Original Article

Willingness-to-pay for urban green space: A meta-analysis of surveys across China

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Abstract

Sustainable ecosystem services are increasingly recognized amid rapid regional transformation. While the rate of urbanization in China continues to rise, there is an urgent need to evaluate public preferences and their associated economic values concerning urban green space (UGS). The aim of this study was to calculate the overall willingness-to-pay (WTP) for UGS across China. Literature search was performed systematically on Scopus, Scilit, PubMed, and Google Scholar databases on 11 November 2023. Studies reporting the WTP in China were included in the analysis. Quality of the included studies were appraised by using Q-SSP tool consisting of 20-item quality of survey studies in psychology. To calculate the overall willing to pay rate and WTP, a meta-analysis was performed using restricted maximum-likelihood model on raw proportions. A total of nine studies were included comprised of 9381 valid responses with high quality according to Q-SSP (score: 70–90%). Findings from the meta-analysis indicated that the rate of willing to pay for UGS was 70.8% (95%CI: 60%, 82%; p-Het<0.001, I^2= 99.37%). The rate was not affected by sample size, age, gender, and education (p>0.05). Among mainland Chinese population alone, the average minimum WTP was 2.97 USD/month, and increased to 3.36 USD/month if combined with Hong Kong population. A majority of over 70% Chinese population were willing to pay for UGS. Nevertheless, high heterogeneity in the pooled estimates suggest the importance of addressing contextual variables and presence of regional disparities.

Keywords: Urban green space, willingness-to-pay, urban ecosystem conservation, urban habitat, China

Introduction

Amount of land use for commercial and residential purposes has decreased the utilization of urban green space (UGS), which affects the environment in urban areas [1] The UGS is being converted into residential areas, industrial and commercial areas, shopping centers, and others impacting the its capacity to carry its environmental functions [2]. The quality of the urban environment is of importance when conducting the development and not only focusing on economic aspects [3]. One way to maintain environmental quality is to increase UGS in urban areas whose existence is crucial in maintaining the balance of urban environment [4].

However, in many countries there is insufficient funding for construction and maintenance, limiting wider implementation of urban green infrastructure. Various developed countries (e.g.,

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the United States, Germany, Australia, and France) set cost for green open space to supplement the construction and maintenance costs of urban green infrastructure to help finance urban green infrastructure [5]. Globally, China has experienced the highest rates of urban land expansion [6]. Thus, studying UGS in China is not only a response to the challenges posed by rapid urbanization but also a proactive measure to ensure that the urban development is sustainable, environmentally friendly, and promotes the well-being of its residents. Charging for green open space is still a question for people in China due to a lack of awareness and information [7]. A study showed that the hedonic pricing approach based on local property markets will affect the estimated value of UGS [7]. In this approach, characteristics such as type, size, and ownership rights strongly influence the value of UGS. Property value can be considered to be a function of its structural, locational, neighborhood and environmental characteristics. Hence, an approach of using willingness-to-pay (WTP) as a parameter to determine the value of UGS can be performed to gain more supporting evidence and perspective.

Despite much research and findings in the area of WTP for UGS, the perceived benefits and functions of the infrastructure remain poorly understood in mainland China and its special administrative regions [8]. Especially, during socioeconomic reconstruction, where variations in the value of UGS at different socioeconomic levels are relatively unknown [8]. Spatial provision of environmental amenities is still the main topic of research in the field of environmental justice. Individuals with middle and upper incomes are starting to create segregated communities leading to social problems and environmental injustice, in which the problems are often accompanied by residential segregation [9-11]. The worsening social inequality in access to green space in China's megacities indicates that there is a negative relationship between the increasing rate of urbanization and economic development and the provision of public green space at the national level [9-11]. Therefore, there are still gaps that can be explored in terms of calculating the overall WTP for green spaces across China. The aim of this study was to determine the overall WTP for UGS across China.

Methods

Search strategies and eligibility criteria

The search for relevant literature was performed on four electronic databases (Scopus, Scilit, PubMed, and Google Scholar) on 12 November 2023 by two independent authors. To find relevant literature truncated keywords of ("*urban green" OR "green space" OR "greenness") AND ("willingness-to-pay" OR "pay" OR "WTP" OR "willingness to pay") AND "China" were employed. WTP was defined as the maximum money each respondent is willing to pay in USD. The screening and selection were assisted by EndNote X9 with automatic duplicate removal. Only studies reporting the WTP survey for the creation or preservation of UGS in China (including Hong Kong) were included. Conference abstracts, retracted articles, editorials, and commentaries were excluded. Discrepancies in the final results were resolved by revisiting the article and discussion until a consensus was reached.

Data extraction

Two independent authors performed the data extraction. Characteristics of the study were collected including author name(s), publication year, and province/municipality where the study was conducted. Number of respondents, gender, age, education level, and monthly income were retrieved from each study. Number of respondents with ‘Yes’ and ‘No’ response for the WTP, was collected. The average WTP per month was extracted and converted to USD based on the currency rate when the study was conducted then adjusted with the inflation rate. Top five perceived benefits of UGS based on the statistical power (*p*-value) and/or frequency (or other statistical approach used by the individual study) were extracted as well. Discrepancies in the extracted data were resolved by consensus.

Quality appraisal

Assessment for the quality of the included studies was carried out with the help of a 20-item quality of survey studies in psychology tool (Q-SSP) [12]. The tool is comprised of four domains;

introduction, participant, data, and ethics. Introduction domain covers the definition of the research problem, research justification, research questions and hypotheses, and definitions of variables used in the study. In participant domain, the inclusion criteria, recruitment strategy and rationalization of the sample size of the study were assessed. Data is the largest domain that evaluates the reporting of attrition rate, measures, data collection, and respondents' characteristics. The last domain, ethics domain, focuses on the informed consent, debriefing, and disclosure of funding sources or conflicts of interest. Each item was answered by 'Yes' or 'No' options. High quality was given to a study with 'Yes' responses of at least 70% of the total responses.

Statistical analysis

Pooled estimates of proportion were carried out on Jamovi 2.3.21.0 with maximum-likelihood model estimator and effect size of raw proportion with 95% confidence interval (95%CI). The rate of willing to pay was calculated by multiplying the obtained proportion by 100%. Heterogeneity was determined by the I^2>50% or p-Het<0.1. Begg's funnel plot was constructed to observe any publication bias as indicated by p-Begg<0.05. One-leave-out analysis was carried out as a sensitivity test. Meta-regression was conducted on Comprehensive Meta-Analysis (version 3.3.070) for sample size, proportion of ≥51-year-old participants, proportion of female respondents, and proportion of participants with at least a university degree. Difference of proportion was estimates using two-tailed Z-statistics (significant at p<0.05). Pooled estimates of mean WTP were carried out using Cochrane's formula through sequential combinations of mean value, where in each combination sequence the following equation (Equation 1) was used.

$$Combined\ mean\ of\ group\ x\ and\ y = \frac{N_x M_x + N_y M_y}{N_x + N_y}$$

Where, N_x and M_x are sample size and mean of group 'x', respectively, and N_y and M_y are sample size and mean of group 'y', respectively.

Results

Searching results

Initial identification of relevant literature based on the keyword combinations used yielded a total of 73 records. Of which, twenty-three records were identified as duplicates and removed. Fifty records were then subjected to title and abstract screening, where 34 of which were excluded because of being irrelevant to the the present study. Following the full-text screening of 16 studies, nine studies were included in both qualitative and quantitative analyses. Exclusion during the full-text screening was made because five of the studies were not reported the survey from China or not investigated WTP for UGS. Flow-chart diagram for the selection of eligible studies is presented in **Figure 1**.

Characteristics of included studies

The included studies were reported from at least seven provinces or municipalities (**Figure 2, Table 1**). Two studies were reported from Hong Kong, 1 in Beijing, 2 in Wuhan, 2 in Hangzhou, and 1 in Jinan. A single study reported the survey findings from three cities situated in distinct provinces, namely Wuhan, Changsha, and Nanchang. In total, there were 9381 valid responses received from the survey. However, a study made exclusions of 18 responses in the WTP analysis, making a total of 9363 responses in the WTP pooled estimates. Most of the studies had responses from relatively equal number of females and males. Almost all studies recruited respondents below 51 years old, except in one study that had 62.73% proportion of 51-year-old respondents. All studies were published between 2006–2019 and had a relatively varied proportion of respondents with at least a university degree (28–84.27%). Variety of median or average monthly income was also found across studies (**Table 1**).

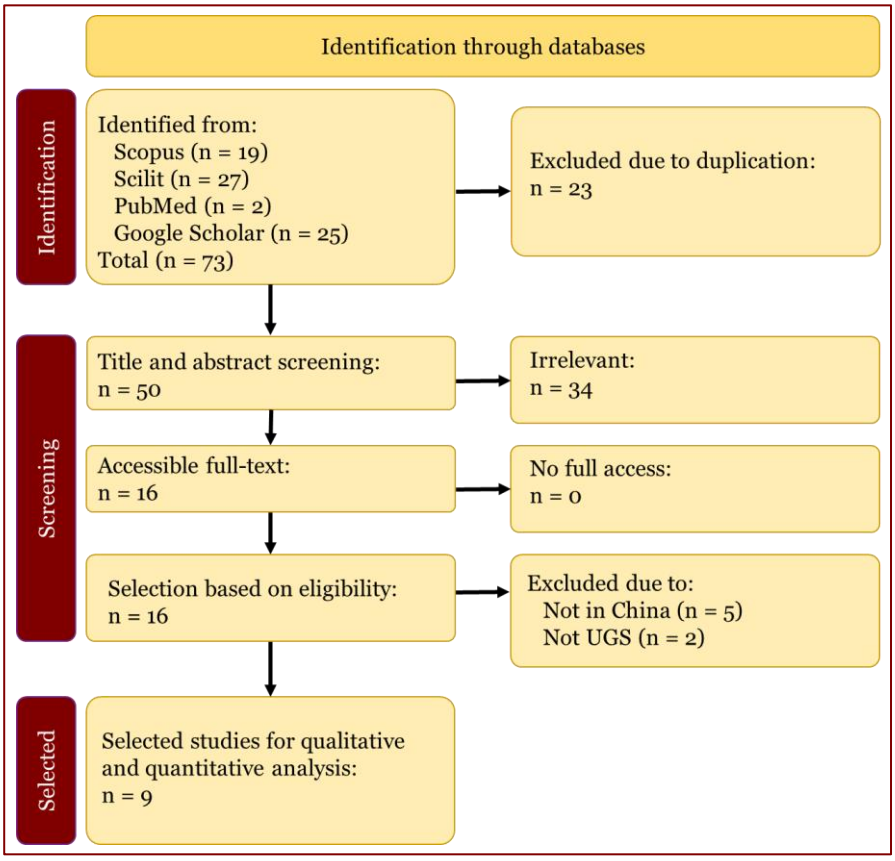

Figure 1. Flow-chart diagram for the selection of eligible studies.

Quality of the included studies

Results from the quality appraisal using Q-SSP score are presented in **Table 1**. All studies had the score of above 70% suggesting the high reliability of the evidence. Nonetheless, most of the studies neglected the reporting of inclusion and exclusion criteria. Moreover, none of the study properly reported or probably performed sample size calculation, making the evidence difficult for generalization.

Pooled analysis of WTP

Pooled estimates were carried out for studies from China which included one of its two special administrative regions, Hong Kong. A part the fact that Hong Kong was part of China, the pooled estimates with its inclusion (n=9363 respondents) were carried out because of the similarity in culture and language [13]. Nonetheless, different political views and government administrations might cause implication to the WTP [14]; therefore, another pooled analysis was computed by excluding Hong Kong (n=8570 respondents). Forest plots for pooled estimates of WTP in China with Hong Kong included or excluded in the analysis are presented in **Figure 3**. When Hong Kong is included, the pooled estimates yielded a willing to pay rate of 70.8% (95%CI: 60% to 82%) (**Figure 3A**). When the pooled analysis was carried out by excluding Hong Kong, the rate of willing to pay significantly increased (p-Z<0.001) by 3.2% (WTP=74.0%; 95%CI: 66% to 82%) (**Figure 3B**). The heterogeneity was significantly observed in both pooled estimates (p-Het<0.001, I^2> 95%).

The pooled estimation on the mean WTP of Chinese and Hong Kong studies (n=7016 respondents) yielded 3.36 USD/month. By excluding studies from Hong Kong, the mean WTP was 2.97 USD/month. In individual study, Hubei Province or Wuhan Municipality had the highest WTP of 15 USD/month (**Table 1**).

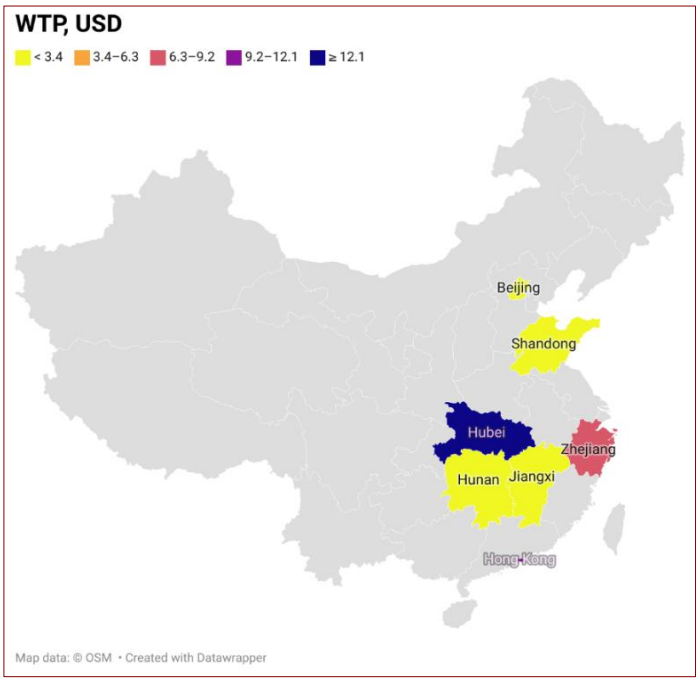

Figure 2. Distribution of WTP across Chinese provinces.

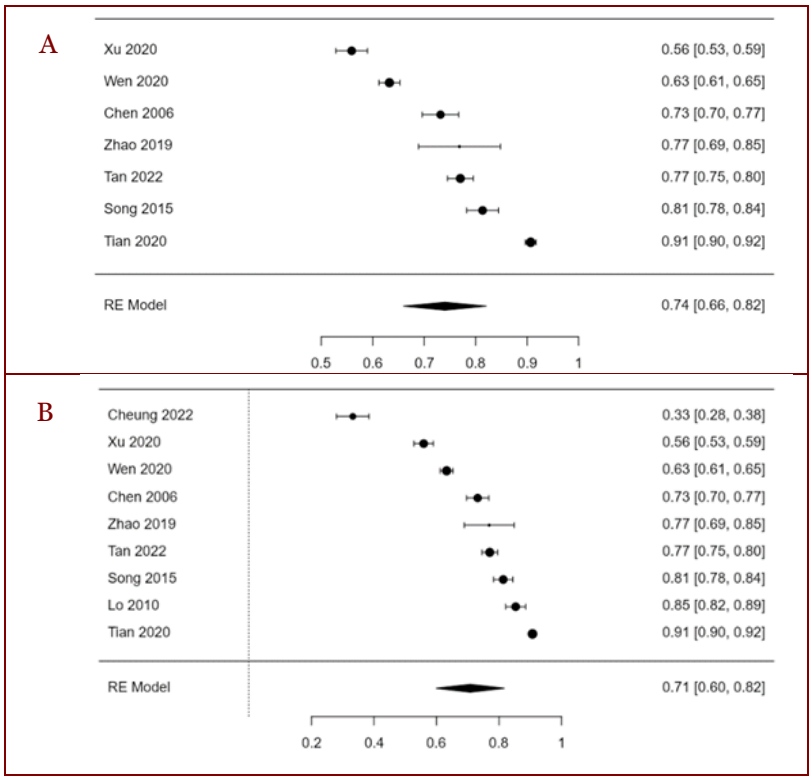

Figure 3. Forest plot for pooled estimates of willing to pay rate in China including (A) and excluding Hong Kong (B). Including Hong Kong, the rate is 70.8% (95%CI: 60% to 82%); *p*-Het<0.001, I^2= 99.37% (A). Excluding Hong Kong, the willing to pay rate is 74.0% (95%CI: 66% to 82%); *p*-Het<0.001, I^2= 98.7% (B).

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Table 1. Characteristics of the included studies along with the willing to pay rate and willing-to-pay (WTP) and perceived benefits of urban green space (UGS)

Reference	Province/ municipality	Characteristics		Willing to pay[a]		WTP (USD) /month*	Top 5 perceived benefits of UGS		Q-SSP score
		Variable	n (%)	Response	*n*		Category	Rank	
Chen *et al.*, 2006 [15]	Hangzhou	Total	600	Yes	439	2.03	Aesthetic	1	70
		Female	290 (48.4)	No	161		Shading place	2	
		≥ 51 years-old	-				Recreational place	3	
		≥ University	168 (28)				Animal shelter	4	
		Median income (USD)	5,000				Climate control	5	
Lo *et al.*, 2010 [16]	Hong Kong	Total	495	Yes	407/477[b]	9.90	Physical exercise	1	85
		Female	261 (52.7)	No	70/477 [b]		Clean air	2	
		≥ 51 years-old	137 (27.7)				Relaxation	3	
		≥ University	149 (30.2)				Enjoying the landscape	4	
		Median income (HKD)	10,000–19,999				Social activities	5	
Song *et al.*, 2015 [17]	Jinan	Total	606	Yes	493	1.09	Leisure and viewing	1	85
		Female	315 (47.7)	No	113		Physical exercise	2	
		≥ 51 years-old	86 (14.2)				Social activities	3	
		≥ University	370 (61.1)				Family quality time	4	
		Median income (RMB)	1000–3000				Enjoying the landscape	5	
Zhao 2019 *et al.*, [18]	Wuhan	Total	108	Yes	83	15	-	-	75
		Female	64 (59.3)	No	25		-	-	
		≥ 51 years-old	7 (6.6)				-	-	
		≥ University	82 (75.9)				-	-	
		Avg. income (RMB)	6000				-	-	
Tian *et al.*, 2020 [8]	Wuhan, Changsha, and Nanchang	Total	3000	Yes	2721	2.55	Climate regulator	1	80
		Female	1469 (48.97)	No	279		Removing air pollutant	2	
		≥ 51 years-old	218 (7.27)				Enjoyable place	3	
		≥ University	2528 (84.27)				Regulating water and preventing soil erosion	4	
		Avg. income (RMB)	4000–8999				Habitat for plants and animal	5	
Wen *et al.*, 2020 [19]	Wuhan	Total	2168	Yes	1371	1.5	-	-	75
		Female	1079 (49.77)	No	797		-	-	
		≥ 51 years-old	136 (62.73)				-	-	
		≥ University	1735 (80)				-	-	
		Median income (RMB)	6000				-	-	
Xu *et al.*, 2020 [20]	Beijing	Total	1000	Yes	559	0.5	-	-	90
		Female	591 (59.1)	No	441		-	-	
		≥ 51 years-old	321 (32.1)				-	-	
		≥ University	472 (47.2)				-	-	
		Median income (RMB)	7000				-	-	
	Hong Kong	Total,	316	Yes	105	2.17	Health	-	90

Reference	Province/ municipality	Characteristics		Willing to pay[a]		WTP (USD) /month*	Top 5 perceived benefits of UGS		Q-SSP score
		Variable	n (%)	Response	*n*		Category	Rank	
Cheung *et al.*, 2022 [21]		Female	155 (49.05)	No	195		Environment and ecology	-	
		≥ 51 years-old	93 (29.5)				Thermal environment	-	
		≥ University	143 (45.3)				Social	-	
		Median income (HKD)	20,000–40,000				Outdoor recreation	-	
Tan *et al.*, 2022 [22]	Hangzhou	Total	1088	Yes	838	8.78	Health benefits (pregnancy)	1	85
		Female	537 (50.4)	No	250		Health benefits	2	
		≥ 51 years-old	50 (4.2)				Water retention	3	
		≥ University	713 (65.5)				Ecological benefits	4	
		Median income (RMB)	>5500				Cooling effect	5	

(-), no data or insufficient data; Q-SSP, quality of survey studies in psychology; UGS, urban green space.
[a] Otherwise stated, the proportion was calculated from the total sample.
[b] Calculated from a specific number of samples.
* Averaged value or range with highest frequency.

Sensitivity of the pooled estimate

The forest plot for one-leave-out analysis is presented in **Figure 4**. Removing one study after another did not significantly change the statistical data summaries with *p*-value remaining below 0.01. In this analysis, the rate of willing to pay ranged from 69.7% to 77.1% which was still in the range of 95%CI from the pooled estimates (60% to 82%). These findings support the robustness of the willing to pay pooled estimate. On the other hand, it is noteworthy to acknowledge the proportion difference caused by removing study with overly high proportion of specific group (such as age) as compared to others. Removing 'Wen 2020' [19] with a proportion of ≥51-year-old participants reaching 62.73%, increased the %WTP to 74.2%.

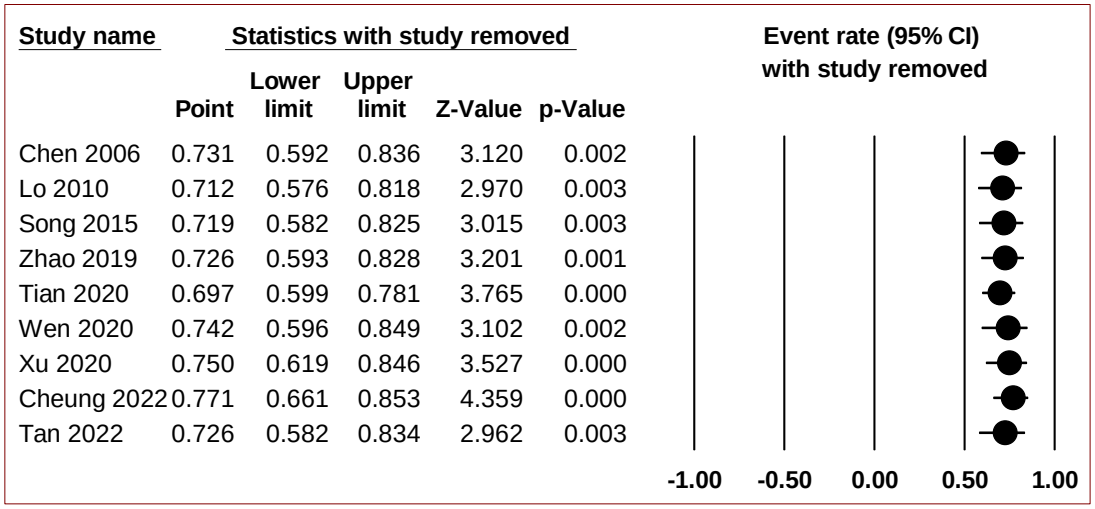

Figure 4. Forest plot for the one-leave-out test. The range of willing to pay rate is 69.7–77.1%.

Publication bias

Begg's funnel plot to observe the publication bias of the pooled estimates is presented in **Figure 5**. The analysis suggests that the presence of publication bias was not statistically significant with *p*-Begg=0.340.

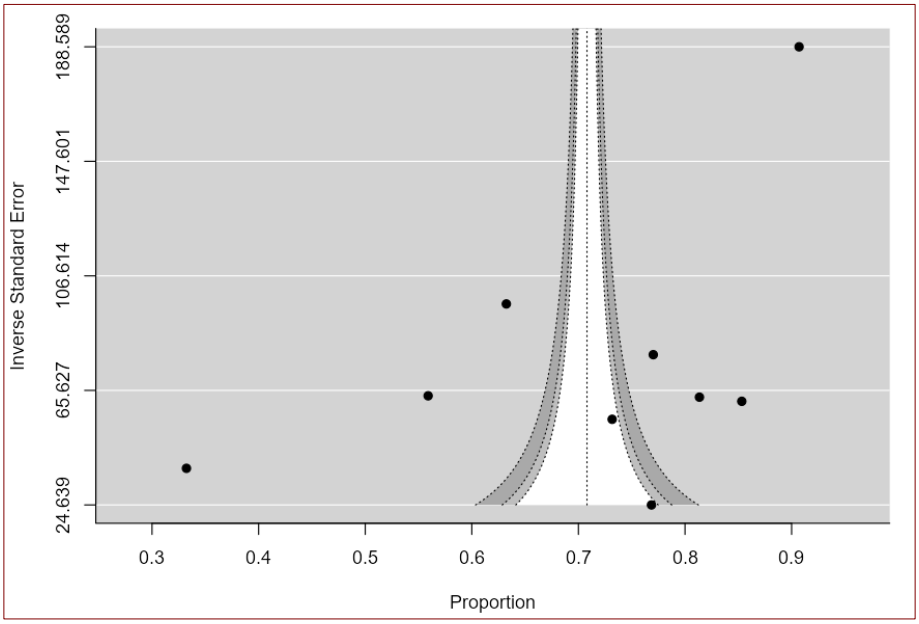

Figure 5. Begg's funnel plot for publication bias analysis. Z=-0.955, *p*-Begg=0.340.

Meta-regression

Bubble plots of meta-regressions with predictors of sample size, proportion of ≥51-year-old participants, proportion of female respondents, and proportion of participants with at least a university degree are presented in **Figure 6**. None of the aforementioned variables could significantly predict the %WTP with $p>0.05$.

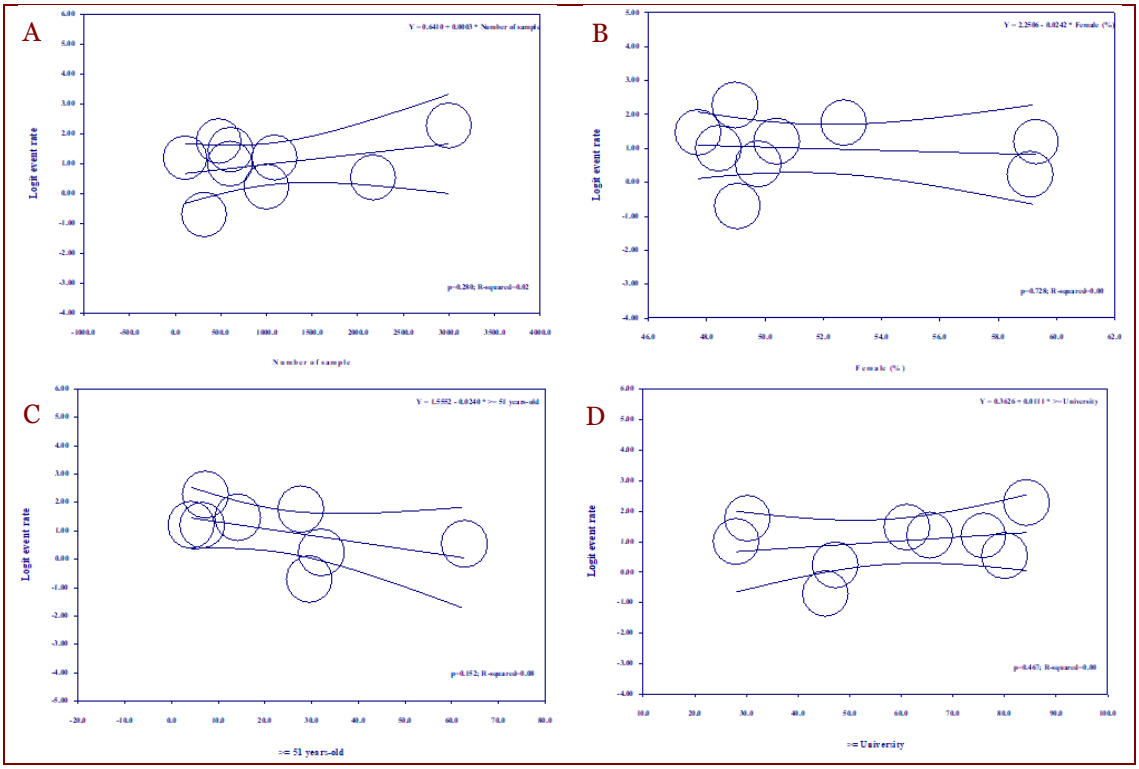

Figure 6. Bubble plot for meta-regression analysis on the effect of sample size (A), female proportion (B), proportion of people aged ≥ 51 years (C), and proportion of people who have attended a university (D).

Perceived benefits of UGS

We have extracted the top 5 perceived benefits across the included studies which are presented in **Table 1**. Respondents perceived the benefits of UGS as an investment for health and disaster mitigation [8, 22]. A study found that respondents specifically perceived UGS could benefit the pregnancy outcome [8]. UGS was perceived as the regulator of heat and capable of reducing the impact of climate change [8, 15, 22]. UGS as a provider of clean air was found as one of major concerns [8, 16]. Aesthetic and recreational functions of UGS were also observed to be highly perceived by respondents [8, 15-17, 21]. Perception on UGS as a place for performing physical exercise was also high in several studies [16, 17]. Most of the respondents also perceived UGS as a venue for social activities [16, 17]. Ecological benefits of UGS such as providing a shelter and habitat for wild animals were perceived by most of the respondents [8, 15, 21, 22].

Discussion

Calculating the rate of willing to pay in a nationwide scale is important to address social problems and environmental injustice following the economic segregation. In the present study, we found that more than 70% mainland Chinese and Hong Kong population agreed to pay for the preservation or creation of UGS. When studies from Hong Kong were excluded the rate of willing to pay even significantly increased to 74%. Our findings suggest that creating and preserving UGS are crucial and pretty much in line with the interest of society. High rate of willing to pay can be associated with the urban compactness, where those living in compact cities are more likely to perceived UGS as the extension of their living place [23]. This stipulation particularly endorsed by a report from Hong Kong [16]. Hong Kong specifically has been experiencing high-density population, where the number was 6,540 persons per km^2 in 2010 and increased to 6,747 persons

per km² in 2022 [24]. Hong Kong was reported by two studies, where each reported a substantially different %WTP – 33% in 2022 [21] and 85% in 2010 [16]. In mainland China, the highest rate of willing to pay was found to be 91% reported in a study performed in cities in Hunan, Hubei, and Jiangxi Provinces whose population densities were only 313.7, 310.9, and 270.7 persons per km² in 2021 [25]. Evidence from this systematic review and meta-analysis, hence, does not support the effect of urban compactness in increasing the rate of willing to pay.

Socioeconomic characteristics are extensively examined variables that impact pro-environmental behaviors. However, based on the meta-regression herein, the rate of willing to pay was not associated with age, gender, or educational degree. These results of meta-regression herein can indicate that high rate of willing to pay are applicable across different population groups. Research conducted in different countries suggests that socioeconomic factors do not exert a significant impact on WTP, as evidenced in Italy [26] and Indonesia [27]. A review-based study also concludes that socioeconomic profiles may not significantly influence users' WTP for UGS services. Instead, it is strengthened by three spatial and non-spatial variables: (1) accessibility/proximity to the nearest UGS, (2) quantity/adequacy of UGS, and (3) quality of UGS within a township area [28]. Nonetheless, the results should be interpreted cautiously, especially with the limitation in meta-regression model that rely on the proportion data. A study in Beijing reported a rate of willing to pay of 56% [20], which was dramatically lower than the overall rate of willing to pay obtained from the pooled estimate (rate of willing to pay 70%). Moreover, removing the study from pooled analysis herein increased the rate of willing to pay up to over 74% (**Figure 3**). Lower rate of willing to pay among elderly population might be attributed to the incapability of senior citizens to pay, since most of them have retired [29]. Moreover, elderly population in China has been associated with lower level of awareness toward environmental issue [30]. Moreover, media used to promote environmental issues, including the benefits of UGS have been focused on younger populations while leaving the elderly population behind [31]. This is unfortunate because several scientific findings have suggested the benefits of UGS for healthy aging [32].

The present study found that Chinese population perceived the UGS as beneficial because of its functions in improving health, mitigating the impact of disaster (especially flood and storm), providing clean air, acting as aesthetic landscape, regulating surrounding residential temperature, providing a venue for social, recreational, and physical exercise activities [8, 15-17, 21, 22]. Most of these are benefits that affect the community directly. These perceptions are in line with scientific findings regarding the benefits of UGS which could improve the quality of urban life [33, 34]. Recent studies have even reported the correlation of green spaces with pregnancy outcomes [35, 36]. A study suggests that individuals living in urban settings shows more preference on benefits affecting them personally rather than affecting the community as a whole (altruistic benefits) [16]. In addition to the aforementioned perceived benefits, UGS was perceived as the habitat and protection place for animals and plants [8, 15, 21, 22]. A study categorized this as ethical values to acknowledge the right to exist for animal and tree, which ranked second among other perceived benefits [16].

This systematic review and meta-analysis have several limitations. Firstly, the study might suffer from selective bias. Though authors included studies reported in Chinese Language, the database used to search the literature was that of international scale. Some of relevant studies might be indexed only in local database and being undetected. Secondly, pooled estimates yielded high heterogeneity suggesting the non-homogenous population across study. A robust meta-analysis for pool estimates should be carried out to handle such data. Interpretation of the data should therefore be carried out with cautiousness. There is a necessity to build more robust independent variable in meta-regression since those used herein were based on the population proportion. Studies from the same region, but different years, reported different results suggesting the presence of temporal effects which were not analyzed in the present study. Moreover, the pooled estimates were not stratified according to the population characteristics or other parameters (income per capita or population density). We have concerning remarks on the included studies regarding the setting of inclusion and exclusion criteria along with the justification of the sample size. Therefore, more studies across China with better design have to be conducted to elucidate more concrete evidence on WTP.

Conclusion

A majority of over seventy percent Chinese population were willing to pay for UGS. The average monthly WTP across China with and without Hong Kong excluded were 3.36 and 2.97 USD, respectively. Significant effects of sample size, gender, age, and educational degree on the rate of willing to pay were not observed, suggesting the results are applicable across different populations in China. Nonetheless, due to the fact the included studies were only reported from several provinces or municipalities, further studies are still required. In order to optimize the public interest, the UGS can be designed to carry benefits in health improvement, reducing air pollution, regulating surrounding temperature, providing shelter and habitat for wild animal and plants, and accommodating recreational, social, and physical exercise activities. Our research contributes to enhancing the understanding of UGS development for urban planning decision-makers. We specifically recommend future studies to address contextual variables and regional disparities in the context of creating or preserving green spaces in urban settings.

Ethics approval

Not applicable.

Acknowledgments

None.

Competing interests

All authors declare that they have no conflicts of interest.

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Underlying data

All data underlying the results are available from the corresponding author upon reasonable request.

How to cite

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