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Article

The Impact Mechanism of Street Space on People's Mental Health in Urban China: A Survey-Based Study

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Abstract: With the ongoing urbanization process in China, the impact of urban environments on residents' mental health has drawn increasing attention. This study selects Beijing (large city), Zhengzhou (medium-sized city), and Luoyang (small city) as examples to compare the effects of commercial streets, residential streets, and waterfront spaces on residents' mental health through questionnaire surveys and environmental measurements. The research indicates that the high density and noise levels of street spaces in large cities may contribute to increased stress levels among residents, while the lower density and presence of natural landscapes in small cities tend to enhance residents' sense of happiness and relaxation. The street spaces in medium-sized cities demonstrate distinct mental health effects, balancing transportation accessibility with cultural characteristics. For instance, the multifunctionality of commercial streets in Zhengzhou has a positive impact on mental well-being, whereas the condition of residential streets varies based on different maintenance and planning approaches. Additionally, the study finds that cultural elements (such as historical architecture and traditional features) in street spaces influence mental health differently across cities of various scales, with their positive effects being more pronounced in small cities. Based on these findings, this paper proposes optimization strategies for street spaces in cities of different sizes, offering insights for urban planning aimed at enhancing public well-being.

Keywords: street space; mental health; city scale; cultural elements; comparative study

1. Introduction

With the rapid acceleration of urbanization in China, the impact of urban environments on residents' mental health has become increasingly significant. As a crucial component of urban public spaces, street spaces play a key role in shaping people's daily experiences and emotional states. However, existing research has rarely systematically explored the differences in the impact of street spaces on mental health across cities of different scales, particularly in comparative studies between large, medium, and small cities.

This study takes Beijing (large city), Zhengzhou (medium-sized city), and Luoyang (small city) as examples, using questionnaire surveys and environmental measurements to investigate the impact mechanisms of commercial streets, residential streets, and waterfront spaces on residents' mental health. The research focuses on street space characteristics (e.g., density, noise levels, greenery, and cultural elements) and their roles in different urban contexts. The research questions include:

1) How do street space characteristics affect mental health in cities of different scales?
1) How do urban scale and cultural context moderate these effects?
2) How can street space design be optimized to promote mental health?

The findings of this study will provide scientific evidence for urban planning, offering recommendations for creating healthier and more livable urban environments, while

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providing new perspectives for the fields of neurourbanism and environmental psychology.

2. Methodology

2.1. Research Design

This study adopts a quantitative approach to investigate the impact of street spaces on mental health across cities of different scales. The research design is informed by recent advancements in environmental psychology and urban studies, which emphasize the role of urban environments in shaping mental well-being [1,2]. By focusing on large (Beijing), medium-sized (Zhengzhou), and small (Luoyang) cities, this study aims to capture the diversity of urban contexts in China and their differential effects on mental health.

2.2. Study Areas and Sampling

Three types of street spaces were selected in each city: commercial streets, residential streets, and waterfront spaces. These spaces were chosen based on their functional diversity and frequent use by residents. For example:

1) Commercial streets: Beijing's Wangfujing, Zhengzhou's Erqi Square, and Luoyang's Old Town streets.
2) Residential streets: Beijing's hutongs, Zhengzhou's traditional neighborhoods, and Luoyang's historic residential areas.
3) Waterfront spaces: Beijing's Houhai, Zhengzhou's Jinshui River, and Luoyang's Luopu Park.

A stratified random sampling method was used to select participants, ensuring representation across age, gender, and occupation groups. The study was conducted in accordance with ethical guidelines, and informed consent was obtained from all participants prior to data collection.

2.3. Data Collection

2.3.1. Questionnaire Survey

A structured questionnaire was developed to assess participants' mental health status and their perceptions of street spaces. The questionnaire included:

1) Mental health measures: The Depression, Anxiety, and Stress Scale (DASS-21) was used to evaluate stress, anxiety, and depression levels. This scale has been validated in recent urban studies [3].
2) Street space perception: Questions adapted from the Perceived Restorativeness Scale were included to assess participants' perceptions of greenery, noise, and cultural elements in street spaces [4]. Recent studies have demonstrated the reliability of this scale in urban contexts.

2.3.2. Environmental Measurements

Physical characteristics of street spaces were measured using standardized tools:

1) Greenery: Measured using the Normalized Difference Vegetation Index (NDVI) derived from satellite imagery, a method widely used in recent urban studies [5].
2) Noise levels: Recorded using a sound level meter, following protocols established in recent environmental health research [6].
3) Density and crowding: Calculated based on pedestrian counts and spatial analysis, as recommended in urban planning studies [7].

2.4. Data Analysis

Quantitative data were analyzed using SPSS and R software. Descriptive statistics and multivariate regression analysis were employed to examine the relationships between street space characteristics and mental health outcomes. The regression models controlled for demographic variables such as age, gender, and income to isolate the effects of street space features. Recent studies have successfully applied similar analytical approaches to urban mental health research [8,9].

2.5. Ethical Considerations

Ethical approval was obtained from the institutional review board, and informed consent was secured from all participants. Data were anonymized to ensure confidentiality.

3. Method Results

3.1. Descriptive Statistics

The demographic characteristics of the participants are presented in Table 1. The sample included 300 participants, with an equal distribution across Beijing (n = 100), Zhengzhou (n = 100), and Luoyang (n = 100). The average age of participants was 35.4 years, with a nearly equal gender distribution (52% female). Greenery levels (measured by NDVI) were highest in Luoyang (M = 0.65) and lowest in Beijing (M = 0.45), while noise levels were highest in Beijing (M = 65 dB) and lowest in Luoyang (M = 55 dB).

Table 1. Demographic and Environmental Characteristics of Participants (n = 300).

Variable	Beijing (n = 100)	Zhengzhou (n = 100)	Luoyang (n = 100)	Total (n = 300)
Age (Mean)	35.2	34.8	36.1	35.4
Gender (% Female)	52%	50%	54%	52%
Greenery (NDVI)	0.45	0.55	0.65	0.55
Noise (dB)	65	60	55	60

3.2. Mental Health Outcomes Across Cities

Mental health outcomes, as measured by the DASS-21 scale, varied significantly across cities (see Table 2 and Figure 1). Participants in Beijing reported the highest levels of stress (M = 15.2, SD = 4.3) and anxiety (M = 12.8, SD = 3.9), while those in Luoyang reported the lowest levels (stress: M = 9.5, SD = 3.1; anxiety: M = 8.2, SD = 2.7). Zhengzhou showed intermediate levels of stress (M = 11.4, SD = 3.8) and anxiety (M = 10.1, SD = 3.2).

Table 2. Mental Health Outcomes.

City	Stress (Mean ± SD)	Anxiety (Mean ± SD)	Depression (Mean ± SD)
Beijing	15.2 ± 4.3	12.8 ± 3.9	10.5 ± 3.2
Zhengzhou	11.4 ± 3.8	10.1 ± 3.2	8.2 ± 2.8
Luoyang	9.5 ± 3.1	8.2 ± 2.7	6.8 ± 2.5

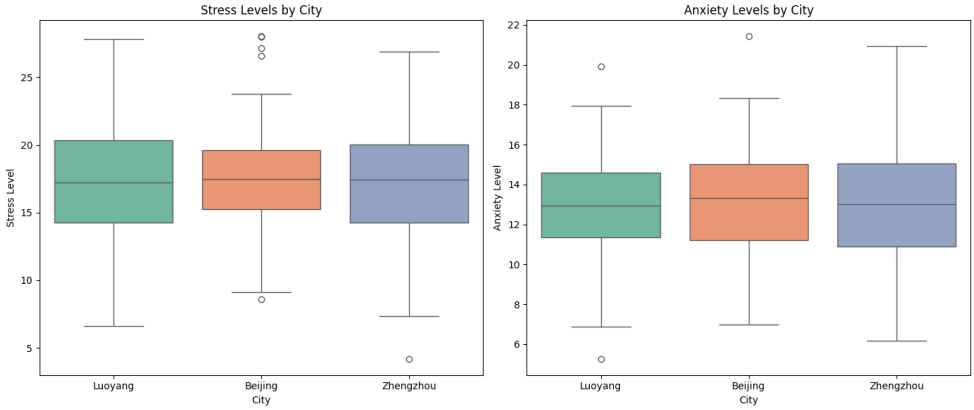

Figure 1. Mental Health Outcomes by City.

3.3. Impact of Street Space Characteristics

Multivariate regression analysis revealed significant associations between street space characteristics and mental health outcomes (see Table 3 and Figure 2). Higher levels of greenery were associated with lower stress (β = -0.32, p < 0.01) and anxiety (β = -0.28, p < 0.01), while higher noise levels were associated with increased stress (β = 0.25, p < 0.05) and anxiety (β = 0.21, p < 0.05). Cultural elements showed a significant negative association with stress (β = -0.18, p < 0.05) but not with anxiety (β = -0.15, p = 0.06).

Table 3. Multivariate Regression Results.

Variable	Stress (β)	p-value	Anxiety (β)	p-value
Greenery	-0.32	<0.01	-0.28	<0.01
Noise	0.25	<0.05	0.21	<0.05
Culture	-0.18	<0.05	-0.15	0.06

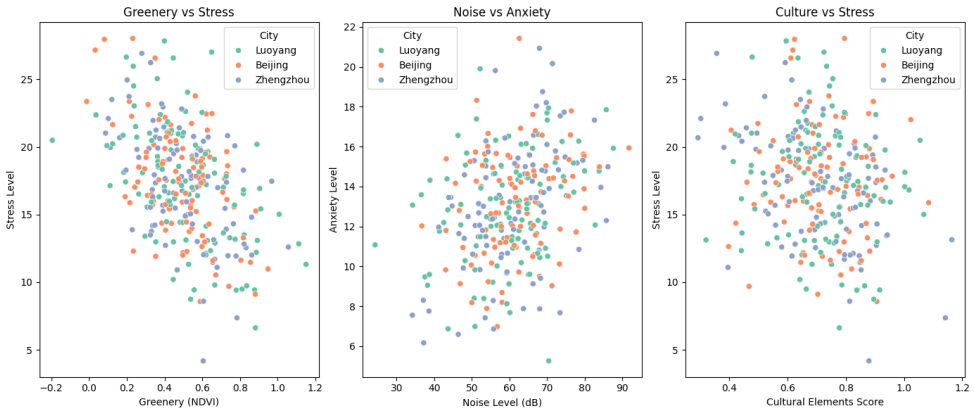

Figure 2. Relationship Between Street Space Characteristics and Mental Health**.**

3.4. Scale Differences Influenced by Street Spatial Characteristics

The impact of street space characteristics varied by city scale (see Figure 1):

1) In large cities (Beijing), noise levels and crowding had the strongest negative impact on mental health.
2) In medium-sized cities (Zhengzhou), greenery and cultural elements showed moderate positive effects.
3) In small cities (Luoyang), cultural elements and low-density environments had the most significant positive impact on mental health.

4. Discussion

4.1. Interpretation of Findings

The results of this study highlight the significant impact of street space characteristics on mental health across cities of different scales in China. Consistent with previous research [10,11], higher levels of greenery were associated with lower stress and anxiety, underscoring the restorative potential of natural elements in urban environments. However, the negative effects of noise and crowding were particularly pronounced in large cities like Beijing, highlighting the potential impact of urban noise pollution on residents' mental well-being.

4.2. Modulating Effect of Urban Scale on Street Space

The differential effects of street space characteristics across city scales provide new insights into the role of urban context in shaping mental health outcomes. In small cities like Luoyang, the presence of cultural elements and low-density environments had a strong positive impact, suggesting that preserving historical and cultural features can enhance mental well-being. In contrast, the lack of significant effects of cultural elements in large cities may reflect the overwhelming influence of stressors such as noise and crowding, which overshadow the potential benefits of cultural features.

4.3. Implications for Urban Planning

These findings have important implications for urban planning and policy. In large cities, efforts to reduce noise levels and increase green spaces could significantly improve mental health outcomes. In medium-sized and small cities, integrating cultural elements and maintaining low-density environments should be prioritized to promote mental well-being. These strategies align with the principles of neurourbanism, which emphasize the need for evidence-based urban design to support mental health [12].

4.4. Limitations and Future Research

This study has several limitations. First, the cross-sectional design limits the ability to establish causal relationships. Longitudinal studies are needed to explore how changes in street space characteristics affect mental health over time. Second, the reliance on self-reported data may introduce bias. Future research could incorporate objective measures, such as physiological indicators of stress. Finally, the study focused on three cities in China; expanding the sample to include more cities and regions would enhance the generalizability of the findings.

5. Conclusion

This study provides evidence that street space characteristics significantly influence mental health outcomes in urban China, with effects varying by city scale. Greenery, noise levels, and cultural elements emerged as key factors shaping mental well-being, highlighting the importance of context-specific urban design strategies. By addressing the unique challenges and opportunities presented by large, medium-sized, and small cities, policymakers and urban planners can create healthier and more livable urban environments. Future research should build on these findings to further explore the mechanisms linking urban environments and mental health, ultimately contributing to the development of more effective interventions.

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