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The impact of urban park accessibility in cold regions on leisure-time physical activity levels of older adults during the winter

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Abstract: Given the situation of public health and population aging, studying the impact of park accessibility on the level of leisure-time physical activity of older adults (60 years and older) in cold regions is of great significance. Public parks in Harbin, China are often frequented by older adults. Furthermore, insufficient activity levels have an impact on health. This study mainly analyzed the accessibility of six parks and quantified the activity profile of older adults in winter. We obtained data through a field investigation on the activity levels of older adults, analyzed the accessibility of parks using the ARCGIS spatial analysis tool and network analysis, and studied the relationship between accessibility and levels of physical leisure activities of older adults with the Pearson correlation coefficient. The results indicated that: 1) The distribution of parks across the region was unbalanced, and overall accessibility via walking was poor; 2) In winter, the proportion of medium- and high-level leisure-time physical activities was 91.3%, and the walking travel rate was 80.65%. Walking was the main travel mode of older adults; 3) Five minutes of walking promoted the occurrence of high-level leisure-time physical activity (with a correlation coefficient 0.244 *). There was no significant relationship between motor vehicles (buses) and high-level activity. Walking had an effect on the level of leisure-time physical activity of older adults. Improving walking accessibility could improve the leisure-time activity levels of older adults in winter. According to the research results, we propose measures to improve walking accessibility to increase leisure-time activity levels in older adults.

1. INTRODUCTION

With the continuous improvement of living standards, China is facing new challenges brought by public health and population aging. By the end of 2020, China's population aged 60 and above had reached 264.02 million, accounting for 18.7% of the total population, an increase of 5.44% compared to 2010 (The Seventh National Census, 2021). The aging of society is accelerating. In 2022, China is posed to enter a society rapidly



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aging society (China Population Report, 2020). Health problems related to aging have attracted much attention. There were a large proportion of older adults in cold regions. By the beginning of 2020, Harbin, Heilongjiang Province had 2.15 million people over the age of 60, with an aging rate of 22.6%, which was higher than the national aging rate. Thus, the phenomenon of aging was more serious in this province.

Previous studies suggested that the activity characteristics of older adults in cold regions were generally reflected by high frequency and short durations (Wang, H., 2015). The research showed that the physical health of older adults in northeast cities who were engaged in outdoor exercise over the long-term was better than that of those who did not exercise. Notably, medium- and high-level leisure-time physical activities such as square dancing and Yangko, a form of Chinese folk dance, were more beneficial to their health (Zou, 2020), and the prevalence of cardiovascular and cerebrovascular diseases in older adults who exercised in parks was also lower than that in those who did not exercise.

Leisure-time physical activities mainly refer to sports such as physical exercise, walking, running, and aerobics but did not include sedentary activities such as watching TV and playing video games during one's leisure time (Wu, Wang et al., 2018). These activities were divided into light intensity (LPA), moderate intensity (MPA) and vigorous intensity (VPA). Physical activity levels have a great impact on public health. Leisure-time physical activity impacts both personal life and the environment. The unique environment of urban parks is an important part of providing opportunities for leisure physical activities and promoting public health (Wolf and Wohlfart, 2014; Zhang, X., Lu et al., 2011). Urban parks facilitate residents' exercise and leisure activities. Research showed that older adults were more likely to enter park and the adjacent green space for leisure physical activities (Hooper, Foster et al., 2020). Furthermore, frequently using parks was related to physical leisure activities. Residents exercising in the park were more likely to attain the recommended level of physical activity compared to other residents (Akpınar and Cankurt, 2017).

Many disciplines (such as public health, landscape architecture, and urban planning) have studied how to improve physical activity and promote health through park construction. The relevant elements of urban parks (park features, facilities, quality, accessibility) has been proven to be related to the health of residents (Levy-Storms, Chen et al., 2018). Nevertheless, in winter, the average temperature in cold cities is -19 °C, and large quantities of ice and snow that are difficult to remove can accumulate on the pavement in urban areas. In these situations, roads become slippery and dangerous for drivers and pedestrians (Clarke, Hirsch et al., 2017). In these conditions, older adults are afraid of falling and reduce the frequency at which they go out (Rantakokko, Mänty et al., 2009). Thus, the choice of travel modes for older adults is reduced, the accessibility of urban parks becomes poor, and the willingness of older adults to participate in outdoor leisure physical activities weakens (Leng, Li et al., 2021). Urban park accessibility referred to "the time (distance) cost spent from the residence to the park center or entrance and exit" and could also be "a quantity of resources obtained from the starting point to the destination." The meaning of urban park accessibility varies and changes with different research contents or by the unit of distance cost or time cost. Parks with good accessibility have been proven to improve residents' level of leisure physical activities (Penedo and Dahn, 2005).

Only 45% of older residents in the northeast of China participate in outdoor exercise in the winter ([Zou, 2020](#)). A large part of older adults had changed their living habits and schedule after retirement or unemployment and thus have more leisure time ([Evenson, Rosamond et al., 2002](#)). An adequate level of physical activity could improve health. The adult physical activity and health guide for Chinese adults states health status and quality of life can be improved by participating in moderate to vigorous physical activities (MVPA) at least three times a week. Notably, increasing the activity level of older adults with insufficient physical activity was an effective strategy to prevent illness and delay aging ([Chodzko-Zajko, Proctor et al., 2009](#)). If older adults cannot attain a sufficient level of leisure-time physical activity, then exercising outdoors in the winter may have a negative impact on their health and increase the risk of cardiovascular disease. Therefore, how to improve the activity level of older adults in winter remains to be studied.

To date, most of relevant studies have focused on western countries ([Kaczynski, Potwarka et al., 2008](#)), park accessibility has been minimally investigated in relation to physical activity, and few studies have examined these two factors concurrently in China. In past studies, the metabolic amount used to study the relationship between parks and physical activity may include activities unrelated to the park itself such as activities completed at home, work, or school. These studies only vaguely connected the relationship between the environment and human activities, ignoring the actual activity level of older adults in the park. This distinction is noteworthy as residents can be sedentary in the park or engaged in moderate- to high-intensity physical activities. During urban planning, it was difficult for the park to be designed to meet the needs of older adults residing in the northeast. The adjacent green space facilities were incomplete, the space was insufficient, and the resources were very scarce.

To better understand the relationships between older adults and urban parks in cold regions, we took Nangang District of Harbin a city in northeast China, as an example. This study explored the accessibility of parks and the leisure physical activities of older adults in parks during the winter, looked for methods to increase physical leisure activities in older adults, and intervened in the construction of urban parks. Doing so reduced the risk of age-related diseases in older adults to realize "active aging" ([Huang, Li et al., 2018](#)) increased the amount of consideration given to ecological equity, public health, and well-being in planning urban parks.

2. METHODS

2.1 Study sample

This study mainly considered the impact of the level of service provided by urban parks on activity level. Therefore, we gave more consideration to the actual situation of urban parks.

Harbin is located in of the typically colder regions of China. Nangang District (longitude: 126.68, latitude: 45.77) is the old city center of Harbin. Therefore, in the selection of parks, 16 parks in Nangang District were investigated, including nine community parks, one agricultural demonstration park, two theme parks, two toll parks, and two comprehensive parks. Among the nine community parks, only Qingbin Park, Majiagou Lishui Park (Mujie Street), and Majiagou Lishui Park (Xuanhua

Street) were open to the broader community and thus has a large flow of people. The other six parks were in an enclosed community, the service scope was small, and external residents could not enter. One agricultural demonstration park and two toll parks did not meet the openness criteria for older adults to use for regular exercise. Among the two theme parks, only Ertong Park was open. Two comprehensive parks, Xiangjiang Park and Hongbo Central Park, were characterized by openness, a large flow of people, and a wide service range.

In summary, through preliminary investigation of on-site investigation and relevant data analysis, we selected six parks with similar environmental elements and surrounding resources, high openness, high vitality, and large service range in Nangang District of Harbin and selected them for the following analysis, as shown in *Figure 1*. With *Table 1*, six parks were classified according to the Classification Standard of Urban Green Space (CJJ/T85-2017). The details are as follows:

(1) The Children's Park is a theme park with a large area and comprehensive facilities and venues. In the preinvestigation, it was found that the elderly partake a large proportion of activities in this park in the winter and summer, and account for more than 70% of the total visitors;

(2) Qingbin Park is a community park Its scale is suitable for community residents. The surrounding transportation is convenient and accessible. However, due to the small site, the diversity of types of activities is not rich;

(3) Xiangjiang park is surrounded by old communities with an overall area larger than Qingbin Park, with a green space rate of more than 80% and fewer facilities. There is only a plastic runway in the park, which is adjacent to the sidewalk and expands inward;

Table 1. The basic situation of the Research Park

Type	Name	Longitude and latitude	Area	Facilities
Special park	Ertong Park	Lng:126.65 Lat:45.76	13hm ²	chair, fitness equipment, children play facilities, table tennis, runway
Community park	Qingbin Park	Lng:126.61 Lat:45.72	3.3hm ²	chair, fitness equipment
Comprehensive park	Xiangjiang Park	Lng:126.68 Lat:45.74	16.8hm ²	chair, fitness equipment
Comprehensive park	Hongbo Central Park	Lng:126.69 Lat:45.75	17.5hm ²	chair
Garden tour	Majiagou River Lishui Park (Mujie Street)	Lng:126.64 Lat:45.74	0.19hm ²	chair
Garden tour	Majiagou River Lishui Park (Xuanhua Street)	Lng:126.66 Lat:45.76	3.8hm ²	chair, fitness equipment

(4) Hongbo Central Park is remote and close to the Hongbo Convention and Exhibition Center, so it will attract both the elderly and families. Additionally, there are a few large-scale group activities, including the following;

(5) Lishui Park on both sides of Majiagou is located between Xuanhua Street and Mujie Street. The park is generally arranged to one side. The pedestrian path along the river, which is relatively narrow and long, is not connected to all locations. There is no connecting bridge within 100 m of the pedestrian along the river on either side.

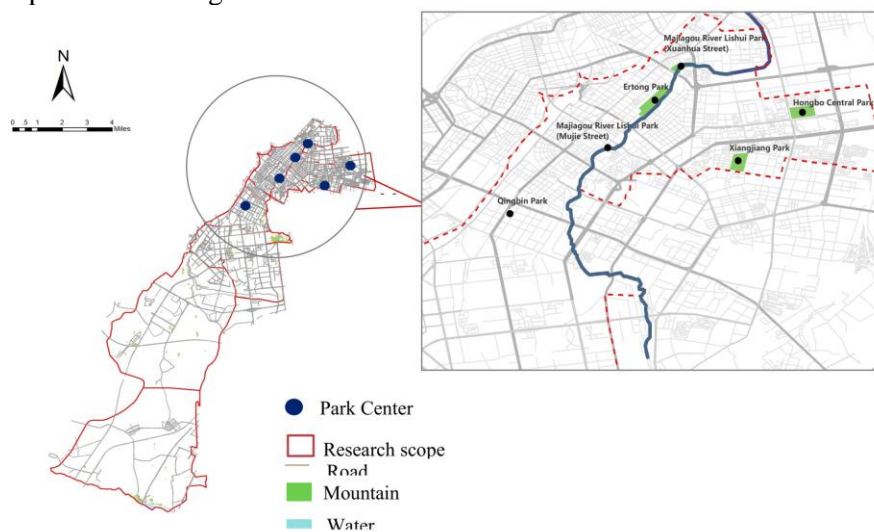


Figure 1. Data map of the central point of the park

2.2 Collection of leisure-time physical activity level

Being an older adults aged 60-80 was the basic condition for being selected for screening samples. This study mainly adopted the methods of on-site observation, interviews, and questionnaires, and was powered by www.wjx.cn to supplement the network investigation.

2.2.1 On-site investigation

Throughout the whole park tour, fixed-point observations, exchange interviews, other forms of investigation, and other relevant information on the park environment and surrounding roads were recorded. To study under the conditions of a severe, cold climate, the survey was conducted from November 2020 to January 2021. Since the weather was cold, almost no one exercised after 16:00 p.m.. The time windows were 8:00-11:30 and 13:00-16:30, and the temperature was less than or equal to -10°C .

During the survey, we spoke to groups of 5-8 people who were randomly selected at each time point to understand the purpose and status of their activities. Each park is open from Monday to Saturday. The number of people in each park was controlled at approximately 15 in a day over a total of 18 days of investigation.

2.2.2 Questionnaire design

The International Physical Activity Questionnaire (IPAQ) ([Fan, Lyu et al., 2014](#)) is an internationally recognized questionnaire that is used to calculate physical activity level and has been proven to be applicable to the activity level calculation of older adults aged 60 and over ([Wang, X., 2015](#)).

The questionnaires were designed according to the IPAQ for leisure physical activities and supplemented after a round of preliminary investigation, which included basic personal information, self-recall of the

category, frequency, duration, and purpose of physical activities in the last seven days. Among them, 265 questions were used in the field survey, and an online questionnaire survey was an auxiliary means. The network questionnaire was distributed to each community.

2.2.3 Activity level calculation

Physical activity level includes "physical activity time + physical activity frequency + activity intensity." Leisure-time physical activity was a physical activity within the scope of leisure time. In this study, the metabolic equivalent (MET) of the task method was used to calculate the total leisure-time physical activity level of each person in the park every week (Dai, Zhu et al., 2019).

The total leisure-time physical activity level was the metabolic equivalent of different types of activities for older adults in six parks \times weekly frequency (D/W) \times the daily time (min/D), and metabolic equivalents of various activities are shown in *Table 2*.

Table 2. ctivity metabolic equivalent of older adults in Nangang Park

Intensity Division	Specific activities	METs
Light (METs<3)	sedentary	1.3
	standing and chatting	1.8
	taking care of a child	2.0
	playing cards	2.5
	playing chess	2.5
	stretching	2.3
	playing the trumpet	1.8
Moderate (3≤METs<6)	walking	3.5
	Tai Chi	3.0
	playing table tennis	4.0
	playing badminton	5.5
	ballroom dancing	3.0
Vigorous (METs≥6)	fishing	3.5
	playing the drums	3.8
	square dancing	7.3
	kicking shuttlecock	6.0
	jogging	7.0
	exercising using fitness equipment	7.0
	Yangko folk dancing	7.8

The leisure physical activity level of older adults was calculated, and then the statistical questionnaire data and network questionnaire data were integrated into an Excel table. Each residential area corresponded to the accessibility coverage area of the park one by one, and the activity level of each older adult was calculated. The relationship between the accessibility coverage of a specific location and the total leisure-time physical activity level of each older adult was analyzed by the SPSS correlation coefficient.

2.3 Park accessibility analysis method

Network analysis is an accessibility analysis method based on travel range. The center was the location of the park, resistance refers to the traffic capacity, including the speed of different traffic modes, and nodes were the intersection points of roads and connected to different levels of roads. The actual calculation adopts the road vector data of the network map.

Establishing a network data set and service area analysis of travel time of different transportation modes could more truly show the accessibility and service scope of the park and solve the disadvantages of other methods (Nicholls, 2001).

To analyze park accessibility using a network analysis method, geographic information systems (GIS) technology were applied based on travel range. The network analysis method is used to calculate the service range of urban parks under different resistances and traffic modes based on road networks. The network analysis method was used to analyze the accessibility of urban parks, incorporate the spatial and temporal dimensions, accurately process the vector data, and precisely reflect the actual results (Wang, L., Jia et al., 2016). In this study, the vector data of land use status in Nangang District in 2018 were used. The road network data of Nangang District and the central point data of urban parks were imported into the ArcGIS 10.2 database to repair the road network connectivity and add travel speed and impedance (travel time) to the road network data. This study involved two arrival modes: walking and motor vehicles. According to the provisions of the (JTGB—2003) technical standard of highway engineering of the People's Republic of China, the average walking speed was set as 5 km/h. The speed of motor vehicles is 80 km/h for fast tracks, 60 km/h for trunk roads, 40 km/h for secondary trunk roads, and 20 km/h for branch roads (Li, 2020).

3. STATISTICAL ANALYSIS

3.1 Park accessibility

According to the time cost, the travel impedance was divided into 5 min, 10 min and 15 min for walking and 5 min, 10 min, 15 min, 20 min, and 30 min for motor vehicles. According to the Standard for Planning and Design of Urban Residential Areas (GB50180-2018), the effective service range of accessibility of different transportation modes was 15 min, and the distribution of park accessibility is shown in *Figure 2*. The results of the spatial analysis showed that the main parks in Nangang District were unevenly distributed across the center of the old urban area in the northeast. The overall accessibility results showed that the pedestrian accessibility range of the six parks in Nangang District was clearly not as wide as that of motor vehicles.

According to the land use vector data map of Nangang District in 2018, this study assumed that residents were evenly distributed in extracting a range of urban residential blocks. We selected 15 min as the effective service range of the three travel modes and eliminated landscape areas that did not belong to the service range to obtain the effective service area ratio (Li, 2020) with *Figure 3*:

Effective service area ratio=Effective service area/Study area (Excluding landscape) × 100%

The walking accessibility of the six parks in Nangang District was relatively poor. Within the streets of Nangang District, the effective service area within 5 minutes accounted for 1.89%, and the effective service area within 15 minutes accounted for only 14.71%. In the research and analysis, it was clear that the service scope of motor vehicles covered almost the whole region, and the accessibility was the best. The accessibility of motor

vehicles within 15 minutes accounted for 85.79%. It was more recommended that older adults with a long distance took the bus.

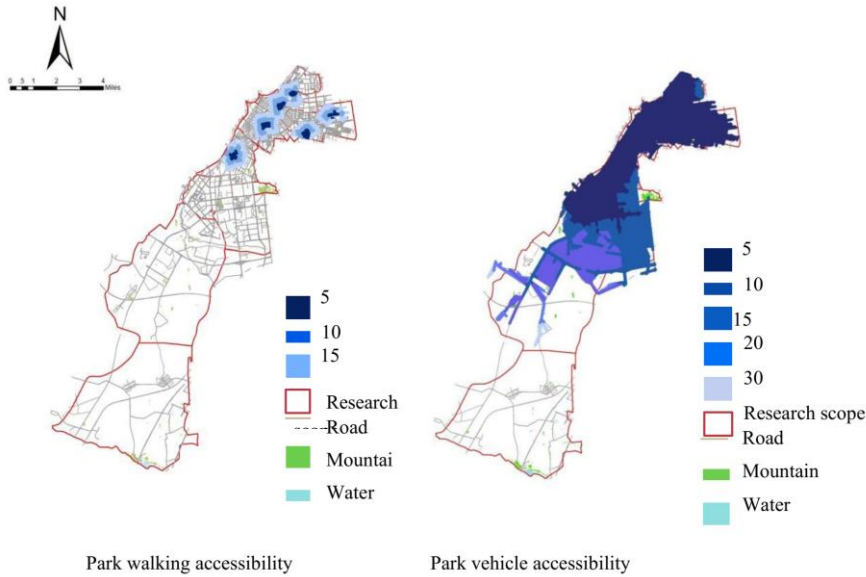


Figure 2. Accessibility of different transportation modes in winter

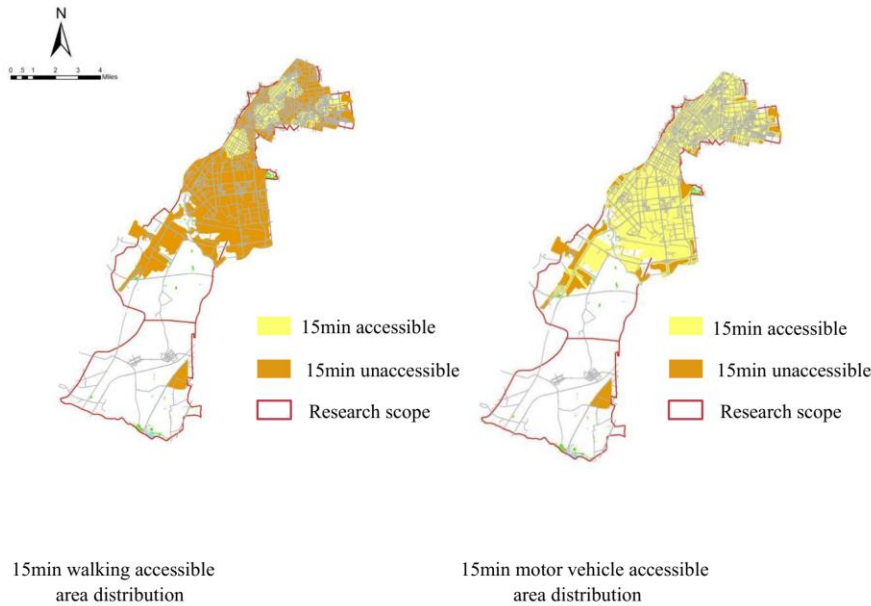


Figure 3. Distribution map of 15min accessible area of different traffic modes

Park roads with large service range in a short time had higher road connectivity and lower grade. For example, Qingbin park had the highest coverage (0.39% and 1.62%) within 5min and 10min by different traffic modes, and the surrounding road density was large, so the passenger flow was relatively large and the accessibility of different traffic modes was better. This would help to put forward intervention measures for park construction.

3.2 On-the-spot investigation and questionnaire survey

Data were collected in Nangang District, through on-the-spot investigation, it was found that the main visitors to the park under the severe cold climate were the local elderly, such could better reflect the typicality of northeast cities in cold regions.

As shown in *Figure 4*, the activities in different parks were different due to different sites. The main activities were walking, standing chat, square dance, chess, cards, badminton, table tennis, etc. They were carried out in fixed areas every day. The personnel of some group activities (such as square dance, cards, Yangko, etc.) were relatively fixed. The proportion of residents under 60 years old (including children) was only 7.1% ~ 9.3%. Through multiple fixed-point observation of the stream of people, the average stream of people in the six parks was 8.5 person times / min in Ertong park, 11.2 person times/min in Qingbin park, 8.6 person times/min in Hongbo Central park, 9.5 person times/min in Xiangjiang park, 9.8 person times/min in Majiagou Lishui Park (Xuanhua Street), and 6.2 person times / min in Majiagou Lishui park (Mujie Street). It could be seen that the park area was not directly related to the flow of people, but may be related to the density of surrounding residential areas.



walking for pleasure



square dancing



Yangko



play chess



table tennis



exercise on fitness equipment

Figure 4. Activity status of older adults in Nangang Park of Harbin

A total of 461 questionnaires were collected in this survey. After removing the juvenile and incomplete answers, 372 valid questionnaires were obtained, for an effective rate of 80.7%. There were 196 males and 176 females, of which 92 people were aged 60-65 years old, 136 people were aged 65-70 years old, 144 people were aged 70-79 years old, and all of whom were retired or unemployed. During the investigation, no park managers were seen walking around the park. Among the respondents, the number of people in good health was 212, the number of patients with chronic disease was 126, and the number of acute patients was four. At the same time, 81.72% of respondents chose to enter the park on foot while the remaining 19.35% chose to enter the park by bus.

Statistics showed that the proportion of vigorous and group activities (except playing chess or cards), such as square dancing, shuttlecock kicking, and playing badminton, was 68.1%. The proportion of hours engaged in

low- and medium-intensity individual and small-group activities, such as meditation, walking, and playing cards, was 31.9%. The interviews revealed that most people would travel together and had a strong willingness to participate in group activities. Older adults on the same team arrived at the park to participate in activities no matter how far away they came from.

3.3 Correlation between park accessibility and leisure-time physical activity level

We used the correlation coefficient-Pearson correlation coefficient in SPSS version 22.0 to examine the correlation between park accessibility and leisure-time physical activity levels in the study.

Questionnaire statistics were analyzed by Cronbach's α efficient reliability analysis, which showed that the value of the reliability coefficient was 0.898, which was greater than 0.8, which showed that the reliability quality of the research data was high. The reliability coefficient did not increase significantly after deleting any individual item and thus the data could be used for further analysis. Data analysis was performed in SPSS version 22.0.

Specifically, according to the residential areas covered by the six parks at different reachable times and the residential areas described by older adults themselves in the questionnaire, the effective data of walking for 5 min, 10 min, 15 min and motor vehicles for 10 min, 15 min, 20 min, and 30 min intervals were obtained. Afterward, the time-related information and leisure-time physical activity intensity were counted in Excel 2019, and a Pearson correlation test of leisure-time physical activity level was conducted. The correlations of various conditions was obtained. Among the older adults, 68.82% (256) had attained a sufficiently high level of physical activity, and only 8.60% (32) of older adults had a low level of leisure-time physical activity, with an average activity duration of 1,272 min/week, indicating that older adults were willing to carry out a high level of leisure-time physical activity despite the cold climate.

As shown in *Table 3*, correlation analysis was used to study the correlation between different leisure-time physical activity levels and walking accessibility and motor vehicle accessibility. The correlation coefficient was used to analyze the strength of the correlation. The analysis revealed the following.

There was a significant correlation between walking accessibility and different levels of leisure-time physical activity according to the Pearson correlation coefficient. The correlation coefficients between low and medium levels of leisure-time physical activity and walking accessibility were -0.311^{**} ($p = 0.002 < 0.01$) and -0.386^{**} ($p = 0.000 < 0.01$), respectively. Both were close to zero. There was a negative correlation between low and medium levels of leisure-time physical activity and walking accessibility. The correlation coefficient between high-level leisure-time physical activity and walking accessibility was 0.244^* ($p = 0.018 < 0.05$), which is close to zero. There was a positive correlation between high-level leisure-time physical activity and walking accessibility, indicating that the impact of walking accessibility for 5 min, 10 min and 15 min on the level of leisure-time physical activity showed a regular change.

Busses were the most commonly used motor vehicle. There was a significant correlation between motor vehicle accessibility and low and medium levels of leisure-time physical activity. The correlation coefficient values with the level of leisure-time physical activity were 0.299^{**} ($p =$

0.004 < 0.01) and 0.373** ($p = 0.000 < 0.01$), respectively. This means that there was a positive correlation between motor vehicle accessibility and low-level leisure physical activities of older adults, indicating that the degree of motor vehicle accessibility affected low-level leisure physical activities. Motor vehicle accessibility within 10 minutes can enable older adults to carry out low- and medium-level leisure physical activities. In contrast, the correlation coefficient between high-level physical activity level and motor vehicle accessibility was $p = 0.062 > 0.05$, which proved that there was no significant correlation between them. Older adults who were far away from the park mostly exercised occasionally (less than or equal to once a week), which usually involved visiting the park as a group and typically no high-level physical activity. The correlation between motor vehicles and walking was not significant, but the degree of walking affecting different levels of activities was more obvious.

Table 3. Correlation between different activity levels and modes of transportation

			Vehicle accessibility	Walking accessibility
Leisure-time physical activity level	Low	correlation coefficient	0.299**	-0.311**
		p value	0.004	0.002
	Medium	correlation coefficient	0.373**	-0.386**
		p value	0.000	0.000
	High	correlation coefficient	-0.194	0.244*
		p value	0.062	0.018

Note: * $p < 0.05$ ** $p < 0.01$

3.4 Factors related to the impact of park accessibility on leisure-time physical activity level

As shown in Table 4, according to the questionnaire data, among the older adults who often entered the park, 67.23% (low level $p = 0.000 < 0.01$, medium level $p = 0.015 < 0.05$, high level $p = 0.034 < 0.05$, showing a significant correlation) thought that park accessibility was the main factor in participating in outdoor leisure physical activities, and 56.58% (the correlation coefficient is close to zero, $p < 0.05$) of the older adults who showed a significant correlation thought that being retired was one of the main reasons for older adults to go out for exercise. Among the older adults who occasionally entered the park, 64.71% thought that they were too far away from the park, and that cold or snow ($p > 0.05$, no significant correlation) were not the main factors hindering older adults from exercising. Physical health, age, and park satisfaction ($p > 0.05$, no significant correlation) were not reasons why older adults chose whether to engage in leisure physical activities. Therefore, accessibility was highly correlated with different levels of leisure-time physical activity.

Table 4. Correlation between different factors and leisure activity level

Level		Age	Health levels	Park satisfaction	Climate	Retired	Accessibility
Low	correlation coefficient	0.067	0.214*	-0.121	-0.087	0.220*	0.492**
	p value	0.525	0.040	0.026	0.407	0.034	0.000
Medium	correlation coefficient	-0.150	0.242*	-0.049	0.066	0.214*	-0.253*
	p value	0.151	0.019	0.640	0.532	0.040	0.015
High	correlation coefficient	0.017	-0.224*	0.055	-0.153	0.217*	0.220*
	p value	0.869	0.031	0.598	0.143	0.037	0.034

Note: * $p < 0.05$ ** $p < 0.01$

As shown in Table 5, an independent sample t test was used to study the relationship between gender and different levels of leisure-time physical activity. Table 5 shows that different genders and Low-level and medium-level leisure-time physical activity levels all showed consistency, and there was no difference. High-level leisure-time physical activity showed a significance level of 0.05 ($t = -2.064$, $p = 0.044$), and the specific comparative differences showed that the average value of men (0.02) was significantly lower than that of women (0.14).

Table 5. Test analysis results

	Gender (average value \pm standard deviation)		t	p
	man	women		
Low	0.18 \pm 0.39	0.20 \pm 0.41	-0.252	0.802
Medium	0.51 \pm 0.51	0.34 \pm 0.48	1.658	0.101
High	0.02 \pm 0.14	0.14 \pm 0.35	-2.064	0.044*

4. CONCLUSION AND DISCUSSION

4.1 Conclusion

This study mainly focused on the relationship between the activity of older adults in cold regions and the spatial element of park accessibility for cold-weather exercise, which is different from that in other climates. When it was known that older adults in Harbin still engaged in high-intensity exercise in the park in winter, we explored whether the accessibility of the park had an impact on their activity level and clarified this relationship.

Through this study, we analyzed and synthesized the relationship the accessibility of urban parks and different levels of leisure-time physical activity in Nangang District, Harbin in the winter among older adults. We found an influencing relationship between them. Adding a detailed analysis of the physical activity overview and distribution of park accessibility, the following conclusions are drawn:

First, park accessibility in winter would have an impact on the level of leisure-time physical activity of older adults. Two different modes of transportation, which were walking and motor vehicles, had different effects

on the levels of leisure-time physical activity. The greater the degree of motor vehicle accessibility within 30 minutes or the lower the walking accessibility within 15 minutes, the lower the level of low- and medium-level leisure-time physical activity. The higher the walking accessibility was, the higher the high level of leisure-time physical activity.

Another more important factor, five minutes' walking distance, was the optimum range to encourage older adults to achieve a higher level of leisure-time physical activity. In the future, when designing the park, we should focus on locating parks within five minutes of many older adults; doing so could also meet the needs of adults and even children.

Furthermore, we also found that among other potential factors, such as age, gender, climate, retirement, physical health, and park satisfaction, the activity level of older adults who went out for exercise was less affected by the climate and more affected by retirement and willingness to engage in certain activities. Additionally, women were more active than men.

Last, it was found that the parks were unevenly distributed, the street connectivity was poor, which contributed to poor walking accessibility for older adults.

4.2 Discussion

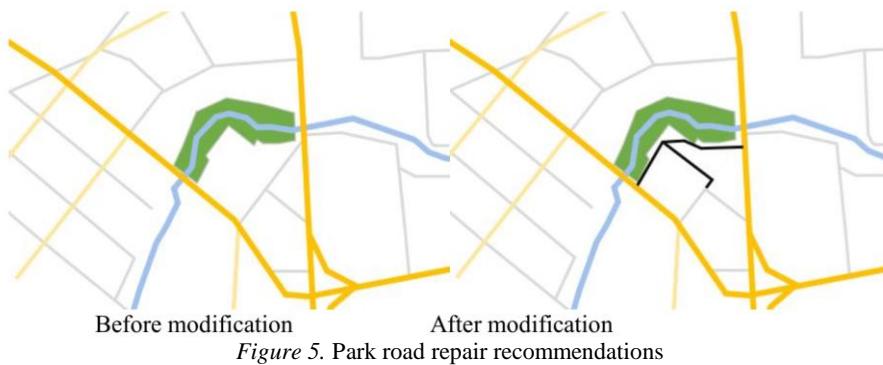
Concretely, for parks in cold regions, the greater the walking accessibility, the smaller the negative impact of the external environment (including streets and parks) ([Jiang, Zhen et al., 2020](#)), and vice versa. Older adults are also spend a relatively long time in leisure-time physical activities, which would increase the overall level of group activities. The reason may be that walking, which is low risk and healthy, was the most economical of all means of transportation in cold regions ([Chi and Zhou, 2019](#)). The comfortable street scale ([Nyunt, Shuvo et al., 2015](#)). and the preferences of older adults were closely related to walking ([Cunningham and Michael, 2004](#)). Therefore, it is necessary to improve the walking accessibility of urban parks. Furthermore, retired or unemployed older adults had different attitudes toward aging ([Wang, K. and Li, 2021](#)), and their different cognitive levels of health reflected differences in activity levels. For example, women thought that socializing was attractive and safe, so they preferred to participate in high-level group activities ([Tan, He et al., 2020](#)). Therefore, considering mental state in the health of older adults is also particularly important.

Evidence has proven that accessibility affects the physical activity level of older adults in cold regions to varying degrees, and older adults are more sensitive to walking distance ([Kamphuis, Van Lenthe et al., 2009](#)). To better explore the relationship between green space and public health and solve the health problems caused by space and aging, we propose the following strategies:

- 1) Establish grid-enabled parks. When planning future parks in cold regions, based on the 15 min living circle implemented in China, it is best to establish an open rehabilitation pocket park ([Zhou and Fang, 2021](#)) at the street corners of other plots ([Niu, Yan et al., 2021](#)). More open space is conducive to improving the overall leisure-time physical activity level of older adults ([Chen and Li, 2021](#)). Pocket parks have similar functional facilities to comprehensive parks but within a small area, which is suitable for the needs and habits of older adults, who prefer to reach the activity site within five minutes, but can also be applicable to other age groups to prolong the duration and intensity of the activity. Furthermore, pocket parks

can foster social cohesion among residents who live in high-density urban neighborhoods ([Liu and Wang, 2021](#)).

2) Create an environment that supports walking. When constructing streets that lead to the park, cities can create an environment that is conducive to walking and improve the connectivity and safety of roads. In future urban design in cold regions, more attention should be given to constructing slow traffic networks and optimizing walking networks. Notably, upgrade the road grade, repair the road, reduce unsafe oblique road intersections with *Figure 5*, provide widened sidewalks and squares, and increase speed bumps, barrier free facilities, and buffer zones according to the current traffic situation. In winter, the municipal authorities should remove ice and snow in a timely manner ([Wang, Q., 2020](#)), especially on pedestrian paths, reduce obstacles, and minimize the risk of falling due to slippery conditions.



3) Enhance the sense of social participation. Older adults tend to not have strong exercise habits, and the cold climate hinders most older adults from going out. Therefore, the government should encourage older adults to exercise outdoors by offering more collective activities other than square dancing and badminton and encouraging community participation. to attain the recommended 30 minutes of activity per day to support health. Furthermore, the sense of participation in social activities ([Zhang, C. and Zhang, 2016](#)) and sense of belonging should be enhanced, health information pamphlets and scientific fitness manuals should be distributed to citizens free of charge, or on-site teaching and activity guidance should be conducted to reduce the inferiority complex and loss psychology of older adults due to lack of knowledge.

5. CLOSING REMARKS

Research on parks and their relationship to people has very important practical significance, such as helping the government and builders better plan parks and cities and promote healthy lifestyles among residents. However, not all parks are equal, especially in terms of accessibility. Therefore, we need to pay more attention to park accessibility and level of activity.

Although we conducted a more detailed on-site investigation and applied the international physical activity level calculation standard, there were still some limitations to this study such as older people not following the routes. Finally, to make the research results more accurate, researchers should

include: 1) long-term observations and average values, 2) actual walking routes, and 3) actual walking speeds. We will improve along these dimensions in the follow-up study.

AUTHOR CONTRIBUTIONS

Conceptualization, Yuan Qing, Zhang Yifang and Leng Hong; methodology, Zhang Yifang; software, Yuan Qing and Zhang Yifang; investigation, Zhang Yifang; resources, Yuan Qing, Zhang Yifang and Leng Hong; data curation, Zhang Yifang; writing—original draft preparation, Zhang Yifang and Leng Hong; writing—review and editing, Yuan Qing and Zhang Yifang; supervision, Yuan Qing and Leng Hong. All authors have read and agreed to the published version of the manuscript.

ETHICS DECLARATION

The authors declare that they have no conflicts of interest regarding the publication of the paper.

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