Analysis of Older People's Use of Nighttime Urban Parks and Landscape Satisfaction

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ABSTRACT

Urban life's busyness and high pressure have increased demand for all-weather park use, yet most studies examine daytime landscapes with limited attention to older adults' nighttime satisfaction. This study analyzes nighttime usage patterns and landscape satisfaction among older adults in five urban parks in Linyi City, China. Data from 78 respondents indicated that physical exercise (89.7%) and social gatherings (83.3%) were primary activities, underscoring parks' roles in supporting physical and social well-being. Frequent visitors rated functional elements highly—satisfaction for lighting (89.7%) and safety facilities (91%) strongly correlated with increased park use. These findings highlight the importance of well-lit, safe, and accessible parks in promoting nighttime visits among older adults. Conversely, plant-related features such as light-colored and aromatic plants were over 90% dissatisfaction, suggesting they contribute little to the nighttime park experience. The weak correlation between plant characteristics and usage patterns indicates older visitors prioritize safety and functionality over aesthetics at night. The study concludes that urban park designs should prioritize improved lighting, safety, and accessibility to better serve older adults after dark, while incorporating inclusive and adaptive features such as age-sensitive lighting and activity zones to enhance the nighttime experience for all generations.

Keywords: Nighttime urban park; Landscape satisfaction evaluation; Sensory experiences; Older adults; Inclusive design

INTRODUCTION

Urban heat, busy lifestyles, and high costs of evening entertainment push many residents toward nighttime park visits(Scotti et al., 2024). Cooler temperatures make outdoor activities more appealing in the evening, particularly in warmer regions (Bonnie et al., 2019; Ngesan and Karim, 2013; Wong, 2009). While traditional park design has focused primarily on daytime use (Li et al., 2021; Jaszczak et al., 2021), the need to improve nighttime experiences is growing as cities expand (Ngesan et al., 2013; Bonnie et al., 2019). This shift reflects a broader trend in urban planning to maximize park use at all times of the day, thereby increasing recreational access (Hami and Maruthaveeran, 2018; Butler, 2014).

Landscape satisfaction evaluation has been a critical focus in park studies as an integral component of visitor satisfaction, shaping the overall quality of park environments (Nordh and Østby, 2013; Shamsuddin et al., 2012). Researchers have consistently highlighted the relationship between landscape quality and user satisfaction, specifically aesthetic value, plant variety, and recreational amenities (Jim and Chen, 2009; Lee and Kim, 2015). Several studies underscore the importance of landscape satisfaction as a primary factor contributing to visitors' positive experiences and return visits (Zhang and Zhou, 2020; Mehta, 2014). The evaluation of landscapes typically involves factors like vegetation, seating arrangements, water features, and overall park design (Golicnik and Thompson, 2010). However, the focus has predominantly been on daytime park use, leading to a significant gap in the literature concerning nighttime landscape satisfaction.

While much attention has been devoted to daytime landscapes, few studies address how these landscapes perform

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after dark, especially in the Chinese context (Bonnie et al., 2019). The nightscape presents a distinct set of challenges and opportunities, especially regarding safety, visibility, and environmental comfort (Xiao et al., 2016). Nighttime park visitors may have different preferences for plant species, lighting, and seating arrangements, often driven by unique sensory experiences like scents or the contrast of light and shadow (Liao et al., 2020). This gap in the research is particularly evident when considering that certain landscape characteristics, such as fragrant or light-colored plants, may enhance nighttime usability by making parks more inviting and safe (Hami and Maruthaveeran, 2018; Gao et al., 2018). Hence, more comprehensive studies focusing on the nightscape of parks could bridge this gap, enhancing the overall understanding of park satisfaction in both daytime and nighttime contexts.

Studies have shown that older adults comprise a significant portion of nighttime park visitors (Godbey, et al., 1992). Designing parks that cater to older adults' nighttime needs is crucial in rapidly urbanizing areas like China, where aging populations continue to grow. However, older adults are also underrepresented in studies of park design and landscape perception after dark (Jim and Chen, 2006; Shan, 2014; Bonnie et al., 2019). Their needs must be considered to ensure urban parks are accessible and inclusive for all ages (Chu et al., 2021; Perry et al., 2021). With these, this study aims to explore how older people use and evaluate landscape characteristics in nighttime parks through the Chinese cultural context. There are three objectives in this study: (1) identify the landscape characteristics of the park at night; (2) investigate how older people use parks at night and assess how satisfied users are with landscape characteristics; and (3) analyze the relationship between the usage patterns and landscape characteristic satisfaction. This study fills a gap in the existing knowledge on nighttime park usage in a rapidly developing metropolitan city, China.

STUDY AREA

Five chosen urban parks in Linyi City, Shandong Province, China, were the study's locations (**Fig. 1**). Linyi City is situated about 34°22'N and 117°24' E. Which covers 17,191.2 square kilometers, with 10,993,100 residents as of the end of 2022 and a 4.92 natural population growth rate, Linyi City is one of Shandong Province's most densely inhabited municipalities.

Five large urban parks in Linyi City were chosen for the study (**Table 1**). These comprehensive parks, located in the Lanshan area and near Luozhan District, serve various purposes and are popular among locals, with extended opening hours into the night.

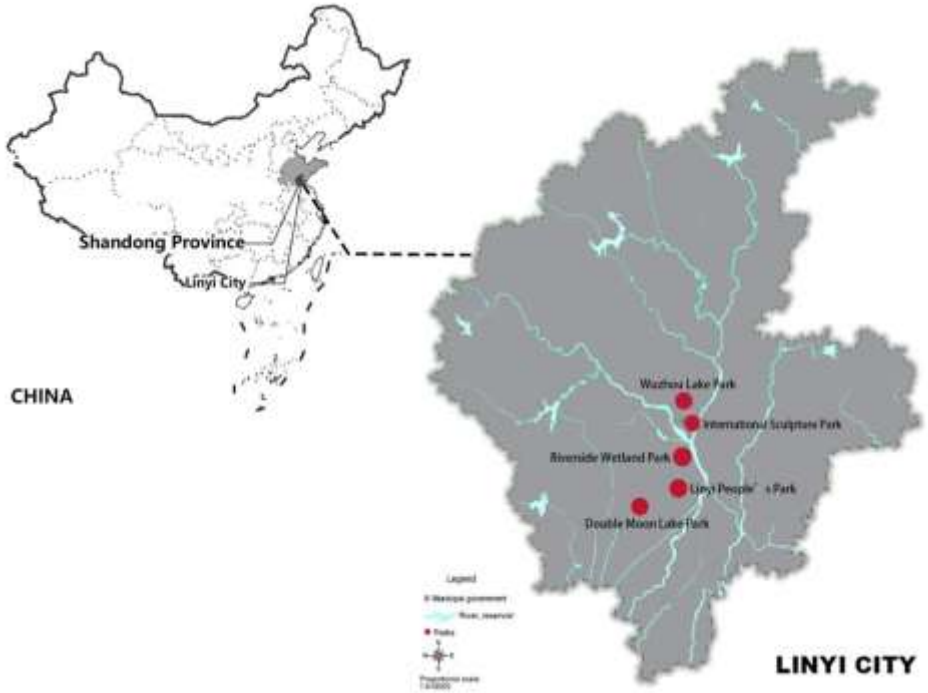

Fig. 1. Selected urban parks as study sites in Linyi City.

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Table 1. Brief description of the study sites.

NO.	Urban park	Park description
1	Linyi People's Park 	Year: 1999 Size: 420 acres Open hours: 6:00-22:00 Character: The park includes lighting, security kiosks, and CPTED. The restaurant overlooks the park and river, and the boulevard has swing chairs, gardens, promenades, fountains, and light displays.
2	Linyi Wuzhou Lake Park 	Year: 2009 Size: 260000 m² Open hours: 00:00-24:00 Character: The park, themed around the world's five continents, features diverse flora and zones for active leisure. Located near City Hall and surrounded by upscale residences, it stands as a city landmark with its shading structure, interactive lighting, and nighttime fountain.
3	Linyi International Sculpture Park 	Year: 2010 Size: 800 acres Open hours: 00:00-24:00 Character: The 800-acre park, with 102 famous sculptures and 95% greenery, is divided into five themed areas, blending nature and art with water features, trees, and pathways.
4	Riverside Wetland Park 	Year: 2003 Size: 70 km² Open hours: 00:00-24:00 Character: The park, built along the river, is a popular spot for nighttime events and fishing. It features open lawns, paths, shady seating, performance areas, a playground, snack shop, and running track.

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5	Double Moon Lake Park 	Year: 1993 Size: 1300 acres Open hours: 00:00-24:00 Character: The park includes bike lanes, walking paths, lawns, performance stages, interactive water and light features, and a plaza for tai chi, square dancing, and other activities.

METHODS

The primary objective of this study is to examine the nighttime usage patterns of urban parks by elderly visitors and assess their satisfaction with various landscape characteristics, with the aim of optimizing night park landscapes and fostering vibrant nighttime spaces. To achieve this, 10 typical night landscape characteristics were identified as satisfaction evaluation indicators through a comprehensive literature review. Subsequently, interviews with elderly park users were conducted to investigate their nighttime park usage patterns and their satisfaction with these landscape characteristics. Based on the data collected, correlation analysis was employed to explore the relationship between park usage patterns and user satisfaction with the 10 selected landscape characteristics. This approach allowed for a deeper understanding of how specific landscape characteristics influence nighttime park use among the older people. **Fig. 2** shows a diagram in which the methodological procedure of this study has been presented.

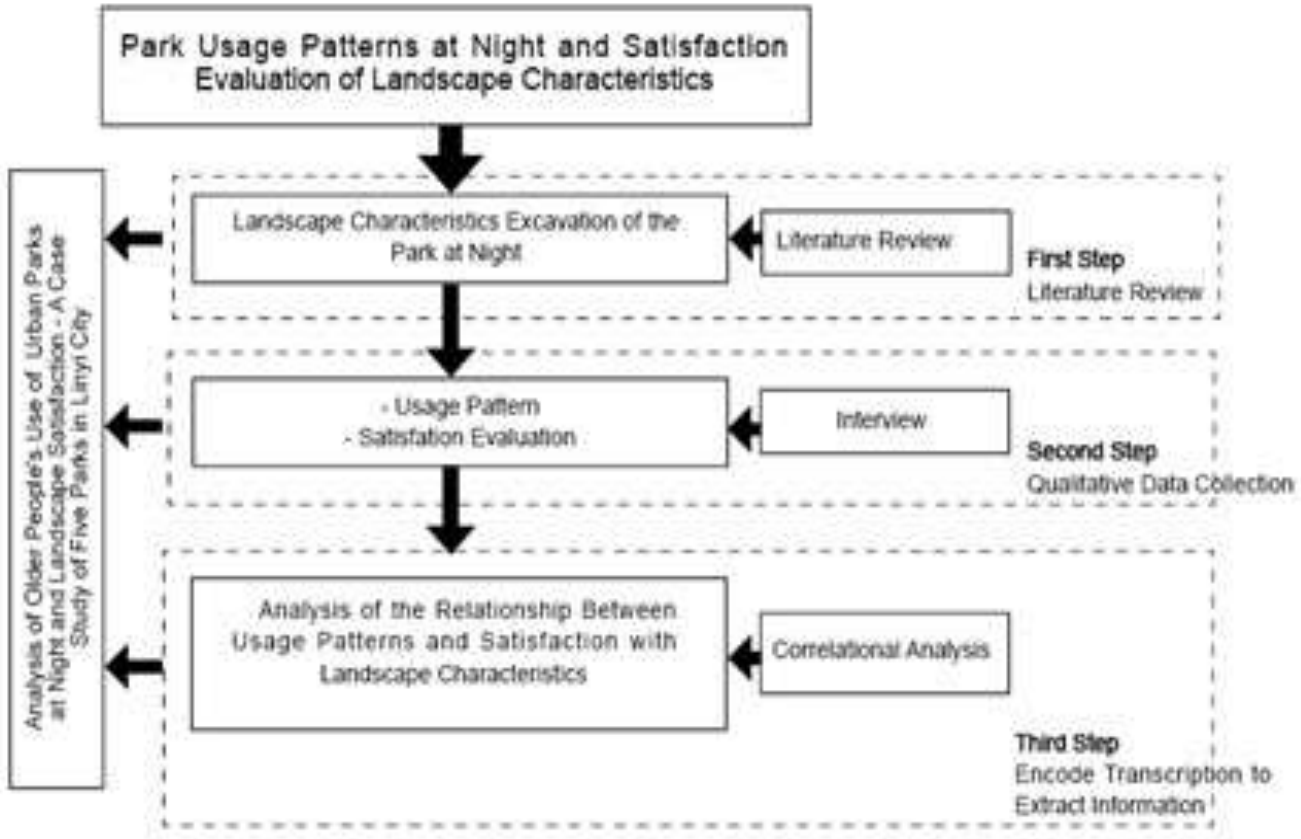

Fig. 2. The methodological procedure diagram of this study.

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Participants selection

Participants in this study were selected using convenience sampling, targeting older adults who were actively using five major urban parks in Linyi City during nighttime hours (6:00 p.m. to 10:00 p.m.). A total of 78 older park users were interviewed between July 15 to July 30, 2024, with interviews conducted in person at various locations within the parks, such as walking trails, rest areas, and exercise zones. This non-probability sampling method was chosen due to the exploratory nature of the research and the need to capture real-time user experiences in context. To ensure a reasonable level of demographic diversity, the sample included both male and female participants aged 60 and above, with ages ranging from 60 to 85 years ($M = 68.4$, $SD = 6.1$). In terms of gender distribution, 41 participants (52.6%) were female and 37 (47.4%) were male. Regarding educational background, 35.9% had completed primary school, 39.7% had a junior high school education, 17.9% had completed high school, and 6.4% held college or higher-level degrees. The majority of participants were retired urban residents who reported regular nighttime park usage, typically for activities such as walking, socializing, dancing, or simply enjoying the environment. This sample provides a varied cross-section of the older population in Linyi's urban areas and is suitable for exploring landscape satisfaction and nighttime park use behaviors among elderly users.

Selection of evaluation indicators for nighttime park landscape satisfaction

Nighttime urban parks, like their daytime counterparts, provide essential ecosystem services. These include cultural services that enhance recreational and spiritual experiences through aromatic and light-colored plants, and regulating services that control climate and soil quality (Toledo-Gallegos et al., 2022; Wu et al., 2021; Hami, 2018; Lynch, 1995). To encourage nighttime visits, parks could introduce areas for social events and excursions beyond traditional sports facilities, alongside adding food stalls after dusk. Safety concerns can be mitigated through careful design and management (Bonnie et al., 2019).

The main environmental factors affecting the attractiveness and satisfaction of nighttime parks include aspects like comfort, aesthetics, and safety (Buxton, 2020; Jaszczak et al., 2021). This study used literature review to identify ten key landscape indicators to assess these factors, drawing on research about walkability, landscape preferences, and planning guidelines. These indicators consider accessibility for diverse user groups, various activities, vegetation coverage, plants with light colors or different forms, aromatic and mosquito-repellent plants, seating options, street connections, lighting, and safety facilities. The full list of these indicators can be found in **Appendix A**.

Park usage patterns and landscape satisfaction evaluation based on interviews

The second method of this study involved conducting interviews with 78 older park users to analyze their nighttime usage patterns and satisfaction with the park's landscape characteristics. After obtaining consent, the researcher provided participants with a brief overview of the study's objectives, interview techniques, content, and expected duration. The face-to-face semi-structured interviews were conducted at night in the park. The interview questions, detailed in **Appendix B**, were divided into three sections. First, participants were asked about their nighttime park usage, including frequency of visits and types of activities. Second, they rated their satisfaction with the park and identified specific landscape characteristics influencing their satisfaction. The final section sought participants' suggestions for future improvements to nighttime park planning, with participants given 5–10 minutes to reflect on their responses before sharing their thoughts.

Correlation analysis between usage patterns and landscape satisfaction

To analyze the relationship between nighttime park usage patterns and satisfaction with landscape characteristics, the Pearson's Correlation Analysis is used to measure the strength and direction of the linear relationship between continuous variables, such as the relationship between the frequency of park visits, duration of stay and satisfaction levels with various landscape characteristics. The specific analysis procedure is shown in **Fig. 3**.

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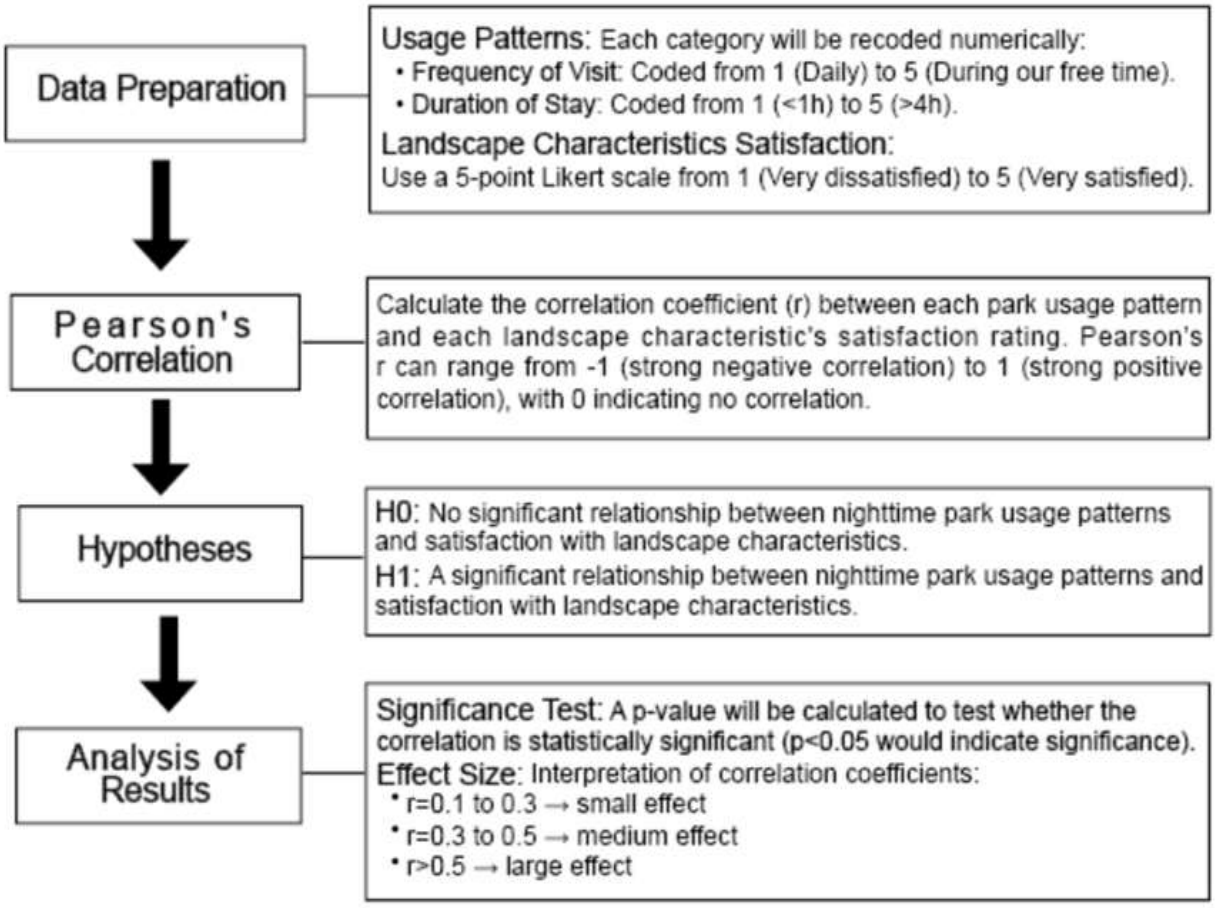

Fig. 3. Analysis procedure.

Research with human subjects

This study obtained Institutional Review Board (IRB) approval for conducting research involving human subjects through online surveys. The initial application received expedited review and was approved by University Putra Malaysia. After the pilot study was completed, additional revisions were submitted and approved as an amendment. No personally identifiable information, such as names, email addresses, or IP addresses was collected from the respondents.

RESULTS

Nighttime park usage pattern

Table 2 presents data on nighttime park usage patterns from 78 respondents. Most participants (74.4%) visit parks 1–2 times per week, with 15.4% visiting daily. Visits lasting 1–2 hours are the most common, accounting for 82.0% of respondents, while only a small portion (12.8%) stays for less than an hour. The primary activities include physical exercise, such as walking, running, or cycling (89.7%), and social gatherings (83.3%). Enjoying nature, like listening to birdsong, is also a frequent activity (79.5%), while quieter activities, such as thinking, reading, or using electronic devices, are engaged in by 38.5%. Eating and drinking in the park are less common, with only 15.4% of respondents participating. The most prevalent reason for visiting parks at night is to exercise or play games, reported by 89.7% of participants, followed by the desire to appreciate nature (83.3%) and the reduced busyness of parks at night (53.8%). Safety and lighting were considerations for 51.3% of respondents. Additionally, 43.6% found nighttime parks to be a quiet space that helps reduce stress and relax, while only 10.3% cited a lack of fear of going out at night as a reason for visiting. Overall, nighttime park visitors prioritize physical activities, social interactions, and a peaceful environment, with safety and tranquillity playing essential roles in visiting.

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Table 2. Park usage (N=78).

Nighttime park usage characteristics	Frequency	Percentage
Frequency of park visit		
During our free time	1	1.3
1-2 times/year	2	2.6
1-2 times/month	5	6.4
1-2 times/week	58	74.4
Daily	12	15.4
Duration of stay		
< 1h	10	12.8
1-2h	64	82.0
2-3h	3	3.8
3-4h	1	1.3
>4h	0	0
Activities*		
Quiet thinking/read/use electronic devices	30	38.5
Social gathering	65	83.3
Enjoy nature/listen to birdsong/fishing and other natural activities	62	79.5
Walking/running/cycling and other physical activities	70	89.7
Eat or drink	12	15.4
Reasons for visiting urban parks at night*		
Not afraid to go out at night	8	10.3
A quiet space at night can reduce stress and relax	34	43.6
To exercise, to play games	70	89.7
To appreciate the nature	65	83.3
Less busy at night	42	53.8
It’s safe and well-lit at night	40	51.3

*Multiple responses were solicited.

Landscape characteristic satisfaction evaluation

After answering several questions about park usage patterns at night, 78 older adults were also asked to rate their satisfaction with specific landscape characteristics (**Fig. 4**). Regarding "Access by different user groups," 28.2% of respondents express dissatisfaction, while 48.7% are neutral. Only 23.1% are satisfied, indicating that accessibility is a concern for nearly a third of the users, though it also leaves room for improvement. For "Activity availability," 53.8% are satisfied, but a significant 46.2% remain neutral, suggesting that while many users find the activities sufficient, nearly half are not engaged enough to form a strong opinion.

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Although "Vegetation coverage" achieves a high degree of satisfaction, with 85.9% of respondents being satisfied and 10.3% being very satisfied, a notable trend is dissatisfaction with certain plant characteristics. "Light-colored & morphological plants" show a high 94% dissatisfaction rate, with only 3.8% of participants expressing satisfaction. "Aromatic plants" follow a similar pattern, with 98.7% dissatisfaction and only 1.3% neutrality, reflecting strong disfavour for these elements in the landscape. The most disapproved characteristic is "Mosquito-repellent plants," where 97.4% of respondents are dissatisfied, and 14.1% are very dissatisfied, suggesting these plants are not providing the intended benefits. Such overwhelming negative responses point to a significant disconnect between the selected plant types and user expectations, requiring reconsideration.

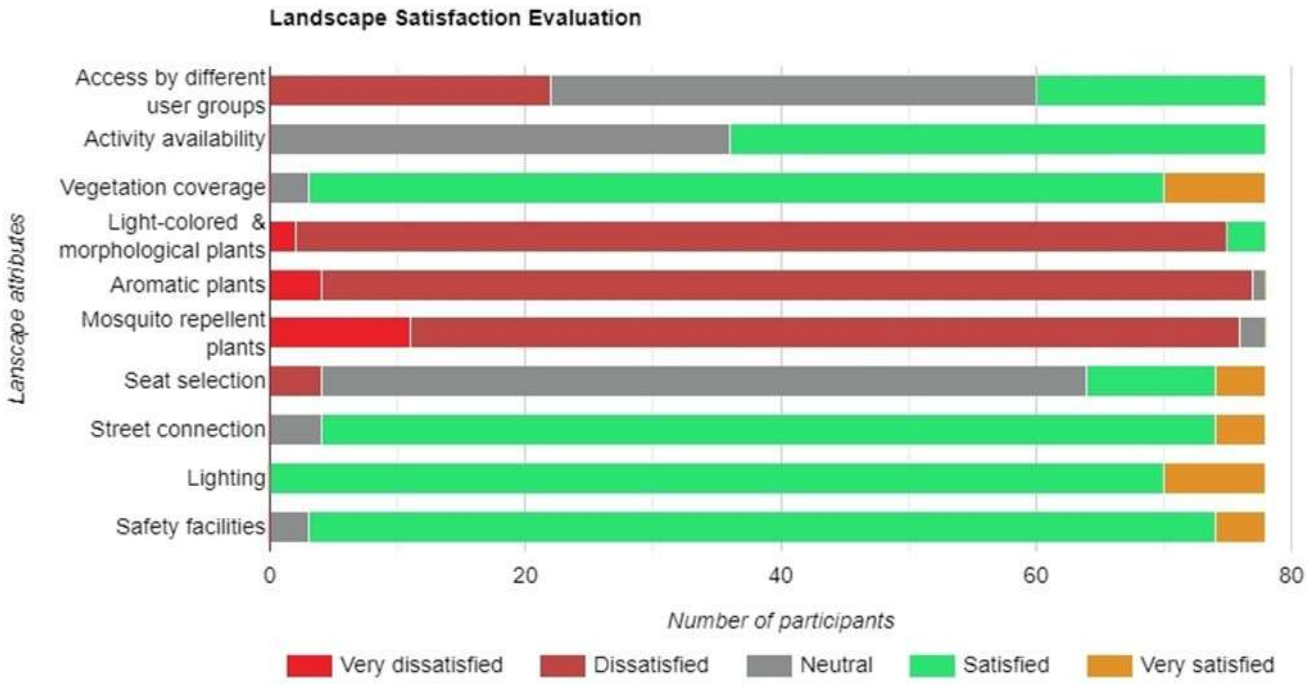

Fig. 4. Landscape satisfaction evaluation by participants.

On the positive side, several infrastructural characteristics received high satisfaction rates. "Street connection" is a standout, with 89.7% of users satisfied or very satisfied, indicating strong approval for the landscape's accessibility to surrounding areas. "Lighting" and "Safety facilities" both garnered positive responses, with 89.7% and 91% satisfaction, respectively. This highlights the importance of well-implemented functional elements in the landscape design, which users appreciate more consistently. Even though "Seat selection" sees 76.9% neutrality, 17.9% are satisfied or very satisfied, suggesting that while improvements can be made, it is not a primary concern compared to the issues with plant-related characteristics. **Table 3** below shows the specific satisfaction statements of the participants.

Table 3. Brief statements explaining variables.

Characteristics	Statements by participants
Access by Different User Groups	"Every time I drive, I can easily reach the park, and it accommodates the needs of all users."
	"They haven't considered the needs of the disabled enough, especially at restrooms and park entrances, where the handrails and ramps are too narrow."
Activity Availability	"The park's fun nighttime activities, like square dancing and tai chi competitions, have brought my friends and me closer together."
	"My granddaughter quickly gets bored at the park due to the lack of play equipment, and the children's area is often closed at night."

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Vegetation Coverage	"The park's diverse plants are intriguing, and their secluded areas provide quiet spots for conversation or relaxation, even if some are less visible at night."
	"There's a big lawn in the park where we may congregate. Summer afternoons on the grass with friends are my favorite because they keep me cool."
Light-colored Plants & Plants with Different Forms	"I can't seem to find many brightly colored plants, and sometimes it frightens me to see large dark greens lined up in front of me in the dark, despite the abundance of trees and shrubs."
	"The large trees in the park all have the same shape, and it becomes dull seeing their identical shadows under the streetlights. I'd love to see a variety of tree shapes silhouetted against the night sky. "
Aromatic Plants	"The park needs attention due to the lack of vibrant flowers. Even with limited night visibility, I'd love to explore nature through the scent of flowers on an evening walk."
	"Unfortunately, managers are overlooking the fact that nighttime plant aromas can create an enchanting atmosphere in the park."
Mosquito-repellent Plants	"Our park experience suffers in summer due to frequent mosquito bites, especially near bushes and water."
	Gardeners should consider growing plants like mint, basil, and rosemary that keep mosquitoes away. These plants have a refreshing effect and keep mosquitoes away."
	"While plants have many advantages, there are also times when those advantages cannot be outweighed, and management needs to take mosquito infestation seriously."
Seat Selection	"Park seating is sufficient, although some chairs have damage that hasn't been fixed."
	"We frequently had difficulty reaching many of the seats because they were positioned so far away from the roadside."
Street Connection	"The park's pathways are well-planned, and I can readily access all the places I want to visit."
Lighting	"The park has a light show during significant holidays, and there are many lights."
Safety Facilities	"I'm not worried about my safety in the park at night due to the many cameras and security guards patrolling the area."

Correlation between nighttime park usage and landscape characteristic satisfaction

Pearson's correlation analysis was conducted to assess the strength and direction of the relationship between nighttime park usage patterns (including frequency of visit, duration of stay) and satisfaction with various landscape characteristics (such as access by different user groups, vegetation coverage, safety facilities, etc.). See **Table 4.**

Table 4. Pearson's correlation coefficients between nighttime park usage patterns and satisfaction with landscape characteristics.

Usage pattern	Frequency of visit	Duration of stay
Access by Different User Groups	0.22*	0.19

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Activity Availability	0.31*	0.34*
Vegetation Coverage	0.12	0.16
Light-colored & Morphological Plants	0.05	-0.03
Aromatic Plants	-0.07	-0.12
Mosquito-Repellent Plants	-0.10	-0.15
Seat Selection	0.29*	0.21*
Street Connection	0.38*	0.33*
Lighting	0.50**	0.42**
Safety Facilities	0.41*	0.40**

*Significant at $p < 0.05$, **Significant at $p < 0.001$

Visit frequency

The results indicate that nighttime park visit frequency is significantly positively correlated with lighting ($r=0.50$, $p<0.01$), safety facilities ($r=0.41$, $p<0.01$), street connectivity ($r=0.38$, $p<0.05$), activity availability ($r=0.31$, $p<0.05$), and seat selection ($r=0.29$, $p<0.05$). Among these, lighting exhibited the highest correlation, suggesting that improvements in lighting quality may directly enhance nighttime park usage. Additionally, accessibility for different user groups ($r=0.22$, $p<0.05$) also showed a positive correlation, indicating that increasing accessibility may encourage higher park visit frequency.

Conversely, satisfaction with vegetation coverage ($r=0.12$, $p>0.05$), light-colored & morphological plants ($r=0.05$, $p>0.05$), aromatic plants ($r=-0.07$, $p>0.05$), and mosquito-repellent plants ($r=-0.10$, $p>0.05$) did not exhibit significant correlations with visit frequency, suggesting that these plant-related landscape characteristics may not be primary determinants of nighttime park visitation.

Stay duration

Table 4 shows that park stay duration is significantly positively correlated with lighting ($r=0.42$, $p<0.01$), safety facilities ($r=0.40$, $p<0.01$), activity availability ($r=0.34$, $p<0.05$), street connectivity ($r=0.33$,$p<0.05r=0.33$, $p<0.05$), and seat selection ($r=0.21$, $p<0.05$). Lighting had the highest correlation, suggesting it not only attracts visitors but also encourages longer stays. Safety facilities also play a key role, enhancing visitors' willingness to remain in the park. In contrast, accessibility for different user groups ($r=0.19$, $p>0.05$), vegetation coverage ($r=0.16$, $p>0.05$), and plant-related factors showed no significant association with stay duration.

In summary, lighting and safety facilities are the most influential factors in nighttime park usage, showing the highest correlation with visit frequency and stay duration ($p<0.01$). Activity availability and street connectivity enhance park attractiveness and encourage longer stays, highlighting the importance of optimizing accessibility. Seat selection has a moderate impact, with significant positive correlations with visit frequency ($r=0.29$, $p<0.05$) and stay duration ($r=0.21$, $p<0.05$), suggesting better seating layouts can improve park use. In contrast, plant-related factors, including vegetation coverage and aromatic plants, show minimal influence, indicating they are not primary drivers of nighttime park visitation.

DISCUSSION

This study provides important insights into how older adults engage with urban parks at night and how they perceive various landscape characteristics. The results show that nighttime park use is primarily driven by physical exercise and social interaction, with 89.7% of participants engaging in walking, jogging, or group activities—consistent with prior research on the health and social benefits of urban parks (Giles-Corti et al., 2016; Shanahan et al., 2016). Although opportunities to experience nature were valued (79.5%), quiet and

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solitary activities were rare, suggesting that seniors prioritize dynamic and socially engaging experiences in open, low-density settings.

In terms of landscape characteristics, infrastructure elements such as lighting, safety facilities, and street connections received the highest satisfaction ratings, with 91% satisfaction for safety facilities and 89.7% for lighting. These findings are consistent with studies emphasizing the pivotal role of lighting in facilitating nighttime park use by improving visibility, enhancing perceived safety, and reducing the risk of accidents or crime (Chen and Marzbali, 2024; Lee et al., 2024). In contrast, plant-related characteristics, including light-colored, aromatic, and mosquito-repellent plants, were overwhelmingly rated as unsatisfactory, with dissatisfaction rates exceeding 90%. This highlights a misalignment between daytime-oriented aesthetic planting strategies and the functional needs of nighttime users. In low-light settings, these features may lose visibility or relevance, suggesting that nighttime park design requires tailored approaches that go beyond traditional daytime landscaping priorities (Edensor and Dunn, 2024).

These findings carry important implications for urban lighting policies. Given that lighting was among the most influential factors in encouraging nighttime use, municipalities should consider developing lighting policies that optimize brightness, color temperature, and spatial distribution, especially in elderly-accessible zones. Rather than uniform illumination, adaptive or sensor-based lighting systems that respond to user presence can ensure both energy efficiency and user comfort.

Furthermore, the results open pathways for intergenerational park design Nelischer & Loukaitou-Sideris, 2023). While this study focused on older adults, designing inclusive parks that cater to multi-age nighttime users, such as elderly walkers, caregivers, and children, requires balancing open spaces, quiet zones, and adequately lit interactive areas (Kreutz, 2024). Creating “time-sensitive” zones that adjust lighting or function based on temporal user needs (e.g., after-dinner walking paths, evening dance spaces) could enhance intergenerational coexistence and safety.

These insights also suggest promising opportunities for integrating AI-driven smart lighting systems into park infrastructure. Such systems can learn usage patterns of older adults (e.g., peak times, preferred paths) and dynamically adjust lighting intensity, detect irregular motion, or provide voice-guided navigation, thereby improving both usability and safety (Stecuła et al., 2023). AI-based systems can also inform maintenance schedules, monitor environmental quality, or trigger alerts in case of medical emergencies, especially for vulnerable users like seniors (Ali et al., 2025).

In sum, while vegetation remains central to daytime park satisfaction, its perceived importance declines in nighttime settings, where visibility, safety, and social functionality take precedence. These findings suggest that future nighttime park planning should emphasize lighting design, safety infrastructure, and inclusive accessibility, while exploring the integration of smart technologies to support age-friendly urban environments.

CONCLUSIONS

This study highlights the close relationship between nighttime park usage and user satisfaction with landscape features in Linyi’s urban parks. Lighting, safety, and street connectivity emerged as the most influential factors, strongly associated with more frequent use and higher satisfaction. These findings underscore the importance of well-lit, secure, and accessible environments in encouraging nighttime park engagement, especially for older adults.

In contrast, plant-related features such as light-colored and aromatic plants were rated poorly, indicating limited relevance for nighttime users who prioritize visibility and safety over aesthetics. The weak correlation between vegetation and nighttime activity suggests that greenery plays a diminished role after dark.

These insights point to the need for urban design strategies that emphasize lighting, safety infrastructure, and spatial connectivity. Future research may explore how alternative lighting technologies or specific plant selections can enhance nighttime usability, and how different demographic groups—such as youth—interact with parks after dark.

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of University Putra Malaysia. All participants provided informed consent prior to participation. A. Liu wrote the main manuscript text. M. Mohd Yunos drafted the work and revised it critically for important intellectual content. S. Shukor made substantial contributions to the acquisition, analysis, and interpretation of data; M. Mat Noor made substantial contributions to creating new software used in the work. All authors reviewed the final manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Nighttime Park Design Characteristic Variables

Variables	Descriptions in the literature	Authors
Considering Access by Different User Groups	People with limited mobility, such as children, the elderly, the impaired, and the unemployed, are most in need of parks and safe outdoor spaces for socializing due to factors like age, income, or lack of transportation.	Thompson, 2002
Offering a Variety of Activities	Night parks should provide diverse opportunities for socializing, leisure, and activities like sports, events, and dining, with spaces for sitting and walking to enhance social interaction.	Thompson, 2002
	Park nighttime activities are a growing urban trend that combine entertainment and enjoyment.	Ngesan & Karim, 2012
Vegetation Coverage	Parks offer calming darkness at night, creating a vital haven for visitors. Increasing vegetation near noise-sensitive entrances and boundaries can reduce unwanted noise and introduce pleasant sounds.	Buxton, 2020; Jaszczak et al.,2021
	The vegetation density largely determines the total noise attenuation in urban environments; thick trees and shrubs around parks also reduce noise.	Gaudon et al.,2022; Papafotiou, 2009
	Noise and crowding are key to nighttime user satisfaction. Adding diverse trees and shrubs, along with sound-absorbing barriers, is recommended to reduce noise pollution.	Rho et. al., 1995 ; Dumitras et. al, 2010
	Evening temperatures in the park are strongly affected by land cover, with deciduous trees providing significant cooling in summer.	Li et al., 2021
	In Beijing's urban parks, nighttime temperatures drop by 0.56°C for every 10% increase in grass cover.	Yan & Dong, 2015
	A 50% increase in tree or shrub cover reduces average overnight temperatures by 0.2°C in moist subtropical urban parks.	Cheung & Jim, 2019
	Parks with tall, broad-canopied trees reduce heat stress more effectively than those with dense, medium-sized trees or grass cover.	Potchter et al., 2006
	Lawn surface temperatures at night are cooler than those below the canopy.	Narita et al., 2002
Light-colored Plants & Plants with Different Forms	Even if the visual experience is greatly reduced in evening and night gardens, the visual environment is still significant.	Gao et al., 2018
	Light-colored plants with elegant forms, combined with moonlight or other lighting, create a beautiful nighttime botanical scene.	Lesseig, 2016; Gao et al., 2018

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	Plants for nighttime landscaping are mainly divided into light-colored plants and beautifully shaped plants.	Gao et al., 2018
Aromatic Plants	At night, scent becomes more significant, and fragrant plants boost the park's comfort and tranquility.	Prazeres & Donohoe, 2014; Franco et al., 2017
	Compared to afternoon visitors, nighttime visitors showed a marked preference for the park's floral landscape.	Hami & Maruthaveeran, 2018
Mosquito- Repellent Plants	When they visit their night gardens in the summer, they are vulnerable to mosquito nuisance.	Gao et al., 2018
Seat Selection	Create strolling and relaxation areas, offer diverse seating for activity viewing, and encourage social interaction.	Gehl, 2011
Street Connection	Pedestrians and well-established street linkages to public areas should be prioritized.	Butler, 2014
	At night, there is a higher density of visits in areas with more connecting paths.	Scotti et al., 2024
	Street connections between buildings and public spaces are essential for vibrant areas; adding more street entrances to buildings can enhance these links.	Gehl, 2011
Lighting	Effective lighting techniques that enhance user comfort, safety, and appeal.	Butler, 2014
	Nighttime artificial lighting in urban parks alters perceptions of space arrangement and visibility.	Rahm et. al, 2017
Safety Facilities	Choose non-slip materials to ensure safe nighttime walking, especially when installing pebble paving in flower beds, pathways, and drainage areas.	Katsavounidou, 2023
	Put cameras in strategic locations to ensure the safety of visitors.	Butler, 2014

Appendix B. Interview Guide for the Study

Key construct	Question	Probe
Usage pattern at Night	• How often do you visit the city park at night? • How long do you usually stay when you visit the park at night? • What activities do you do in the park at night? • Why did you choose to visit the park at night?	• Did you visit the park more frequently or less at night? Why? • Do you think sufficient time spend at the night park? Why? • Why? • Why? How about other reasons?
Evaluation	• Are you satisfied with the overall night image of the park? • How would you rate the specific characteristics of the night park?	• Why/Why not? • Why/Why not?
Open-ended question	• What other improvements do you want the park to make in the future night planning?	