Evaluation of the open space performance for the mass fitness activities in an urban park

Evaluation of the open space performance for the mass fitness activities in an urban park
a case study of Lixiang Park in Shenzhen City

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Abstract: In the perspective of urban design, the open space performance for mass fitness activities is the objective of this study. Lixiang Park, popular for mass fitness activities for residents in Shenzhen, was selected as a case study. The fitness activities are divided into two categories, track sports and field sports, according to their different spatial characteristics.

Inspired by the literature review, the study procedure is established by evaluation with on-site observation and questionnaire. Through the on-site observation at Lixiang Park, the data of the fitness activities and the preference of places were collected and analyzed by observation counting method and behaviour annotation method. On the other hand, a questionnaire survey was done at Lixiang Park with its fitness people as the subjects in order to obtain the data on their perception and satisfaction.

Analyzed by SPSS, the results of these two kinds of data both revealed the high performance places. Finally, the open space system with good performance for mass fitness activities in an urban park in Shenzhen, including a loop road, fitness equipment court and lawn, etc.，is inferred by the case study. However, it will be testified by more cases later. Open spaces for mass fitness activities play an important role at human health and well-being, and it is also positive for maintaining social sustainability.

1.   INTRODUCTION

In China's first-tier cities such as Shenzhen, people are busy with working and living every day. How to keep healthy has been a common concern to people. Outdoor fitness is an important way of life (Shen, 2018). In October 2016, China's central government issued the policy titled the "Healthy China 2030", which articulated the national strategies on health and promoted physical exercises for an entire population to keep healthy.

1.1   Literature review

1.1.1   Urban open space and sports fitness activities

The parks with full facilities, sufficient fitness activity space and complex terrain, tend to let more dynamic and pass-through behaviour occur. Tan, Sun, and Shen (2018) testified this with the study of four typical parks in Chongqing.

About the study methods in the study of urban open space and sports fitness activities, observation and questionnaire survey are the major ways. On the observation respect, Xu et al. (2018) analysed 4 local parks as study objects based on SOPARC (system for observing play and recreation in the communities), the physical activities and their environmental spatial characteristics were analyzed. Wang, C., He, and Chen (2018) used ActiGraph GT3X+ accelerometer to measure the level of physical activities at different times in different periods, analyzed the relationship between the spatial characteristics of the exercise places near the community of the study object and the physical activities of the adults for a specific time period with ArcGIS V10. 0 software. Zhang et al. (2016) explored an activity pattern of suburban residents in both spatial and temporal dimensions based on a GPS based activity-travel survey in Beijing in 2012.

On the questionnaire respect, Wu, Qin, and Zhou (2018) conducted a questionnaire survey with 595 residents at community fitness places in Shenzhen, China. The results showed that jogging and walking were the most popular individual exercise activities, where the preferred places were neighbourhood gardens, urban squares and parks. The preferred places were professional fitness clubs, urban squares and parks. Gender differences significantly determine the choices of sports. Esther, Winky, and Edwin (2017) obtained the relevant factors to promote the use of park for the satisfaction of the elderly by questionnaire interview research and PCA (principal component analysis) analysis combined with ordered LOGIT model auxiliary analysis. There was also a study of the relative importance of the characteristics of parks using the CBC analysis (choice-based conjoint analysis), in which adolescents participated. (Van Hecke et al., 2018) On the study of park path, Zhao et al. (2018) put forward three levels of sports cognitive model in the fitness path of city parks in cold areas, explaining the cognitive path of spatial users. Fan, Da, and Zhang (2015) selected thirteen public parks as examples in Shanghai, investigated fitness facilities in parks and users' satisfaction with on-site observation and questionnaire, they analyzed the number of fitness facilities, types, characteristics of usage, satisfaction, management and maintenance, etc. The optimizing strategy on urban park services from meeting users' fitness needs, facilities management and maintenance were proposed.

Several studies involved experiments and spacial syntax analysis. There is also a study of the preference of roads in natural parks through discrete selection experiments, and an in-depth understanding of the relative importance of different resources, social and management conditions in parks (Sever & Verbič, 2018). The study of park open space, Hou, Zhao, and Zhang (2017) used spatial syntax theory to quantify the spatial organization characteristics of urban park activities, which found the differentiation characteristics of morning exercise space and non-morning exercise space at the spatial organization level, and four types of collective morning exercise preference characteristics.

1.1.2   The impact of an urban built environment on human health

Some studies discussed the theoretical issues on the impact of an urban built environment on human health. The theoretical basis of the impact of environmental design on health behaviour was reviewed (Wang, M., 2018). With the purpose to promote residents' physical vitality through urban design, the design strategy of daily travel space was proposed to meet the demands of different activities such as walking, cycling, jogging, roller skating and skateboarding, etc. (Liu & Guo, 2006).

Wolf and Wohlfart (2014) used two different evaluation methods (questionnaires and GPS tracking walkers, hikers and runners) to evaluate the energy consumption of park users.

There are more and more evidence-based studies on the impact of built environment on human health. Kessel et al. (2009) studied that walking and exercise in green spaces like community parks could promote the residents' physical and mental health by a case study of Thames community forest in London. Coombes, Jones, and Hillsdon (2010) analyzed the life quality data of 6821 adults in Bristol community in 2005 with a GIS database of neighbourhood and green features, it was found that green space with good accessibility could promote physical activity of residents. Day (2016) had reviewed on the relationship between residents' physical activities and built environment in China. She indicated that the special environmental issues of affecting healthy behaviour should be emphasized in China, such as pollution, high density, traffic safety, etc.

The plants in parks play great roles at the promotion of health. Ke (2014) testified the plants can improve air quality, and adjust the temperature and humidity of the environment (Yuan & Wang, 2014) . They affect a person's physiological state directly or indirectly and reduce the occurrence of some diseases (CPCB, 2008), and they also improve mood or reduce fatigue and stress of residents (Bringslimark, Hartig, & G.Patil, 2009).

1.1.3   The study procedure of the open space performance for mass fitness activities

The literature has revealed several respects on residents' health correlating with the urban open spaces: the open space characteristic with the corresponding fitness activities; on-site observation, and GPS tracking are the main ways of capturing behavioral data; questionnaire is the major way to obtain the subjects' motives, demands, satisfaction and environmental perception data; green landscape and sports facilities indeed have positive impact on residents' health. However, how to evaluate open space for mass fitness activities in the parks should be studied further in the dimension of urban design. Inspired from the above research, a study procedure can be made for the study on the primary open space pattern suitable for mass fitness activities (*Figure 1*).
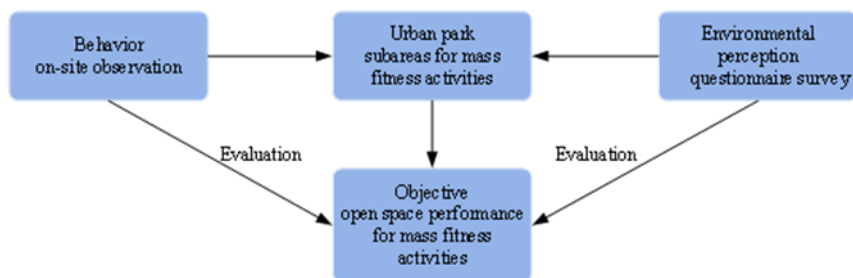
Figure 1. The study procedure of the open space performance for mass fitness activities

1.2 Research Objectives

Through the pre-investigation, it was found that there were many more people doing different fitness or leisure activities in different areas of the park on weekdays or weekends. We classified the fitness activities into two categories according to space characteristics: field sports like equipment exercising, yoga, dancing, ball games, leisure activities (sitting, chatting, kite fly); track sports like jogging, walking, etc.

In Nanshan district, Shenzhen, Lixiang Park is a popular urban park located in the centre of the district. The park opened in October 2000 with a total area of 230,000 square meters. There are various facilities in the park, such as the basketball courts, the tennis centre, fitness fields, and a large lawn. It can meet the residents' demands for sports, fitness and recreation. The park is classified into 6 sub areas according to their facilities and features. They are five field sports venues (A1 Pearl Square, A2 Northwest Station of Exercise Equipment, A3 South Station of Exercise Equipment, A4 Basketball Courts and A5 Sunshine Lawn), and one for track sports (B1 Park Ring Road) (*Figure 2*).

This study is expected to evaluate open space performance for mass fitness activities of the park. Through investigating the relationship between fitness activities and the places where people like to go, the open spaces with well performance for mass fitness activities will be found out in the dimension of urban design. Then it will be helpful to provide a guideline on the construction or renovation of the urban parks in Shenzhen in the future.
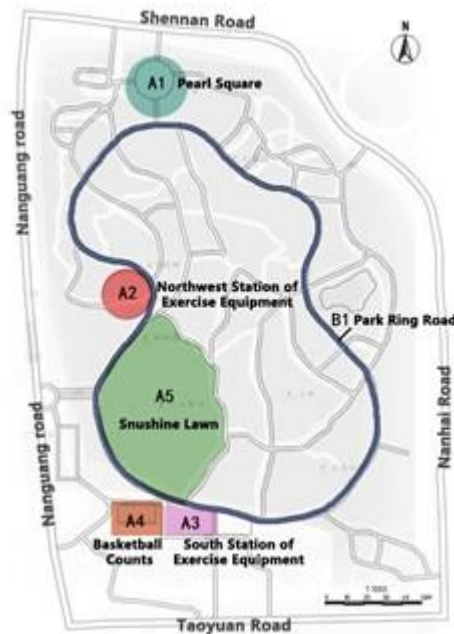
Figure 2. Diagram of sports venues

2.   STUDY METHODOLOGY

2.1   On-site observation

Shenzhen City has a subtropical monsoon climate. The typical climate in Shenzhen is hot and humid, outdoor sports are undertaken during the whole year. In this study, the climate factor can be regarded as a controlled variable, because of the point which is the open structure relevant to the mass fitness sports. On-site observations were done during 4 days (weekday: April 19, April 24; weekend: April 22, May 12; 2018), these days were at an average temperature of 24℃, the mean humidity of 77%.

According to the pre-investigation, the park consists of 6 sub areas as shown in *Table 1*. Through Baidu Map and other ways, the size and circumference of these six areas are as follows:

Table 1. The sub areas of the park

Number	Sub areas	Measurement
A1	Pearl Square	1071 m^2
A2	Northwest Station of Exercise Equipment	1656 m^2
A3	South Station of Exercise Equipment	1124 m^2
A4	Basketball Courts	634 m^2
A5	Sunshine Lawn	14706 m^2
B1	Park Ring Road	1250 m long and 4.5 m wide

In regard to mass fitness behaviour, the observation method and behaviour annotation method are mainly used. The observation method is the observer to count the number of exercisers at different sports venues with gender statistics; behaviour annotation method refers to the use of annotation tables by observers in the field to mark the activities and positions observed in a certain place.

In order to make the research data more universal, two days (April 22, April 24) were weekdays and the other two days (April 19, May 12) were weekends. According to the pre-investigation, the 7:00-9:00 and 17:00-21:00 in the concentration of the sports population were selected as the two time periods of observation records.

For track sports, sampling was carried out in the form of a video recording of the number of people every half an hour, with the type of jogging. The researcher unified in the fixed time at the fixed position to the jogging crowd to take sample videos at a fixed angle, recorded with the length of one minute, and did statistical analysis afterwards.

For field sports, the number of exercisers sampling statistics was carried out in an hourly visual or snapshot way. Sports types included: equipment training (weight training using existing park equipment), square dance, Tai Ji (Tai Chi), yoga, ball games, and leisure activities (kite flying, sitting, chatting and resting, etc.). The investigators also recorded weather conditions, outdoor temperature, humidity and wind speed. After the investigation, the data was analyzed by IBM SPSS (*Figure 3*).

Figure 3. The photos of sports scene

2.2   The questionnaire

This questionnaire design involved personal information, exercising habits and satisfaction evaluation of the subjects, users' environmental perception and selection of exercising places, etc. The five-point scale (Likert Scale) was used to measure the users' subjective perception of built environment variables. The data were mainly obtained from the different categories (*Figure 4*), such as personal information, areas of activities, exercise habits, satisfaction evaluation, environment perception, and suggestion on the park space or service. Options and ratings were set up according to the different questions. Before the questionnaire survey, according to the landscape layout characteristics of Lixiang Park, 9 zones were divided, and randomly sampled for some subjects in each zones.
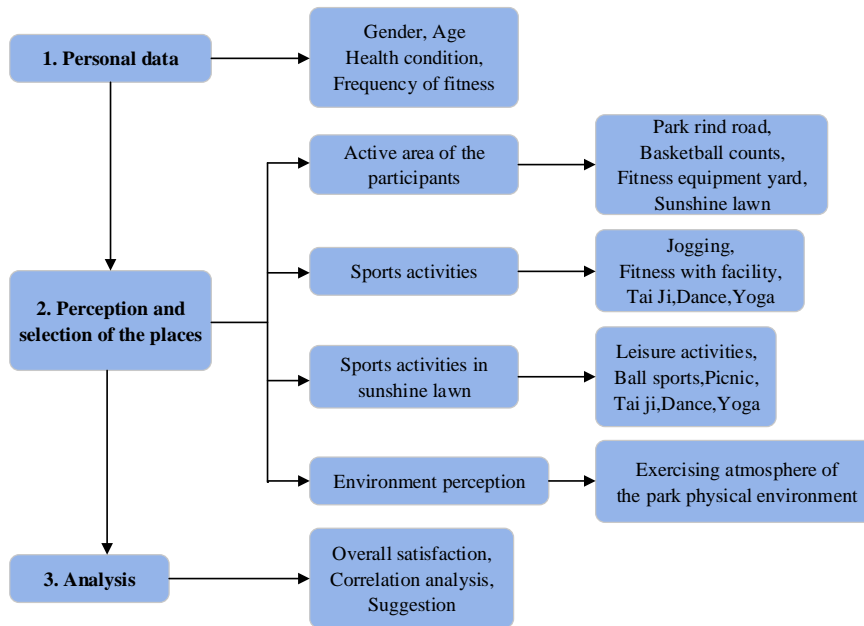
Figure 4. The framework of the questionnaire

On May 10, 2018, our team did the questionnaire survey on-site at Lixiang Park in Nanshan District, Shenzhen. 231 questionnaires were distributed to the subjects. 226 were valid. The questionnaires' data was analyzed by IBM SPSS.

3.   DATA ANALYSIS AND RESULTS

3.1   Observation data: fitness human flow at different open spaces

In the respect of track sports, statistical analysis was made on the total number of jogging samples within four days. The number of people involved in jogging on weekdays was 383 and 316 respectively, with an average of 350, and the number on weekends was 374 and 342, with an average of 358, which speculated that the number of joggers would be almost the same during a week. However, in the respect of the number of people doing field sports as shown in *Figure 5*, the number was significantly less during weekdays than on weekends, the number was 1447 and 896 for the weekdays respectively, the mean value was 1171.5, the number was 2196 and 2314 for weekends respectively, the mean value was 2255, about twice times the average number of weekdays. It can be seen that there are more people who do field sports on weekends.

Aiming at the obvious difference between the daily number of field sports on weekdays and the one on weekends, a cross-correlation analysis has been made further. As shown in *Figure 6*, the number of people at A5 Sunshine Lawn varied significantly for different sports venues, the number on weekends was over three times more than the number on weekdays on average. And the second most affected was the number of exercise equipment, which was almost twice; the number of A4 basketball courts and the one of A1 Pearl Square were quite similar.
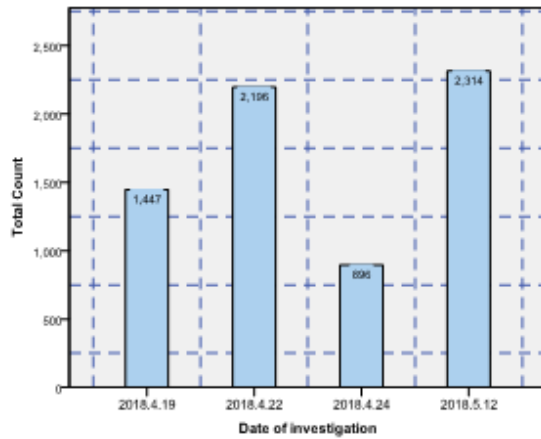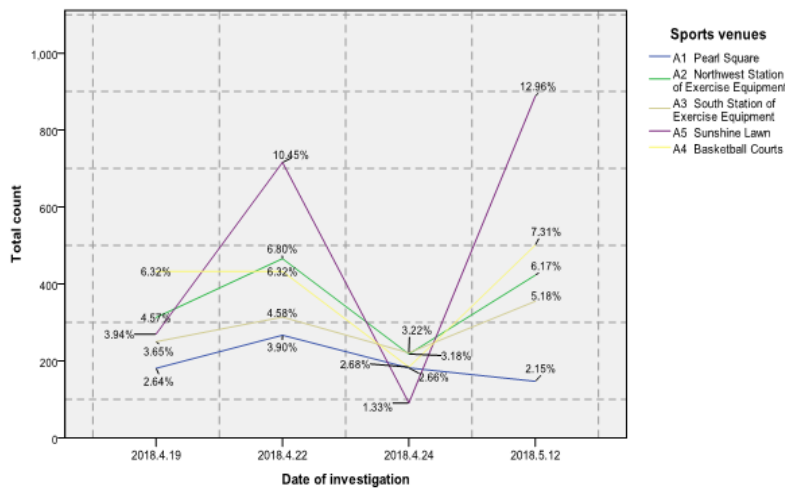
Figure 5. Figure of the number of field sports

Figure 6. Figure of the number of people based on date and field sports venues

There was also a certain correlation between the specific daily moment and the exercising movement. There was a large difference in the number of joggers per moment, 7:30 and 20:30 were the peak time of the number of joggers, the number of people in the morning is 144, and the number at 20:30 in the evening is 164, which shows that most of them jogged in the morning or evening in the park. For field sports, as shown in *Figure 7*, there was a significant difference in the total number of people at different times, the number was 770 reaching its peak at 8:00 in the morning, and the number was 1119 reaching its peak of at 20:00 in the evening too.
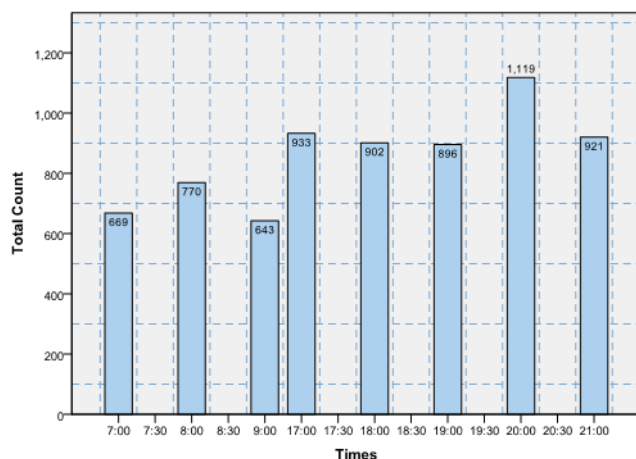
Figure 7. Figure of the number of field sports at different times

Through a cross-analysis between sports venues and types of exercise at different times, it is found that the number of joggers was the fewest at around 17:00. With regard to field sports, the number of people in various activity venues changed little in the morning, the largest crowd was the one of A5 Sunshine Lawn and it increased in the afternoon, which was significantly more than other sports venues, the number of A1 Pearl Square was increased the least; the number of A4 basketball courts peaked at 19:00 and then decreased, while the numbers of exercisers at other venues increased. In one day, the largest number of equipment sports and ball games was in the morning, while the number of leisure activities was the largest in the afternoon.

3.2 Questionnaire data: fitness people characteristics and their selection of fitness places

3.2.1 Personal information

The subjects consisted of 125 males accounted for 55.31% and 101 females accounted for 44.69%. Among the all age groups of respondents, the largest group was 31~50 years of age group with 40.27%, the fewest one was 51~60 years group with 6.19%. The group over 61 years old followed with 11.95%; the 7~18 years of age group of was 16.81%; and the 19~30 years of age was 24.78%.
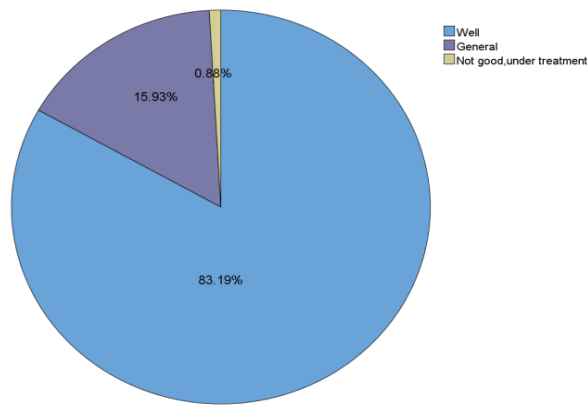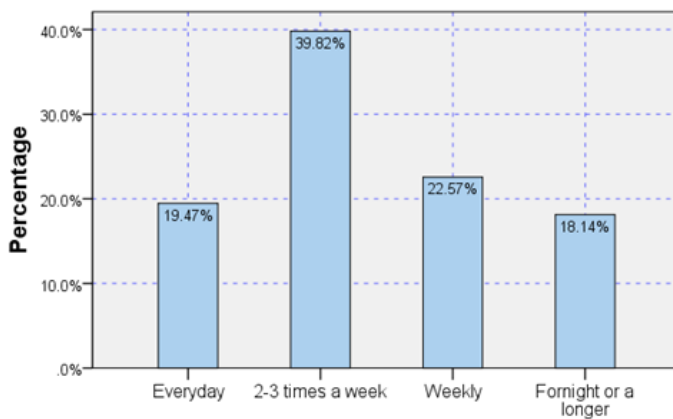
Figure 8. Health condition of sport people

Figure 9. The frequency of sport in park

During the health status survey (*Figure 8*), most respondents were in good physical condition accounted of 83.2%, while 15.9% of them were general level, 0.88% of them were not well. Regarding the frequency of coming to the park (*Figure 9*), the largest group was exercising 2~3 times a week, which accounted for 39.82%; the group that exercised every day and the one exercising once over more than a week were almost similar at about 20%; the group coming to the park once a week accounted for 22.57%.

3.2.2　Exercising motive

In terms of exercising motives, 32.74% of respondents, being the largest group, were to keep fit and prolong life, the group to grow healthily follows as 31.86%, the one to reduce stress and relax was 22.57%, and the one to stay in shape was 12.83%. Among the group of staying in shape, there were more females than males. For the age, the exercising motives of over 31 years of age groups were mainly to prolong life.

3.2.3　Accessibility——the time coming to the park

Most of respondents came to the park on foot, accounting for 77.9%; the percentage of other ways coming to the park was quite similar, such as bicycles, private cars, subways, buses, etc., accounting for up to 7.5% each. Most exercisers spent less than 20 minutes to get to the park, which indicates they were within about 2 kilometers of the park if they had come by walking or running.

3.2.4   Active areas of the participants

For the people having different exercising motives, they may choose different activity areas in the park. B1 Park Ring Road was a track sports area that was the first choice for exercising people-, while most of field sports people tended to exercise at a fitness field in A2 Northwest Station of Exercise Equipment. Because A5 Sunshine Lawn in the park covers a large area, about 14,706 square meters. Many people did leisure activities on the lawn, such as chatting and picnic parties. There were a certain number of people who exercised in A3 South Station of Exercise Equipment and A4 Basketball Courts located in a sheltered area in southern park. Moreover, there were a handful of people exercising in A1Pearl Square, or other spaces under trees.

3.2.5   Exercising characteristic of subjects

According to the questionnaire data (*Figure 10*), the most popular sport was jogging (116), and followed by leisure activities (sit or chat, etc.) (103). There were the same number of people having other relaxation (62) and fitness with facilities (A2 Northwest Station of Exercise Equipment, A3 South Station of Exercise Equipment) (62). However, sports such as Tai Ji, yoga and dancing were less popular in the park. It showed the people jogging and doing fitness with facilities (116+62=178) are more than those undertaking leisure activities (103+62=165).
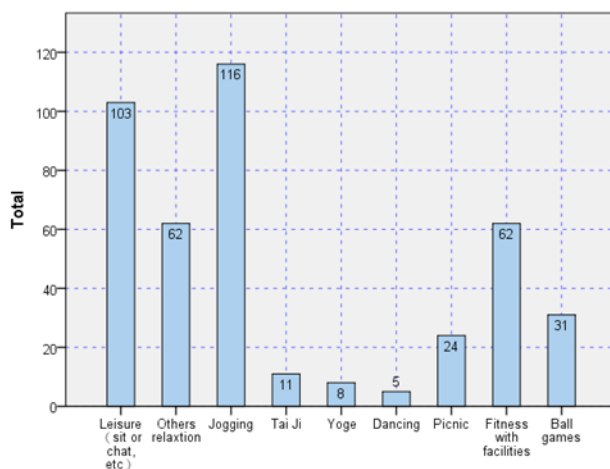

Figure 10. Exercising characteristic

3.2.6   Activity diversity in Sunshine Lawn

With a large flat area of the park, A5 Sunshine Lawn is an open view space with rich landscape, where it is suitable for all ages to do activities. For example, most people chose to rest on A5 Sunshine Lawn (*Figure 11*), accounting for 47.58%; the percentage of other leisure was 23.64%. There were a few groups to do Tai Ji, yoga, or dance on the lawn. It showed that A5 Sunshine Lawn is a great place for residents nearby to relax and recreate.

Most of the sport events that men and women chose on the lawn were balanced, except that female preferred to do yoga, there was no obvious gender difference in other exercising types on the lawn. The proportion of groups of different ages on the lawn was analyzed (*Figure 12*), people in all

ages joined these exercise events like leisure (sit or chat, etc.), ball games and picnic party. The age of 31~50 made up the majority of these, followed by the 19- 30 years age group. There was no person aged 7-18 and aged 19-30 doing Tai Ji; Over 51 years of age group only danced; those who did yoga were almost not undertaken by the 60 years age group. For the people on A5 Sunshine Lawn, the different age groups were quite balanced, where it was the general place for all ages.
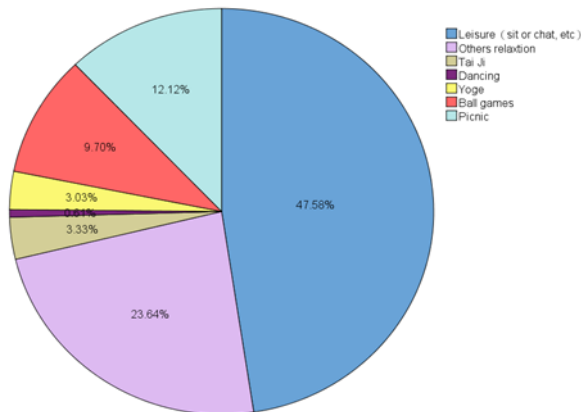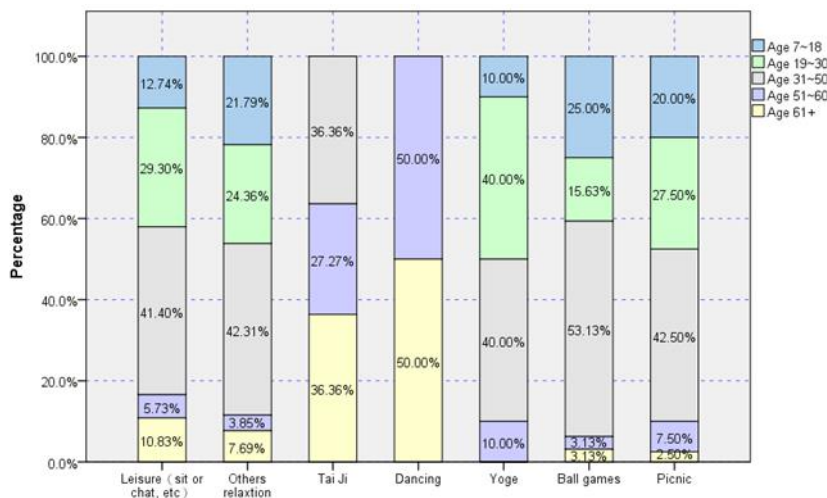

Figure 11. Sports types in Sunshine Lawn

Figure 12. The age proportion of sports people in Sunshine Lawn

3.3   Environment Perception

As *Figure13* showed the perception of the sports environment, the participants generally agreed that the park was a popular place for sports (1=Very agree, 2=Agree, 3=General, 4=Disagree, 5=Very disagree). However, there was a general sense of congestion during peak hours. On the other hand, the subjects could perceive the exercising atmosphere of the park, stimulating their own fitness enthusiasm. On the environmental assessment of the park, the subjects agreed that the park environment had rich landscape resources that could make them relax and enjoy its aesthetics.

It showed that both the park physical environment and exercising atmosphere have the initiation on exercising behaviour; favourable

environmental factors could stimulate the exercising motivation of the person, revealing that the environment can promote the people to do exercise.
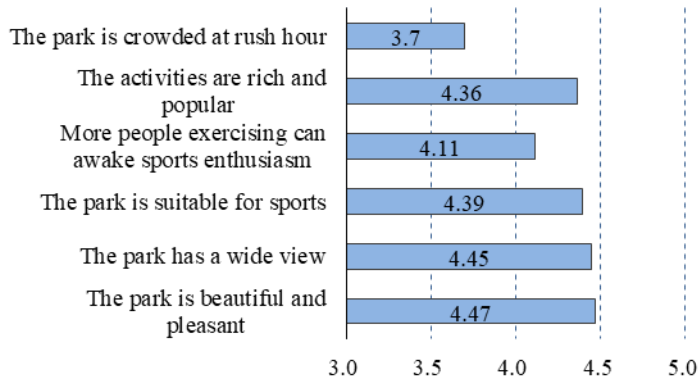

Figure 13. Participant's perception of the park

3.3.1   Satisfaction of the park environment

3.3.1.1   Overall satisfaction evaluation of the park

The overall satisfaction score of the sports environment of the park for the subjects was 4.26, which showed they were quite satisfied with the park environment. (1=Very Dissatisfied, 2=Dissatisfied, 3=General, 4=Satisfied, 5=Very Satisfied), the rate of answering satisfied (include satisfied and very satisfied) was 85.4% (40.71% and 44.69%).

3.3.1.2   Satisfaction of field sports areas

As *Figure 14* shows, the satisfactions of A5 Sunshine Lawn and the configuration of A5 Sunshine Lawn for the subjects were generally high with the mean value 4.35 and 4.19 respectively; the satisfaction of A4 Basketball Courts was generally low, the mean value was 3.79; the one of the 3 venues (A1 Pearl Square, two Stations of Exercise Equipment (A2, A3) were second with mean value 3.97.
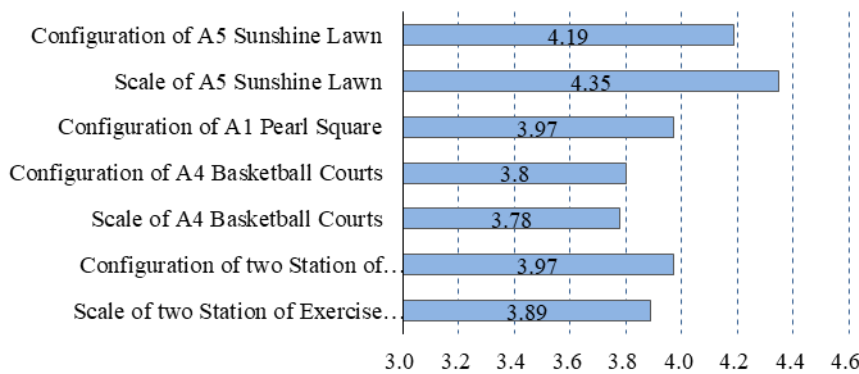

Figure 14. The satisfaction of field sports

3.3.1.3   Satisfaction of track sport area

The data showed that the subjects were satisfied with the track sports area. The mean satisfaction of the width of B1 Park Ring Road was 4.20; the mean satisfaction of the gradient of road was 4.23, in which the range of slope was between 1.0%~6.0%; the mean satisfaction of the overall facility

configuration was 4.15. It indicated the subjects had good feelings about the flat road, where it has good design variables (such as width, slope, etc.) in favour of jogging.

Figure 15. The photos of most popular sports areas in Lixiang Park

3.3.2   Demands on the open spaces for fitness people

The results of the questionnaire survey show the fitness people's demands on open spaces. According to the questionnaire data, it can be summarized as follows:

The biggest fitness group was the jogging one according to *Figure 10*. On track sports, the number of jogging was roughly the same whether on weekdays or weekends, there were many people who liked to jog on the B1 Park Ring Road every day.

In regard to field sports, the people liked to gather and relax in A5 Sunshine Lawn on a weekend, they also may like to do other types of leisure activities. Fitness fields (A2 Northwest Station of Exercise Equipment, A3 South Station of Exercise Equipment) and A5 Sunshine Lawn were the most popular sports areas among the field sport areas (*Figure 15*).

Being consistent with the one of on-site observations, the results of questionnaire analysis basically show that the order of the demands on open space from fitness people from high to low in the park sub-areas is B1 Park Ring Road, fitness fields (A2 Northwest Station of Exercise Equipment, A3 South Station of Exercise Equipment), A5 Sunshine Lawn, and A4 Basketball Courts.

For different age groups, fitness people had different demands on different open spaces. On track sports, the number of joggers grew with age, the over 50 age groups are the major ones. On field sports, the older people (over 51) preferred Tai Ji and dancing, the younger people (under 50) preferred to play ball games, do yoga or do other leisure activities.

From the gender correlation analysis, it was found that the males had higher frequency to the park than the females, they liked to exercise in A4 Basketball Courts and jog in B1 Park Ring Road, while the females liked to do leisure activities on A5 Sunshine Lawn, such as taking rest, yoga, picnic party, etc.

3.3.3   Suggestion and improvement measures of the park

From *Figure 16*, it was known that there were a lot of mosquitoes in the park and that was the biggest problem. Dim lighting at night was another problem. Measures to control mosquito population are imperative for the park; improving the lighting in those public activity areas at night is also important in order to ensure the safety of the park. Other issues on the park that the respondents generally considered were lack of storage facilities, lack of shade and shelter, few drinking water facilities (*Figure 17*).
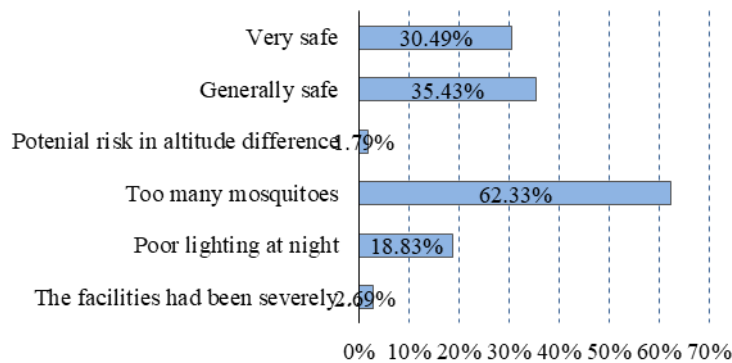
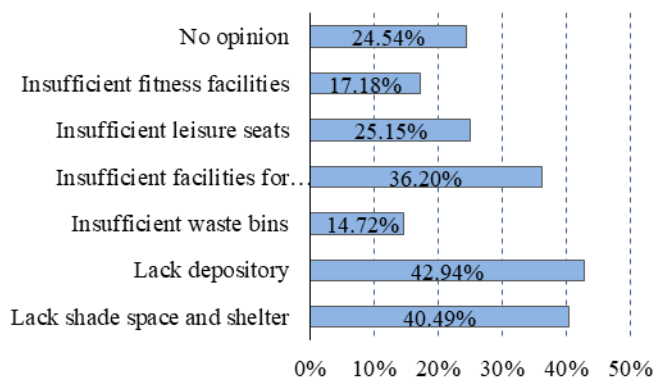*Figure 16.* The safety evaluation of the park environment

Figure 17. The inadequacy of the park environment

4.   CONCLUSION AND FUTURE WORK

4.1   Evaluation of the performance of open spaces for mass fitness activities

On the respect of the performance of the 6 subareas, it can be seen in the use intensity of a sub area (the number of people exercising at the statistical time) and the complexity of a subarea (the number of people exercising activities at the statistical time).

Firstly, statistics were done on the numbers of users at each sub area within four days. Since the number of joggers was sampled by one minute video at a point every half an hour, it was found that the number of people measured within a minute video was 1:20 proportional to the number of people in the entire loop, after simulating the flow of people at a later stage by using Massmotion software. It was concluded that the total number of joggers in 6 whole moments in 4 days was between 14000 and 14200. Correspondingly, for field sports, the same 6 whole point time were also selected to estimate the total number of people in 4 days, and the spatial using intensity analysis diagram is shown in *Figure 18*. Overall, the use intensity of B1 Park Ring Road was significantly higher than that of the field sports venues. It is known that the main field sports place was A5 Sunshine Lawn (1400-1600 people), followed by A4 Basketball Courts (1200-1400 people), and again A2

Northwest Station of Exercise Equipment (1000-1200 people), the relatively fewer were A3 South Station of Exercise Equipment and A1 Pearl Square (less than 1000 people).

Secondly, the numbers of the activity types in each sub area within four days were counted, and the analysis diagram shown in *Figure 18* was obtained. Among them, A5 Sunshine Lawn and A1 Pearl Square had the most abundant types of sports (4-5 kinds), followed by A3 South Station of Exercise Equipment (2-3 kinds), and A2, A4 and B1 (1-2 kinds). The A5 Sunshine Lawn was not only strong in use intensity, but also rich in sports types. The use intensity of A1 Pearl Square was low. However, it had the potential for a variety of sports types because of the smooth site and open space. According to the activity annotation map of A5 Sunshine Lawn, the types of activities on the grassy area were more popular during weekends than weekdays. The largest number of leisure activities was carried out on the area, followed by ball games, Tai Ji and yoga; the largest number of in A1 Pearl Square is square dance, followed by leisure activities, Tai Ji and ball games.
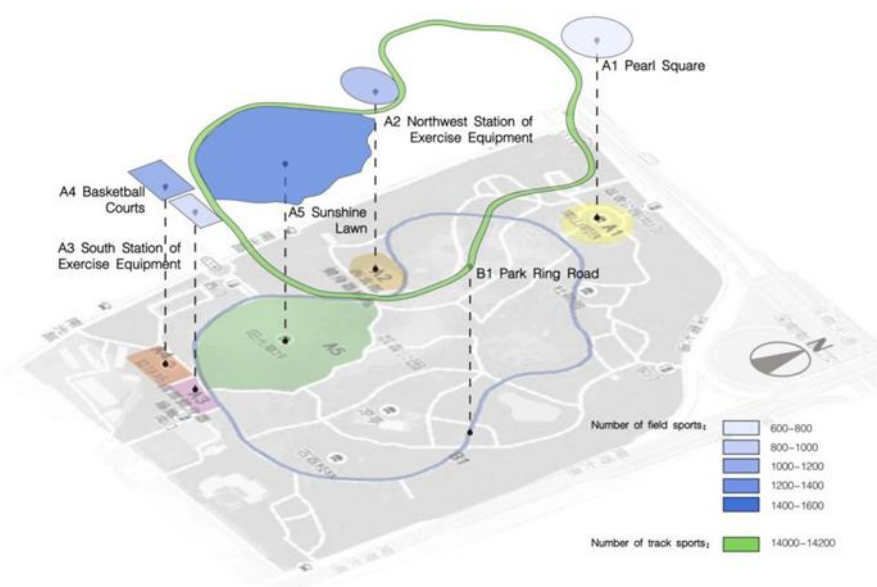

Figure 18. Analysis diagram of space use intensity of sports area

Generally, it can be seen that B1 Park Ring Road and A5 Sunshine Lawn were the most popular sports venues for the public, where they both had high use intensity respectively. For field sports place, A5 Sunshine Lawn had the richest physical activities. Both B1 and A5 also got higher satisfaction points among the 6 sub areas. So these two sub areas both had the highest exercising performance for the users.

4.2   Open space system for the mass fitness activities

As per the literature review, open space with green landscape tend to be the major mass fitness space with the common sense by the academics (Wang, M., 2018; Wolf & Wohlfart, 2014; Kessel et al., 2009). For track sports, it is necessary to build a loop runway in the park, where it is favorable for jogging that is a most popular aerobic exercise. For field sports, fitness equipment venue and grassy areas are popular fitness and leisure places for the residents. The fitness equipment is quite important for strength training, which is also

free for users in comparison with the paid ones at health clubs. For mass fitness activities, these three kinds of places constitute the whole fitness system, where residents can do both aerobic and anaerobic exercises that will improve their health levels. Therefore, the open spaces of the urban park play an important role at human health and well-being, and it is also positive to maintain social sustainability.

In summary, the open space system with well performance for mass fitness activities at a park in Shenzhen may have these elements like *Figure 18*: loop road, great lawn, court with fitness equipment or square. These places corresponding to the mass fitness activities will form a whole system which is good to improve users' health, and the system will be expected to receive high satisfaction in Shenzhen like Lixiang Park. (*Figure 19*).
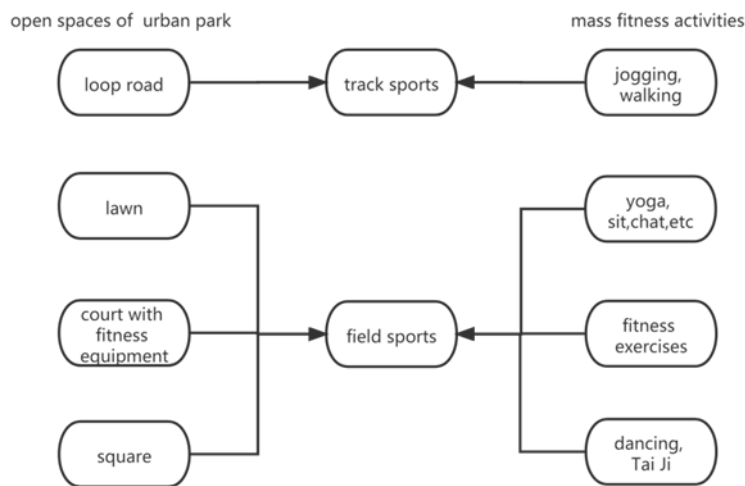

Figure 19. The open space system of urban park with well performance for mass fitness activities in Shenzhen

4.3   Future Work

The study has some limitations that some other factors (e.g. weather, social company, facilities, or management strategies) have not been explored in-depth when focusing on the space. Due to the random sampling and the limited samples, the results may not reflect the actual usage of spaces for the people in the park at a high level of completeness and accuracy. However, the performance of open spaces can still be evaluated for mass fitness activities by comparing the questionnaire survey with the results of on-site observations. The data shows that the overall satisfaction of the Lixiang Park was quite high, and its open space system works very well for mass fitness activities. It inspires us afterwards to plan and design the open space with well performance for mass fitness activities. This is the significance of this study comparing with other existed ones.

In the future research direction, more could be done on the quantification and refinement of open space fit for mass fitness activities. For track sports, the loop road should be studied further on the width, length, material fit for the jogging group. For field sports, the kinds of fitness equipment at the venues can be evaluated carefully, designed and selected to have better exercising performance. The management and operation of the park and its facilities can also be considered during construction to make the fitness and recreation service sustainable in the future. Considering the hot and humid

climate in Shenzhen, some design strategies can also be achieved with further study. As a case study, the open space system needs to be testified through more examples in the future as well.

REFERENCES

Bringslimark, T., Hartig, T., & G.Patil, G. (2009). "The Psychological Benefits of Indoor Plants: A Critical Review of the Experimental Literature". *Journal of Environmental Psychology*, *29*(4), 422-433. doi: https://doi.org/10.1016/j.jenvp.2009.05.001.

Coombes, E., Jones, A. P., & Hillsdon, M. (2010). "The Relationship of Physical Activity and Overweight to Objectively Measured Green Space Accessibility and Use". *Social Science & Medicine*, *70*(6), 816-822. doi: https://doi.org/10.1016/j.socscimed.2009.11.020.

Day, K. (2016). "Built Environmental Correlates of Physical Activity in China: A Review". *Preventive Medicine Reports*, *3*, 303-316. doi: https://doi.org/10.1016/j.pmedr.2016.03.007.

Esther, Y., Winky, H., & Edwin, C. (2017). "Elderly Satisfaction with Planning and Design of Public Parks in High Density Old Districts: An Ordered Logit Model". *Landscape and Urban Planning*, *165*, 39-53. doi: https://doi.org/10.1016/j.landurbplan.2017.05.006.

Fan, W., Da, L., & Zhang, K. (2015). "Research on the Use Characteristics of Physical Fitness Facilities in City Parks——a Case Study in Shanghai". *Modern Urban Research*, *10*, 94-99. doi: https://doi.org/10.3969/j.issn.1009-6000.2015.10.016.

Hou, Y., Zhao, X., & Zhang, B. (2017). "Significance Analysis between Morning Exercise and Spatial Organization Characteristics of Urban Park—Taking 4 Urban Parks in Harbin for Example". *Landscape Architecture*, *2*, 109-116. doi: https://doi.org/10.14085/j.fjyl.2017.02.0109.08.

Ke, W. (2014). "Investigation on the Effect of the Air Purification of Indoor Green Wall". *Landscape Architecture*, (5), 107-109. doi: https://doi.org/10.14085/j.fjyl.2014.05.0107.03.

Kessel, A., Green, J., Pinder, R., Wilkinson, P., Grundy, C., & Lachowycz, K. (2009). "Multidisciplinary Research in Public Health: A Case Study of Research on Access to Green Space". *Public Health*, *123*(1), 32-38. doi: https://doi.org/10.1016/j.puhe.2008.08.005.

Liu, B., & Guo, C. (2006). "Promoting Health through Design: A Brief Introduction of "Active Living by Design", an American National Program". *Urban Planning International*, *21*(2), 60-65.

Sever, I., & Verbič, M. (2018). "Providing Information to Respondents in Complex Choice Studies: A Survey on Recreational Trail Preferences in an Urban Nature Park". *Landscape and Urban Planning*, *169*, 160-177. doi: https://doi.org/10.1016/j.landurbplan.2017.09.003.

Shen, L. (2018). "Fitness and Leisure: The Purpose of Mass Sports Science-Comment on the Theory and Practice of Scientific Fitness of Mass Sports ". *University Education Science*, (1), 134.

Tan, S., Sun, Y., & Shen, J. (2018). "Research on the Impact of Urban Park Environment on Public Health: From the Perspectives of Psychological Perception and Behaviors". *Urbanism and Architecture*, (24), 24-28. doi: https://doi.org/10.19892/j.cnki.csjz.2018.24.005.

Van Hecke, L., Ghekiere, A., Van Cauwenberg, J., Veitch, J., De Bourdeaudhuij, I., Van Dyck, D., . . . Deforche, B. (2018). "Park Characteristics Preferred for Adolescent Park Visitation and Physical Activity: A Choice-Based Conjoint Analysis Using Manipulated Photographs". *Landscape and Urban Planning*, *178*, 144-155. doi: https://doi.org/10.1016/j.landurbplan.2018.05.017.

Wang, C., He, G., & Chen, X. (2018). "Relationship between Spatial Features of Exercise Facilities and Physical Activity in Adolescents: An Analysis Using Gis and Accelerometer". *Journal of Shanghai University of Sport*, *42*(3), 36-43. doi: http://dx.doi.org/10.16099/j.sus.2018.03.006.

Wang, M. (2018). "Review of Studies on Health Behaviour Promotion by Built Environment Design". *Urbanism and Architecture*, (11), 107-110. doi: https://doi.org/10.19892/j.cnki.csjz.2018.11.028.

Wolf, I. D., & Wohlfart, T. (2014). "Walking, Hiking and Running in Parks: A Multidisciplinary Assessment of Health and Well-Being Benefits". *Landscape and Urban Planning*, *130*, 89-103. doi: https://doi.org/10.1016/j.landurbplan.2014.06.006.

Wu, X., Qin, X., & Zhou, H. (2018). "Use of Community Spaces for Sports and Fitness–a Case Study of Urban Inhabitants in Shenzhen City, China". *International Review for Spatial Planning Sustainable Development*, *6*(3), 49-62. doi: https://doi.org/10.14246/irspsd.6.3_49.

Xu, Y., Li, A., Guo, S., & Lei, B. (2018). "Residents' Outdoor Physical Activity and Environment in Wuhan City——a Case Study Based on Soparc". *Journal of Wuhan Institute of Physical Education*, *52*(4), 33-38.

Yuan, M., & Wang, Y. (2014). "Experimental Research on Impact of Indoor Air Temperature and Humidity on Human Thermal Comfort". *Building Energy Efficiency*, *42*(8), 17-20. doi: https://doi.org/10.3969/j.issn.1673-7237.2014.08.004.

Zhang, X., Chai, Y., Chen, Z., & Tan, Y. (2016). "Analysis of Spatial and Temporal Patterns of Daily Activities of Suburban Residents Based on Gps Data: A Case Study of the Shangdi-Qinghe Area of Beijing". *International Review for Spatial Planning Sustainable Development*, *4*(1), 4-16. doi: https://doi.org/10.14246/IRSPSD.4.1_4.

Zhao, X., Hou, Y., Jin, H., & Zhao, R. (2018). "A Study on the Cognitive Mode of Exercise Path in Urban Parks in Cold Regions as Exemplified in Harbin". *Architecture Journal*, (2), 50-54.