: A systematic review. Urban Forestry and Urban Greening, 61, 127105. doi:10.1016/j.ufug.2021.127105.

[36] Yu, Z., Yang, G., Zuo, S., Jørgensen, G., Koga, M., & Vejre, H. (2020). Critical review on the cooling effect of urban blue-green space: A threshold-size perspective. Urban Forestry & Urban Greening, 49, 126630. doi:10.1016/j.ufug.2020.126630.

[37] Artmann, M., Chen, X., Iojă, C., Hof, A., Onose, D., Poniży, L., Lamovšek, A. Z., & Breuste, J. (2017). The role of urban green spaces in care facilities for elderly people across European cities. Urban Forestry & Urban Greening, 27, 203–213. doi:10.1016/j.ufug.2017.08.007.

[38] Habibi, S., & Asadi, N. (2011). Causes, results and methods of controlling urban sprawl. Procedia Engineering, 21, 133–141. doi:10.1016/j.proeng.2011.11.1996.

[39] Haaland, C., & van den Bosch, C. K. (2015). Challenges and strategies for urban green-space planning in cities undergoing densification: A review. Urban Forestry & Urban Greening, 14(4), 760–771. doi:10.1016/j.ufug.2015.07.009.

[40] Wosiek, M. (2020). Rural-Urban divide in human capital in Poland after 1988. Oeconomia Copernicana, 11(1), 183–201. doi:10.24136/oc.2020.008.

[41] Dinda, S., Das Chatterjee, N., & Ghosh, S. (2021). An integrated simulation approach to the assessment of urban growth pattern and loss in urban green space in Kolkata, India: A GIS-based analysis. Ecological Indicators, 121, 107178. doi:10.1016/j.ecolind.2020.107178.

[42] Setiowati, R., & Koestoer, R. H. (2024). Valuation of Urban Green Open Spaces Using the Life Satisfaction Approach. Civil Engineering Journal, 10(4), 1159–1181. doi:10.28991/CEJ-2024-010-04-010.

[43] Kahn, M. E. (2009). Urban Growth and Climate Change. Annual Review of Resource Economics, 1(1), 333–350. doi:10.1146/annurev.resource.050708.144249.

[44] Gehl, J. (2006). The Humanization of Urban Space: Social Life Between Buildings. Editorial Reverté, Barcelona. Spain. (In Spanish).

[45] Francis, J., Giles-Corti, B., Wood, L., & Knuiman, M. (2012). Creating sense of community: The role of public space. Journal of Environmental Psychology, 32(4), 401–409. doi:10.1016/j.jenvp.2012.07.002.

[46] Clark, L. F. (1993). Stress and the Cognitive-Conversational Benefits of Social Interaction. Journal of Social and Clinical Psychology, 12(1), 25–55. doi:10.1521/jscp.1993.12.1.25.

[47] Brueckner, J. K., & Largey, A. G. (2008). Social interaction and urban sprawl. Journal of Urban Economics, 64(1), 18–34. doi:10.1016/j.jue.2007.08.002.

[48] Lynch, K. (1960). The Image of the City. MIT Press, Cambridge, United States.

[49] Beere, P., Keeling, S., & Jamieson, H. (2019). Ageing, loneliness, and the geographic distribution of New Zealand's interRAI-HC cohort. Social Science & Medicine, 227, 84–92. doi:10.1016/j.socscimed.2018.08.002.

[50] Lim, M. H., Eres, R., & Vasan, S. (2020). Understanding loneliness in the twenty-first century: an update on correlates, risk factors, and potential solutions. Social Psychiatry and Psychiatric Epidemiology, 55(7), 793–810. doi:10.1007/s00127-020-01889-7.

[51] Twenge, J. M., Spitzberg, B. H., & Campbell, W. K. (2019). Less in-person social interaction with peers among U.S. adolescents in the 21st century and links to loneliness. Journal of Social and Personal Relationships, 36(6), 1892–1913. doi:10.1177/0265407519836170.

[52] Khalaf, A. M., Alubied, A. A., Khalaf, A. M., & Rifaey, A. A. (2023). The Impact of Social Media on the Mental Health of Adolescents and Young Adults: A Systematic Review. Cureus, 15(8), 42990. doi:10.7759/cureus.42990.

[53] Mathie, A., & Cunningham, G. (2003). From clients to citizens: Asset-based Community Development as a strategy for community-driven development. Development in Practice, 13(5), 474–486. doi:10.1080/0961452032000125857.

[54] Tsahor, M., Katoshevski-Cavari, R., & Alfasi, N. (2023). Assessing urban adaptability: The key is in the land use plan. Land Use Policy, 126, 106508. doi:10.1016/j.landusepol.2022.106508.

[55] Ma, B., Zhou, T., Lei, S., Wen, Y., & Htun, T. T. (2019). Effects of urban green spaces on residents' well-being. Environment, Development and Sustainability, 21(6), 2793–2809. doi:10.1007/s10668-018-0161-8.

[56] Sun, Y., Xie, S., & Zhao, S. (2019). Valuing urban green spaces in mitigating climate change: A city-wide estimate of aboveground carbon stored in urban green spaces of China's Capital. Global Change Biology, 25(5), 1717–1732. doi:10.1111/gcb.14566.

[57] Das, D. (2008). Urban quality of life: A case study of Guwahati. Social Indicators Research, 88(2), 297–310. doi:10.1007/s11205-007-9191-6.

[58] Barber, A., Haase, D., & Wolff, M. (2021). Permeability of the city – Physical barriers of and in urban green spaces in the city of Halle, Germany. Ecological Indicators, 125, 107555. doi:10.1016/j.ecolind.2021.107555.

[59] Kothencz, G., Kolcsár, R., Cabrera-Barona, P., & Szilassi, P. (2017). Urban green space perception and its contribution to well-being. International Journal of Environmental Research and Public Health, 14(7), 766. doi:10.3390/ijerph14070766.

[60] Wesz, J. G. B., Miron, L. I. G., Delsante, I., & Tzortzopoulos, P. (2023). Urban Quality of Life: A Systematic Literature Review. Urban Science, 7(2), 56. doi:10.3390/urbansci7020056.

[61] Einav, M., & Margalit, M. (2023). Loneliness before and after COVID-19: Sense of Coherence and Hope as Coping Mechanisms. International Journal of Environmental Research and Public Health, 20(10), 5840. doi:10.3390/ijerph20105840.

[62] Prescott, S. L. (2023). Lost Connections: Why the Growing Crisis of Loneliness Matters for Planetary Health. Challenges, 14(3), 31. doi:10.3390/challe14030031.

[63] Shankar, A., Rafnsson, S. B., & Steptoe, A. (2015). Longitudinal associations between social connections and subjective wellbeing in the English Longitudinal Study of Ageing. Psychology & Health, 30(6), 686–698. doi:10.1080/08870446.2014.979823.

[64] Pasanen, T. P., White, M. P., Elliott, L. R., van den Bosch, M., Bratman, G. N., Ojala, A., Korpela, K., & Fleming, L. E. (2023). Urban green space and mental health among people living alone: The mediating roles of relational and collective restoration in an 18-country sample. Environmental Research, 232, 116324. doi:10.1016/j.envres.2023.116324.

[65] Conedera, M., Del Biaggio, A., Seeland, K., Moretti, M., & Home, R. (2015). Residents' preferences and use of urban and peri-urban green spaces in a Swiss mountainous region of the Southern Alps. Urban Forestry & Urban Greening, 14(1), 139–147. doi:10.1016/j.ufug.2015.01.003.

[66] Wang, K., Frison, E., Eggermont, S., & Vandenbosch, L. (2018). Active public Facebook use and adolescents' feelings of loneliness: Evidence for a curvilinear relationship. Journal of Adolescence, 67, 35–44. doi:10.1016/j.adolescence.2018.05.008.

[67] Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. Psychometrika, 16(3), 297–334. doi:10.1007/BF02310555.

[68] Schober, P., & Schwarte, L. A. (2018). Correlation coefficients: Appropriate use and interpretation. Anesthesia and Analgesia, 126(5), 1763–1768. doi:10.1213/ANE.0000000000002864.

[69] Giannico, V., Spano, G., Elia, M., D'Este, M., Sanesi, G., & Lafortezza, R. (2021). Green spaces, quality of life, and citizen perception in European cities. Environmental Research, 196(110922), 110922. doi:10.1016/j.envres.2021.110922.

[70] Akpinar, A. (2016). How is quality of urban green spaces associated with physical activity and health? Urban Forestry & Urban Greening, 16, 76–83. doi:10.1016/j.ufug.2016.01.011.

[71] Zhang, Y., Van den Berg, A. E., Van Dijk, T., & Weitkamp, G. (2017). Quality over quantity: Contribution of urban green space to neighborhood satisfaction. International Journal of Environmental Research and Public Health, 14(5), 535. doi:10.3390/ijerph14050535.

[72] Bartlett, M. Y., & Arpin, S. N. (2019). Gratitude and Loneliness: Enhancing Health and Well-Being in Older Adults. Research on Aging, 41(8), 772–793. doi:10.1177/0164027519845354.

[73] Terkelsen, A. S., Gulis, G., Jespersen, J., Berg-Beckhoff, G., & Andersen, P. T. (2025). Quality of Life, Loneliness, and Social Interactions Among Older People Moving to a Senior Village: A Longitudinal Study of an Age-Friendly Community Initiative. Journal of Aging and Environment, 1–17. doi:10.1080/26892618.2025.2475436.

[74] Li, R., Yan, Q., Qu, Y., & Wang, Y. (2025). Square dance, loneliness, quality of life, and attitude toward aging in middle-aged and older women in China. Frontiers in Public Health, 13, 1508556. doi:10.3389/fpubh.2025.1508556.

[75] Binte Mohammad Adib, N. A., & Sabharwal, J. K. (2024). Experience of loneliness on well-being among young individuals: A systematic scoping review. Current Psychology, 43(3), 1965–1985. doi:10.1007/s12144-023-04445-z.

[76] Kirwan, E. M., Burns, A., O'Súilleabháin, P. S., Summerville, S., McGeehan, M., McMahon, J., Gowda, A., & Creaven, A. M. (2025). Loneliness in Emerging Adulthood: A Scoping Review. Adolescent Research Review, 10(1), 47–67. doi:10.1007/s40894-024-00240-4.

[77] Matthews, T., Danese, A., Caspi, A., Fisher, H. L., Goldman-Mellor, S., Kepa, A., Moffitt, T. E., Odgers, C. L., & Arseneault, L. (2019). Lonely young adults in modern Britain: Findings from an epidemiological cohort study. Psychological Medicine, 49(2), 268–277. doi:10.1017/S0033291718000788.

[78] Shah, H. A., & Househ, M. (2023). Understanding Loneliness in Younger People: Review of the Opportunities and Challenges for Loneliness Interventions. Interactive Journal of Medical Research, 12, e45197. doi:10.2196/45197.

[79] Musich, S., Wang, S. S., Hawkins, K., & Yeh, C. S. (2015). The Impact of Loneliness on Quality of Life and Patient Satisfaction Among Older, Sicker Adults. Gerontology and Geriatric Medicine, 1. doi:10.1177/2333721415582119.

[80] Bergefurt, L., Kemperman, A., van den Berg, P., Borgers, A., van der Waerden, P., Oosterhuis, G., & Hommel, M. (2019). Loneliness and life satisfaction explained by public-space use and mobility patterns. International Journal of Environmental Research and Public Health, 16(21), 4282. doi:10.3390/ijerph16214282.

[81] van den Berg, M. M., van Poppel, M., van Kamp, I., Ruijsbroek, A., Triguero-Mas, M., Gidlow, C., Nieuwenhuijsen, M. J., Gražulevičiene, R., van Mechelen, W., Kruize, H., & Maas, J. (2019). Do Physical Activity, Social Cohesion, and Loneliness Mediate the Association Between Time Spent Visiting Green Space and Mental Health? Environment and Behavior, 51(2), 144–166. doi:10.1177/0013916517738563.

[82] Jones, P., & Comfort, D. (2021). Placemaking and the United Kingdom's largest housebuilders. Journal of Public Affairs, 21(2), e2458. doi:10.1002/pa.2458.

[83] Cardinali, M., Beenackers, M. A., van Timmeren, A., & Pottgiesser, U. (2023). Preferred reporting items in green space health research. Guiding principles for an interdisciplinary field. Environmental Research, 228, 115893. doi:10.1016/j.envres.2023.115893.