

Article

Differences in Users' Activity Characteristics and Spatial Patterns in Neighborhood Parks during the Late Afternoon and Evening Periods

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Abstract: Evidence shows that neighborhood parks play an important role in serving nearby residents, such as promoting physical activity and relieving stress, but thus far, little attention has been given to the impact of time on park use. This study explored users' behavioral patterns at different time periods and their perception of attributes during the nighttime in three neighborhood parks in Nanjing, China. A total of 7482 park users were documented using the method of behavior mapping, and the results revealed that the spatial clusters of hotspots for the locations of the observed users differed significantly between late afternoon and evening, and the nighttime park users were more in number and were more active in physical activity. This study also found that improvements in site diversity and incorporations of night markets and shows were emphasized by park users based on their nighttime experience. The findings can be used to improve the future design and management of neighborhood parks, especially for promoting nighttime use.

Keywords: nightfall; park use; behavior mapping; physical activity; recreation experience; China



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1. Introduction

Neighborhood parks are the basic units of a park system and serve the surrounding residents by providing accessible green natural landscapes and a range of facilities within walking distance. There are many benefits that come from having high-quality neighborhood parks [1,2]. In urban areas, neighborhood parks provide ideal places for residents to engage with nature and be active [3] and can improve visitors' state of well-being [4,5], promote their physical activity [6,7], enhance community attachment [8,9], and create a better urban quality of life for visitors of all ages [10]. Although a neighborhood park is usually a small green space, typically five acres or more in size [11], it benefits native plants and animals [12] that, in turn, induce happiness in human well-being [13]. There is also evidence that neighborhood parks can help build safer communities [14]. Affected by the coronavirus disease (COVID-19) pandemic, people's movement is restricted in closed public spaces, and the role of neighborhood parks has received special attention.

There are three main areas of research on neighborhood parks: *Proximity and social equality*. Studies have shown that the frequency of one's use in a specific neighborhood park appears strongly related to the distance to the park from the individual's home [15,16]. From the perspective of environmental justice, research suggests that park managers need to plan neighborhood parks strategically to ensure social equality in the spatial distribution and quality of parks [17,18]. Disparities in park use by gender, age, and ethnicity were also found in previous research [19–21]. *Effects on Physical Activity*: Although it is well known that neighborhood parks can provide opportunities for physical activity and that park-based activity is associated with various health outcomes [22,23], few studies

have focused on the energy levels of physical activity, especially moderate to vigorous activity [24,25]. An observational study in the United States showed that almost two-thirds of neighborhood park users were sedentary, and one-third of them were physically active [26], suggesting the importance of promoting moderate and vigorous physical activity (MVPA) in parks. *Influence of park attributes on use:* Evidence shows that park usage is related to park attributes, including safety, aesthetics, facilities, maintenance, organized activities, and proximity [27–29]. Many studies have addressed participants' visual preference for park features [30], while only a small amount of research has focused on the space–behavior relationship for preferred park features [31,32]. Several studies have shown that various environmental settings can support different types and levels of activity, and specific features may have effects on encouraging active movement [15,33]. Although the above topics have been addressed in previous research, almost all have relied on systematic momentary assessment, and snapshots of park use were usually taken during the daytime period [34]; therefore, little has been learned about users' physical activity and experience of neighborhood parks in the evening.

The time factor deserves special consideration when studying the usage of neighborhood parks [35], as they are close to residents' homes and can be visited and enjoyed day and night. Considering an individual's leisure time allocation, after-dark time may be very important [36], especially for people who need to go to work during the day. It has been documented that the location and quality of neighborhood parks are associated with people's level of use [27]; however, having available leisure time may play a key role in putting the demand for park visits into actual action. It is also worth noting that landscape perception at night can be quite different from that during the day [37], and people may have different environmental experiences and choices for activity sites in the evening [38,39]. This study aims to fill this gap by investigating the user characteristics and spatial behavioral patterns of park visitors during the late afternoon and evening periods.

Behavior mapping, which is based on the concept of affordance and Barker's "behavior setting theory", is an effective tool to link people and places by in situ observation [40]. Behavioral maps can include diverse information on the participants, such as their involved physical activity, locations, genders, age groups, and time periods [41,42]. This method allows researchers to collect both quantitative and qualitative data to analyze the attributes of neighborhood parks associated with participants' recreational choices [43–45], such as the time periods and the types of physical activity. Behavior mapping is advantageous in obtaining objective and direct information on park users and accurately collecting the environmental context of the activity [46]. The tool has been applied in various settings, including city streets, schools, nurseries, and neighborhood open spaces [47,48]. As neighborhood parks are relatively modest in size, with users of diverse characteristics and activity types, the tool of behavior mapping is suitable for exploring the interaction between behavior settings and physical activities in accordance with different time periods.

In regard to measuring user experience, the research may have examined only one aspect of perception: either the importance of the park attributes [2] or visitors' satisfaction with the park settings [49]. Importance–performance analysis (IPA), first proposed by Martilla and James [50], is a useful tool in measuring how people feel about certain characteristics of a thing and evaluating the relative significance and performance, which can help policy managers identify the level of importance for the attributes and make informed choices about resource allocation, which could contribute to higher satisfaction among users [51]. Although this tool was originally developed for marketing purposes, it has been widely used in tourism, health care services, the e-government, and other fields [52,53]. IPA provides insights into the needs of the users and the areas managers should focus on. Using IPA, visitors' perception of the attributes in neighborhood parks during the evening can be detected, which could help improve the quality of the parks in a cost-effective manner. On the other hand, surveys of user experience can partially supplement the behavior mapping data to reflect users' feelings during the visit and their preferences for the setting.

The purpose of this study was to explore the differences in users' activity characteristics and spatial distribution between the late afternoon and evening hours in the neighborhood parks to reflect the impact of the time factor on park usage and people's park experience in the evening. This study used behavior mapping to investigate the spatial patterns of users at different time periods in neighborhood parks. By comparing user characteristics and their levels of physical activity in the late afternoon and the evening, the nighttime use of the neighborhood park was empirically analyzed, which fills an existing gap in the literature. User experience with park attributes during the evening was examined using the IPA technique to better understand the performance of park attributes relative to their importance, which can help park managers allocate limited resources in an efficient way to promote the quality of the neighborhood park. The findings can help improve the design and management of neighborhood parks to promote the nighttime use of neighborhood parks.

2. Methods

2.1. Study Sites

All three neighborhood parks selected for this study were located in Qinhuai District, Nanjing City, China. The four seasons are distinct in Nanjing, with cold winters and hot, muggy, and rainy summers. The annual temperature of Nanjing averages 15.4 °C, and the total annual precipitation is 1200 mm. There are approximately 120 rainfall days throughout the year. Qinhuai District is located in southeastern Nanjing, having an area of 49.11 square kilometers and a permanent population of over 742 thousand by the end of 2020.

The three parks studied were Yueyahu Park (32°1'51.96" N, 118°49'49.77" E), Zhenghe Park (32°1'53.23" N, 118°47'38.41" E), and Mingyuhe Park (32°1'44.15" N, 118°48'54.19" E), with areas of 2.62 ha, 2.20 ha, and 1.73 ha, respectively (Figure 1). The parks were built in the second half of the twentieth century and have been repaired several times since then. With large residential areas around the neighborhood parks, these parks are all located in high-density population areas.

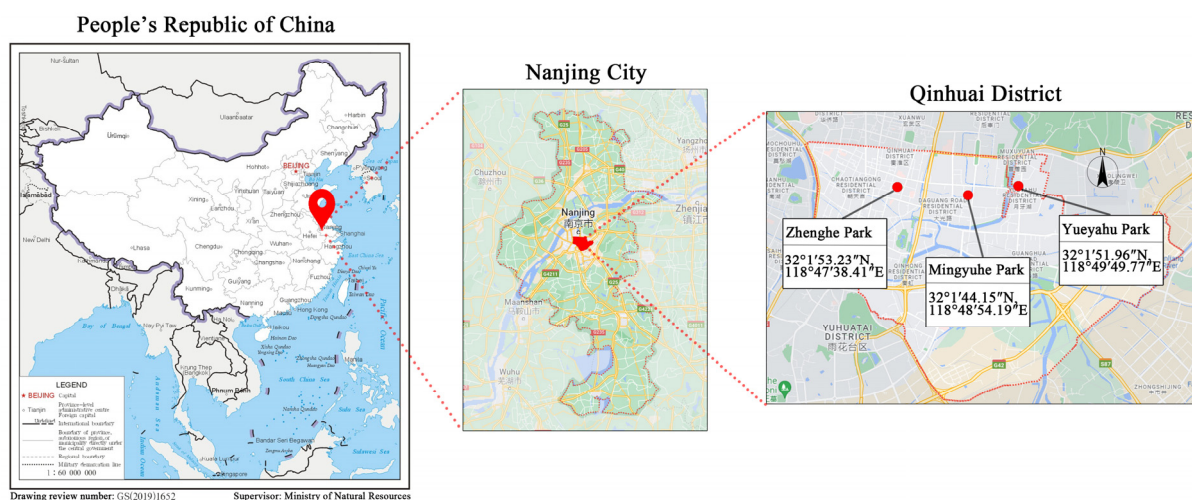


Figure 1. Locations of the study sites (Sources: Gov.cn, Google Maps).

As shown in Figure 2, the main entrance of Yueyahu Park is in the round square at the southeast corner, and there are two secondary entrances located in the southwest and northeast corners. Zhenghe Park is built around water in the west and surrounds the plaza in the east, and there is no specific entrance; thus, users can enter the park easily from nearby streets. Mingyuhe Park is narrow and long in the east–west direction, close to the Mingyu River. The main entrance of Mingyuhe Park is located in the east, and there is another entrance in the west corner.

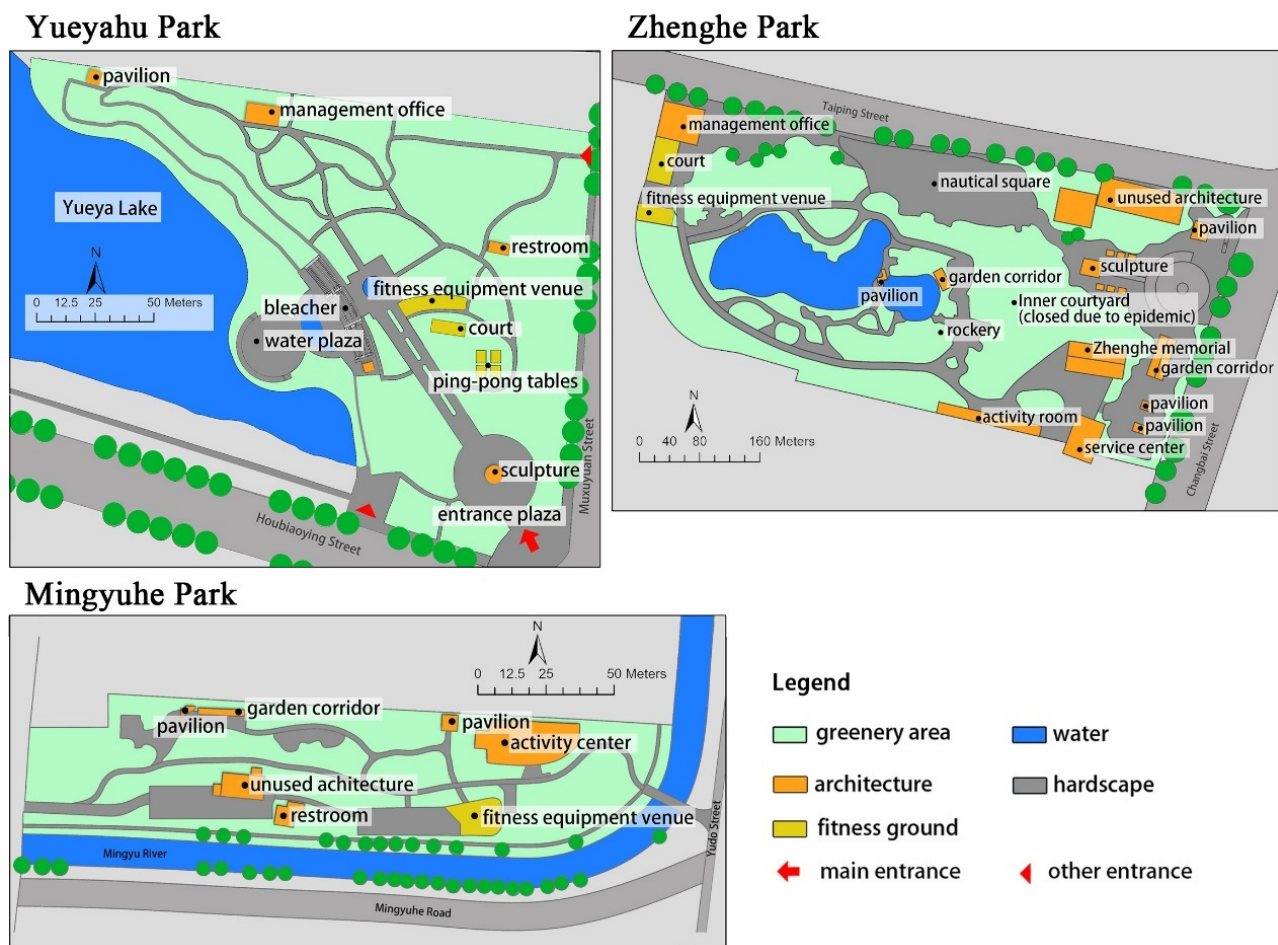


Figure 2. The plans of the three neighborhood parks.

2.2. Behavioral Mapping

The behavioral mapping method was used to observe and record behaviors in the neighborhood parks in the late afternoon and evening periods. Based on the plan drawing and site investigation, observing zones with standing points were identified for each park according to the following rule: when the observer stands at this position, they can clearly observe all site conditions in the zone without disturbing the use of park visitors. Observation zones and the standing points help observers record visitors' use of the park in sequence. A total of 24 observation zones were identified in the three neighborhood parks: eight in Yueyahu Park, nine in Zhenghe Park, and seven in Mingyuhe Park. Details of the methods for scanning each observation zone are given in the referenced papers [25]. The investigators recorded the users' location in the form of points on the paper map of the park (1:500 scale), with codes representing the individuals' genders, age groups, and the activities involved [46]. Observations were conducted in all zones throughout the neighborhood parks.

Systematic observations of the selected neighborhood parks were conducted from June 2021 to April 2022 to reflect the use of neighborhood parks throughout the year in four seasons. Every neighborhood park was observed 16 times, for each season, on the weekday and the weekend and in the late afternoon and the evening (four seasons $\times$ weekday/weekend $\times$ late afternoon/evening = 16 times). Observations were conducted on days of no rain. The four seasons were divided by month, with spring from March to April, summer from June to July, autumn from September to October, and winter from December to January. The time for observation was set for 4:00–6:00 pm for the late afternoon period and 7:00–9:00 pm for the evening period, as the average sunset time in Nanjing throughout the year is 18:14 pm, and it will take some time for the sky to get

completely dark. We also took into account people's working schedules, who usually leave work at 5:30 pm and start activities in the evening after dinner at about 7:00 pm. All three neighborhood parks (24 zones) were observed for the specific time period, resulting in 48 park scans (284 rounds of zone observations) in total.

2.3. User Experience Questionnaire

Respondents were asked a variety of questions about their experience using the neighborhood park in the evening (Appendix A). Respondents were asked how often they used the neighborhood park at night (almost every day, weekly, monthly, and occasionally), the average duration of the visit (less than 1 h, 1–2 h, 2–3 h, and more than 3 h), and their user group (alone, with family, with friends, with colleagues, and with others). They were also asked to indicate the activities they participated in during their night visit to the neighborhood park using a multiple-choice question (e.g., walking, running, viewing the night scenery, sitting, and dancing). Demographic information, including gender (male or female) and age group (less than 18 years, 18–40 years, 41–65 years, and over 65 years), was also collected from the respondents.

To identify the attribute importance and performance of park features, a set of key attributes for neighborhood parks was generated based on previous research examining the environmental quality of parks [2,27,33]. After unstructured personal interviews with 10 users and 3 experts, nineteen items in aspects of spatial arrangement, lighting condition, conservation management, and safety precautions were used to understand users' night tour experience toward park features. Importance items used a five-point Likert scale, ranging from 1 = not at all important to 5 = extremely important. Performance items were measured using the same set of attributes and a five-point scale from 1 = very unsatisfied to 5 = very satisfied. The importance items were grouped together in one section and were measured prior to all of the performance items in a later section to minimize compounding and order effects. Before the beginning of the data collection process, the preliminary questionnaire was pretested with a sample of 10 respondents from Xuanwuhu Park, an urban park just outside the Qinhuai District. Based on participants' responses, amendments were made to the wording of some questions. Data from the pretest were not included in the main study.

Questionnaire surveys were conducted in the evening period for 7:00–8:00 pm. The number of questionnaires distributed was stratified by the four seasons and the three neighborhood parks. In the survey, the investigators stood at the designated survey point, either at the entrance or the plaza on the edge of the neighborhood park. They approached the first person coming by and briefly explained to them the purpose of the study. Upon consent, the potential respondents were invited to complete the two-page questionnaire. Older adults with insufficient reading skills or presbyopia were aided in completing the questionnaire by research assistants. It took approximately 10–15 min to finish the questionnaire. When the questionnaire was completed, the investigators thanked the respondents for their time and waited five minutes before asking another person to participate. This process could help investigators reduce selection bias by avoiding personal judgment and experience. A total of 198 visitors completed surveys in the three neighborhood parks with a response rate of 78%; 107 (55.7%) were males, and 85 (44.3%) were females. People aged over 40 years constituted the main age group of park users, accounting for 68% of the sample.

2.4. Data Analysis

The manually recorded data were used to create the spatial positions and attributes in the desktop geographic information system (GIS) software ArcGIS Pro, developed by Esri. Activity types were classified into three categories based on activity level: sedentary, walking, and moderate to vigorous physical activity (MVPA) [42]. Optimized hotspot analysis was used to identify statistically significant spatial clusters of hotspots and cold spots for the locations of the observed users, which were depicted as points on the map. Hexagon

cells were used for mapping geographical data, as hexagons are the most circular-shaped polygon that can tessellate to form an evenly spaced grid [24]. Point maps symbolized by activity level and hotspot maps were used to visualize the characteristics and spatial patterns of the users at different time periods. The associations between users at different time periods and their levels of physical activity, sexes, and age ranges were examined using the chi-squared test. Cramér's V is an effect size measurement for the chi-squared test (0.1 for small, 0.3 for medium, and 0.5 for large) [54].

Descriptive statistical analysis was used to summarize and describe the data from the user experience questionnaire, including gender, age range, visit frequency, visit duration, and physical activity of the respondents. The attributes of neighborhood park users experienced in the evening were analyzed by IPA. It combines measures of users' perceived attribute importance and performance into a two-dimensional scale grid, which forms a four-quadrant matrix to facilitate data interpretation and derive practical suggestions (Figure 3) [50,51]. The mean values of importance and performance scores were used as the intersection point in constructing the IPA plot. The quadrants include "keep up the good work" (quadrant (Q1)), "possible overkill" (Q2), "low priority" (Q3), and "concentrate here" (Q4). Q1 indicates that the attributes are very important, and users are pleased with the performance. Q2 captures the attributes with slight importance but performs well. Q3 contains the attributes with low importance and performance score values, suggesting that they are likely to receive a low priority in resource allocation. The attributes that fall in Q4 are considered to be very important, but they are not satisfied by the users, so efforts should be made to improve their performance.

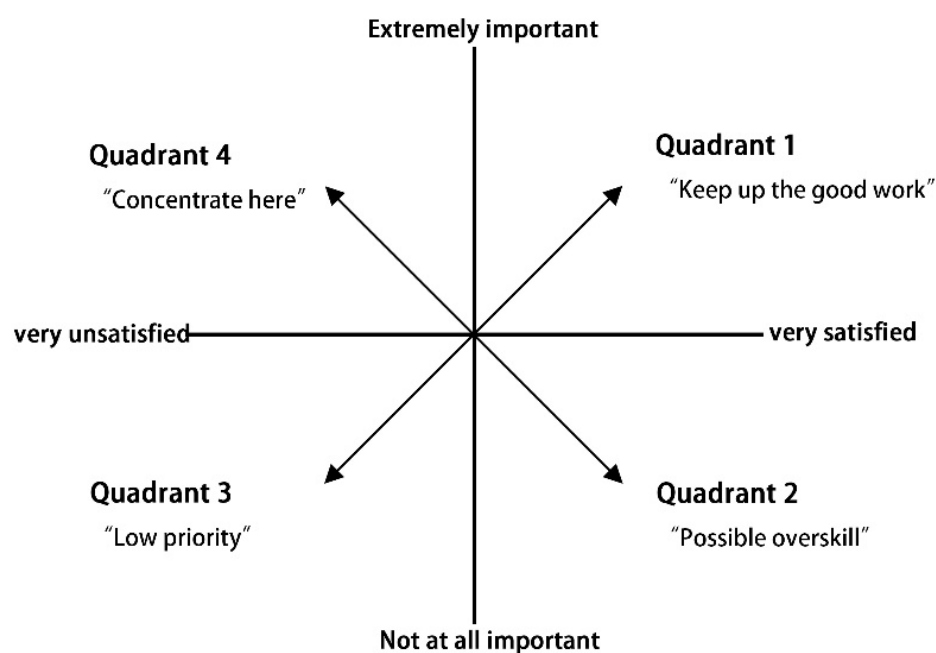


Figure 3. Importance–performance grid.

3. Results

3.1. Number of Observations and Activity Types

For the three surveyed neighborhood parks, a total of 7482 observations were documented. Data collection spanned a whole year, with 2189 recordings in spring, 1826 recordings in summer, 1989 recordings in autumn, and 1477 recordings in winter. More users were observed during the evening period than in the late afternoon period in all three parks, with 3394 observations recorded in the late afternoon period and 4088 observations recorded in the evening period. Of the physical activity types observed, walking was the most recorded form of activity in the neighborhood parks, and there were sedentary activities, such as sitting, standing, playing cards, playing chess, watching a play, playing musical instruments,

and singing. Moderate or vigorous physical activity (MVPA) included dance, exercising on fitness equipment, Tai Chi, stretching exercises, jogging, and playing table tennis.

3.2. Users' Spatial Patterns between Late Afternoon and Evening

Figures 4–6 show the dot mapping and the hexagon grid-based hotspot maps of the three neighborhood parks, from which the differences in the users' spatial patterns between the late afternoon and evening periods in the neighborhood parks could be detected.

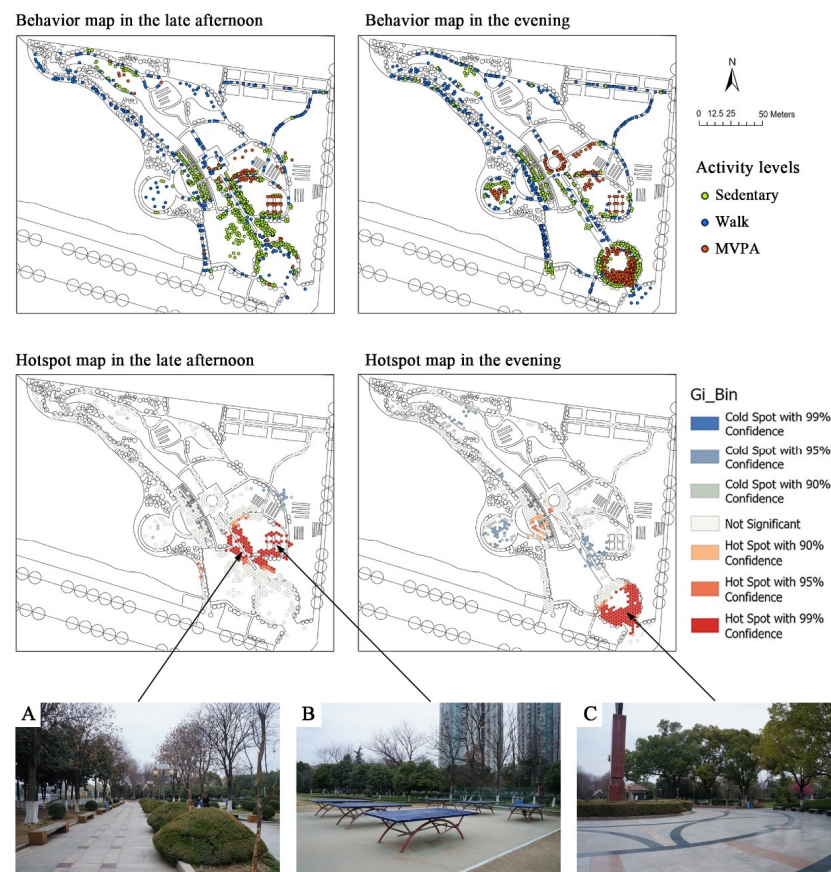


Figure 4. Behavioral map and hotspot map of Yueya Park during the late afternoon and evening, with the subfigures (A–C) show the scenes at the locations of the site.

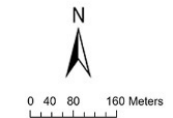
In Yueyahu Park, a total of 1269 observations were documented in the late afternoon, and the high concentration areas were near the seats around the trees along the main walkway (Figure 4A) and on both sides of the ping-pong tables (Figure 4B). In the evening, the number of observations rose to 1507, which was mostly concentrated around the plaza at the entrance with 99% confidence (Figure 4C), and a few hotspots with 90% and 95% confidence were shown near the bleacher not far from the southwest entrance.

In Zhenghe Park, more people visited the park in the evening ($n = 1875$) than in the late afternoon ($n = 1539$). When night fell, the hotspot sections moved from sitting areas along the walkways and the pergola (Figure 5A) to the plazas adjacent to the roads (Figure 5B). The fitness equipment venue, together with a small plaza, was used from the late afternoon to the evening (Figure 5C). For both the late afternoon and evening periods, there were a few hotspots along the main walkway, especially for the trail intersections.

Behavior map in the late afternoon



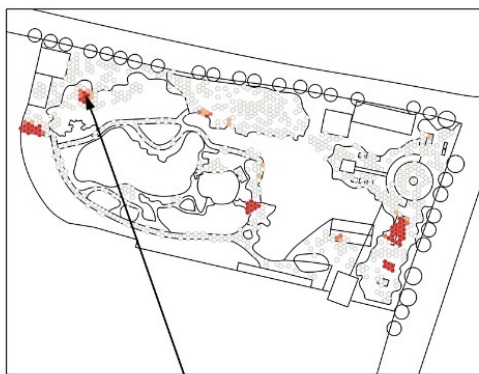
Behavior map in the evening



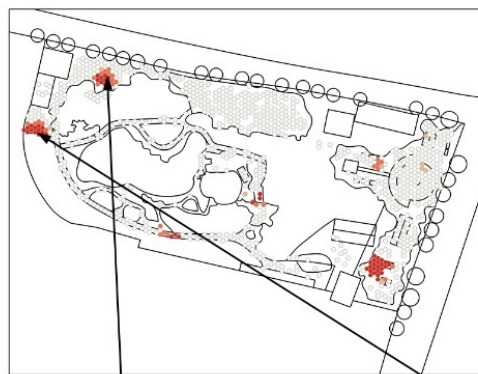
Activity levels

- Sedentary
- Walk
- MVPA

Hotspot map in the late afternoon



Hotspot map in the evening



Gi_Bin

- Cold Spot with 99% Confidence
- Cold Spot with 95% Confidence
- Cold Spot with 90% Confidence
- Not Significant
- Hot Spot with 90% Confidence
- Hot Spot with 95% Confidence
- Hot Spot with 99% Confidence



Figure 5. Behavioral map and hotspot map of Zhenghe Park during the late afternoon and evening, with the subfigures (A–C) show the scenes at the locations of the site.

In Mingyuhe Park, which is smaller than the other two neighborhood parks, more observations were recorded in the evening period ($n = 706$) than in the late afternoon ($n = 586$). During the late afternoon period, people were mostly gathered at the plaza located in the northwest corner, where there are rest facilities (Figure 6A). In the evening, there were three areas of hotspot sites: the plaza in the northwest corner, not far from the west entrance, and the other two in the southeast corner, where there is a plaza together with a fitness equipment venue, which is near the walkway to the main entrance (Figure 6B,C).

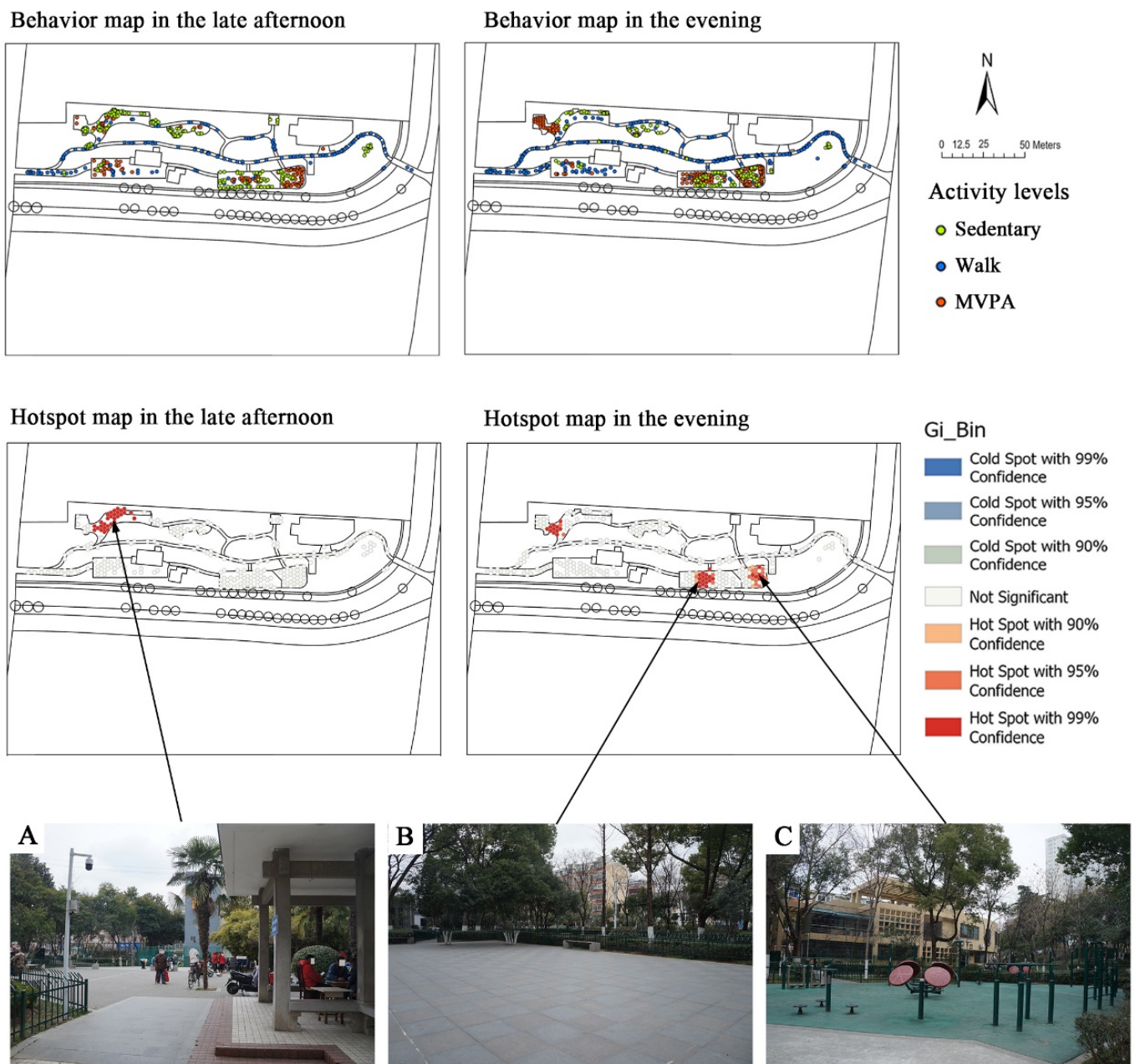


Figure 6. Behavior map and hotspot map of Mingyuhe Park during the late afternoon and evening, with the subfigures (A–C) show the scenes at the locations of the site.

3.3. Users' Activity Levels between Late Afternoon and Evening

Figure 7 shows the behavior maps by different levels of physical activity, from which the spatial patterns of the users with different activity levels could be detected. The sedentary activity was mostly distributed near the seating facilities and at the edge areas of the plaza. The walking activity was mainly distributed along the walkways, partly crossing the plazas. The MVPA was most frequently observed at the plazas, the fitness equipment venue, and some of the wider walkways.

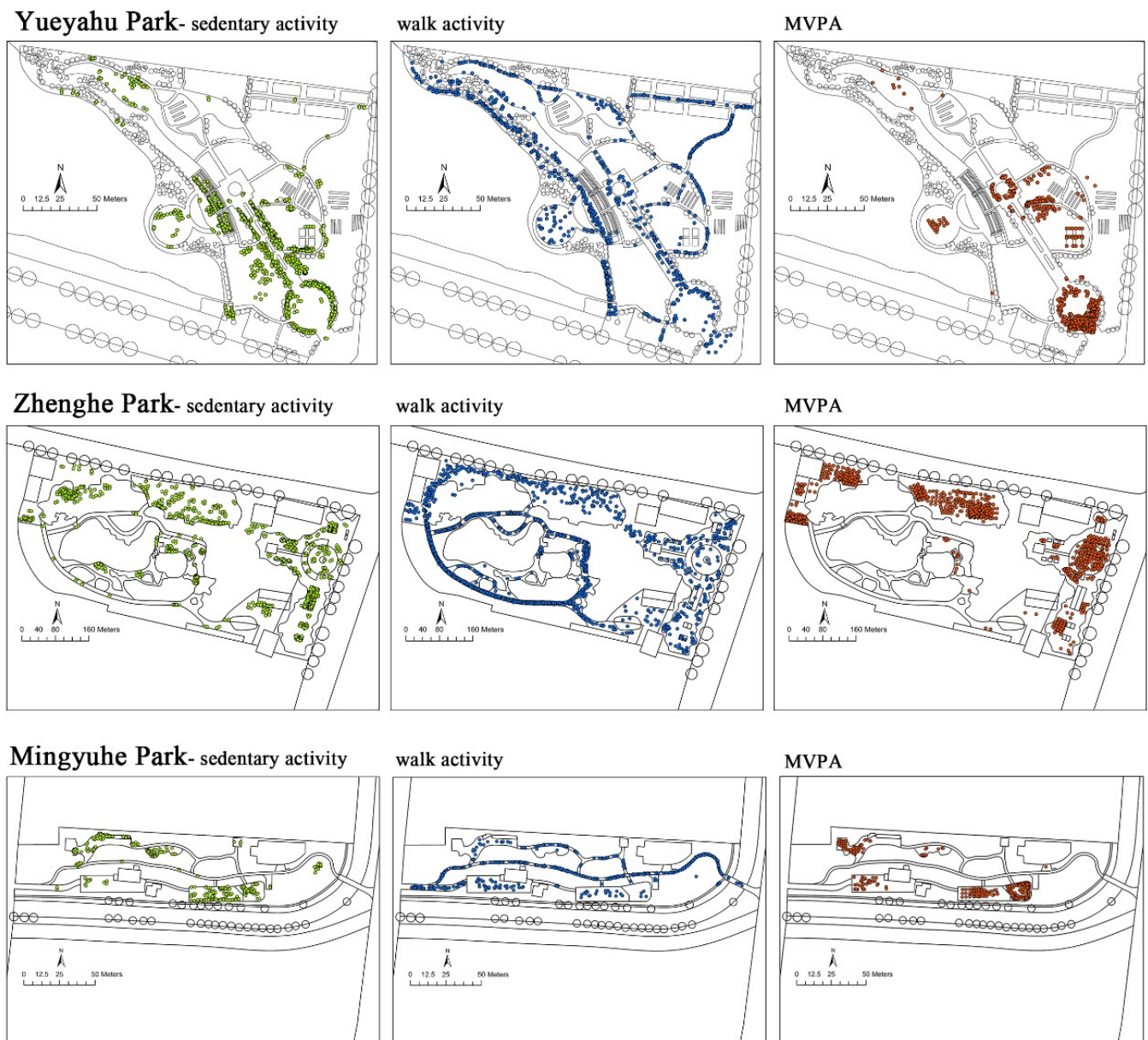


Figure 7. Behavior map by different levels of physical activity for the three neighborhood parks, with green, blue and red dots showing the activities of sedentary, walk, and MVPA respectively.

Users' activity levels not only vary by setting but may also differ by time period. By using the two-way chi-squared test, data from all three neighborhood parks showed that the levels of physical activity varied with different time periods ($\chi^2 = 663.19$, $p < 0.001$) at a medium effect size (Cramer's $V = 0.298$) (Table 1). People were more likely to be sedentary in the late afternoon (52% during the late afternoon compared to 25% in the evening) and to conduct MVPA in the evening (16% compared to 37%), and there were also slightly more people walking in the evening (33% compared to 38%). Although the degree of variance between the activity level and time period was somewhat different in each park, they all reached a significant level, and the directionality of the relationship was consistent.

Table 1. Cross tabulation of the number of users in different time periods and by physical activity level.

		Yueya Park		Zhenghe Park		Mingyuhe Park	
		Late Afternoon	Evening	Late Afternoon	Evening	Late Afternoon	Evening
Sedentary activity	Count	700	501	775	364	273	159
	Expected count	549	652	514	626	196	236
	% Within activity	58.3%	41.7%	68.0%	32.0%	63.2%	36.8%
	Adjusted Residual	11.6	−11.6	19.1	−19.1	9.1	−9.1
Walk activity	Count	401	540	541	720	165	300
	Expected count	430	511	568	693	211	254
	% Within activity	42.6%	57.4%	42.9%	57.1%	35.5%	64.5%
	Adjusted Residual	−2.3	2.3	−2.0	2.0	−5.3	5.3
MVPA	Count	168	466	223	791	148	247
	Expected count	290	344	457	557	179	216
	% Within activity	26.5%	73.5%	22.0%	78.0%	37.5%	62.5%
	Adjusted Residual	−11.1	11.1	−17.6	17.6	−3.8	3.8

3.4. Other Factors Affecting Differences in Use between Late Afternoon and Evening

The number of park users varied by gender during the late afternoon and evening periods ($\chi^2 = 123.88$, $p < 0.001$) at a small effect size (Cramer's $V = 0.129$) (Table 2). The gender difference between the time periods was prominent in Zhenghe Park, and many more females (61%) than males (39%) visited the park during the evening. A significant difference was also found in Yueyahu Park (adjusted residual = 3.6). In Mingyuhe Park, more females were still observed during the evening, although the results did not reach the confidence threshold (adjusted residual = 1.9).

Table 2. Cross tabulation of the number of users in different time periods and by gender.

		Yueya Park		Zhenghe Park		Mingyuhe Park	
		Late Afternoon	Evening	Late Afternoon	Evening	Late Afternoon	Evening
Male	Count	747	784	925	614	295	318
	Expected count	700	831	750	789	278	335
	% Within gender	48.8%	51.2%	55.6%	44.4%	48.1%	51.9%
	Adjusted Residual	3.6	−3.6	12.0	−12.0	1.9	−1.9
Female	Count	522	723	739	1136	291	388
	Expected count	569	676	014	961	308	371
	% Within gender	41.9%	58.1%	35.1%	64.9%	42.9%	57.1%
	Adjusted Residual	−3.6	3.6	−12.0	12.0	−1.9	1.9

Park users had different age ranges for the late afternoon and evening periods, as more middle-aged people visited the parks during the evening, while the number of younger and older visitors was less than expected in the evening ($\chi^2 = 81.49$, $p < 0.001$, Cramer's $V = 0.104$). This difference in age range by time period was manifested in all three parks (Table 3).

Table 3. Cross tabulation of the number of users in different time periods and by age ranges.

		Yueya Park		Zhenghe Park		Mingyuhe Park	
		Late Afternoon	Evening	Late Afternoon	Evening	Late Afternoon	Evening
Young and adults	Count	222	236	415	352	121	136
	Expected count	209	249	346	421	117	140
	% Within age level	48.5%	51.5%	54.1%	45.9%	47.1%	52.9%
	Adjusted Residual	1.3	−1.3	5.7	−5.7	0.6	−0.6
Middle age	Count	787	1081	876	1277	346	467
	Expected count	854	1014	971	1182	369	444
	% Within age level	42.1%	57.9%	40.7%	59.3%	42.6%	57.4%
	Adjusted Residual	−5.4	5.4	−6.7	6.7	−2.6	2.6
Older adults	Count	260	190	248	246	119	103
	Expected count	206	244	223	271	101	121
	% Within age level	57.8%	42.2%	50.2%	49.8%	53.6%	46.4%
	Adjusted Residual	5.6	−5.6	2.5	−2.5	2.7	−2.7

3.5. Importance–Performance Analysis of the Attributes for Night Park Use

Over 90% of the surveyed users were regular visitors who came to the neighborhood park almost every day (51%), weekly (33%), or monthly (6.8%). Their visit time usually lasted one to three hours (84%). Over 44% of the respondents came alone, and others were with family (34%), with colleagues (19%), or with friends (2%). The activities mostly mentioned by the respondents included walking (73%), sitting (64%), dancing (53%), and exercising on fitness equipment (52%).

As shown in Table 4, the overall importance means ranged from 2.32 to 4.79 across the attributes, and the overall performance means ranged from 2.24 to 4.56 across the attributes. The mean values for importance and performance were 3.39 and 3.27, respectively.

Table 4. Importance and performance ratings for park attributes experienced in the evening.

	Importance	Performance
Pathway lighting	4.79	4.56
Hygienic environment	4.76	4.29
Site security	4.57	3.99
Water quality	4.21	3.76
Electronic monitoring equipment	4.20	3.55
Facility lighting	4.10	3.67
Site diversity	3.66	3.06
Night market and show	3.57	2.57
Landscape maintenance	3.18	3.20
Alarm system	3.03	2.81
Lighting brightness	2.98	3.18
Wayfinding system	2.96	3.91
Water lighting	2.93	2.53
Lighting color	2.76	2.84
Noise control	2.69	3.01
Emergency treatment station	2.67	2.85
Security patrol	2.63	2.77
Plant lighting	2.38	2.24
Site privacy	2.32	3.32

Reference lines marking the mean values were used to establish the parameters of the four quadrants. In Q1 (“keep up the good work”), the attributes “pathway lighting”, “hygienic environment”, “site security”, “water quality”, “electronic monitoring equipment”, and “facility lighting” are positioned, which indicates that visitors valued these

attributes as very important for nighttime park use and that these attributes had high performance. In Q2 (“possible overkill”), two items, “wayfinding system” and “site privacy”, are positioned, suggesting that visitors attached relatively slight importance to these features, and the current situation was basically good. In Q3 (“low priority”), the attributes include “landscape maintenance”, “alarm system”, “lighting brightness”, “lighting color”, “noise control”, “emergency treatment station”, “security patrol”, and “plant lighting” in the sequence of importance. Although these attributes were not of particular importance, some efforts can be made to improve them in promoting users’ visit experience during the evening. In Q4 (“concentrate here”), two items, “site diversity” and “night market and show”, are positioned, as park users placed substantial value on the attributes but indicated low satisfaction with the performance, and these items need much improvement (Figure 8).

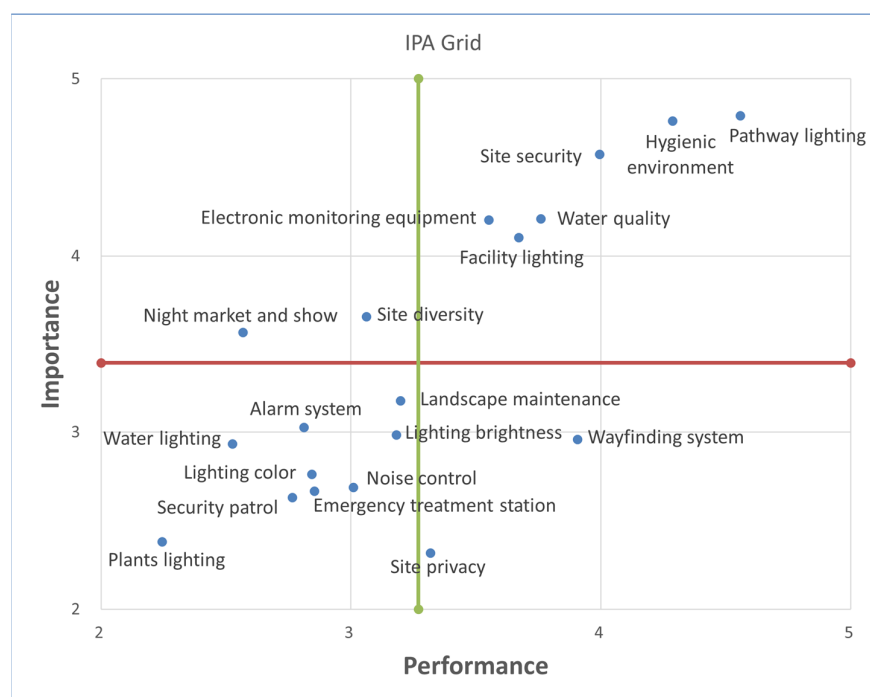


Figure 8. Importance–performance grid with ratings for park attributes experienced in the evening, with reference lines in red and green marking the mean values for importance and performance.

4. Discussion

4.1. Changes in Spatial Patterns and Physical Activity of Users in Neighborhood Parks after Nightfall

In a sample of neighborhood parks in a high-density urban area in Nanjing, China, the findings indicated that more participants visited the parks during the evening than in the late afternoon. Besides the number of visitors, differences were found in age groups and genders for the different periods, such that middle-aged people and females were more likely to visit the neighborhood park in the evening. The results suggest that the time factor plays an important role in park usage, which cannot be ignored in promoting the vitality of nearby residents. People may have different amounts and lengths of leisure time and may adopt diverse strategies of time allocation, especially for adults who need to go to work and women who undertake most of the housework [55]. Neighborhood parks are usually close to home and offer great options for those who want to use their evening time to enjoy the outdoors [6,56]. Considering the high utilization rate in the evening hours, more attention needs to be paid to improving the nighttime landscape of the neighborhood parks.

This study investigated the spatial distribution and behavioral activity of users in neighborhood parks at different time periods and found that users differed significantly in hotspot distribution and levels of physical activity in the two time periods. The changes in the spatial patterns of users in neighborhood parks at night mainly have two characteristics:

a concentrated distribution of users moved from internal distribution to peripheral corner distribution and moved from a semi-enclosed space to a relatively more open space. The movements reflect changes in users' levels of physical activity, safety considerations, and social interactions after nightfall. Users of neighborhood parks are more inclined to be sedentary in the late afternoon and enjoy shade and sun in a quiet setting. At night, people are more willing to engage in MVPA, such as plaza dancing, which can be supported by more open space, namely, the plaza hardscape. The choice of settings that match the activity needs may be a reason for the variation in nighttime crowd gatherings. Another reason may lie in the safety concerns of nighttime users [57]. Settings adjacent to streets with visual and physical connections can attract more park users, as they can provide perceived safety [30]. Lighting is also an important factor for a sense of safety, and the results of this study indicate that good lighting conditions can bring more vitality to the sites, which partially supports previous research regarding the impact of urban lighting on citizens' quality of life [36]. It is worth mentioning that social interaction may also play an important role in the distribution of park users [28]. People like to stop where there are people around, and sedentary people in neighborhood parks are usually mixed with walking people and those conducting MVPA [58]. When night falls, sedentary people usually move their places to sites where they can continue to observe and interact.

4.2. Importance and Performance of Park Attributes Based on Nighttime Experience

This study analyzed users' preference and satisfaction for park attributes based on their visiting experience in the evening and found several attributes that require special consideration. "Pathway lighting" is considered the most important attribute for nighttime users in neighborhood parks and can dramatically influence the experience quality of visitors. In the three investigated neighborhood parks, pathway lighting is the main component of the lighting system, apart from sporadic lighting at the edge of the plaza, according to our field survey. Pathway lighting attracts walking participants and provides perceived safety, and the quality of pathway lighting can impact visitors' route choices after dark. Although the brightness and color of the lighting were rated as of relatively low importance and low satisfaction by the users, some effort can be made to create a comfortable lighting environment that benefits users' physical and mental health by providing a quality night experience, which has received extensive attention in indoor lighting studies [59,60], but until now, much less attention has been given to outdoor lighting [61,62].

The results of this study also suggest that the "site diversity" of nighttime needs much improvement in the neighborhood park, as it was valued as important but of low satisfaction by the users. In the evening, the sites for activity in the neighborhood park mainly take place in plazas and along the walkways. Enclosed greenery spaces are rarely visited by park users due to the weak light conditions at night and safety concerns. Strategies can be implemented to promote site diversity in the evening, such as improving the light conditions in potential hotspot areas, providing flexible spaces for a variety of activities, and carrying out planned activities such as night markets and night shows. In this study, we observed that visitors seldom used the venue only filled with outdoor fitness equipment in the evening, while a combination of a fitness venue with a small plaza could stay active at night, as the setting could provide a wider choice of physical activity, and the occurrence of one kind of activity may stimulate the development of other activities. "Night market and show" was also highly valued and expected by the park users, which is partially related to the site diversity and can effectively enhance the nighttime vitality of neighborhood parks. The findings may help designers understand how to promote the experience quality of nighttime neighborhood parks and promote the active usage of parks by meeting visitors' personal needs.

4.3. Limitations and Future Research

The samples in this study were collected from visitors to neighborhood parks other than all potential users within the accessible distance, which may lead to the findings only representing the behavioral patterns and perspectives of the actual park users. What reasons deter potential users from coming to parks at night needs to be further investigated [63], especially for those who have leisure time and recreational needs in their daily life. Future studies could conduct additional analysis of sample residents within reach of neighborhood parks. Although the number of questionnaire surveys distributed was stratified by the seasons and parks, the sample size was kindly small, and the questionnaire surveys were carried out in the period of 7:00–8:00 pm, which may not represent all park users in the evening. Due to the limited sample size, the structure of respondents was not taken into account when conducting IPA. Future research could survey park users over a long-term period in the evening and conduct more detailed comparative analyses for different groups of people at different periods.

5. Conclusions

Neighborhood parks can accommodate a wide range of recreational needs for urban citizens and keep visitors of all ages active and engaged for an entire day. The nighttime usage of neighborhood parks deserves more attention, as the time period coincides with leisure time for most residents who need to go to work. By considering space together with time, this study compared user characteristics and their levels of physical activity during the late afternoon and evening periods in neighborhood parks. This study revealed that there are changes in the types of physical activity and spatial distributions of visitors to neighborhood parks after nightfall. The findings may help park designers understand the effect of time on park use and how to promote park quality to enhance nighttime use. By evaluating the importance and performance of park attributes at night, this study suggests that “site diversity” and “night market and show” need much improvement for night park users, which could contribute to the development of management strategies for promoting recreational experiences in neighborhood parks.

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Appendix A. Questionnaire for Use of Neighborhood Parks in the Evening

We are researchers from Nanjing Agricultural University and are doing a questionnaire survey about nighttime use for the neighborhood parks. The survey does not include sensitive personal information, please feel free to fill it out. Thanks for your support.

1. How often you come to the park in the evening?
☐ almost every day ☐ weekly ☐ monthly ☐ occasionally
2. What is the average duration of your visit?
☐ less than 1 h ☐ 1–2 h ☐ 2–3 h ☐ more than 3 h
3. Who you are usually come with?
☐ alone ☐ with family ☐ with friends ☐ with colleagues ☐ with others

4. What kind of activities you usually participate in during your visit to the park in the evening (a multiple-choice question)?
☐walking ☐running ☐viewing the night scenery ☐sitting ☐playing chess ☐drinking tea ☐singing ☐watching a show ☐camping ☐dancing ☐playing Tai Chi ☐exercising with fitness equipment ☐others: _____
5. Please rate the IMPORTANCE of the following attributes in the neighborhood parks based on your experience in the evening (1 = not at all important to 5 = extremely important).
 Site security 1 2 3 4 5
 Site diversity 1 2 3 4 5
 Site privacy 1 2 3 4 5
 Night market and show 1 2 3 4 5
 Wayfinding system 1 2 3 4 5
 Pathway lighting 1 2 3 4 5
 Water lighting 1 2 3 4 5
 Plants lighting 1 2 3 4 5
 facility lighting 1 2 3 4 5
 Lighting brightness 1 2 3 4 5
 Lighting color 1 2 3 4 5
 Hygienic environment 1 2 3 4 5
 Water quality 1 2 3 4 5
 Landscape maintenance 1 2 3 4 5
 Noise control 1 2 3 4 5
 Electronic monitoring equipment 1 2 3 4 5
 Emergency treatment station 1 2 3 4 5
 Security patrol 1 2 3 4 5
 Alarm system 1 2 3 4 5
6. Please rate the PERFORMANCE of the following attributes in the neighborhood parks based on your experience in the evening (1 = very unsatisfied to 5 = very satisfied).
 Site security 1 2 3 4 5
 Site diversity 1 2 3 4 5
 Site privacy 1 2 3 4 5
 Night market and show 1 2 3 4 5
 Wayfinding system 1 2 3 4 5
 Pathway lighting 1 2 3 4 5
 Water lighting 1 2 3 4 5
 Plants lighting 1 2 3 4 5
 facility lighting 1 2 3 4 5
 Lighting brightness 1 2 3 4 5
 Lighting color 1 2 3 4 5
 Hygienic environment 1 2 3 4 5
 Water quality 1 2 3 4 5
 Landscape maintenance 1 2 3 4 5
 Noise control 1 2 3 4 5
 Electronic monitoring equipment 1 2 3 4 5
 Emergency treatment station 1 2 3 4 5
 Security patrol 1 2 3 4 5
 Alarm system 1 2 3 4 5

The following questions do not involve sensitive personal information, and are used for research purposes only.

7. Your gender:
☐male ☐female

8. Your age range:

☐less than 18 years ☐18–40 years ☐41–65 years ☐over 65 years

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