

## Article

# Urban Street Environmental Factors Influencing Mental Stress Alleviation

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**Abstract:** The concept of sustainable cities encompasses not only environmental concerns but also extends to the physical and mental well-being of residents. Urban design, particularly the structuring of street environments, plays a crucial role in alleviating stress and promoting public health when it emulates the qualities of natural settings. The present study adopts a multifaceted methodology, incorporating semi-structured interviews, semantic differential analysis and a seven-point imagery scale, to explore the influence of street life on emotional states. The case study focuses on Zhongshan Road in Chiayi City. Furthermore, field perceptual experiments, environmental feature extraction, and video recording were conducted to analyse correlations between specific street characteristics and psychological well-being. The findings identify several key environmental factors that significantly affect mental health: green space ratio, vehicle presence, walkability, environmental complexity, building enclosure, facility distribution, sky visibility, facade transparency, proportion of slow events, and color richness. The present study found vehicle presence and excessive environmental complexity to be positively correlated with feelings of boredom, while facade transparency was found to be positively correlated with engagement. Moreover, a higher ratio of green space and building enclosure has been demonstrated to be associated with heightened interest. The results of this study demonstrate that street environments exert a measurable psychological impact on well-being, either fostering or diminishing it, depending on their configuration. Beyond the empirical insights yielded by the study, its findings are closely aligned with the broader objectives of sustainable urban development. The expansion of green spaces and the prioritisation of pedestrian-friendly street design have been identified as key strategies for reducing carbon emissions and enhancing sustainability.

**Keywords:** City street environment, City sustainability, Stress relief, Psychological experience, Aesthetics

## 1. Introduction

Urban environments profoundly influence the physical and mental well-being of urban residents. Previous studies have shown that the design of street environments can alleviate stress and promote public health by incorporating elements that resemble natural settings. Features such as street furniture, building facades, lighting, and commercial services can enhance street vitality, foster social interaction, and strengthen residents' sense of belonging and social cohesion [1–3]. Streets with permeable facades, shop windows, and high-quality lighting can improve perceived safety and encourage socio-emotional connections through physical activity and everyday social encounters [4,5]. In contrast, impermeable facades—defined as building frontages with limited visual transparency or interaction with the street, often characterised by blank walls or closed storefronts—and poorly designed streetscapes can generate feelings of isolation, obstruct visibility, and foster distrust and fear. The thoughtful use of colour can enhance social integration, reduce isolation, and mitigate depression and anxiety, although excessive colour may induce psychological fatigue [6,4]. Other environmental factors, including street greenery, sidewalk width, mixed land use, store density, seating, and street network connectivity, contribute to psychological well-being and sustainable urban development. Despite these insights, the mechanisms linking street design and mental health remain complex, and methodological limitations have constrained the precise measurement of environmental stressors. Although economic perspectives are important in sustainable urban development, the present study focuses primarily on the psychological and environmental dimensions of street environments.

Recent developments in neurourbanism provide a new perspective for understanding these relationships by integrating neuroscience, psychiatry, urban planning, medicine, and sociology to investigate how urban living influences the brain and mental health [7,8]. By examining neural responses to environmental stimuli, neurourbanism bridges sociocultural and biological perspectives and allows researchers to conceptualize urban stressors, anticipate residents' environmental needs, and develop evidence-based strategies for healthier urban design [3].

The neighbourhood street environment is also an important determinant of mental health. Poorly designed environments have been associated with negative health outcomes, including increased air pollution exposure, reduced life expectancy, and diminished well-being. Conversely, walkable neighbourhoods can reduce traffic congestion, noise, and emissions while promoting both physical and mental health [9,10]. Residents' satisfaction with their neighbourhood environment—encompassing natural, built, and social dimensions—can mediate the relationship between environmental exposure and mental health by shaping perceptions of safety, social cohesion, and quality of life [11,12,13]. In this study, neighbourhood satisfaction refers to residents' evaluation of the quality, safety, and comfort of the local street environment. Favourable neighbourhood conditions, including green spaces, accessibility, proximity to amenities, and strong social networks, can increase self-worth, happiness, and resilience against depression and anxiety [14,15]. Consequently, personal stress relief may moderate the relationship between neighbourhood environment and mental health, highlighting the importance of both objective environmental characteristics and subjective perceptions.

The objective of this study is to examine how urban street environmental factors influence residents' mental stress and psychological well-being. To address these interrelated factors—including street greenery, sidewalk comfort, and neighbourhood satisfaction—the present study focuses on Zhongshan Road in Chiayi City. The study integrates street observations, environmental characteristics, and residents' subjective perceptions to evaluate the quality of the street environment. Environmental exposure is assessed through the analysis of streetscape facades, street furniture, and perceived greenery, while built environment characteristics are evaluated using indicators such as walkability and pedestrian comfort. The aesthetic quality of the street environment is also considered an important dimension in evaluating environmental quality. This study therefore investigates how environmental stressors—such as sidewalk comfort—interact with personal stress relief, physical activity, and neighbourhood satisfaction in shaping mental health outcomes.

This study contributes to the literature in several ways. First, it clarifies the role of neighbourhood environments and aesthetic qualities in influencing adults' mental health. Second, it incorporates multiple observational perspectives to better capture residents' experiences of urban streets. Third, the findings provide empirical evidence to support sustainable urban and community planning aimed at improving public well-being. As illustrated in the conceptual framework (Figure 1), the relationships between community environment, individual factors, and mental health outcomes are conceptualized. In this study, the term “street environment” refers to the physical and perceptual characteristics of urban streets, including greenery, building facades, pedestrian facilities, and traffic conditions. As shown in Figure 1, environmental factors such as greenery, traffic conditions, and street design may influence residents' mental stress and psychological well-being.

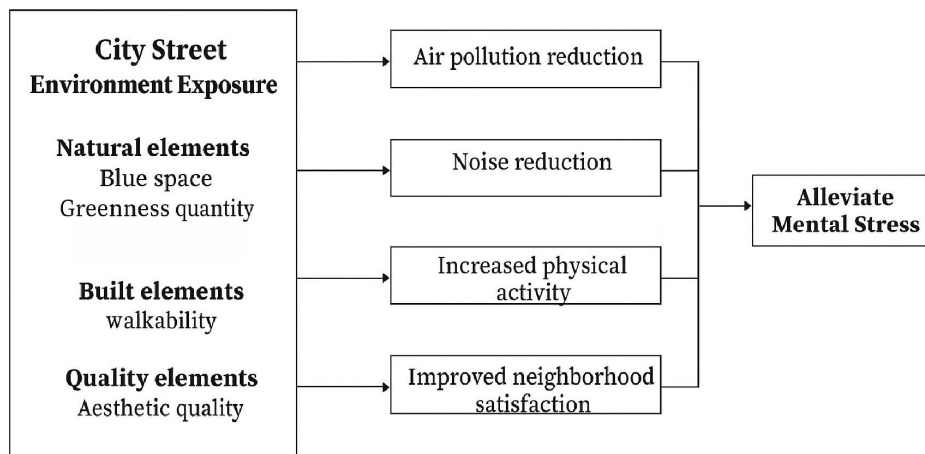


Fig. 1. Conceptual framework of environmental factors influencing mental stress.

## 2. Material and Methods

### 2.1. Study Area and Participants

This study was conducted in Chiayi City, a city in southern Taiwan known for its historical and cultural heritage related to the forestry industry and often referred to as the “Painting City.” Zhongshan Road, the primary corridor connecting Chiayi Railway Station with the city centre, was selected as the focal study area due to its importance in daily urban activities and pedestrian

movement. As of 2024, Chiayi City had a population of approximately 262,177 and an urbanisation rate of nearly 70%. The city has also consistently ranked among the top four cities in Taiwan's Happiness Index Survey for five consecutive years since 2020.

Data for this study were obtained from a field survey conducted in August 2023. A total of 150 participants were recruited using a convenience sampling approach among residents familiar with the Zhongshan Road area. All participants were adults aged 18 years or older and voluntarily agreed to participate in the survey. The survey instrument was designed with reference to the five well-being indicators proposed by the World Health Organization (WHO) and aimed to explore the relationship between urban street environmental characteristics and residents' psychological well-being. All questionnaires were administered through face-to-face interviews conducted by trained interviewers.

## 2.2. Research Scope

This study examined multiple aspects of the street environment, including natural environmental features, built environment characteristics, and overall environmental quality. Key environmental indicators included streetscape facades, street furniture, greenery, pedestrian infrastructure, and walkability conditions. These indicators were used to evaluate how environmental exposure may influence residents' perceptions of street quality and psychological stress.

As shown in Figure 2, observation points were distributed across residential areas within the core urban area of Chiayi City, with particular emphasis on Zhongshan Road as the primary case study street.



Fig. 2. Study area: Zhongshan Road, Chiayi City (Source: Taiwan Design Research Institute).

## 2.3. Measurement of Mental Health

Mental health outcomes were assessed using the WHO-5 Well-being Index (Krieger et al., 2014; Liu et al., 2019). The WHO-5 index consists of five questions designed to measure respondents' subjective well-being over the previous two weeks. Participants rated their responses using a five-point Likert scale, where higher scores indicated better psychological well-being. The WHO-5 index is widely used in public health and urban studies due to its reliability and simplicity in assessing mental health conditions.

## 2.4. Moderating Variables

This study evaluated four moderating variables in the relationship between the neighbourhood street environment and mental health: environmental stress relief, physical activity (walking behaviour), personal stress relief, and neighbourhood satisfaction.

Environmental stress relief was measured through respondents' satisfaction with environmental quality and noise levels in their residential area using a five-point Likert scale (1 = very dissatisfied, 5 = very satisfied). Lower scores indicated higher perceived exposure to environmental stressors such as noise and air pollution.

Physical activity was measured by the frequency of walking within the neighbourhood per week, as walking is the most common form of daily physical activity in urban environments.

Personal stress relief was measured using a five-point Likert scale evaluating the frequency with which emotional stress interfered with daily activities during the past month (1 = always, 5 = never).

Neighbourhood satisfaction was defined as residents' evaluation of the natural, built, and social characteristics of their local street environment. Higher scores indicated greater satisfaction with neighbourhood environmental quality.

### 2.5. Survey Method

The research design adopted a perception-based empirical approach to examine the relationship between street environmental characteristics and psychological stress. Previous studies have shown that environmental exposure, including streetscape design, street furniture, and perceived greenery, can influence pedestrians' emotional responses and stress levels.

Following this research tradition, the present study used a combination of visual stimuli and semi-structured interviews to assess participants' perceptions of urban street environments. Participants were shown visual materials representing street scenes and asked to evaluate their perceptions of environmental quality and emotional responses.

Data were collected through in-person interviews with 150 participants. The research process included three main stages: (1) environmental observation and documentation of street characteristics, (2) perception-based evaluation using structured questionnaires, and (3) analysis of the relationship between environmental factors and psychological responses.

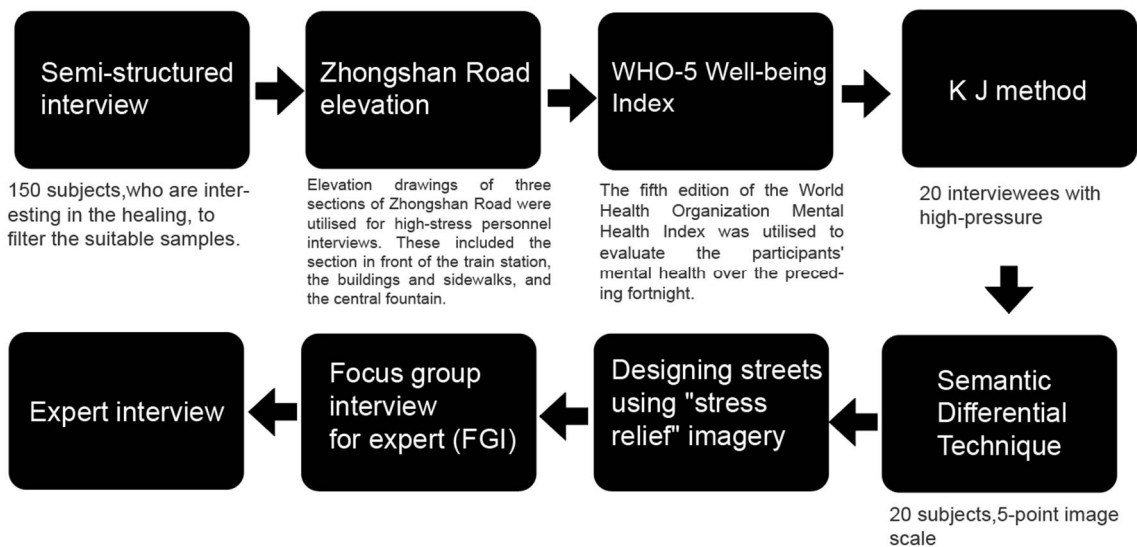


Fig. 3. Research Process.

## 3. Results

### 3.1. Characteristics of the Study Population

The present study recruited 150 adult participants familiar with the Zhongshan Road area in Chiayi City using a convenience sampling approach. Participants were recruited through voluntary participation and local community networks. All respondents were aged 18 years or above and reported normal or corrected-to-normal vision to ensure accurate perception of the visual stimuli used in the experiment. The average weekly working hours were 48, and the average age of the participants was 40 years.

Table 1 presents the descriptive characteristics of the respondents. The sample predominantly comprised middle-aged individuals, with 50.7% aged 40 years or above. Considerable variation was observed in household income, educational attainment, and neighbourhood characteristics. Males accounted for 36% of the sample, and 48.7% of respondents were married, with an average monthly income of NT\$38,000.

Participants took part in semi-structured interviews conducted in the same room. Each participant was shown ten images of urban streets related to stress perception and environmental quality, followed by a 40-minute interview session. The selection of sample streets was guided by participants' familiarity with the locations, with Zhongshan Road in Chiayi City serving as a prominent example due to its recognition through prior visits, online exposure, and daily experience.

Based on participants' perceptions and visual evaluations, three groups of street facades were identified for further analysis. To ensure the validity and consistency of the categorisation, experts in architectural design were invited to assist in classifying the street environments (see Figures 4–6).

**Table 1.** Subjects in this study.

Demographic Item	Number	Proportion (%)	Demographic Item	Number	Proportion (%)	
Gender	Male	54	20 or below	11	7.3	
	Female	96	21–30	33	22	
Profession	Government	37	24.6	31–40	30	20
	Administrative	19	12.6	41–50	53	35.3
	Project assistant	7	4.6	50 or above	23	15.4
	Business	13	8.6	General and vocational High School	12	8
Marriage	Self-employment	15	10	Post-secondary School	8	5.3
	Stewardship	4	2.6	University/College	94	62.6
	Others	55	36.6	Master or above	36	24
	Married	73	48.7	WHO 5-scores	Male	12.40
Unmarried	77	51.3	Male	13.45		



**Fig. 4.** A-A' Zhongshan Road Street Elevation



Fig. 5. B-B' Zhongshan Road Street Elevation



Fig. 6. C-C' Zhongshan Road Street Elevation

### 3.2. Perceived Environmental Characteristics of Zhongshan Road

The present study examined several environmental factors that may influence stress perception in street environments, including environmental comfort, perceived pollution, opportunities for physical activity, and neighbourhood satisfaction. The perceived emotional responses to the street environment were further explored using the KJ method to identify descriptive adjectives associated with stress-relieving street environments (see Table 2).

Table 2. Top 5 Attractive Feelings.

Adjective	Related
Comfortable	Satisfied, relaxed, comfortable, cheerful, quiet
Natural	Safe, peaceful, kind, gentle, kind, simple
Friendly	beauty, kindness, heaven, stability
Simple	Bright, plain, quiet, pure
Fun	Happy, colorful, diverse, changing, rich

The results of the KJ method analysis indicate that participants generally associate stress-relieving streets with environments that are comfortable, aesthetically pleasing, and visually balanced. These environments were perceived as fostering relaxation and a sense of psychological ease.

However, Zhongshan Road in Chiayi City was frequently described as a relatively stressful street environment. Participants attributed this perception primarily to limited greenery, a lack of aesthetic design, and heavy traffic flow. The absence of natural elements and visual coherence was repeatedly mentioned as contributing to sensory fatigue and environmental discomfort.

Quantitative analysis further supported these perceptions. The mean WHO-5 well-being score among respondents was 63.4 (SD = 14.2), indicating a moderate level of psychological well-being. Participants who reported higher satisfaction with the street environment also tended to report better perceived well-being.

These findings suggest that visual comfort, greenery, and environmental coherence are important factors influencing how urban street environments are perceived in relation to stress reduction.

### 3.3. Design Strategies for Stress-Relieving Street Environments

The findings from Zhongshan Road in Chiayi City highlight the importance of integrating psychological comfort into urban street design. Although the street functions as an important commercial and transportation corridor, its lack of greenery, limited blue-space visibility (primarily represented by a single fountain), and absence of coherent aesthetic planning contribute to elevated stress perceptions among residents.

More than 70% of survey respondents described the street environment as visually monotonous and emotionally fatiguing. Participants noted that prolonged exposure to heat, traffic noise, and rigid urban forms intensified feelings of environmental pressure. These observations indicate that functional mobility alone cannot ensure psychological well-being; urban comfort must also derive from sensory, spatial, and emotional qualities.

To further interpret these findings, ten experts in architecture and urban design were invited to participate in a focus group discussion (see Table 3). The experts analysed the survey results and visual records of the street environment. Most experts agreed that Zhongshan Road's linear spatial configuration, dense commercial signage, and insufficient vegetation reduce its restorative potential.

**Table 3.** Expert list.

Code	Personal Profile	Code	Personal Profile
A1	Mr. Ho; Age: 65–70 Occupation: Professor	A6	Mr. Tu; Age: 60–65 Occupation: Professor
A2	Miss Wu; Age: 50–55 Occupation: Associate Professor	A7	Mr. Lin; Age: 45–50 Occupation: Executive Officer
A3	Miss Lin; Age: 35–40 Occupation: Executive Officer	A8	Miss Li; Age: 40–45 Occupation: Architect
A4	Mr. Pan; Age: 40–45 Occupation: Associate Professor	A9	Miss Wu; Age: 40–45 Occupation: Environmental Designer
A5	Miss Su; Age: 50–55 Occupation: Architect	A10	Mr. Liu; Age: 40–45 Occupation: Executive Officer

Several experts emphasised that micro-scale design interventions—including vertical greening systems, modular planters, and façade shading devices—could improve both perceived walkability and environmental quality without compromising commercial activity. In addition, some experts highlighted the potential of cultural landscape integration, suggesting that artistic installations and locally inspired materials reflecting Chiayi's forestry and painting heritage could strengthen the street's identity and emotional connection with residents.

Overall, the results suggest that street-level aesthetics and micro-environmental design should become priorities in future redevelopment plans. Elements such as coherent signage, context-sensitive street furniture, and the integration of greenery may contribute to reducing sensory fatigue and improving perceived urban well-being.

## 4. Discussion

### 4.1. Discussion Based on the Semantic Differential Method

The Semantic Differential (SD) method, originally proposed by Osgood, Suci, and Tannenbaum [16], was employed in this study to examine residents' affective evaluations of the street environment on Zhongshan Road. The results provide insight into how urban environmental qualities influence psychological perceptions of comfort, naturalness, and experiential value.

The overall mean score of 2.84 suggests that residents perceive the street environment as having a slightly negative to neutral impact on psychological comfort. In particular, the lowest score was observed in the comfortable–uncomfortable dimension, indicating that thermal discomfort, insufficient shading, and heavy vehicular traffic significantly affect residents' perceptions of environmental quality. This finding is consistent with previous studies suggesting that microclimatic conditions and pedestrian-oriented design are critical determinants of perceived urban comfort.

Similarly, the relatively low score for the natural–artificial dimension reflects the limited presence of greenery and the dominance of built structures along Zhongshan Road. Previous research has shown that urban greenery can contribute significantly

to stress reduction and psychological restoration by providing visual relief and improving environmental quality. The absence of such natural elements therefore reduces the street's capacity to function as a restorative urban space.

The friendly–hostile dimension also received relatively modest ratings. Although Zhongshan Road remains an important commercial corridor with high accessibility, the dominance of vehicular traffic and limited pedestrian space reduce its perceived friendliness and social interaction potential. This finding highlights the importance of human-scale urban design in fostering positive emotional responses in public spaces.

By contrast, the slightly higher score in the fun–boring dimension suggests that commercial activities and occasional local events contribute to a moderate sense of urban vitality. However, this level of vibrancy remains limited due to the lack of coherent aesthetic design and cultural expression within the streetscape.

Overall, the SD results support the broader findings of this study, indicating that visual comfort, environmental coherence, and the integration of natural elements play important roles in shaping residents' perceptions of urban street environments. These results also reinforce the argument that urban streets should be designed not only for mobility and commercial activity but also for psychological well-being and environmental quality.

**Table 4.** Mean SD Scores for Zhongshan Road.

Semantic Differential Pair	Mean Score	Interpretation
Comfortable – Uncomfortable	2.5	Residents reported low thermal and physical comfort due to heat, lack of shade, and traffic stress.
Natural – Artificial	2.6	The dominance of hard paving and limited vegetation resulted in perceptions of artificiality.
Friendly – Hostile	2.8	Although the area is familiar, heavy traffic and narrow sidewalks reduced perceived friendliness.
Simple – Complex	3.0	Visual organization is moderately legible, but excessive signage creates mild visual clutter.
Fun – Boring	3.1	Occasional commercial vibrancy or local activities contribute to a limited sense of fun.
Overall Mean	2.84	Indicates a generally negative to neutral perception of the street's psychological comfort.

Note: Scores were measured on a 5-point scale (1 = highly negative, 5 = highly positive). N = 150 residents participated in the SD evaluation. Higher scores represent more positive affective evaluations of the street environment.

#### 4.2. Design Implications Based on SD Findings

Based on the SD analysis and expert evaluations, several design implications can be identified for improving the environmental quality and psychological comfort of Zhongshan Road.

First, enhancing thermal comfort should be prioritised through the integration of shading elements such as street trees, pergolas, and building awnings. These features can mitigate heat stress and improve pedestrian comfort in subtropical urban environments.

Second, increasing the presence of greenery through vertical greening systems, modular planters, and small-scale urban gardens may enhance perceptions of naturalness. Integrating locally meaningful materials and design elements related to Chiayi's forestry and cultural heritage could further strengthen the emotional connection between residents and the street environment.

Third, improving pedestrian friendliness is essential. Measures such as widening sidewalks, reducing vehicular dominance, and providing clearly marked pedestrian crossings may help create a safer and more socially engaging street environment.

Fourth, visual coherence should be improved by introducing coordinated signage systems and consistent streetscape design elements. Reducing visual clutter can help create a more legible and aesthetically balanced urban environment.

Finally, cultural and artistic interventions may enhance the experiential quality of the street. Public art installations, small event spaces, and temporary cultural activities could help increase the sense of place and emotional attachment among residents.

Taken together, these findings suggest that relatively small-scale design interventions can significantly influence how residents perceive and experience urban streets. By incorporating human-centred and biophilic design principles, Zhongshan Road could gradually transition from a purely functional transport corridor into a more psychologically supportive urban environment.

## 5. Conclusions

This study examined how urban street environments influence residents' mental stress and psychological well-being, using Zhongshan Road in Chiayi City as a case study. The findings indicate that functional mobility alone is insufficient to support psychological comfort in urban environments. Instead, environmental characteristics such as greenery, shading, visual coherence, and cultural identity appear to play important roles in shaping residents' perceptions of stress and well-being. The WHO-5 well-being assessment suggests that residents generally experience a moderate level of psychological well-being, with lower scores associated with streets perceived as less comfortable, natural, or friendly.

The results of the Semantic Differential analysis and expert evaluations further suggest that micro-scale design interventions—including the integration of greening systems, shading devices, human-scale street furniture, coherent signage, and cultural or artistic elements—may enhance the restorative and aesthetic qualities of urban streets without necessarily reducing their commercial vitality.

Based on these findings, this study proposes a framework comprising five design dimensions—Comfortable, Natural, Friendly, Simple, and Fun—as a potential reference for future street redevelopment. The application of these principles may help transform urban streets from purely functional corridors into environments that better support psychological well-being, social interaction, and urban livability.

From a theoretical perspective, this study contributes to the growing body of research linking urban environmental design with psychological well-being by integrating residents' perceptions, well-being assessments, and affective evaluations of streetscape environments. From a practical perspective, the findings provide insights for urban planners and designers seeking to incorporate human-centered design principles into street redevelopment strategies.

Nevertheless, several limitations should be acknowledged. First, the study focuses on a single case study street in Chiayi City, which may limit the generalisability of the findings to other urban contexts. Second, the study relies primarily on perception-based evaluations, which may be influenced by individual subjective experiences. Future research could expand the analysis to multiple urban streets and incorporate additional objective environmental indicators to further explore the relationship between urban design and psychological well-being.

Overall, the findings suggest that thoughtfully designed street environments may contribute to reducing mental stress and improving urban quality of life, highlighting the importance of integrating psychological considerations into contemporary urban design and planning practices.

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**Conflicts of Interest:** The author declares no conflict of interest.

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