The effects of urban park on residents' health: an empirical study based on Tangxi River Park in Hefei

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Abstract. As an important way for urban residents to access nature environment, urban park has a certain degree of impact on the health of the population. In this study, Tangxihe Park in Hefei City was used as the research site, and the impact of urban parks on population health was quantitatively studied by analyzing the demographic characteristics, physical and mental health of park users, and park satisfaction. The results show that the quality of overall environment, green space and activity facilities of the park have a positive effect on improving the physical and mental health of the residents, the time of residents spending in the park have a positive effect on their physical and mental health, the longer of the residents spending in the park, the higher of the health benefits they received. Physical health regression analysis showed that residents received better physical health benefits by using the park between 6am to 9am compared to those entering the park between 12pm to 14pm and 14pm to 18pm. Mental health regression analysis showed that residents entering the park between 14pm to 18pm received better mental health benefits than those entering the park between 6am to 9am. The research results verify the specific health effects of urban parks in the context of Chinese demographic and geographic background, and enrich the theoretical content on the health benefits of urban parks in different regional contexts.

1. Introduction
Currently, about half of the world's population live in cities and the number of urban dwellers reaches to 3 billion [1]. Urbanization is an important feature of modern society, which promotes social development while also destroys the natural environment. The isolation of urban residents from nature environment and the deterioration of urban living environment have led to an impairment of the physical and mental health of the residents [2]. As a part of the natural space in the urban environment, urban parks play an important role in improving natural elements such as air, soil and hydrology. At the same time, the green space of urban park is also the main way for residents to contact nature environment, and they are the place for people to have fun and relax.

With the deterioration of urban living environment and the increase of chronic diseases, obesity and other sub-health population [3], the health-promoting effects of urban park on the population have received more and more attention by many sectors. Many studies have explored the relationship between urban park and the health of urban residents, and concluded that parks have positive effects in improving the physical health and mental health of the population [4-6]. Relevant researches show that urban park can produce certain healthy promotion benefits to park users no matter they are exposed to the natural or semi natural environment for a long time or a short time [1]. According to the indicators
of healthy outcomes used in theoretical and practical research, the healthy promotion effects of urban park mainly include the promotion of mental health, physical health, social health and overall health (Table 1). Among them, reducing all-cause mortality, prolonging life, improving overall general health (perceived general health), well-being, life satisfaction, and well-being are classified as overall health benefits.

**Table 1. Healthy promotion benefits of urban park.**

| Sort               | Benefits                                                                 |
|--------------------|--------------------------------------------------------------------------|
| Mental Health      | Promote general mental health[7], regulate mood[7], Improve anxiety and depression symptoms[7], Improve cognitive ability[7], Improve attention deficit disorder symptoms[8], Reduce pain[8], Relieve stress[8] |
| Physical Health    | Promote physical health perception[3], Reduce the risk of cardiovascular and diabetes[7], Reduce the incidence rate of respiratory diseases[8], Reduce the risk of cancer[8], Improve infant birth weight[9], Reduce the risk of overweight or obesity[10] |
| Social Health      | Reduce crime rate[9], Improve social cohesion[10], Improve community satisfaction[10], Enhance social security[11], Promote overall social health[11] |
| Overall General Health | Reduce number of health-related complaints[7], Reduce all-cause mortality[9], Promote general mental health[10], Improve happiness and life satisfaction[10] |

Existing related researches are mainly based on the demographic and geographic background in North America and Northern Europe, and there are few related studies on the Chinese background. Therefore, in order to verify the specific characteristics of the urban park health effect on the Chinese demographic and geographic background, this study research the physical and mental health status of residents living around the park, the way of residents using the park, and the residents’ satisfaction of the characteristics of the park, to explore the effects of urban park on the physical and mental health of surrounding residents. The results can enrich the theoretical content of health benefits of urban park under the different demographic and geographic backgrounds.

2. Object and Methods

2.1. Study site

The study site is located in Tangxi River Park, Hefei City in China (Figure 1). The planned area of the park is about 5.5 million m², which is the largest existing urban wetland park in the city. The spatial layout of the park is based on the natural water system, of which the area of the water body is about 1,800,000 m² and the area of aquatic plants is about 287,000 m² (Figure 2-A).

![Figure 1. The Masterplan of Tangxi River Park.](image1)

![Figure 2. The Scenes of Tangxi River Park.](image2)

The eastern part of the park is mainly semi-open space, with the large green space of many plants (Figure 2-B). The whole area is covered with cherry blossom forest, cinnamon flower forest and other plant communities of different grades, with a high greening coverage. The facilities such as a university for the elderly and a public schoolhouse also are built in this part. The western part of the park is mainly a series of public spaces (Figure 2-C), including a 50,000 m² skating area, a 230,000 m² artificial beach, a sports park and a cultural activity center. The green space of the west part is dominated by large lawns and is configured with low density trees and shrubs.

2.2. Study object

The research object is residents who live around the park within 1.5 km service radius. According to ethical requirements, between October and December 2019, stratified sampling was used to conduct the questionnaire survey in the park with different time. All research participants voluntarily filled out
the questionnaire with agreement and the questionnaire was filled on the spot. A total of 150 questionnaires were returned, excluding those with chronic diseases, and 122 valid questionnaires were obtained, with an efficiency of 81.33 percent.

2.3. Study content and tools

The study included information of the demographic characteristics of residents, their physical and mental health status, and park satisfaction evaluations. Demographic information was investigated by using a self-designed questionnaire, physical and mental health status was evaluated by using 12 health checklists (SF-12 scale), and park satisfaction was evaluated by using a self-designed satisfaction questionnaire.

The demographic characteristics information of the residents was obtained by using self-designed questionnaires, which included gender, age, height, weight, marital status, type of education, type of occupation and income level.

Physical and mental health status assessment is based on the SF-12 scale, a simplified version of the universal and concise quality of life scale SF-36 developed by the Institute for Health Education in Boston of United State [12], which has good validity and therefore is often used as a priority for the assessment of life quality. Wang Haitang et al. verified the applicability of the SF-12 scale in China and showed that the F-12 scale can be widely used in the investigation of the health status of Chinese people [13]. The scale contains 12 entries evaluating 8 dimensions of health-related quality of life, like general health, physical functioning, mental health and so on [13].

Park satisfaction was evaluated by using a self-designed satisfaction questionnaire. The questionnaire consists of three self-assessment entries: "What is your level of satisfaction with the quality of overall environment of the park?", "What is your level of satisfaction with the quality of the green space of the park?", "What is your level of satisfaction with the quality of activity facilities of the park?" Item assignment adopts Likert scale method, which is composed of five levels from unsatisfactory (1 point) to very satisfied (5 points).

2.4. Analysis method and variable assignment

Table 2. Variable assignment description.

| Variable                        | Code | Assignment Description |
|---------------------------------|------|------------------------|
| Gender                          | X1   | 0=Male, 1=FEMALE       |
| Age (year)                      | X2   | 1<18, 2=18~23, 3=23~30, 4=30~50, 5>50 |
| Height (cm)                     | X3   | 1<150, 2=150~160, 3=160~170, 4=170~180, 5>180 |
| Weight (kg)                     | X4   | 1<45, 2=45~55, 3=55~65, 4=65~75, 5>75 |
| Marital Status                  | X5   | 1=Unmarried, 2=married, 3=Divorced, 4=Widowed |
| Education Level                 | X6   | 1=Primary school, 2=junior high school, 3=high school, 4=diploma, 5=Bachelor or above |
| Vocation Type                   | X7   | 1=student, 2=Office work, 3=Physical work, 4=Retired |
| Income (RMB)                    | X8   | 1<2000, 2=2000~5000, 3=5000~8000, 4=8000~12000, 5>12000 |
| The satisfaction of the overall environment | X9 | 1=Low, 2=Relatively Low, 3=Middle, 4=Relatively High, 5=High |
| The satisfaction of green quality | X10  | 1=Low, 2=Relatively Low, 3=Middle, 4=Relatively High, 5=High |
| The satisfaction of activity facilities | X11 | 1=Low, 2=Relatively Low, 3=Middle, 4=Relatively High, 5=High |
| Time to reach the park          | X12  | 1=6am~9am, 2=9am~12am, 3=12am~14pm, 4=14pm~18pm, 5=after 18pm |
| Time spent in the park (min)    | X13  | 1<30, 2=31~60, 3=60~120, 4=120~180, 5>180 |
| Physical Health                 | Y1   | Quantitative Data      |
| Mental Health                   | Y2   | Quantitative Data      |

This study uses Stata version 14.0 for statistical analysis. Residents' satisfaction scores of the park, their physical and mental health scores are expressed in the form of mean with standard deviation (Mean±SD). Multivariate linear regression analysis uses the scores of residents' physical and mental health as the dependent variables, and takes the time of entering the park, the length of staying in the park, the satisfaction of the quality of the park as independent variables, and also incorporates demographic characteristics as control variables. See Table 2 for the details of variable assignment.
3. Results

3.1. General information of respondents

A total of 122 people were included in the study, and 82 women, 67.21%, are shown in Table 3.

Table 3. General information and health score of residents.

| Variable          | Sort    | Number | Ratio(%) | Physical Health | Mental Health |
|-------------------|---------|--------|----------|-----------------|---------------|
| Total             |         | 122    | 100      | 50.96±6.68      | 51.73±7.42    |
| Gender            | Male    | 40     | 32.79    | 56.05±6.24      | 48.84±8.18    |
|                   | Female  | 82     | 67.21    | 49.41±6.87      | 54.17±7.03    |
| Age (year)        | <18     | 6      | 4.92     | 54.23±3.21      | 50.81±6.42    |
|                   | =18~23  | 22     | 18.03    | 49.60±6.65      | 52.76±6.55    |
|                   | =23~30  | 33     | 27.05    | 48.12±6.37      | 48.07±7.18    |
|                   | >30~50  | 50     | 40.98    | 47.65±6.30      | 45.87±8.11    |
|                   | >50     | 11     | 9.02     | 45.42±9.63      | 54.33±4.44    |
| Height (cm)       | <150    | 5      | 4.10     | 54.68±3.51      | 55.26±3.88    |
|                   | =150~160| 40     | 32.79    | 49.01±7.52      | 50.87±6.74    |
|                   | =160~170| 46     | 37.70    | 48.95±5.64      | 49.30±7.80    |
|                   | >170~180| 24     | 19.67    | 48.59±6.61      | 48.21±8.19    |
|                   | >180    | 7      | 5.74     | 45.97±8.86      | 47.98±6.52    |
| Weight (kg)       | <45     | 8      | 6.56     | 49.95±7.29      | 55.10±5.86    |
|                   | =45~55  | 42     | 34.43    | 54.96±6.28      | 49.32±7.34    |
|                   | =56~65  | 41     | 33.61    | 51.70±6.11      | 49.64±7.55    |
|                   | =66~75  | 21     | 17.21    | 46.48±6.77      | 49.08±8.24    |
|                   | >75     | 10     | 8.20     | 45.37±8.43      | 48.89±9.53    |
| Marital Status    | Unmarried| 33   | 27.05    | 49.17±6.74      | 51.92±6.82    |
|                   | Married  | 75     | 61.48    | 48.74±6.51      | 55.39±7.47    |
|                   | Divorced | 5      | 4.10     | 49.06±9.79      | 55.99±5.42    |
| Education Level   | Primary school | 9 | 7.38 | 51.78±3.32 | 55.82±2.22 |
|                   | Junior high school | 11 | 9.02 | 49.15±7.94 | 53.62±6.91 |
|                   | High school          | 14 | 11.48 | 48.90±6.06 | 51.72±6.76 |
|                   | Diploma              | 36 | 29.51 | 47.47±7.71 | 50.07±6.35 |
|                   | Bachelor or above    | 52 | 42.62 | 49.48±6.19 | 52.71±8.31 |
| Vocation Type     | Student             | 10 | 8.20 | 53.45±7.38 | 50.98±5.43 |
|                   | Office work          | 62 | 50.82 | 48.28±6.88 | 48.35±8.43 |
|                   | Physical work        | 37 | 30.33 | 55.56±5.34 | 55.03±6.16 |
|                   | Retired              | 13 | 10.66 | 50.52±8.01 | 52.94±5.26 |
| Income (RMB)      | <2000               | 17 | 13.93 | 50.76±5.57 | 55.52±5.33 |
|                   | =2000~5000          | 46 | 37.70 | 48.27±7.47 | 52.31±6.79 |
|                   | =5000~8000          | 32 | 26.23 | 48.45±6.46 | 49.01±8.46 |
|                   | =8000~12000         | 18 | 14.75 | 46.50±7.56 | 49.08±8.24 |
|                   | >12000              | 9  | 7.38  | 50.86±6.89 | 50.45±9.71 |

3.2. Physical and mental health scores

The physical and mental status score of the residents was descriptively analyzed from the different level of demographic. The details is shown in Table 3. In terms of physical health status, the score of 122 residents was (50.96±6.68). Differences in physical health status scores were statistically significant across gender ($P<0.05$), age ($P<0.05$), weight ($P<0.05$) and occupation type ($P<0.01$). At the aspect of mental health status, the score of 122 residents was (51.73±7.42). Differences in mental health status scores were statistically significant across gender ($P<0.05$), age ($P<0.01$), marital status ($P<0.01$), education type ($P<0.01$), occupation type ($P<0.01$) and income level ($P<0.05$).

3.3. Regression analysis

Based on the results of the existing literature, the study explores the effects of urban park on the physical and mental health of the surrounding residents by constructing a multiple linear regression model.

3.3.1. Regression analysis of physical health

The results of the physical health regression analysis showed that variables such as gender, age, weight, type of work, the time of arriving at the park, the time of spending in the park, satisfaction with the quality of the overall environment, green space and activity facilities of the park could be included in the physical health regression equation, where...
variables such as gender, age, weight, type of work, the time of arriving at the park were included in the equation as dummy variables. The equation is as follows:

\[ \hat{Y}_1 = 52.91 - 1.723X_1 - 4.024X_2 + 0.583X_3 - 0.650X_5 + 2.226X_6 + 0.928X_{10} + 0.445X_{11} - 2.734X_{12} - 3.20X_{13} + 2.58X_{14} \]

The results showed that the physical health status scores of women were lower than men. The physical health status scores of residents between 30 to 50 years old were lower than those of younger than 18 years old, and there was no significant difference between other categories. The physical health status scores of residents working in office were lower than those of students, and there was no significant difference between other categories. Residents' satisfaction with the overall park environment, the quality of green space and activity facilities was positively correlated with their physical health status scores, and the higher of the satisfaction, the better of the physical health status of residents. Residents arriving at the park between 12pm to 14pm and 14pm to 18pm had lower physical health status scores than those who arriving between 6am to 9am; the time of spending in the park was positively correlated with their physical health status scores, and the longer of the time spending, the better of their physical health status. The results showed that the mental health scores of women were higher than men; in the different age groups, the mental health scores of residents aged between 30 to 50 years were lower than those younger than 18 years old, and there was no significant difference between other categories. In the different groups of marital status, the mental health scores of married people were higher than those of unmarried people, and the mental health scores of divorced people were lower than those of unmarried people. In the different groups of occupational types, the mental health scores of office workers were lower than those of students, and there was no significant difference among other categories. The

### Table 4. Coefficient of regression model of physical health.

| Independent Variable | Physical Health | Mental Health |
|----------------------|-----------------|---------------|
|                      | Coef.           | t             | 95% CI | VIF | Coef. | t             | 95% CI | VIF |
| Femalea               | -1.723***       | -2.39         | -4.384~ -2.938 | 1.13 | 0.916*** | 2.36         | 4.015~ 6.557 | 1.39 |
| Age=30–50b            | -4.024***       | -3.93         | -8.615~ -4.658 | 1.53 | -5.103*    | -1.99         | -6.128~ -4.34 | 1.78 |
| Weight<45–55c         | 0.583***        | 3.20          | 3.148~ 6.314  | 1.21 | --         | --           | --         | -- |
| Marriedd              | --              | --            | --        | 5.727** | 2.52         | 3.355~ 6.017 | 1.44 |
| Divorced              | --              | --            | --        | -2.755** | -2.13        | -5.793~ -3.421 | 1.25 |
| Diploma                | --              | --            | --        | -3.629  | -2.94        | -7.101~ -4.033 | 2.13 |
| Office workc          | -0.650**        | -2.58         | -7.339~ -4.223 | 2.57 | -4.064*** | -3.52         | -7.547~ -3.889 | 2.41 |
| The satisfaction of the overall environment | 2.226*** | 2.39 | 0.387~ 4.066 | 1.34 | 2.551*** | 3.39         | 2.241~ 4.902 | 1.53 |
| The satisfaction of greening quality | 0.928* | 2.22 | 0.573~ 2.429 | 1.71 | 2.622** | 2.45         | 1.375~ 3.996 | 1.77 |
| The satisfaction of activity facilities | 0.445** | 3.49 | 0.578~ 4.117 | 1.25 | 0.709*    | 2.19         | 2.871~ 5.022 | 1.39 |
| Time to reach the park 12am–14pm | -2.734** | -2.54 | -9.53~ -7.263 | 2.47 | --         | --           | --         | -- |
| Time to reach the park 14pm–18pm | -3.379*** | -2.72 | -9.73~ -6.902 | 2.12 | 6.706*** | 3.21         | 4.276~ 7.661 | 1.34 |
| Time spent in the park (min) | 2.287*** | 3.38 | 1.891~ 5.219 | 1.63 | 3.153*** | 3.71         | 5.937~ 9.671 | 1.45 |
| Constant              | 52.91           | 5.75          | 48.75~ 58.082 | 53.37*** | 5.24         | 45.45~ 60.087 | -- |
| $R^2$                 | 0.43            | 4.11          | 0.497     | 4.63 | 0          | 0             | --         | -- |

*P <0.1, **P <0.05, ***P <0.01. *Male, **<18, ***<45, *Unmarried, *Student, *6am–9am as the control group.

### 3.3.2. Regression analysis of mental health.

The results of the mental health regression analysis showed that variables such as gender, age, marital status, type of work, the time of arriving at the park, the time of spending in the park, satisfaction with the quality of the overall environment, green space and activity facilities of the park could be included in the mental health regression equation. Among these, gender, age, marital status, type of work and the time of arriving at the park are included as dummy variables. The equation is as follows:

\[ \hat{Y}_2 = 53.37 + 0.916X_1 - 5.103X_2 + 5.727X_3 - 2.755X_4 - 3.629X_5 - 4.064X_7 + 2.551X_8 + 2.622X_{10} + 0.709X_{11} + 6.706X_{12} + 3.153X_{13} \]

The results showed that the mental health status scores of women were higher than men; in the different groups of age, the mental health scores of residents aged between 30 to 50 years were lower than those younger than 18 years, and there was no significant difference among other categories. In the different groups of marital status, the mental health scores of married people were higher than those of unmarried people, and the mental health scores of divorced people were lower than those of unmarried people. In the different groups of occupational types, the mental health scores of office workers were lower than those of students, and there was no significant difference among other categories. The
residents’ satisfaction of the quality of the overall environment, green space, and activity facilities of the park was positively correlated with their mental health scores, the higher of the satisfaction, the higher of the mental health score, indicating better mental health status. Residents arriving at the park between 14pm to 18pm had higher mental health status scores than those who arriving at the park between 6am to 9am. The time of residents spending in the park was positively correlated with their mental health status score, the longer of staying in the park, the higher of the resident's mental health status score, indicating better mental health status. The regression coefficient results are shown in Table 4.

4. Conclusion

Based on the context of Chinese demographic and geographic background, this study researched the impact of urban parks on the physical and mental health of surrounding residents by investigating the physical and mental health of urban residents living around the park and evaluating the satisfaction of the park and the way of using the park. In the study, the general physical health score of 122 residents is (50.96±6.68) point, and the general mental health score is (51.73±7.42) point, the mental health score was slightly higher than the physical health score, which meant the general status of mental health of residents is better than the physical health. Among the residents, the difference in physical health scores is statistically significant by different genders, ages, weights, and occupation types; the difference in mental health scores is statistically significant by different genders, ages, marital status, education types, occupation types, and income levels. It can be found that the social characteristics of the residents have a greater impact on their mental health than physical health.

Regression analysis showed that the residents’ satisfaction of the quality of the overall environment, green space and activity facilities of the park had a positive effect on improving the physical and mental health of the residents, which means the better of the quality, the higher of the physical and mental health benefits they could receive. The time spending in the park had a positive effect on the physical and mental health of the residents, the longer of the time spending in the park, the higher of the residents' mental health status score, indicating better mental health status. The regression coefficient results are shown in Table 4.

Regression analysis showed that residents received better physical health benefits by using the park between 6am to 9am compared to those entering the park between 12pm to 14pm and 14pm to 18pm, while mental health regression analysis showed that residents received better mental health benefits by using the park between 6am to 9am compared to those entering the park between 6am to 9am and 14pm to 18pm. This result shows that residents could obtain the better promotion benefits of physical health from visiting park by entering the park in the morning. According to the literature, compared to other times of the day, there are higher quality of air and other natural environmental characteristics in the morning [14], which is beneficial to human physiological health[14]. However, tuning to the aspect of mental health, the residents could obtain the better promotion benefits of mental health from visiting park by entering the park in the afternoon. This result may be related to people's living and working habits. After doing life chores and busy working affairs in the morning, people's psychological status is in the state of fatigue and stress. Under this context, when people enter the park in the afternoon, the good green environment could significantly improve people's mental stress and fatigue.

The study mainly researches the effects of urban park on the physical and mental health of the residents, and discusses the differences in the physical and mental health benefits that people received when they using the park in the different time. However, there are some limitations of the study. First, the number of samples is insufficient to reflect the characteristics of the residents. Second, the frequency of visits to the park was not considered. Third, depending on the purpose of visiting the park, there may be a difference in the satisfaction level of the park. In the future research, we should further explore the relationship between people’s different park usage and the health effects of urban park. For example, the different health impact of park on people when they use the park by independent or group, and also when they use the park with different time and frequency.
5. Discussion
At present, urban and rural planning and landscape architecture disciplines pay more attention to the ecological function, aesthetic function and recreational function of urban park, and pay less attention to the function of health restoration. The theoretical framework of the health restoration system of park environment has not been established. In the existing attention recovery theory and stress relief theory, it is necessary to further improve the elements, mechanism and experimental methods of the park environmental health recovery theory, so that the theoretical research content and practical application can be effectively combined. Based on the findings of the study, the health effects of urban park should been better performed for facing the global urbanization. Therefore, when carrying out landscape design of a park, more attention should be paid to the natural landscape in the park, so that urban residents could access to nature and enjoy nature easily. At the same time, the needs of the surrounding population should be fully studied for meeting the different needs of different groups of people.

Acknowledgments
This paper is supported by The Students’ Innovation and Entrepreneurship Training Program of Anhui Jianzhu University “A study on the spatio-temporal relationship between new urban parks and human health: a case study of Tangxi River Park in Hefei”(Program No.36).

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