

Perceived Environmental Qualities, Satisfaction and Mental Health in Outdoor Public Spaces of University Campus A Survey of University Students in China

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ABSTRACT: If there is the association between perceived environmental qualities of campus public spaces and overall satisfaction or mental health among current Chinese university students? To answer this question, an online survey with a structured questionnaire was recently implemented. The survey instrument included five components: perceived environmental qualities, place attachment, overall satisfaction, mental health, and background (socioeconomic & demographic). Two types of campus public space were studied, such as centre and normal public spaces. A multiple mediation analysis was first conducted on the surveyed data. Several findings were achieved as: 1) For both centre and normal public spaces, effects of environmental satisfaction on the overall satisfaction and students' mental health were positive. 2) The effect on the overall satisfaction was partially mediated by the place attachment, while the place attachment can fully mediate the effect on students' mental health. In addition, a paired t-test exposed that the mean scores on facilities in normal public spaces were significantly higher than those of centre public spaces. This study can provide guidance for the design of more psychologically sustainable university campus in China.

KEYWORDS: Environmental Qualities, Mental Health, Students' Satisfaction, Public Spaces, Chinese Universities

1. INTRODUCTION

The World Health Organization (WHO) defines the quality of life (QOL) as "individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" [1]. The QOL among young people is a complex combination of physical health, psychological state, and the relationship with environmental impact, and cultural and social backgrounds [1, 2]. Globally, there are rising rates of mental disorders among university students, such as attention fatigue, anxiety, stress, depression, bad sleep quality, etc [2, 3].

Over the past 10 years, it has been proved that there are significant effects of environmental features of the university campus on the satisfaction and mental health among students and staffs, including greenery, visual qualities, accessibilities, environmental pollution, facilities and maintenance, and safety [4-12]. The greenspace in university campus has been recognized as the most important environmental factor to provide students and/or staffs with a space to relax and conduct social activities [4, 5]. The association between the greenness of campus environment and students' quality of life was well identified by some studies among university students [4, 5, 6, 7]. A cross-region investigation

also exposed that there is significant impact of greenspace location on the restoration potential of university campus [6]. A study in Hong Kong [7] explored the application of healing gardens to a compact campus environment and produced suggestions for the improvement of both the existing campus natural space and possible new design in terms of providing a healthier environment for study and leisure. The campus healing garden could also be planned to enhance visual connections between urban and natural environment and facilitate natural ventilation and daylighting utilization [7]. In addition to the effect of greenery, a public space in a university campus with colourful visual arts and seats had a higher restoration effect on the students than the standard setting with basic facilities [8]. Several investigations pointed out facilities and maintenance, and perceived safety can take clear effects on satisfaction in a university campus [9, 10], whilst the level of environmental pollution (e.g., noise, litter) was closely related to dissatisfaction in an outdoor campus area [10]. Similar to a normal urban neighbourhood [11], the accessibility of campus public space has been commonly used as one of critical indicators to justify environmental qualities and students' satisfaction [12].

In addition, the place attachment has been identified as an important social factor affecting

satisfaction and mental health among university students [13, 14]. The homesickness can affect students during their studies at university or college, which will receive direct impact from the multiple place attachment [14].

In current China, university students can receive high pressure from their routine life and studies, especially when approaching the end of each semester [15]. However, current design theories and practices of such campuses do not have substantial strategies to address issues relating to students' mental health and wellbeing [12]. Thus, this article aims to conduct an online survey to examine the association of perceived environmental qualities in university campus public spaces, and satisfaction and mental health among current university students.

2. METHODS AND MATERIALS

2.1 Survey design and instrument

This online survey has been approved by the University of Liverpool Ethics Committee (no. 10368). It was conducted through a self-reported questionnaire (Fig. 1), with a total of 76 items. This questionnaire included five components, such as the background information of participants (university students), perceived environmental qualities in campus outdoor public spaces, place attachment at the university location, overall satisfaction for university campus, and students' mental health. The dependent variables were 'Overall Satisfaction' and 'Mental Health', while independent variables included 'Perceived Environmental Qualities', 'Place Attachment', and 'Background'.

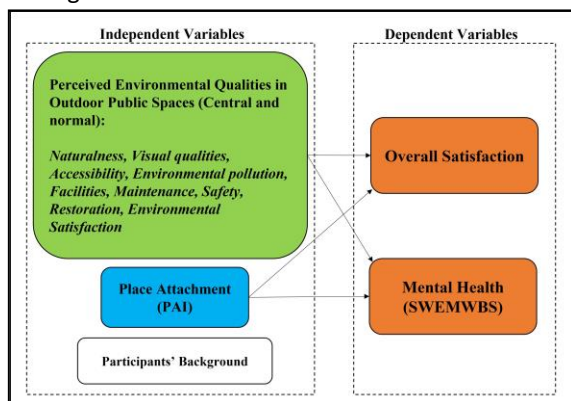


Figure 1: Research design: independent and dependent variables in the survey.

'Perceived Environmental Qualities', the largest part, has nine sub sections (domain), including Naturalness (4 Items) visual qualities (5 items), accessibility (4 items), environmental pollution (4 items), facilities (2 items), maintenance (2 items), safety (2 items), restoration (4 items: being away and fascination), and environmental satisfaction (1

item). As the most important instrument, it aimed to collect participants' perceptions on the environment in their campus public spaces. Two typical types of campus public spaces are investigated as: (1) Centre – located at campus centre, with the most important social and cultural status in this university (CPE); (2) Normal – others used for leisure activities (NPE). A 5-item instrument for 'Place Attachment' was developed from the Placement Attachment Inventory (PAI) [16], which was applied to test participants' affective or emotional response to the locations of their universities.

The component of 'Overall Satisfaction' includes three items, such as 'I like this campus; I prefer to walk around in this campus when I feel bored; I would invite friend to visit here'.

The 'Mental Health' was tested using a professional instrument of Short Warwick-Edinburgh Mental Well-being Scale (SWEMWBS) (<https://warwick.ac.uk/fac/sci/med/research/platform/wemwbs/about>), with seven items to express the status of human mental wellbeing.

The 'Background' has eight questions to gather socioeconomic & demographic information.

2.2 Participants

There were 97 participants who have attended the survey (until 24th January 2022). Three completed questionnaires have been discarded due to the missing information. All valid feedback (n=92; female: 62) was given by undergraduate and postgraduate students who are currently studying in a university (age: 21±3.81). They come from 11 programmes, three of which are engineering (55.43%), art (16.30%) and literature (15.22%). 96.74% of students live in campus accommodations.

2.3 Data analysis

Data description, correlation, mediating analyses, and multiple regression were used to test the association between environmental qualities, overall satisfaction, and mental health (significance level: 0.05) [17]. Statistical analyses were performed using IBM-SPSS (v27).

3. RESULTS

3.1 Correlation analyses

A Pearson correlation analysis was conducted to assess the relationship between the perceived environmental qualities, place attachment, overall satisfaction, and mental health.

In the centre public space, there were positive correlations between nine domains of perceived environmental qualities, and overall satisfaction or mental health:

1). For the overall satisfaction, naturalness ($r = 0.537, p < 0.01$); visual qualities ($r = 0.480, p < 0.01$); accessibility ($r = 0.473, p < 0.01$); environmental pollution ($r = 0.498, p < 0.01$); facilities ($r = 0.450, p < 0.01$); maintenance ($r = 0.384, p < 0.01$); safety ($r = 0.415, p < 0.01$); restoration ($r = 0.584, p < 0.01$); environmental satisfaction ($r = 0.603, p < 0.01$).

2). For the mental health, naturalness ($r = 0.200, p > 0.05$); visual qualities ($r = 0.218, p < 0.05$); accessibility ($r = 0.185, p > 0.05$); environmental pollution ($r = 0.268, p < 0.01$); facilities ($r = 0.234, p < 0.05$); maintenance ($r = 0.174, p > 0.05$); safety ($r = 0.199, p > 0.05$); restoration ($r = 0.245, p < 0.05$); environmental satisfaction ($r = 0.283, p < 0.01$).

In the normal public space, similarly, the positive correlations were found between nine domains of perceived environmental qualities and overall satisfaction or mental health:

1). For the overall satisfaction, restoration ($r = 0.437, p < 0.01$); accessibility ($r = 0.488, p < 0.01$); environmental pollution ($r = 0.507, p < 0.01$); visual qualities ($r = 0.614, p < 0.01$); facilities ($r = 0.516, p < 0.01$); maintenance ($r = 0.477, p < 0.01$); safety ($r = 0.328, p < 0.01$); naturalness ($r = 0.585, p < 0.01$); environmental satisfaction ($r = 0.656, p < 0.01$).

2). For the mental health, restoration ($r = 0.279, p < 0.01$); accessibility ($r = 0.328, p < 0.01$); environmental pollution ($r = 0.224, p < 0.05$); visual qualities ($r = 0.281, p < 0.01$); facilities ($r = 0.284, p < 0.01$); maintenance ($r = 0.334, p < 0.01$); safety ($r = 0.215, p < 0.05$); naturalness ($r = 0.232, p < 0.05$); environmental satisfaction ($r = 0.332, p < 0.01$).

In addition, there were positive correlations between place attachment and overall satisfaction or mental health as: overall satisfaction ($r = 0.627, p < 0.01$); mental health ($r = 0.412, p < 0.01$). Positive correlation was found between overall satisfaction and mental health, ($r = 0.393, p < 0.01$).

Overall, there were strong positive correlations between perceived environmental qualities, place attachment, overall satisfaction, and mental health.

3.2 Effect of perceived environmental qualities on the overall satisfaction

When analysing the surveyed data, the environmental satisfaction for the public spaces was assumed to be an individual predictor for the overall satisfaction, while other perceived environmental qualities (8 domains) and the place attachment were tested as the mediators. Respondent characteristics were controlled for in the mediating analysis.

Table 1 & 2 show the multiple regression analysis in centre and normal public spaces, respectively.

In Table 1, the model 1 indicates that the predicting role of environmental satisfaction for the

overall satisfaction in centre public spaces of university campuses was significant ($p < 0.01$). When the nine mediators were entered into the regression (model 2), the direct effect of environmental satisfaction on overall satisfaction decreased, but still presented as significant ($p < 0.01$), while the effect of place attachment was significant ($p < 0.01$). Thus, the indirect effect (95% bias-corrected Confidence Interval) was achieved (INDIRECT, 5000 boot-strapped samples). The analysis expressed that there was partial mediating effect of place attachment (0.0591 0.3663) on the overall satisfaction, with the environmental satisfaction as the predictor.

Table 1: Multiple regression with overall satisfaction as outcome variable (centre public space).

Predictors	Model 1		Model 2	
	B	SE	B	SE
constant	-2.00	1.13	-2.99**	1.08
Gender	-0.27	0.13	-0.17	0.13
Age	0.10**	0.04	0.09*	0.03
University status	0.31**	0.09	0.23*	0.09
Programme	0.09**	0.03	0.08**	0.03
Year of study	-0.16*	0.05	-0.11*	0.05
University location	0.13	0.09	0.14	0.09
Hometown	0.14	0.11	0.19	0.11
Environmental Satisfaction	0.64**	0.08	0.41**	0.11
Naturalness			0.02	0.13
Visual qualities			-0.16	0.14
Accessibility			-0.10	0.13
Environment pollution			0.22	0.15
Facilities			-0.12	0.09
Maintenance			-0.11	0.12
Safety			0.23	0.13
Restoration			0.26	0.14
Place Attachment			0.30**	0.09
R^2	0.53		0.66	

Significant: *, $p < 0.05$, **, $p < 0.01$

Table 2 displays that the predicting role of environmental satisfaction for the overall satisfaction in normal public spaces of university campuses was significant ($p < 0.01$) (see model 1). When the nine mediators were entered into the regression (model 2), the direct effect of environmental satisfaction on overall satisfaction tended to go down, but still presented as significant ($p < 0.01$). Meanwhile, the effect of place attachment was significant ($p < 0.01$). The indirect effect (95% bias-corrected Confidence Interval) was achieved (INDIRECT, 5000 boot-strapped samples). Thus, it can be found that there were partial mediating effects of place attachment (0.0178

0.3590) on the overall satisfaction, with the environmental satisfaction as the predictor.

Table 2: Multiple regression with overall satisfaction as outcome variable (normal public space).

Predictors	Model 1		Model 2	
	B	SE	B	SE
Constant	-1.79	1.08	-1.87	1.06
Gender	-0.20	0.13	-0.17	0.13
Age	0.13**	0.04	0.10*	0.04
University status	0.24**	0.09	0.20*	0.08
Programme	0.08**	0.03	0.06*	0.03
Year of study	-0.19**	0.05	-0.16**	0.05
University location	-0.01	0.08	0.01	0.08
Hometown	0.08	0.11	0.13	0.11
Environmental Satisfaction	0.64**	0.07	0.42**	0.11
Restoration			-0.11	0.10
Accessibility			0.07	0.12
Environment pollution			0.07	0.12
Visual qualities			0.18	0.17
Facilities			0.04	0.10
Maintenance			0.04	0.14
Safety			-0.12	0.14
Naturalness			-0.08	0.15
Place			0.29**	0.09
Attachment				
R^2	0.56		0.66	

Significant: *. $p \leq 0.05$, **. $p \leq 0.01$

Furthermore, it is worth noting the role some participants' characteristics played for the overall satisfaction. According to the regression analysis, independent, significant, and predictive effects of age ($B=0.10$, $p < 0.01$), university status ($B=0.31$, $p < 0.01$), programme ($B=0.09$, $p < 0.01$), and year of study ($B=-0.16$, $p < 0.05$) for overall satisfaction were found in centre public spaces. The same results were achieved in normal public spaces as age ($B=0.13$, $p < 0.01$), university status ($B=0.24$, $p < 0.01$), programme ($B=0.08$, $p < 0.01$), and year of study ($B=-0.19$, $p < 0.01$).

3.3 Effect of perceived environmental qualities on the mental health

During the analysis of the surveyed data, the environmental satisfaction for the public spaces was assumed to be an individual predictor for the mental health, while other perceived environmental qualities and place attachment were tested as the mediators. Respondent characteristics were controlled for in the mediating analysis.

In Table 3 & 4, the multiple regression with mental health as outcome variable was conducted to test if the environmental qualities can predict the mental health in centre public spaces and normal public spaces, respectively.

Table 3: Multiple regression with mental health as outcome variable (centre public space).

Predictors	Model 1		Model 2	
	B	SE	B	SE
Constant	1.99	1.08	1.51	1.11
Gender	-0.10	0.12	-0.04	0.13
Age	0.06	0.04	0.05	0.04
University status	0.17	0.09	0.13	0.09
Programme	0.00	0.03	-0.01	0.03
Year of study	-0.06	0.05	-0.02	0.05
University location	-0.01	0.09	-0.00	0.09
Hometown	-0.11	0.11	-0.06	0.12
Environmental Satisfaction	0.20*	0.08	0.06	0.11
Naturalness			-0.18	0.13
Visual qualities			0.07	0.15
Accessibility			-0.11	0.14
Environment pollution			0.31*	0.15
Facilities			0.04	0.09
Maintenance			-0.18	0.12
Safety			0.10	0.13
Restoration			-0.00	0.14
Place Attachment			0.25**	0.09
R^2	0.17		0.30	

Significant: *. $p \leq 0.05$, **. $p \leq 0.01$

In Table 3 (centre public space), Model 1 supports that the predicting role of environmental satisfaction for mental health was significant ($p < 0.01$). When the nine mediators were entered into the regression as mentioned in Model 2, the direct effect of environmental satisfaction on the mental health was proved as insignificant ($p > 0.05$), while the effects of environmental pollution and place attachment were tested as significant ($p < 0.01$). The indirect effect (95% bias-corrected Confidence Interval) was achieved (INDIRECT, 5000 bootstrapped samples). Thus, a full mediating effect was found for the place attachment (0.0386 0.3334), with the environmental satisfaction as the predictor.

Similar regression analysis was presented in Table 4 (normal public space). For Model1, insignificant effect of environmental satisfaction was found on the mental health ($p < 0.01$). When the nine mediators were entered into the regression (Model 2), the direct effect of environmental satisfaction on the mental health was insignificant ($p > 0.05$), while effects of maintenance and place attachment were significant ($p < 0.01$). The indirect effect (95% bias-corrected Confidence Interval) was achieved (INDIRECT, 5000 bootstrapped samples). It can be found that the place attachment can fully mediate the effect of environmental satisfaction on the mental health, with the bias-corrected Confidence Interval of (0.0034 0.2866).

Table 4: Multiple regression with mental health as outcome variable (normal public space).

Predictors	Model 1		Model 2	
	B	SE	B	SE
Constant	1.73	1.03	1.91	1.06
Gender	-0.07	0.12	-0.00	0.13
Age	0.07	0.04	0.03	0.04
University status	0.15	0.08	0.12	0.08
Programme	0.00	0.03	-0.02	0.03
Year of study	-0.07	0.05	-0.03	0.05
University location	-0.04	0.08	-0.06	0.08
Hometown	-0.12	0.10	-0.07	0.11
Environmental Satisfaction	0.24**	0.07	0.18	0.11
Restoration			0.04	0.10
Accessibility			0.07	0.12
Environment pollution			-0.04	0.12
Visual qualities			0.03	0.17
Facilities			-0.03	0.10
Maintenance			0.28*	0.14
Safety			-0.14	0.14
Naturalness			-0.24	0.15
Place Attachment			0.20*	0.09
R^2	0.22		0.33	

Significant: *. $p \leq 0.05$, **. $p \leq 0.01$

3.4 Comparisons of effects of environmental satisfaction in centre & normal public spaces

Table 5 & 6 presents the multiple regression analysis of the predicting effects from CPE-environmental satisfaction, NPE-environmental satisfaction, place attachment and other participants' characteristics for the overall satisfaction and the mental health, respectively.

Table 5: Multiple regression with overall satisfaction as outcome variable (two types of public spaces).

Predictors	B	SE	95% CI	
			Lower	Upper
Constant	-2.48*	1.01	-4.48	-0.47
CPE-Environmental Satisfaction	0.19	0.12	-0.05	0.42
NPE-Environmental Satisfaction	0.32**	0.11	0.10	0.54
Place attachment	0.29**	0.08	0.13	0.46
Gender	-0.19	0.12	-0.42	0.04
Age	0.10**	0.04	0.03	0.17
University status	0.26**	0.08	0.10	0.41
Programme	0.08**	0.03	0.02	0.13
Year of study	-0.15**	0.05	-0.24	-0.06
University location	0.08	0.08	-0.09	0.24
Accommodation	0.17	0.21	-0.24	0.57
Hometown	0.18	0.10	-0.02	0.38
R^2	0.60			

Significant: *. $p \leq 0.05$, **. $p < 0.01$

Table 5 explained a statically significant amount of variance in overall satisfaction, $F(11,80) = 13.37$,

$R^2=0.60$. NPE-environmental satisfaction and place attachment were significant predictors of the overall satisfaction, ($B=0.32$, $p=0.01$ and $B=0.29$, $p=0.00$). The same results were achieved at age ($B=0.10$, $p=0.01$), university status ($B=0.26$, $p=0.00$), programme ($B=0.08$, $p=0.01$), and year of study ($B=-0.15$, $p=0.00$). However, the predicting role of CPE-environmental satisfaction was found as insignificant for the overall satisfaction, $B=0.19$, $p=0.12$, 95%CI [-0.05,0.42].

Table 6: Multiple regression with mental health as outcome variable (two types of public spaces).

Predictors	B	SE	95% CI	
			Lower	Upper
Constant	1.66	1.03	-0.39	3.71
CPE-Environmental Satisfaction	-0.09	0.12	-0.33	0.15
NPE-Environmental Satisfaction	0.17	0.11	-0.05	0.40
Place attachment	0.22*	0.09	0.05	0.39
Gender	-0.05	0.12	-0.28	0.19
Age	0.05	0.04	-0.03	0.12
University status	0.13	0.08	-0.04	0.29
Programme	-0.01	0.03	-0.07	0.04
Year of study	-0.05	0.05	-0.14	0.05
University location	-0.04	0.08	-0.21	0.12
Accommodation	0.24	0.21	-0.18	0.66
Hometown	-0.06	0.10	-0.27	0.15
R^2	0.18			

Significant: *. $p \leq 0.05$, **. $p < 0.01$

In Table 6, similarly, a multiple regression indicated that this model explained 18.3% of the variance and that there was a significant effect on the mental health, $F(11,80) = 2.85$, $p=0.00$. The place attachment was identified as an effective predictor of the mental health ($B=0.22$, $p=0.01$), while the effects of environmental satisfaction (CPE and NPE) were insignificant ($p=0.45$ and $p=0.13$).

Table 7: Comparison of perceived environmental qualities between two public spaces (paired t-test, sig. $p \leq 0.05$).

Items	Mean difference (CPE-NPE)	SE	t	p
Environmental satisfaction	-0.03	0.06	-0.52	0.60
Naturalness	0.02	0.08	0.21	0.83
Visual qualities	0.05	0.09	0.55	0.58
Accessibility	0.01	0.09	0.16	0.88
Environmental pollution	-0.05	0.07	-0.75	0.46
Facilities	-0.16	0.07	-2.09	0.04
Maintenance	0.04	0.06	0.67	0.51
Safety	-0.09	0.06	-1.39	0.17

A paired-samples t-test (Table 7) was conducted to compare nine domains of environmental quality

in centre and normal public spaces. There was significant difference only found between the scores for facilities [mean difference (CPE-NPE) = -0.16, $t(92) = -2.09$, $p = 0.04$]. Specifically, this could expose that the facility qualities in centre public spaces were lower than those in normal public spaces. There were no significant differences noticed at other environmental features.

4. CONCLUSION

Based on an online survey among current Chinese university students, this article examined the association between the perceived environmental qualities and overall satisfaction or mental health in university campuses, and a possible mediating role of the place attachment.

First, the effect of environmental satisfaction of centre and normal public spaces on students' overall satisfaction has been proved as significantly positive. This effect can be partially mediated by the place attachment, which may be linked to students' affective or emotional response to their university locations. However, other environmental features have no effect on the overall satisfaction.

Second, students' mental health in universities can receive positive effect from the environmental satisfaction of centre and normal public spaces, which can be fully mediated by the place attachment. Except for the environmental pollution and maintenance, other environmental features have no effects on students' mental health.

Third, some confounding variables, such as age, university status, programme, and year of study, can also have a positive effect on the overall satisfaction, but not students' mental health.

Finally, except for the feedback on facilities, there were no significant differences of other environmental qualities (eight domains) between centre and normal public spaces.

As a pilot study, this research has some limitations. Due to the delay of ethics process, the number of participants has not achieved a level as expected (e.g. 200 samples). In addition, it seems that the survey period could be considered as effective factor. These aspects will be further studied in the future work.

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