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Generating Inclusive Health Benefits from Urban Green Spaces: An Empirical Study of Beijing Olympic Forest Park

Jialin He [1], Li Li [1] and Jiaming Li [2,*]

[1] Key Laboratory of Ecosystem Network Observation and Modeling, Institute of Geographic Sciences and Natural Resources Research (CAS), Beijing 100101, China; jialin.he@igsnrr.ac.cn (J.H.); li.li@igsnrr.ac.cn (L.L.)

[2] Key Lab of Regional Sustainable Development Modeling, Institute of Geographic Sciences and Natural Resources Research (CAS), Beijing 100101, China

* Correspondence: lijm@igsnrr.ac.cn

Abstract: Nature proximity contributes to improving many people's health. In urban areas, how to increase the gaining of health benefits from urban green space (UGS) has gradually become a topic of concern for urban planners and public health practitioners. However, studies that can make causal inferences and evidence from developing countries and societies are still limited, and little has been done to address the issue of equity. Using data gathered in face-to-face surveys from 997 visitors to the Beijing Olympic Forest Park, we applied the instrumental variable approach to analyze park visit benefits to human physical and mental health, and explore ways that can help motivate visits and enhance equitable use. The results show that the overweight had more frequent visits, indicating that people with less-than-ideal health status might feel the urgency in improving their health and choose to engage in more recreation. In this sense, UGS showed a tendency to provide means for a certain group of people to proactively improve health. The study also solidifies the mid-term stress-relieving effect of park recreation that increased with visiting frequency, and found that visits to different types of UGS should all be beneficial, and do not have to be to large green parks. While distance is a decisive factor in encouraging UGS visits, route friendliness was found to have a complementing role, implying that creating routes to UGS that are more conducive to non-motorized travel (walking and cycling) could be seen as an important instrument. Both the incentives to park visitation and stress-relieving effect are more pronounced in elder groups, indicating higher potentials of such an approach in cities with an aging population. In terms of equity, differences in knowledge and income levels associated with use levels indicated inequitable use. To promote inclusiveness, the policy could start by increasing people's recognition of health benefits derived from UGS recreation through for example publicity programs. The study could bring implications for planning practitioners to leverage health potentials from increased and equitable use of UGS. Limitations of the study includes: (1) given the nature of cross-sectional data, the possibility of two-way causality cannot be ruled out, and (2) the study was conducted in one park and only park visitors were surveyed. In the future, researchers could consider conducting multi-period surveys, and to look at the city level to include all kinds of recreational UGS, and, if possible, to cover all residents.

Keywords: equity; megacity; mental health; physical health; UGS recreation; Beijing

Citation: He, J.; Li, L.; Li, J. Generating Inclusive Health Benefits from Urban Green Spaces: An Empirical Study of Beijing Olympic Forest Park. *Buildings* **2022**, *12*, 397. https://doi.org/10.3390/buildings12040397

Academic Editor: Derek Clements-Croome

Received: 23 February 2022
Accepted: 15 March 2022
Published: 24 March 2022

1. Introduction

For many people, proximity to nature contributes to improving their health and well-being [1,2]. In the urban context, living with more green spaces has been associated with lower incidences of overweight or obesity [3,4], lower cardiovascular disease morbidity and mortality [5–7], lower outpatient visits for anxiety and mood disorders [8–10], and longer life expectancy for the aged [11]. Recreation in urban green spaces (UGS) can bring immediate health benefits, such as greater feelings of recovery, pleasure, and satisfaction and reduced tension, confusion, anger, and frustration [12–14], suggesting additional health effects than exercises alone. UGS also has the potential to help reduce health inequalities caused by income disparities [15]. Although health benefits derived from UGS may be small compared to other factors affecting health, such as income, education, and smoking, even small benefits can contribute greatly to public health if the population is large enough [16].

There are three recognized mechanisms by which UGS promotes health through direct contacts. The first is the motivational role of exercises. Natural experiments have demonstrated that improved UGS can increase residents' physical activity levels, as many people engage in some form or degree of exercise when visiting [17,18]. Secondly, exposure to and perception of nature has a direct positive effect on people's brain and body working through the neuroendocrine system [19,20]. Finally, UGS contributes to social cohesion by providing opportunities and venues for social gatherings [21], as research has already substantiated the positive role of social cohesion on human health and wellbeing.

For an increased and more inclusive gaining of health benefits from UGS, gaps in knowledge remain [22]. These gaps point to important research areas. The first is to make research capable of making causal inferences. Although short-term health effects have been demonstrated through laboratory studies or field trials, most studies of long-term health benefits can only reveal correlations. It is very important to understand the causal relationship between the two if we are to use UGS as a tool to promote public health. The second is to complement the evidence pool with empirical studies from developing countries or areas. Although the number of studies in developing countries has risen in recent years, they still cannot match the quantity and quality of studies from developed countries. The third is to start paying attention to equity, which has rarely been touched upon in existing studies. Ways to start could include shifting from spatial-based assessment to one that is use-based, where equity can be measured by exploring which predictors of use are dominant [23].

In this study, we focus on Beijing Olympic Forest Park, a big green park in the megacity, and try to understand (1) whether there are health benefits (physical and mental) derived through visits, and, if yes, (2) to look into ways that can help motivate visits as well as enhance equitable use. We applied the Conceptual Model of Urban Green Space Recreation Service Generation and Delivery proposed by He et al. to our case [23], and used the Instrumental Variable approach in econometrics to deal with endogeneity in regressions to reveal causality between visits and health status. The study aims to explore the public health potential of UGS by providing evidence from China, a country that is developing and in transition, with a view of informing intervention strategies to promote increased and equitable use of UGS, and therefore, contribute to urban landscape design and public health management.

2. Study Area

Beijing is the capital city of China and a megacity with an area of 16,411 km^2 and a population of permanent residents of 21,516 million [24]. The study was carried out in Beijing Olympic Forest Park (40°00′ N, 116°22′ E) ('the Park' hereafter), which is located in the north of Beijing with an area of 6.8 km^2 (Figure 1). It is divided into the south and north parts by the Fifth Ring Road and re-connected by a green bridge spanning across the ring road, serving as a passageway for humans and wildlife. The Park incorporates a manmade semi-natural landscape with pre-existing landforms and flora. It is the green heritage of the 2008 Summer Olympics that has remained open to the public free of charge since then. Although it is not located in the downtown area, people can easily gain access through well-planned transportation systems.

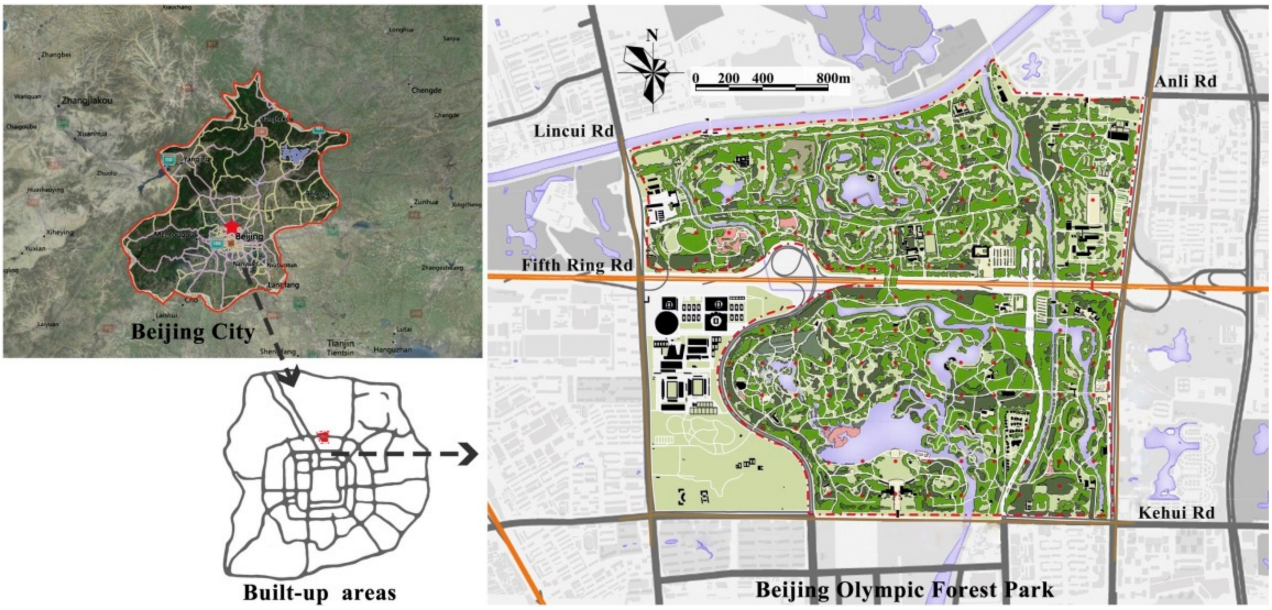

Figure 1. The geographic location of the study area (reproduced with authorization from Professor DONG Li's research team from School of Landscape Architecture, Beijing Forestry University).

3. Research Design and Methods

3.1. Conceptual Framework

The relationship examined in this study was simplified and customized from an evidence-based conceptual model which provides a comprehensive understanding of the correlates of UGS recreation behavior and its potential benefits from an ecosystem service perspective [23]. Figure 2 illustrates the relationships examined in this study. We hypothesize that the Park-visiting behavior is associated with individual predisposing characteristics, enabling factors, and other recreation behavior. Health benefits examined include aspects of physical and mental health.

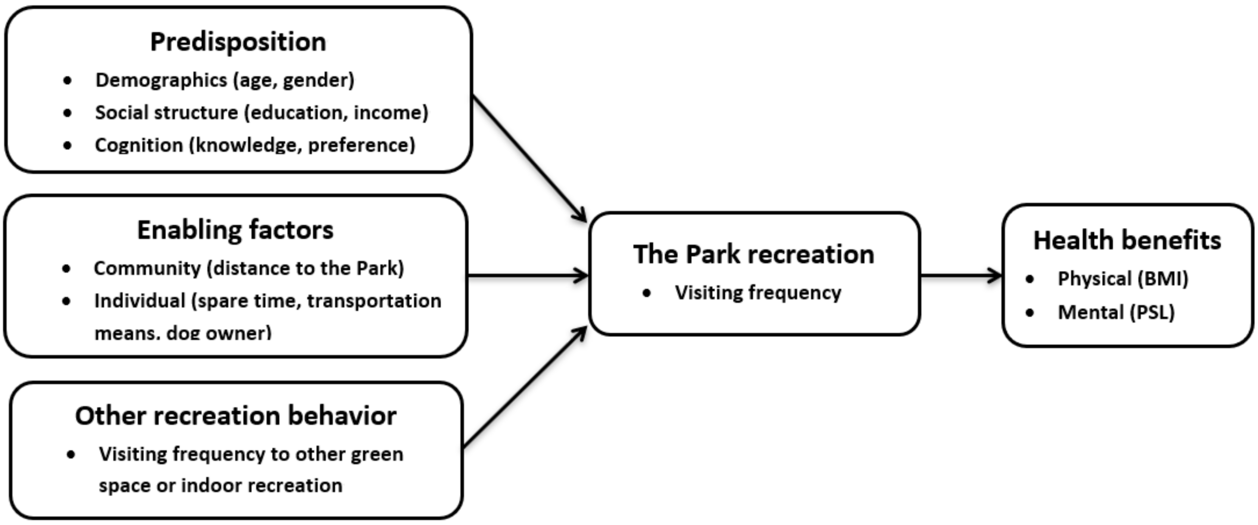

Figure 2. Conceptual framework of the study.

3.1.1. Econometric Models

As shown by Figure 3, four analysis models were established to explore:

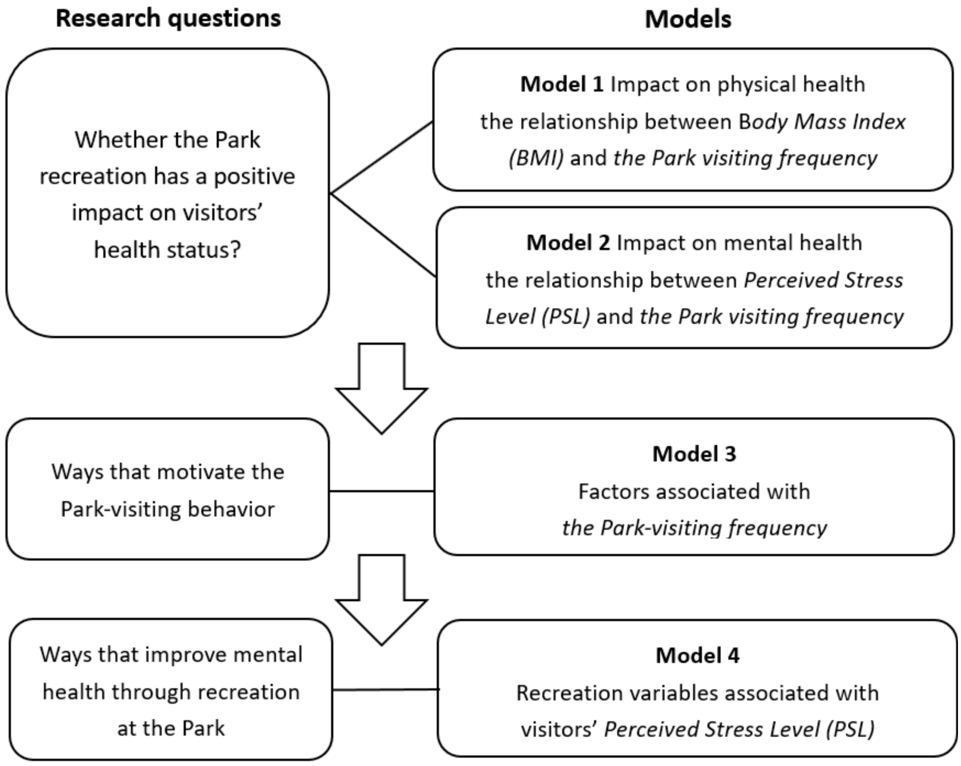

Figure 3. Logic flow of setting up the econometric models.

(1) Whether the Park recreation has a positive impact on visitors' health status, physically or mentally, by exploring the relationship between the Park-visiting frequency and visitors' Body Mass Index (BMI) and Perceived Stress Level (PSL).

Model 1: *BMI = f (the Park-visiting frequency, other urban green space-visiting frequency, indoor recreation frequency, gender, age, education, income; distance to the Park) (1).*

Model 2: *PSL = f (the Park-visiting frequency, other urban green space-visiting frequency, indoor recreation frequency, gender, age, education, income; distance to the Park) (2).*

(2) Ways that can help motivate the Park-visiting behavior, by looking at factors that are associated with the Park-visiting frequency.

Model 3: *The Park-visiting frequency = f (distance to the Park, way of transportation, spare time, knowledge, preference, dog owner, gender, age, education, income) (3).*

(3) Ways that can help improve visitors' mental health through recreation at the Park, by looking at important recreation variables about visitors' PSL.

Model 4: *PSL = f (the Park-visiting frequency, duration, type of activity, companion, years of regular visit, other urban green space-visiting frequency, indoor recreation frequency, gender, age, education, income) (4).*

In model 1 and model 2, the dependent variables are BMI and PSL, respectively, while the Park-visiting frequency is treated as the target-independent variable for both models. Other recreation behaviors (other urban green space-visiting frequency and indoor recreation frequency) and predisposing characteristics (gender, age, education, and income) were treated as controlling variables, with distance to the Park as the instrumental variable (IV). The study presumes that the more frequent Park visits are, the better the health status would be.

In econometrics, the IV approach is one way to solve the issue of endogeneity [25,26]. In this study, certain factors (such as dietary habits) that also influence people's health status were not included in the model as control variables because they were either hard to observe or time consuming to collect. The omission of explanatory variables in the model leads to endogeneity. The idea of the IV approach is to find and use an extra variable as an instrument in regression so that the possibility of correlation between the explanatory variable and the error item can be eliminated.

In simple terms, an eligible IV needs to meet the following conditions: (i) correlates with the target-independent variable (that means, in our model, IV should be directly associated with the Park-visiting frequency), (ii) has no direct association with the dependent variable (i.e., IV should not have a direct relationship with health status), and (iii) does not correlate with the residual (i.e., IV should be independent of those undocumentable variables that correlate with Park-visiting frequency and affect health status).

Variable distance to the Park meets the above three requirements. While selective migration might be disturbing as people living closer to parks can be more physically active [27–29], we excluded its possibility by checking the reason behind residence choosing and removing ones that reported the Park as one of the reasons of choosing where to live from the sample.

It is noteworthy that although the study used the IV approach to deal with the issue of endogeneity, and eliminated samples of selective migration, the possibility of two-way causality may not be ruled out given the nature of cross-sectional data.

In model 3, the dependent variable is the Park-visiting frequency, and the independent variables include those about enabling factors (distance to the Park, way of transportation, spare time, and dog owner) and predisposing characteristics (knowledge, preference, gender, age, education, and income). The study presumes that the closer residences are to the Park, the more frequent visits would be.

In model 4, the dependent variable is PSL, and the independent variables include several aspects of recreation activity at the Park (the Park-visiting frequency, duration, type of activity, companion, and years of regular visit) and demographics (gender, age, education, and income), while other recreation behaviors (other urban green space-visiting frequency and indoor recreation frequency) are seen as control variables.

3.1.2. Questionnaire Design

The first draft questionnaire was formed based on a literature review, expert consultation, and open interviews with the Park visitors. It went through several rounds of pre-tests and revisions before finalization to ensure pertinence and rigorousness, and that questions asked can be easily understood. The total length of the interview was kept within 15 mins. Content of the questionnaire included recreation behavior, health status, knowledge and preference, residence address, and demographic information. Details of variables and measurements are explained in Table 1.

3.1.3. Sampling and Data Collection

The study used a stratified random sampling method. The first step is to stratify and sample park entrances. There are eight entrances in total, five primary entrances that handle a high number of daily visits and three secondary ones that handle less. We randomly selected four out of the five primary entrances and two out of the four secondary ones. Visitors at each entrance were then randomly sampled proportionate to the total volume of visitors at each entrance. Table 2 shows the pattern of visitors sampled.

In July 2014, a total of 997 visitors were interviewed, which accounted for 0.0083% of the 12 million yearly visits. Face-to-face interviews was conducted with randomly chosen visitors by a group of ten investigators, with time covering early morning, daytime, and evening on both weekdays and weekends.

Table 1. Definition of variables.

Variable	Explanation
Body Mass Index (BMI)	Calculated by the weight in kilograms divided by the square of the height in meters (kg/m^2). Four BMI categories were employed using cutoffs suggested by PRC's *Criteria of Weight for Adults* (S/T428-2013): underweight (BMI < 18.5), normal ($18.5 \leq$ BMI < 24), overweight ($24.0 \leq$ BMI < 28.0), and obesity (BMI ≥ 28.0).
Perceived Stress Level (PSL)	Assessed by the simplified Perceived Stress Scale proposed by Cohen et al. [30] and widely used and validated afterward [31], that provides a validated 4-item instrument measuring how unpredictable, uncontrollable, unhandleable, or overwhelmed people felt their lives were during the past month *. It has a range from 0 to 16, and higher scores indicate more perceived stress.
The Park-visiting frequency	Respondents were asked to recall how many times they had visited the Park in the past 28 days.
Distance to the Park	The number of kilometers from the respondents' departure place to the nearest entrance to the Park, calculated by the commercial map navigation software AutoNavi.
Other urban green space-visiting frequency	How often respondents visited UGS other than the Park, calculated by adding up the number of visits to other parks and the number of visits to community green space over the past 28 days.
Indoor recreation frequency	How many times respondents participated in indoor recreation in the past 28 days.
Spare time	The number of hours respondents were free to spend in the past week, excluding time spent eating, sleeping, and doing housework. It was obtained by asking respondents to recall the length of such spare time they spent on both working- and non-working days each week and then adding up the two.
Knowledge	The degree to which respondents acknowledge the possible health benefits of UGS recreation, assessed by the number of agreed items of a list of 4 statements of possible health benefits.
Preference	Respondents' preference to UGS recreation, obtained by asking 'generally, how much do you feel like going to UGS for recreation?', with options provided as "very high", "high", "so so", "not much", and "almost none".
Ways of transportation	The kind of transportation respondents usually takes to get to the Park. Options included "walking", "cycling", "public transport (bus or subway)", and "private car or taxi".
Duration	Average length of stay in the Park.
Type of activity	The types of recreation activities undertaken in the Park. Options included "jogging", "other aerobic exercise", and "other general activities".
Companion	Whether respondents are usually accompanied when going to the Park.
Time of regular visit	The length of time since respondents started visiting the Park regularly. Options included "irregular visit", "1–2 months", "3–6 months", "7–12 months", "1–3 years", and "4–6 years".
Dog owner	Whether respondents had a pet dog. This was considered as no pet dogs were allowed in the Park.

* In PSL calculation, respondents rate how often they experience stressful situations on a 5-point Likert scale ranging from 'never' to 'very often'. Specific questions for PSL calculation were: (1) In the last month how often have you felt you were unable to control the important things in your life? (2) In the last month how often have you felt confident about your ability to handle your personal problems? (3) In the last month, how often have you felt that things were going your way? (4) In the last month how often have you felt difficulties were piling up so high that you could not overcome them?

Table 2. The pattern of the visitors sampled.

Entrances	Primary			Secondary			Total
	A	B	C	D	E	F	
Number of visitors sampled	632	80	81	145	32	27	997

Entrance A stands for the south gate of the south park (S.ga. S.pa.), B—the east gate of the south park (E.ga S.pa), C—the west gate of the south park (W.ga. S.pa.), D—the west gate of the north park (W.ga N.pa.), E—the north gate of north park (N.ga N.pa), and F—the east gate of the north park (E.ga. N.pa.).

3.2. Data Pre-Processing and the Sample Profile

Figure 4 shows the sample cleaning and screening process. Out of the 997 visitors to the Park aged 12 years or older that were randomly chosen, 68 had incomplete information, 8 showed a low level of cooperation during the interview, and 45 were biased with selective migration effect; these were excluded from the analysis. In total, 876 samples were used for the analysis of the Park recreation behavior and perceived stress level. For analysis of BMI, 43 samples, of which 40 aged below 18 and 3 were pregnant, were further excluded to meet the preconditions for BMI calculation, leaving 833 samples for BMI analysis.

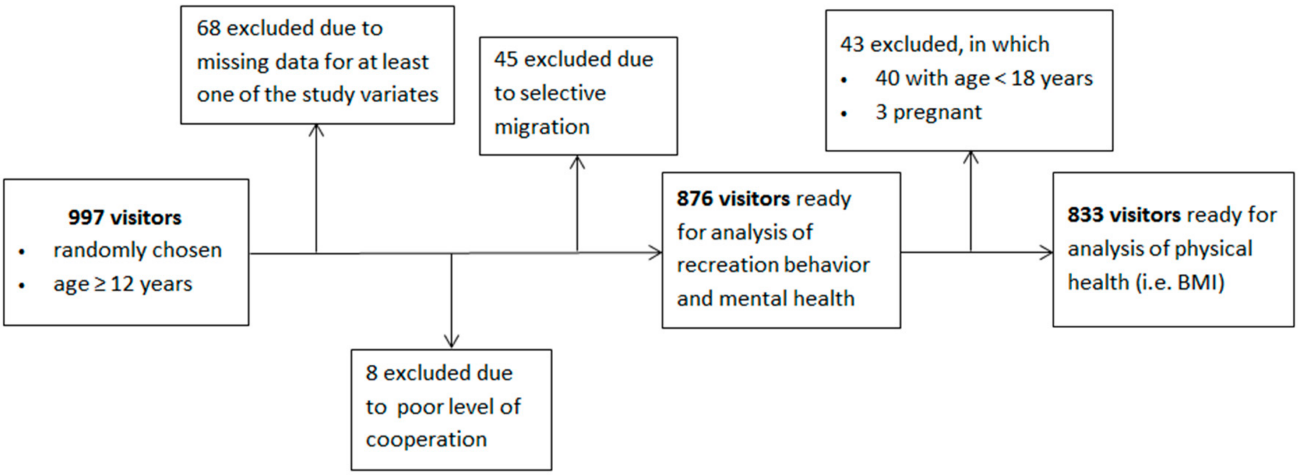

Figure 4. Flowchart of pre-processing of samples.

Table 3 shows the sample profile. Of the 876 respondents for analysis, 45.8% were female, 75.5% were 18 to 49 years old, 74.5% had a bachelor's degree or above, and 78.7% had a monthly income of less than 8000 CNY. In terms of recreation behavior features, 37.2% of respondents only visited the Park once in the past 28 days and 6.8% visited every day. More than half of respondents (51.5%) engaged with non-sports leisure activities in the Park, followed by jogging (29.6%) and other aerobic activities (18.9%). In terms of distance to the Park, 23.8% lived less than 3 km, 14.8% 3–5 km, 28.2% 5–10 km, 29.9% 10–30 km, and 3.3% more than 30 km. To get to the Park, public transportation (subway and bus) had been used mainly (57.4%), followed by walking (19.1%) and private car (17.6%), and cycling and other means accounted for 5.9%.

3.3. Data Analysis

Model 1—In the analysis of Model 1 on whether the Park-visiting behavior has an impact on visitors' physical health, this study focused on pairwise comparisons of adjacent BMI classes—binary samples of BMI (underweight/normal), BMI (normal/overweight), and BMI (overweight/obese) were yielded after binary conversion. Binary conversions were also performed to categorical variables gender, age, education, and income. Target-independent variable the Park-visiting frequency, control variables other urban green space-visiting frequency, indoor recreation frequency, and the IV distance to the Park were treated as continuous.

Table 3. Profile of the sample (n = 876).

	Number	Share (%)		Number	Share (%)
Gender			Was of transportation		
female	401	45.8	walking	167	19.1
male	475	54.2	cycling	52	5.9
Age			subway/bus	503	57.4
12~17	43	4.9	private car/taxi	154	17.6
18~29	343	39.2	Companion		
30~39	209	23.9	alone	266	30.4
40~49	109	12.4	with companion	610	69.6
50~59	79	9.0	Type of activity		
60~69	77	8.8	jogging	259	29.6
≥70	16	1.8	other acrobatic exercises	166	18.9
Education			other general activities	451	51.5
below bachelor	223	25.5	Duration		
bachelor	482	55.0	≤1 h	114	13.0
above bachelor	171	19.5	1–2 h	305	34.8
Income			2–4 h	346	39.5
0~2999	266	30.4	4–8 h	108	12.3
3000~4999	216	24.7	>8 h	3	0.4
5000~7999	207	23.6	Time of regular visit		
8000~9999	67	7.6	irregular visit	257	29.3
10,000~14,999	77	8.8	1–2 months	143	16.3
15,000~19,999	23	2.6	3–6 months	114	13.0
20,000~29,999	15	1.7	7–12 months	93	10.6
≥30,000	5	0.6	1–3 years	172	19.7
The Park-visiting frequency in the past 28 days			4–6 years	97	11.1
Once	326	37.2	Other green space-visiting frequency in the past 28 days		
2–4 times	284	32.4	none	265	30.2
5–8 times	87	10.0	1–16 times	373	42.6
9–16 times	100	11.4	17–28 times	131	15.0
17–27 times	19	2.2	>28 times	107	12.2
28 times	60	6.8	Indoor recreation frequency in the past 28 days		
Distance to the Park			none	556	63.5
≤3 km	208	23.8	1–16 times	302	34.5
3–5 km	130	14.8	17–28 times	18	2.0
5–10 km	247	28.2			
10–30 km	262	29.9			
30–60 km	27	3.1			
>60 km	2	0.2			

Because the regressions for variables BMI (underweight/normal) and BMI (overweight/obese) did not converge and valid statistical values could not be obtained, this study only presents the result from analyzing the dependent variable BMI (normal/overweight). In total, 747 samples were analyzed.

Instrumental variable probit (IV-Probit) was fitted, followed by an endogeneity check. A Wald test of endogeneity showed a p-value of 0.44, indicating that the Park-visiting frequency was exogenous of the error term and that a Probit regression should be used. A further homogeneity-of-variance test showed significant heteroscedasticity ($p < 0.001$), calling for the Het-Probit model to be used.

Model 2—In the analysis of Model 2 on whether the Park-visiting behavior has an impact on visitors' mental health, binary conversions were performed to categorical variables gender, age, education, and income. The dependent variable PSL, target-independent variable the Park-visiting frequency, control variables other urban green space-visiting frequency, indoor recreation frequency, and the IV distance to the Park were treated as continuous variables.

A two-stage instrumental variable (2SLS-IV) regression was first used. A White test of homogeneity-of-variance showed a p-value of 0.63, indicating no heteroscedasticity. A

Durbin–Wu–Hausman test of endogeneity showed a p-value of 0.48, indicating that the target-variable the Park-visiting frequency was exogenous of the error term. General linear regression was then used, with variance inflation factor (VIF) at 2.29 showing no multicollinearity and the p-value of _hatsq was 0.76, indicating reasonable model specification.

Model 3—In the analysis of Model 3 on related factors of the Park-visiting frequency, binary conversions were performed to categorical variables way of transportation, gender, age, education, and income.

Given Park-visiting frequency are integers greater than zero and almost equidispersed (mean = 5.76, SD = 7.84, n = 876), zero-truncated Poisson regression and maximum likelihood estimation (MLE) were used, followed by a model specification check that showed that the p-value of _hatsq was 0.48, indicating reasonable model specification.

Model 4—In the analysis of Model 4 on the related recreational features of visitors' PSL, binary conversions were performed to categorical variables type of activity, companions, time of regular visit, gender, age, education, and income.

General linear regression and Ordinary Least Square (OLS) estimation were used, followed by checks on homoscedasticity, collinearity, and model specification. A White test of homogeneity of variance showed a p-value of 0.89, indicating no heteroscedasticity. VIF in the multicollinearity test was 2.07, indicating no multicollinearity. The p-value of _hatsq item in the model specification check was 0.167, indicating reasonable. All analyses were conducted in Stata version 12.0.

4. Results

4.1. Relationship between Physical Health and the Park Visits

Results from Het-Probit regression (Table 4) showed that, when holding other variables constant, the relationship between the Park-visiting frequency and BMI (normal/overweight) was not significant at $p < 0.05$. However, the relationship is marginally significant if we lose the statistic threshold to $p < 0.1$. In the latter case, the average marginal effect dy/dx of the Park-visiting frequency was 0.00506, indicating that, on average, the probability of being overweight increased by 0.5% with each additional visit.

Table 4. Results from Het-Probit regression on BMI (normal/overweight).

	Coef.	Robust SE	z Value	p-Value	95% Conf. Interval	
The Park-visiting frequency	−0.024	0.014	−1.71	0.088	−0.051	0.003
Other urban green space-visiting frequency	−0.007	0.005	−1.42	0.155	−0.018	0.003
Indoor recreation frequency	0.073	0.039	1.87	0.061	−0.003	0.149
Male	1.427	0.749	1.90	0.057	−0.041	2.895
Age group				0.000 **		
18~29 (benchmark)	/	/	/	/	/	/
30~39	1.766	0.950	1.86	0.063	−0.096	3.629
40~49	1.937	1.040	1.86	0.063	−0.102	3.975
50~59	1.947	1.016	1.92	0.055	−0.044	3.939
60~69	2.785	1.625	1.71	0.087	−0.400	5.970
≥70	−12,230.5	417.55	−29.29	0.000	−13,048.8	−11,412.1
Education level				0.028 *		
Below bachelor (benchmark)	/	/	/	/	/	/
Bachelor	−2.138	1.166	−1.83	0.067	−4.424	0.148
Above bachelor	−1.679	0.924	−1.82	0.069	−3.491	0.132
Income group				0.000 **		
0~2999 (benchmark)	/	/	/	/	/	/
3000~4999	0.990	0.852	1.16	0.245	−0.680	2.660
~7999	1.078	1.121	0.96	0.336	−1.119	3.275
8000~9999	0.365	2.433	0.11	0.913	−4.504	5.033
10,000~14,999	1.915	0.749	2.56	0.011	0.448	3.382
15,000~19,999	1.242	2.635	0.47	0.637	−3.922	6.405
20,000~29,999	1.412	1.285	1.10	0.272	−1.106	3.930
≥30,000	0.118	5.640	0.02	0.983	−10.937	11.172

* significant at $p < 0.05$. ** significant at $p < 0.01$.

4.2. Relationship between Mental Health and the Park Visits

Results showed that (Table 5), when holding other variables constant, the Park-visiting frequency was negatively correlated with PSL ($p < 0.05$); with every increase of one visit per month to the Park, there was a 0.03 decrease in PSL.

Table 5. Results from general linear regression on perceived stress level.

	Coef.	SE	t Value	*p*-Value	95% Conf. Interval	
The Park-visiting frequency	−0.030	0.013	−2.28	0.023 *	−0.056	−0.004
Other urban green space-visiting	−0.032	0.007	−4.75	0.000 **	−0.045	−0.019
Indoor recreation frequency	−0.018	0.019	−0.96	0.340	−0.056	0.019
Male	−0.019	0.170	−0.11	0.909	−0.354	0.315
Age group				0.000 **		
12~17 (benchmark)	/	/	/	/	/	/
18~29	0.217	0.449	0.48	0.630	−0.665	1.098
30~39	−0.266	0.475	−0.56	0.576	−1.198	0.667
40~49	−0.892	0.502	−1.78	0.076	−1.879	0.093
50~59	−1.455	0.504	−2.89	0.004 **	−2.445	−0.466
60~69	−1.645	0.512	−3.21	0.001 **	−2.650	−0.641
≥70	−1.605	0.753	−2.13	0.033 *	−3.083	−0.127
Education level				0.4695		
Below bachelor (benchmark)	/	/	/	/	/	/
Bachelor	−0.082	0.239	−0.35	0.730	−0.551	0.386
Above bachelor	0.195	0.306	0.64	0.524	−0.405	0.796
Income group				0.756		
0~2999 (benchmark)	/	/	/	/	/	/
3000~4999	−0.208	0.237	−0.88	0.380	−0.674	0.257
5000~7999	−0.315	0.256	−1.23	0.218	−0.817	0.187
8000~9999	−0.079	0.365	−0.22	0.829	−0.794	0.637
10,000~14,999	−0.399	0.359	−1.11	0.267	−1.105	0.306
15,000~19,999	−0.862	0.567	−1.52	0.129	−1.974	0.250
20,000~29,999	−0.395	0.689	−0.57	0.566	−1.747	0.957
≥30,000	−1.151	1.121	−1.03	0.305	−3.351	1.048

* significant at $p < 0.05$. ** significant at $p < 0.01$.

4.3. Correlates of the Park Visits

Results showed that there was a significant negative correlation between distance to the Park and the Park-visiting frequency ($p < 0.01$), that is, keeping other factors unchanged, for every 1 km increase in distance, the visiting frequency decreased by 5.3% (Table 6). Transportation and the visiting frequency were highly related ($p < 0.01$), but the degree of correlation between transportation means and the visiting frequency varied (Table 6). For example, the difference in visiting frequency between cycling and walking was non-significant, but as compared with walking, a 42.5% drop in visiting frequency was found for respondents who chose the subway/bus, while a 56.7% drop was found for those taking private cars or taxis.

Every one-unit increase in knowledge of possible health benefits from UGS recreation was significantly related to a 12.8% increase in visiting frequency ($p < 0.01$), and for every one unit in preference of UGS recreation, a 14% increase in visiting frequency was found ($p < 0.05$; Table 6).

Gender ($p < 0.05$) and age ($p < 0.01$) were found to be significantly related to the visiting frequency (Table 6). Men's visiting frequency was 16.9% higher than women's (Table 6). Basically, the older the age, the more frequent the visits. No significant difference in visiting frequency was found among age groups under 40, while the visiting frequency of the age group 40–49, 50–59, 60–69, and over 70 years old were 74.4%, 155.7%, 183.9%, and 159.9% higher as compared to the 12–17 age group, respectively (Table 6).

Table 6. Results from zero-truncated Poisson regression on the Park-visiting frequency.

	IRR	Robust SE	z Value	p-Value	95% Conf. Interval	
Distance to the Park	0.947	0.008	−6.54	0.000 **	0.931	0.962
Ways of transportation				0.000 **		
Walking (benchmark)	/	/	/	/	/	/
Cycling	0.891	0.101	−1.02	0.309	0.714	1.113
Subway/bus	0.575	0.059	−5.42	0.000 **	0.470	0.702
Private car/taxi	0.453	0.054	−6.61	0.000 **	0.358	0.573
Spare time	1.005	0.005	1.00	0.315	0.995	1.015
Pet dog	0.820	0.103	−1.58	0.113	0.642	1.048
Knowledge	1.128	0.043	3.17	0.002 **	1.047	1.215
Preference	1.140	0.065	2.32	0.021 *	1.020	1.274
Male	1.169	0.082	2.22	0.026 *	1.019	1.341
Age group				0.000 **		
12~17 (benchmark)	/	/	/	/	/	/
18~29	1.174	0.281	0.67	0.502	0.735	1.877
30~39	1.461	0.368	1.50	0.133	0.891	2.394
40~49	1.744	0.455	2.31	0.033 *	1.045	2.909
50~59	2.557	0.615	3.90	0.000 **	1.596	4.096
60~69	2.839	0.686	4.32	0.000 **	1.768	4.557
≥70	2.599	0.692	3.58	0.000 **	1.542	4.381
Education level				0.150		
Below bachelor (benchmark)	/	/	/	/	/	/
Bachelor	0.880	0.081	−1.39	0.165	0.724	1.054
Above bachelor	0.777	0.103	−1.90	0.058	0.598	1.008
Income group				0.030 *		
0~2999 (benchmark)	/	/	/	/	/	/
3000~4999	1.193	0.107	1.96	0.050	1.000	1.423
5000~7999	1.137	0.132	1.10	0.271	0.905	1.428
8000~9999	0.954	0.171	−0.26	0.796	0.671	1.358
10,000~14,999	1.212	0.175	1.33	0.184	0.913	1.609
15,000~19,999	1.288	0.351	0.93	0.354	0.754	2.199
20,000~29,999	1.679	0.409	2.31	0.033 *	1.042	2.706
≥30,000	2.222	0.533	3.33	0.001 **	1.389	3.554

* significant at $p < 0.05$. ** significant at $p < 0.01$.

Positive correlations were found between visiting frequency and monthly income ($p < 0.05$) with varying levels of correlation among groups (Table 6). As compared with the income group with less than 3000 CNY per month, the visiting frequency increased by 67.9% in respondents with a monthly income of 20,000–29,999 CNY ($p < 0.05$), and a 122.2% increase in those with monthly income more than 30,000 CNY ($p < 0.05$; Table 6).

4.4. Correlates of PSL

Results showed that the relationship between the Park-visiting frequency and PSL was marginally significant ($p = 0.058$), and an increase of one Park visit corresponded with a 0.028 decrease in visitor's PSL (Table 7). Variables other green space-visiting frequency and age were significantly ($p < 0.01$) correlated while others showed no significant correlation with visitors' PSL (Table 7). Results also showed that people over the age of 50 had a greater stress relief effect from UGS recreation as compared to younger groups.

Table 7. Results from general linear regression on related recreational features of visitors' PSL.

	Coef.	SE	t Value	*p*-Value	95% Conf. Interval	
The Park-visiting frequency	−0.028	0.015	−1.90	0.058	−0.058	0.001
Duration	−0.001	0.001	−1.00	0.317	−0.003	0.001
Type of activity				0.184		
Jogging (benchmark)	/	/	/	/	/	/
Other aerobic exercises	−0.364	0.254	−1.43	0.153	−0.863	0.136
Other general activities	0.049	0.213	0.23	0.816	−0.368	0.467
Companion	−0.365	0.199	−1.83	0.068	−0.756	0.027
Time of regular visit				0.158		
Non-regular (benchmark)	/	/	/	/	/	/
1–2 months	−0.068	0.266	−0.25	0.800	−0.590	0.455
3–6 months	0.046	0.295	0.16	0.876	−0.533	0.625
7–12 months	−0.181	0.310	−0.58	0.560	−0.789	0.427
1–3 years	−0.407	0.271	−0.150	0.134	−0.940	0.126
3–6 years	−0.805	0.338	−2.38	0.017 *	−1.468	−0.142
Other green space-visiting frequency	−0.032	0.007	−4.71	0.000 **	−0.045	−0.018
Indoor recreation frequency	−0.018	0.019	−0.92	0.358	−0.055	0.020
Male	−0.067	0.174	−0.38	0.701	−0.408	0.274
Age group				0.000 **		
12~17 (benchmark)	/	/	/	/	/	/
18~29	0.114	0.453	0.25	0.801	−0.776	1.004
30~39	−0.174	0.479	−0.36	0.717	−1.114	0.766
40~49	−0.749	0.508	−1.47	0.141	−1.747	0.249
50~59	−1.262	0.510	−2.47	0.014 *	−2.263	−0.260
60~69	−1.569	0.523	−3.00	0.003 **	−2.595	−0.544
≥70	−1.392	0.768	−1.81	0.070	−2.900	0.116
Education level				0.461		
Below bachelor (benchmark)	/	/	/	/	/	/
Bachelor	−0.050	0.241	−0.21	0.835	−0.522	0.422
Above bachelor	0.236	0.310	0.76	0.447	−0.373	0.844
Income group				0.820		
0~2999 (benchmark)	/	/	/	/	/	/
3000~4999	−0.172	0.238	−0.72	0.469	−0.639	0.294
5000~7999	−0.346	0.257	−1.34	0.180	−0.851	0.160
8000~9999	−0.117	0.366	−0.32	0.748	−0.835	0.600
10,000~14,999	−0.361	0.362	−1.00	0.318	−1.071	0.349
15,000~19,999	−0.848	0.568	−1.49	0.136	−1.963	0.267
20,000~29,999	−0.422	0.693	−0.61	0.543	−1.783	0.938
≥30,000	−0.755	1.126	−0.67	0.503	−2.966	1.456

* significant at $p < 0.05$. ** significant at $p < 0.01$.

5. Discussion

The effect of visiting large UGS such as Beijing Olympic Forest Park in relieving stress and soothing emotions in mid-term (monthly, assessed by the simplified Perceived Stress Scale) is solidified by this study (Table 5). Both results of Model 2 and Model 4 suggested that in addition to the Park-visiting frequency, other UGS-visiting frequency also mattered, implying that differences among types of UGS may not be obvious. In the literature, the complementarity in providing recreation venues of different types of UGS is discussed, which represented a different trend to our study result. For example, a Swedish study found that residents do not visit large UGS even with an absence of community green spaces [32], and similarly, the results of a Canadian study showed that the use of courtyard green spaces could not offset the use of park spaces [33]. We think there may be little difference in generating mental health benefits from different types of UGS, but the use pattern does vary between large and community UGSs.

The frequency of visits outweighed other recreation variables, such as type of activity and duration, as a more important factor to mental health improvement. As regards age groups, results showed that such an approach gained more benefits in relieving mental stress for people over 50. Model 3 also showed that elder people come more often to the Park. These findings suggest higher potentials of such an approach in cities with an aging population.

Although the literature broadly supported the effect of UGS recreation in relieving stress, there is still no clear message on whether it can help bodyweight control [16]. This is understandable from a mechanism's point of view—bodyweight control requires a balanced diet and exercise regime, yet UGS recreation does not necessarily result in more calories burned, as our results showed that 51.5% of the interviewed visitors mainly engaged in leisure activities such as walking, camping, and picnicking, which do not require too much intensity. On the other hand, even if visitors do engage in aerobic or even anaerobic exercises in UGS, it takes time for weight change to happen and that requires longer observation for any research to capture. In this study, people who go to the Park more frequently are more likely to be overweight (Table 4). This goes against our hypothesis that frequent visits would lead to better physical health. Here, self-selection effect offers one possible interpretation—people with a less-than-ideal health status might feel the urgency in improving their health status and, thus, choose to engage in more recreational activities in UGS. In this sense, UGS offered means for a certain group of people to proactively engage in physical activities and, thus, toward gaining health benefits.

An interesting point regarding self-selection in the result is that it contrasts with our original assumption. The notion that people who are more health-conscious are more likely to participate in UGS recreation and, thus, are usually healthier came from existing literature, in which residents who live in greener environments or live closer to large public green spaces were found to maintain a certain level of physical activity [3,27–29,34]. However, the majority of such evidence was from developed countries. This study focused on China, a country that is developing and in transition. This brings up some interesting topics worth exploring: for people from countries/areas with different levels of development, are there self-selection effects between the use of UGS and health status? How do they function, and do they vary with different levels of socio-economic conditions?

Given the potentials of UGS in improving people's health status through behavioral change, this study also provides insights on how to promote the use. As shown in the results of Model 3, distance is one of the most important factors influencing people in making visiting decisions. Moreover, means of transportation also played a role independent of distance and spare time. This implies that creating an environment suitable for non-motorized travel such as walking and cycling could be motivational. Distance together with a conducive environment on the way should be considered important elements of accessibility during urban landscape planning.

Among the variables in Model 3 that are shown to be related to the visiting frequency, knowledge and income are the two factors that need our attention. Unlike other variables such as age, gender, and preference, the fact that differences in knowledge and income levels led to different use levels, especially when higher income groups or people with better knowledge had higher levels of visiting frequency as our study showed, suggests that inequitable use existed [23]. Removing social and physical barriers to nature contact is an issue of environmental justice [35–37]. Ways to promote equitable use could start by increasing people's recognition of health benefits derived from UGS recreation through, for example, government publicity programs.

This study used two steps to increase the reliability of its results: (1) eliminate samples that selectively lived near the Park to exclude selective migration, and (2) use the IV approach to handle the issue of endogeneity. However, given the nature of cross-sectional data, the possibility of two-way causality cannot be ruled out, which is confirmed by the study results indicating that overweight people are more likely to visit the Park. Another limitation is that the study was conducted in one park (albeit a large iconic park) and only park visitors were surveyed. This prevents us from understanding the role of UGS features such as greenery, ponds, lawns, and park facilities in motivating visitation due to lack of variations in UGS features in our samples, as well as an analytical discussion of UGS access and uses at the urban scale. Researching at the city level will need to include all recreational UGS and cover all residents. Although resource-intensive, it is worthy of future research.

6. Conclusions

Health implications from UGS recreation make the design and management of green space a concern not only for the urban planning sector but also for the public health department. By investigating visitors to a large green park, Beijing Olympic Forest Park, this study examined both physical and mental health implications from UGS recreation. Firstly, it solidified the mid-term effect (a month time span) in relieving stress and soothing emotions, which increased with the frequency of visits, and magnified in the aging groups (age > 50). In terms of weight control, the results showed that overweighed visitors had more frequent visits, which was against the original presumption but brought us to an interesting extrapolation—that the park served as an important means for people with less-than-ideal health status to proactively improve their health.

There are some implications for planning practitioners if we are to leverage health potential from UGS recreation. While distance is one of the most important factors influencing people in making visiting decisions, route friendliness may provide a complementary role in encouraging UGS visits. Creating routes to UGS that are more conducive to non-motorized travel, such as walking and cycling, could be seen as an important instrument to increase UGS visitation. Secondly, in relieving stress, encouraging visits to different types of UGS should be beneficial, regardless of activity types, and these do not have to be to large green parks. Thirdly, both the incentives to park visitation and the stress-relieving effect are more pronounced in elder groups, indicating higher potentials of such an approach in cities with an aging population.

The characteristics of an inclusive city would include equitable access to its UGS. This study also shed some light on this dimension by analyzing factors influencing the use of the Park. Among the factors, differences in knowledge and income levels were associated with use levels, indicating room for promoting equitable use. That could start by increasing people's recognition of health benefits derived from UGS recreation through, for example, publicity programs.

Author Contributions: Conceptualization, J.H.; methodology, J.H. and L.L.; software, J.H. and L.L.; validation, J.H., L.L. and J.L.; formal analysis, J.H. and L.L.; investigation, J.H.; resources, J.L.; data curation, J.H. and L.L.; writing—original draft preparation, J.H.; writing—review and editing, L.L.; visualization, J.H. and L.L.; supervision, J.L.; project administration, J.L.; funding acquisition, J.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Program of National Natural Science of China, grant number No. 42171178.

Institutional Review Board Statement: Ethical review and approval were waived for this study because the research process did not include identifiable personal information and informed consent was obtained at the time of original data collection.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available as per the informed consent at the time of original data collection.

Conflicts of Interest: The authors declare no conflict of interest.

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