

Effects of Urban Parks on Resident Use Behaviors and Anxiety Relief

Jiayue YUN^{1,2}, Houzhi WANG^{1,2,*}, Wenfei Yao³

¹ School of Transportation, Southeast University, Nanjing 211189, China

² Nanjing Modern Comprehensive Transportation Laboratory, Nanjing 211189, China

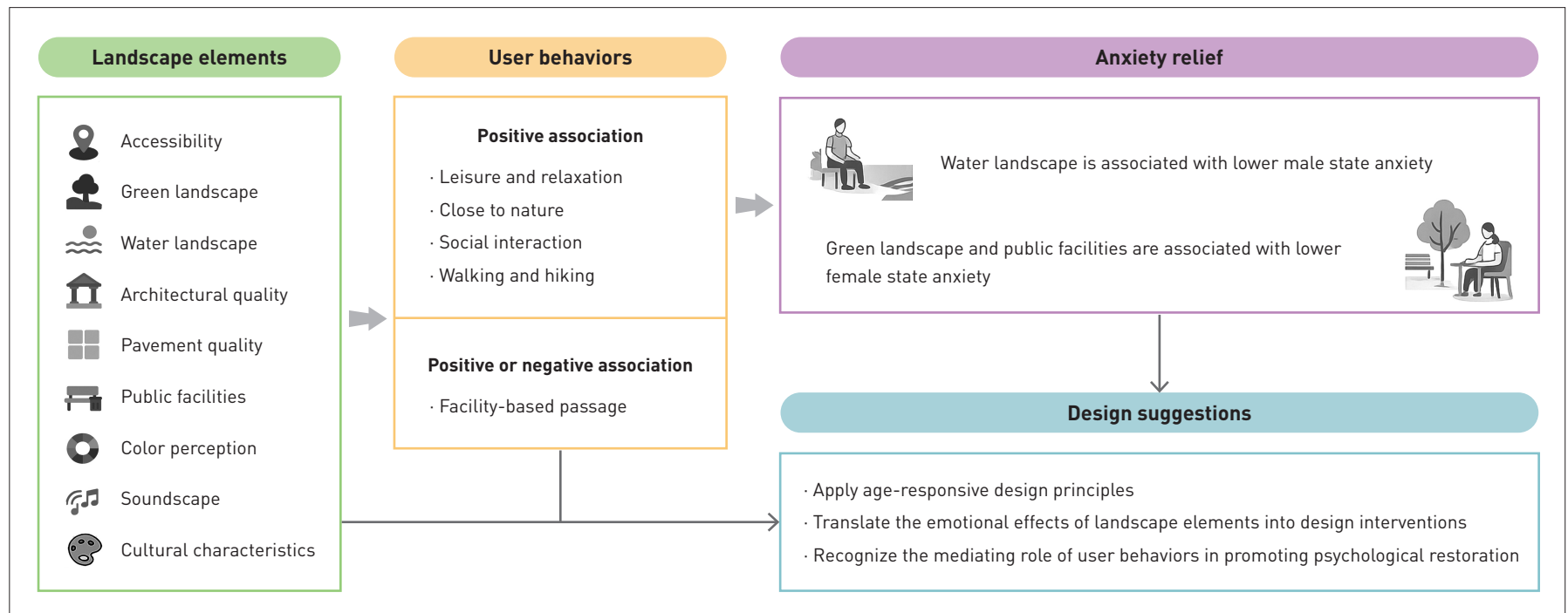
³ College of Architecture and Urban Planning, Qingdao University of Technology, Qingdao 266525, China

*CORRESPONDING AUTHOR

Address: No. 2 Southeast University Road, Jiangning District, Nanjing 211189, China

Email: houzhi_wang@seu.edu.cn

GRAPHICAL ABSTRACT



ABSTRACT

Rapid socioeconomic development and recent public health crises have posed increasing challenges to both physical and mental health, with anxiety emerging as a prevalent concern. Although studies have linked urban green spaces to improved health conditions, the interactional mechanisms among landscape, behavior, and mental health remain insufficiently tested. This study selected five representative urban parks in Qingdao as research sites and collected data on users' perceived landscape quality, user behaviors, and anxiety states using a structured questionnaire and the State-Trait Anxiety Inventory. The correlation analysis indicates that different landscape elements are significantly associated with

distinct user behaviors. Moreover, certain landscape elements are significantly correlated with users' state anxiety, with clear gender differences. Specifically, water landscape is significantly negatively correlated with male state anxiety, while green landscape and public facilities are significantly negatively correlated with female state anxiety. Overall, the relationships among urban park landscape elements, user behaviors, and anxiety relief are characterized by associative and non-linear patterns rather than a unidirectional pathway. This study provides empirical evidence to support urban park design and regeneration, contributing to scientifically bringing out their potential health benefits.

KEYWORDS

Urban Park; User Behavior; Anxiety Relief; Public Health; State–Trait Anxiety Inventory

HIGHLIGHTS

- Green landscape correlates with more leisure and relaxation and less facility-based passage
- Water landscape links to lower male anxiety, while green landscape and public facilities to lower female anxiety
- Anxiety relief is jointly associated with park use behavior and perceptual experience
- Behavior-informed park design can strengthen the urban park–user behavior–anxiety relief pathway

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1 Introduction

With the rapid economic development and accelerated pace of life, health issues, including population aging, chronic diseases, new infectious diseases, mental illnesses, and sub-health, have brought unprecedented challenges to modern people in terms of lifestyle and quality of life. Meanwhile, the cases of depression and anxiety have increased globally by 28% and 26%, respectively, in 2020 compared with pre-pandemic levels^[1]. The mounting health pressures have

drawn renewed attention to the importance of mental restoration in everyday environments^[2]. Some studies have shown that urban parks, as the main form of green space in built-up areas, not only regulate the urban environment and directly improve residents’ living environment with ecological benefits, but also indirectly generate physical and mental health benefits by encouraging users’ physical activities^[3–7]. It has been found that walking in a natural environment can lead to a greater sense of pleasure^[8]. Scholars have found a significant reduction in negative emotions and anxiety after walking in an urban park^[9–11]. These health effects of natural environments have been confirmed by Stephen Kaplan’s Attention Restoration Theory (ART) and Roger S. Ulrich’s Stress Recovery Theory^[12–13]. Higher tree coverage can effectively reduce the risk of mental illness and among urban residents^[14]. A growing amount of research has pinpointed the park characteristics that significantly impact anxiety levels, as well as the magnitudes of these effects. For example, research has demonstrated that youth are more satisfied with greenery landscapes and color perceptions of park landscape, and these factors are significantly correlated with socializing activities, disease rehabilitation, and relieving tension and anxiety^[3]. Urban green infrastructure has also been acknowledged for its positive impacts on mental health and well-being, which include lowering the prevalence of anxiety, promoting mental restoration, and reducing stress^[15]. Additionally, an existing study showed that the spatial arrangement of urban green spaces, such as viewing distance and vegetation edge permeability, can influence the restorative effect of depression^[16]. The presence of flowers, dense trees, and leisure facilities in urban parks influences public behavior and preferences^[17–18].

Although existing comparative and context-sensitive studies have examined how certain park attributes influence user behaviors or mental health, few have linked these dimensions within a unified framework or employed standardized measures to quantify anxiety responses. Such studies often overlook the interactive and multidimensional nature of park environments that collectively shape restorative experiences^[19]. Recent findings have confirmed the mental health benefits of green space exposure; however, the included indicators remain limited, often relying on single metrics or mixed objective–subjective approaches that fail to reconcile their conceptual disparities, thereby constraining cross-cultural applicability^[20]. Notably, stress and anxiety are more strongly associated with perceived greenness than with objective spatial measures^[21], underscoring a methodological gap in defining and evaluating the quality of environment. Even in areas with high green coverage, parks that are inaccessible, poorly maintained, or unsafe

may fail to promote psychological restoration, whereas small, aesthetically pleasing, and easily accessible parks can effectively alleviate anxiety. Therefore, comprehensive investigations should adopt multi-method, field-based strategies to clarify how perceived environmental attributes foster user engagement and contribute to anxiety relief.

Moreover, previous studies on the associations of green space and mental health have treated participants as a homogeneous population, relying primarily on large-scale national surveys (e.g., WHO-5, GHQ-12, GAD-7) or objective indices (e.g., NDVI)^[22]. These approaches capture the general trend that “greater greenness correlates with better mental health,” yet they fail to explain how differences in user preferences, motivations, and perceptions lead to varied outcomes. Therefore, it is essential to employ a standardized and culturally adaptable instrument capable of quantifying both transient and enduring forms of anxiety. The State-Trait Anxiety Inventory (STAI), established by Charles Spielberger with collaborators in 1970, is one of the most widely used measures for determining an individual’s anxiety level^[23] in psychological and related research, being translated into multiple languages and verified in a variety of cultural settings. To acquire a better knowledge of how the park environment influences anxiety relief, the STAI scale can be used to assess park visitors’ anxiety in a specific context as well as their chronic anxiety tendencies.

The environment–behavior–psychology linkage, frequently emphasized yet rarely verified through empirical testing in international research, calls for integrative analyses that jointly examine subjective perception, behavioral engagement, and psychological response within park environments. This methodological gap remains particularly evident in cross-cultural contexts, where users’ environmental perceptions and behavioral motivations may differ substantially^[24–26]. Addressing these gaps, this research aims to investigate how specific design elements of urban parks in Qingdao influence visitors’ state anxiety through

distinct perceptual and behavioral pathways. Recognizing that cultural variations may affect both the processes and outcomes of green space exposure, this research emphasizes the need to evaluate urban parks not only as ecological infrastructures but also as psychological restoration spaces^[27]. To achieve this, a user-based evaluation scale was developed, drawing upon domestic and international literature and tailored to the spatial characteristics of local urban parks. It integrated environmental perception metrics, behavioral observation, and psychological assessment to examine how perceived environmental quality shapes user behaviors and alleviates anxiety. Ultimately, this research aims to propose evidence-based design strategies to enhance park usability, strengthen residents’ mental health resilience, and contribute to the global discourse on restorative urban landscapes.

2 Methods

2.1 Research Subjects

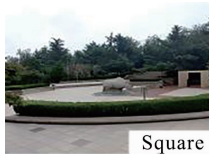
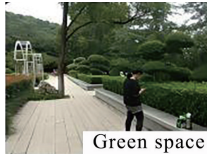


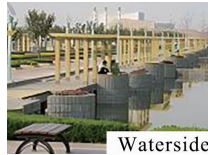










Qingdao, located in the southern part of Shandong Peninsula, is a famous tourist city and garden city in China and plays an important role in the region’s economic development. This research selected four districts of Qingdao with a large residential population: Chengyang, Shinan, Shibei, and Laoshan. Then, five highly representative and universal urban parks were selected through a preliminary site investigation and pilot study (Fig. 1), according to four criteria: 1) representing different types and characteristics; 2) exhibiting relatively high spatial accessibility and frequent visits; 3) maintaining stable and sound environmental quality and management conditions during the study period to minimize external interference; and 4) attracting users with diverse demographic and behavioral characteristics, enabling comparative analyses across groups (Table 1).

The five selected parks exhibit diverse spatial forms and functional orientations. Beiling Mountain Forest Park, situated

Fig. 1 Site plan of the five selected parks.



Table 1: Details of the selected parks

Park Name	Location	Area (hm ²)	Green space ratio (%)	Type	Pictures			
Beiling Mountain Forest Park	Shibei District	46.54	86.0	Forest park	 Square	 Green space	 Mountain area	 Waterside
Chengyang Century Park	Chengyang District	43.00	89.5	Science-themed and educational park	 Square	 Green space	 Mountain area	 Waterside
Haipohe Park	Shibei District	17.46	81.4	Cultural and recreational park	 Square	 Green space	 Mountain area	 Waterside
Xiaomaidao Park	Laoshan District	12.20	71.1	Coastal park	 Square	 Green space	 Mountain area	 Waterside
Zhongshan Park	Shinan District	75.00	83.0	Historic and comprehensive parks	 Square	 Green space	 Mountain area	 Waterside

NOTE

All pictures were taken by the authors during field investigations, and all data were collected through preliminary research and field investigation.

in the northern urban area, functions as a major forest park that integrates plant observation, recreation, and ecological restoration. Chengyang Century Park, located in Chengyang District, serves as the largest botanical and ecological park in Shandong Province, featuring extensive greenery and water bodies that support plant display, floral exhibitions, science and environmental education. Haipohe Park, located in a dense urban area, serves as a cultural and recreational park equipped with diverse public and fitness facilities for visitors of all ages. Xiaomaidao Park, positioned on a coastal island in the southern part of Qingdao, is characterized by its open landscape, panoramic sea views, and modern coastal design integrating leisure and tourism. Zhongshan Park, built in the early 20th century and surrounded by mountains and sea, represents one of Qingdao's most historic and comprehensive parks.^{[28-29]①}

All selected parks are located within high-density districts under municipal green space planning and are characterized by high green space ratios (above 70%) and stable maintenance systems. The parks exhibit consistent public activity and diverse user profiles were confirmed through preliminary field audits and systematic on-site observations.

2.2 Research Methodology

This research employed behavioral observation, questionnaires, and interviews to analyze the activities and anxiety characteristics

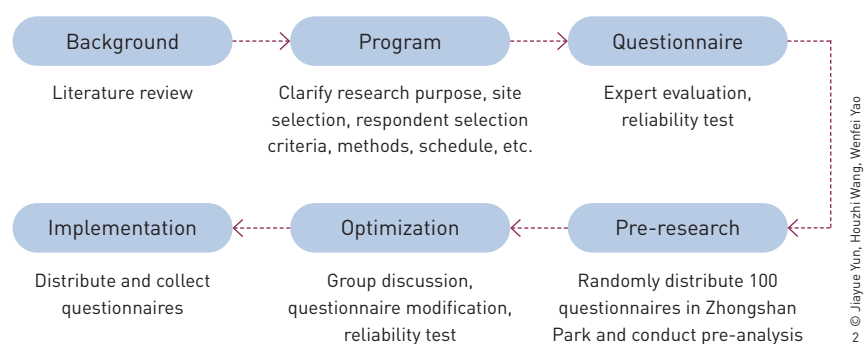
① Information on the current conditions and operational status of the five selected parks was obtained from the official website of the Qingdao Municipal Bureau of Culture and Tourism.

of urban park users in Qingdao. The questionnaire consisted of five parts. 1) Demographic characteristics: it collected the demographic data from the respondents. 2) Landscape quality: based on the respondents' spatial experiences, the spatial elements were assessed using a 5-point Likert scale. The evaluated elements included accessibility, green landscape, water landscape, architectural quality, pavement quality, public facilities, color perception, soundscape, and cultural characteristics. A score from 1 to 5 represented quality levels of the spatial elements perceived as very poor, poor, average, good, and very good^[23]. 3) User behaviors: this section examined the self-reported behaviors of visitors in urban parks and recorded the activity categories and spatial locations. 4) Anxiety state: to fully understand the anxiety state of park users, STAI was adopted. The STAI can be divided into the State Anxiety Inventory (SAI) and the Trait Anxiety Inventory (TAI). Typically, the SAI scores are slightly lower than the TAI scores in ordinary situations; however, the TAI scores would remain unaffected while the SAI scores would rise in stressful conditions, and the reverse occurs in relaxed environments^[23]. 5) Additional insights were collected through semi-structured interviews exploring participants' individual experiences, motivations for park visits, and opinions on anxiety alleviation and mental health benefits, with the complete questionnaire provided in the supplementary material.

2.3 Data Acquisition and Processing

Prior to the formal survey, a brief preparatory process was undertaken, which included a literature review, expert evaluation, pilot testing, and instrument improvement (Fig. 2). This research was conducted on weekends from August to October 2024, when the parks had a high flow of visitors. The questionnaires were distributed randomly in four types of spaces (i.e., mountains, watersides, green spaces, squares) within the five parks to ensure spatial diversity and minimize bias arising from site differences. A

Fig. 2 The workflow of the survey.



total of 500 questionnaires were distributed, with 100 in each park. Respondents were included if they met the following criteria and agree to participate in the questionnaire: 1) being active in the park and having stayed for a period of time; 2) having resided in Qingdao for at least 3 months prior to the survey and being familiar with the surveyed site, regardless of their place of birth; 3) aged 18 years or older; 4) able to communicate and writing in Chinese sufficiently to complete the questionnaire; 5) without medical conditions affecting walking ability or evident cognitive impairment; 6) not engaging in behaviors that could affect observation reliability or public safety (e.g., visible intoxication, disorderly conduct).

The data were organized and analyzed using SPSS 26.0 and Microsoft Excel. The questionnaire demonstrated good reliability (Cronbach's $\alpha = 0.758$) and validity ($KMO = 0.818 > 0.5$; Bartlett's test of sphericity, $p < 0.001$), confirming the adequacy of the sample size and correlation matrix for factor analysis. Pearson's correlation analysis was performed to quantify the linear relationship between urban park elements, user behaviors, and anxiety states, determining both the strength and direction of these associations.

3 Results

3.1 Users' Demographic characteristics

The surveyors distributed the questionnaires by random sampling within the parks and collected them on site. After eliminating invalid responses, 473 questionnaires were retained, yielding a valid response rate of 94.6%. The demographic characteristics of the surveyed park users are shown in Table 2. In terms of the age distribution, the respondents in Beiling Mountain Forest Park and Haipohe Park were predominantly aged 55 ~ 64 years, with fewer aged 18 ~ 44 years. In contrast, Xiaomaidao Park had the youngest user profile, with 55 users aged 18 ~ 24 years. Chengyang Century Park showed the highest proportion of users aged 25 ~ 44. Zhongshan Park also attracted 49 young visitors (aged 18 ~ 24). Other demographic factors, such as gender and residence, showed very consistent distributions among parks, with no significant differences across sites. This indicates that the variations in park types and overall design styles attract distinct age groups.

3.2 Users' Evaluation of Landscape Quality

As shown in Table 3, the overall landscape quality of the five city parks is ranked as follows: Chengyang Century Park, Xiaomaidao Park, Beiling Mountain Forest Park, Zhongshan Park, and Haipohe Park (ranking of average scores from highest to lowest). Among

Table 2: Demographic characteristics of the users

Demographic information		Beiling Mountain Forest Park	Chengyang Century Park	Haipohe Park	Xiaomaidao park	Zhongshan Park	Average
Valid response rate		92%	89%	100%	96%	96%	94.60%
Gender	Male	42	42	48	49	46	45.4
	Female	50	47	52	47	50	49.2
Age	18 ~ 24	7	30	3	55	49	28.8
	25 ~ 44	15	43	7	27	25	23.4
	45 ~ 54	15	10	19	8	12	12.8
	55 ~ 64	45	3	38	4	10	20.0
	65 or above	10	3	33	2	0	9.6
Place of birth	Within Qingdao	70	86	88	74	80	80.4
	Other	22	3	12	22	16	15.0

NOTE

No gender quota was applied during questionnaire distribution, the balanced gender proportions resulted from random on-site sampling.

Table 3: Ratings of landscape elements of each park

Landscape element	Beiling Mountain Forest Park	Chengyang Century Park	Haipohe Park	Xiaomaidao park	Zhongshan Park	Average
Accessibility	3.62	3.91	3.56	3.76	3.62	3.71
Green landscape	3.70	4.12	3.34	3.91	3.85	3.81
Water landscape	3.80	4.08	3.34	4.03	3.41	3.72
Architectural quality	3.61	3.88	3.15	3.68	3.66	3.59
Pavement quality	3.47	3.89	2.99	3.90	3.74	3.63
Public facilities	3.55	3.97	2.80	3.74	3.65	3.54
Color perception	3.80	4.01	3.29	4.04	3.70	3.76
Soundscape	3.67	3.91	3.27	3.88	3.57	3.66
Cultural characteristics	3.66	4.15	3.29	3.75	3.58	3.69
Average	3.65	3.99	3.23	3.85	3.64	—

them, the scores of all landscape elements in Haipohe Park were lower than average, with pavement quality and public facilities showing the greatest deficiencies.

3.3 User Behaviors

Drawing on the questionnaire survey, on-site observations, and classifications from the previous studies^[3,30-32], visitor activities

were classified into seven primary types of user behaviors in urban parks (Table 4).

3.4 Users' Anxiety State

The mean SAI and TAI scores for park visitors by gender are summarized in Table 5. Overall, women exhibited slightly higher mean SAI and TAI scores than men, suggesting that female visitors experienced greater sensitivity to environmental and social factors during park visits. A cross-sectional comparison between the anxiety scores of the five parks revealed that Haipohe Park visitors had the highest anxiety score, followed by Zhongshan Park, Xiaomaidao Park, Chengyang Century Park, and Beiling Mountain Forest Park. This pattern suggests that users of Haipohe Park experienced relatively greater psychological tension and less emotional restoration. In contrast, Beiling Mountain Forest Park and Chengyang Century Park, with richer vegetation and quieter, more natural environments, exhibited lower mean SAI and TAI values in both genders, indicating stronger restorative potential.

Table 4: User behaviors in urban parks

Activity type	User behavior	Specific activity
Static	Leisure and relaxation	Reading, meditation, playing, singing, drinking, etc.
	Close to nature	Observing vegetation, observing wildlife, informal ecological education, taking nature-focused photos, etc.
	Social interaction	Chatting, meeting, playing cards and chess, picnics, etc.
Dynamic	Facility-based activity	Fitness equipment activity, amusement facility activity, leisure facilities activity, etc.
	Venue event	Running, dancing, sword dancing, martial arts, playground entertainment, etc.
Passing	Walking and hiking	Walking, pet walking, mountain/trail hiking, walking with a stroller, etc.
	Facility-based passage	Skateboarding, scooter riding, tramway, boating, etc.
Other		Merchandising, plant research, etc.

Table 5: Users' anxiety state

Anxiety state	Beiling Mountain Forest Park	Chengyang Century Park	Haipohe Park	Xiaomaidao park	Zhongshan Park	Average
Mean male SAI	27.33	31.12	39.73	33.59	40.11	34.38
Mean female SAI	34.57	34.40	42.86	34.68	29.72	35.25
Mean male TAI	29.07	32.92	39.17	36.68	41.26	35.82
Mean female TAI	36.88	37.10	42.02	38.04	32.96	37.40
Overall average	31.96	33.89	40.95	35.75	36.01	—

3.5 Correlation Analysis Between Landscape Elements and User Behaviors

The results of correlation analysis (Table 6) show that the leisure and relaxation behavior of users was positively and significantly correlated with perceived accessibility, green landscape, architectural quality, color perception, and cultural characteristics. The behavior of close to nature was positively and significantly correlated with color perception and cultural characteristics. Facility-based passage behavior had a significant negative correlation with perceived green landscape. Overall, the findings reflect differentiated behavior-landscape relationships rather than uniform responses across activities.

3.6 Correlation Analysis Between Landscape Elements and Anxiety States

The correlation analysis between landscape elements and anxiety states (Table 7) indicated that water landscape was significantly negatively correlated with male state anxiety, while green landscape and public facilities showed significant negative correlation with female state anxiety. For TAI, none of the landscape elements showed statistically significant correlations for either gender, consistent with the relative stability of TAI, which is shaped more by enduring personal dispositions than by immediate environmental factors.

Table 6: Correlation analysis between landscape elements and user behaviors

User behavior	Landscape element								
	Accessibility	Green landscape	Water landscape	Architectural quality	Pavement quality	Public facilities	Color perception	Soundscape	Cultural characteristics
Leisure and relaxation	0.487**	0.548**	0.245	0.480*	0.444	0.421	0.318*	0.480	0.415*
Close to nature	0.241	0.349	0.366	0.209	0.104	0.268	0.320*	0.327	0.306**
Social interaction	0.487*	0.482	0.378	0.322	0.488*	0.387	0.384	0.389	0.308
Facility-based activity	0.489	0.464	0.449	0.452	0.484	0.337	0.300	0.366	0.401
Venue event	0.365	0.322	0.410	0.592	0.327	0.396	0.387	0.471	0.457
Walking and hiking	0.212	0.221	0.431	0.336	0.046*	0.223	0.357	0.422*	0.423*
Facility-based passage	0.444	-0.535**	0.448	0.392	0.460*	0.462*	0.322*	0.420	0.387

NOTE

* means $p < 0.05$, ** means $p < 0.01$.

Table 7: Correlation analysis between landscape elements and anxiety states

Anxiety state	Landscape element								
	Accessibility	Green landscape	Water landscape	Architectural quality	Pavement quality	Public facilities	Color perception	Soundscape	Cultural characteristics
Male SAI	-2.900	-1.100	-0.469*	-0.044	-0.900	-0.490	-0.401	-0.332	-0.118
Female SAI	0.142	-0.122*	-0.070	0.104	-0.182	-0.553*	-0.193	0.191	0.405
Male TAI	-0.300	-0.197	-0.412	-0.073	-0.128	-0.153	-0.440	-0.280	-0.182
Female TAI	0.187	-0.064	-0.027	0.137	-0.181	-0.53	-0.222	0.310	0.414

NOTE

* means $p < 0.05$.

4 Discussion

4.1 Preference for Landscapes

A combination of on-site observations and interviews revealed that different types of parks and their overall design styles appeal to different age groups. The elderly tended to have higher expectations regarding the quality of public facilities and environmental hygiene, and younger users responding more strongly to visually cohesive and activity-supportive environments. These patterns correspond with the landscape performance scores in Table 3. Chengyang Century Park and Xiaomaidao Park received the highest scores for

perceived landscape quality according to the average score of all the landscape elements for each park, characterized by consistent satisfaction of green landscape, water landscape, pavement quality, and color perception, suggesting well-integrated spatial and visual structures. Beiling Mountain Forest Park and Zhongshan Park demonstrated moderate but stable performance, with notable strengths in green landscape. As the largest of Qingdao's ten major forest Parks, Beiling Mountain Forest Park contains natural vegetation^[28,33], including *Pinus massoniana* Lamb., *Cedrus deodara* (Roxb.) G. Don, *Prunus serrulata* var. *lannesian.*, *Rosa chinensis* Jacq., and *Alcea rosea* L., which provide abundant seasonal changes

and contribute to well-performing water features and green landscapes.

4.2 Environment-Mediated Pathways of Activity

Among the identified users' behaviors of the participants, the motivation for leisure and relaxation is relatively more susceptible to environmental features. This research shows that residents pay more attention to accessibility, green landscape, color perception, and culture characteristics of urban parks when engaging in static behaviors (i.e., leisure and relaxation, close to nature, social interaction). Facility-based passage was more strongly associated with pavement quality and public facilities (e.g., resting areas). Color perception also exhibited a significant positive association with facility-based passage, highlighting the role of coherent color patterns in facilitating efficient movement. Areas with dense vegetation or complex terrain tended to hinder facility-based passage, whereas open paths and well-designed hardscape encouraged its usage.

These findings align with previous research emphasizing the role of perceived accessibility and landscape comfort in shaping leisure and relaxation use^[34]. In this study, users prefer semi-sheltered settings, which feature tree canopy covering, plant enclosure, and controlled acoustic conditions, over fully open or exposed locations. The preference for semi-enclosed spaces is consistent with existing environmental psychology research, which found that plant structure and enclosure enhance perceived safety and relaxation^[35]. Residents engaged in static behaviors often prefer environmental features that offer visual and acoustic comfort, as well as cultural expression. Moreover, densely vegetated areas in this study appeared to relate with inhibited facility-based passage, whereas prior literature predominantly attributes limitations in physical activity to terrain variation^[36]. Conversely, well-maintained hardscape and strong color experiences enhance users' motivation for play-related activities^[32].

4.3 Anxiety Recovery Pathways

The results revealed distinct gender differences in the pathways through which landscape elements in urban parks influence anxiety. For male visitors, a significant negative correlation was found between water landscapes and state anxiety, indicating that the presence of water elements, such as ponds, fountains, and rivers, was associated with lower momentary anxiety, suggesting a restorative effect by reducing tension and facilitating emotional regulation. For female visitors, the presence of green

landscapes and public facilities were more strongly associated with lower anxiety levels. Although the correlation between green landscape and female anxiety was relatively weak, it still suggests that vegetation and visual contact with nature may contribute to psychological relaxation. Well-designed and adequately maintained public facilities also showed a moderating effect on female anxiety, likely through enhanced comfort, accessibility, and perceived safety. Importantly, these results also demonstrate that a restorative urban park environment cannot rely solely on a high green coverage rate. While vegetation coverage contributes to visual comfort and microclimate regulation, this research indicates that the psychological benefits of parks depend on holistic interaction of multiple environmental elements, including spatial openness, water features, soundscape, lighting, and facility accessibility.

These findings are consistent with previous research showing that water environments promote relaxation and improve mental health by offering tranquil auditory and visual stimuli^[37]. Research on physiological responses further suggest that visual exposure to water scenes reduce negative emotions such as anger, fatigue, and confusion^[38]. In line with existing studies, women were found to be more vulnerable to environmental stressors and more likely to experience anxiety in unsafe or dimly lit park spaces^[39-40]. Meanwhile, the mitigating effect of well-managed, illuminated public facilities on female anxiety observed in this research corroborates Vania Ceccato et al.^[41]. Similarly, Jian Xu et al. reported that the presence of developed recreational facilities enhances physical activity^[42], and physical activity has been shown to reduce fatigue, and relieves anxiety symptoms^[43].

Although no direct evidence links user behaviors to reduce anxiety, environmental characteristics strongly influence both behavioral patterns and emotional responses in urban parks. Environments with higher accessibility, richer greenery, more abundant water features, and well-maintained facilities encourage users to stay longer, engage in leisure or social interaction, all of which may indirectly contribute to lower momentary anxiety. Therefore, creating restorative parks requires an integrated design approach that considers not only vegetation coverage but also the interaction between spatial quality, behavioral experience, and psychological response. Enhancing green landscape, accessibility, water landscape, public facilities, and sensory diversity can guide users toward beneficial patterns of park use and strengthen the environment-behavior-psychology linkage. In this context, behavior could enable psychological recovery as a response to environmental affordances. This viewpoint is supported by recent

empirical studies, which demonstrate that spatial openness, shaded vegetation, and seating arrangements promote restorative behaviors (e.g., relaxation, quiet contemplation), thereby corresponding to lower perceived stress and anxiety^[44-46]. This underscores the importance of behavior-informed urban park design, where environmental elements should be carefully planned to encourage positive and restorative engagement and foster emotional recovery and mental well-being.

4.4 Suggestions on Park Planning and Design Practice

Based on the findings of this paper, three suggestions can be provided for park planning and design practice. 1) Age-responsive design principles should be applied into park planning, enhancing accessibility and supportive infrastructure for older adults and enriching experiential and activity-based environments for younger populations. 2) Park planning and design should translate the landscape elements' effects on emotion into concrete design interventions. Improving the legibility, maintenance quality, and sensory qualities of parks—such as accessible water features, well-kept facilities, and ordered, visually open green spaces—may improve the restorativeness of urban park environments for reducing immediate anxiety. It is necessary to consider both the existing site conditions and the influencing factors of users' emotions, and carry out targeted planning, design, and optimization measures of the park. 3) Implement park design that recognizes the mediating role of user behaviors in promoting psychological restoration. Although differences in user behaviors have not directly linked to anxiety reduction, such behaviors may act as a mediating mechanism: supportive landscape elements can encourage users to interact with the environment for longer and greater comfort, creating conditions that may help reduce momentary anxiety. Specifically, designers should provide comfortable seating, clear visual openness, and shaded or semi-enclosed areas to support longer stays, relaxation, and low-intensity engagement, which indirectly promote emotional recovery. Moreover, a balanced combination of natural and built elements, such as greenery, water features, lighting, and accessible pathways, can stimulate diverse behavioral patterns that strengthen the environment-behavior-psychology linkage. In this way, park design can move beyond aesthetic or ecological goals to actively foster psychological well-being through behavior-oriented spatial planning.

This research also brings up specific recommendations for the five investigated parks. Historic and comprehensive parks should improve the blending of green and blue landscapes

while maintaining high-quality, multifunctional facilities. Clearer interpretative systems and well-organized activity spaces that facilitate learning and engagement would improve science-themed and educational parks. Coastal parks should promote waterfront accessibility, encourage coastal circulation patterns, and maintain visual consistency with the coastline environment. Cultural and recreational parks necessitate careful preservation of historical features, inviting gathering areas, and unified architectural design. Forest parks should stress accessible paths, enhanced landscaping structure, and clear way finding to ensure secure accessibility across challenging terrain.

5 Conclusions

By exploring the relationship and influence mechanism between urban parks and public health, this research aims to propose a theoretical basis and reference value for building an urban environment that enhances physical activity, physical and mental health, and overall well-being. Analysis of the five sample parks revealed the following key findings.

1) Different landscape elements are significantly associated with distinct user behaviors. The relationship between these behaviors and landscapes demonstrates the various pathways through which people interact with environmental elements.

2) Certain landscape elements are significantly correlated with users' state anxiety, with clear gender differences. Specifically, water landscape is significantly negatively correlated with male state anxiety, while green landscape and public facilities are significantly negatively correlated with female state anxiety.

3) The relationship among urban park landscape elements, user behaviors, and anxiety relief is characterized by non-linear associative patterns. Urban parks shape users' behavioral patterns, which might help alleviate brief anxiety through interaction with environmental features. Anxiety relief therefore arises not merely from the physical environment itself but from the dynamic feedback between park use and perception.

Designing parks that encourage active and multisensory engagement can strengthen the urban park-use behavior-anxiety relief pathway, enhancing restorative outcomes and promoting public mental well-being.

6 Limitations and Prospects

This research relied primarily on questionnaires and on-site observations, which allowed researchers to acquire subjective

evaluations and affective responses to park environments. However, objective environmental measurements were not included. For example, this research did not consider park microclimate characteristics (e.g., temperature, humidity, wind speed), air quality, or noise levels. These parameters may have a major impact on user behaviors and anxiety reduction, and the lack of such data limits the research to comprehensively understand the mechanisms underlying the urban park–use behavior–anxiety relief pathway. In addition, due to limited observation time and sample sites, this research may not be able to thoroughly capture all kinds of behavioral patterns and processes of behavioral change, consequently disregarding behavioral variations across time. Furthermore, as the study did not assess anxiety states before and after park use, it was unable to detect any changes in anxiety related to entering or remaining in the park environment; thus, the findings reflect associations rather than pre-post effects. It is advised that future research can apply technological tools (e.g., environmental monitoring equipment, portable mobile monitoring) to systematically measure the objective environment parameters and uses behaviors.

ELECTRONIC SUPPLEMENTARY MATERIAL

Supplementary material is available in the online version of this article at <https://doi.org/10.15302/J-LAF-0-020057>.

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城市公园对居民使用行为和焦虑缓解的影响

员佳乐^{1,2}, 王厚植^{1,2,*}, 姚文飞³

1 东南大学交通学院, 南京 211189

2 南京现代综合交通实验室, 南京 211189

3 青岛理工大学建筑与城市规划学院, 青岛 266525

*通信作者

地址: 江苏省南京市江宁区东南大学路2号

邮编: 211189

邮箱: houzhi_wang@seu.edu.cn

摘要

快速社会经济发展与近期公共卫生危机同时对大众身心健康带来日益严峻的挑战, 其中焦虑问题已成为普遍困扰。尽管已有研究表明城市绿地与健康改善存在关联, 但景观、行为及心理健康的相互作用机制仍缺乏充分探讨。本研究选取青岛5处代表性城市公园为研究对象, 通过结构化问卷和状态-特质焦虑量表采集使用者感知的景观质量、使用行为及焦虑状态数据。相关性分析结果发现, 不同景观要素与特定使用行为之间存在显著关联。城市公园使用者以静态使用行为为主, 这类行为与特定景观要素显著相关。此外, 部分景观要素与使用者状态焦虑显著相关: 水景与男性状态焦虑呈显著负相关, 而绿地景观和公共设施与女性状态焦虑呈显著负相关。总体而言, 城市公园景观要素、使用行为与焦虑缓解之间呈现出非线性、关联性特征, 而非单向作用路径。本研究为城市公园设计与更新提供了实证依据, 有助于科学发挥其潜在健康效益。

关键词

城市公园; 使用行为; 焦虑缓解; 公共健康; 状态-特质焦虑问卷

文章亮点

- 绿地景观与休闲放松呈正相关, 与基于设施的通行活动呈负相关
- 水景与较低的男性焦虑水平相关, 绿地景观和公共设施则与较低的女性焦虑水平相关
- 公园使用行为与感知体验共同影响焦虑缓解
- 基于行为特征的公园设计可强化“城市公园-使用行为-焦虑缓解”的关联路径

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