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The Restorative and Contingent Value of Biophilic Indoor Environments in Healthcare Settings

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Abstract: During the COVID-19 pandemic, individuals undergoing healthcare-related quarantine often experience heightened anxiety and stress. While biophilic indoor environments have shown potential in reducing stress, their effectiveness within healthcare quarantine settings remains uncertain. Additionally, the economic value associated with implementing biophilic interventions in healthcare environments remains largely unknown. This study aimed to explore the effects of biophilic interventions in indoor quarantine environments on the perceived outcomes of individuals (such as preference, perceived restorativeness, and satisfaction) and their willingness-to-pay (WTP). Participants were asked to imagine themselves in quarantine and were subsequently assigned to one of four indoor rooms, each featuring a different level of biophilic intervention (non-biophilic, low, medium, and high indoor green). Their perceived outcomes and WTP were then evaluated. The findings consistently demonstrated that incorporating biophilic interventions had a significantly positive impact on perceived outcomes and WTP compared with non-biophilic interventions within healthcare quarantine settings. Among the three levels of biophilic intervention, high indoor green spaces had the highest influence, while low indoor green spaces had the lowest. Moreover, perceived restorativeness consistently played a role in influencing WTP across all three biophilic indoor rooms. Further analysis indicated that a medium level of biophilic intervention would be more advantageous and practical in the design of healthcare indoor environments. This study offers valuable insights into both the monetary and nonmonetary values of biophilic interventions in healthcare settings, aiding designers in selecting appropriate biophilic designs to create enhanced restorative indoor environments.

Keywords: biophilia; psychological restoration; indoor plants; healthcare settings; willingness-to-pay

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1. Introduction

The novel coronavirus disease (COVID-19) broke out at the end of 2019 and has spread to more than 200 countries in the world, resulting to a global public health crisis. Additionally, over 92 million people worldwide had been diagnosed with COVID-19, and around 1,980,000 infected individuals had died from the disease as at 14 January 2021 [1]. In China, the government has taken several control measures since the outbreak of COVID-19, including the ban of mass gatherings, imposing lockdowns on cities, mandatory isolation, and compulsory home reclusion and social distancing. These approaches have been proven to be effective ways of slowing down the spread of COVID-19 and ideally controlling the pandemic. However, these measures and the spread of the disease have also resulted in the occurrence of psychological health problems. Notably, anxiety, depression (16–28%), and stress (8%) were reported to be the most common symptoms during the pandemic [2]. During the pandemic, individuals who had been in close contact with infected patients or a potentially high-risk environment were required to stay in quarantine for two weeks, at home or at assembly sites across China. In addition, individuals suspected of being infected were required to isolate in healthcare settings. Nonetheless, quarantine can lead to negative psychological effects, including post-traumatic stress symptoms, confusion, and anger [3]. For instance, an online study conducted in Ireland during mass public quarantine (27 March 2020 to 8 June 2020) revealed that there was an increase in the mean levels of participants' depression, anxiety, and stress, with the levels of depression having the highest increase [4]. Notably, previous studies have proposed several interventions to reduce the potential negative impacts of quarantine. These include reducing the quarantine period as much as possible, giving people as much information as possible, and providing adequate supplies, as well as reducing boredom and improving communication [3]. However, little information exists on the influence of living environments on the mental health of individuals kept in quarantine in healthcare settings. Thus, a better understanding of interventions in healthcare settings that alleviate the anxiety and stress resulting from the quarantine is needed in such uncertain circumstances.

Exposure to natural outdoor environments has become a frequently used approach by people in urban areas to relax and reduce stress [5]. In addition, studies have shown that interacting with nature improves health and well-being by restoring attention, reducing stress, and enhancing social cohesion [6–8]. Moreover, a previous study revealed that having a household with a green area was helpful during the quarantine period [9]. However, rapid urbanization across the world has made accessibility to green spaces quite difficult [10]. Worse still, the people who were kept in quarantine for 14 days at healthcare settings spent most of their time indoors, resulting in more separation from natural environments. According to previous research, living environments devoid of nature may act as a "discord", i.e., have a negative effect on health [11], and living in environments with minimal or without plants may result in irritation, hostility, or other negative behaviors [12]. These negative behaviors may particularly be experienced following quarantine due to the COVID-19 pandemic [3] and may further result in increased levels of negative emotions, including fear, disappointment, uncertainty, and stress [13].

Existing research suggests that including nature in indoor environments also confers several benefits, including reducing stress, increasing cognition and emotion, and improving health and well-being [11,14]. Studies on the interior spaces of hospitals also showed that the inclusion of natural sounds and green plants helped reduce mental stress and increase tolerance to pain [15,16]. In addition, Kim et al. [17] found that the inclusion of plants or artificial windows in underground environments could help increase positive perceptions. Employees were also shown to prefer natural construction material in patient rooms [18]. Integrating nature into built environments refers to the concept of biophilic design, which has been considered as a new approach to incorporate the positive experience of nature into indoor environments [19]. Biophilic design stems from the concept of biophilia, which literally means "love of life and living systems" and holds that humans have an innate inclination to nature [20–22]. The deep affinity of humans to nature is rooted in our genetic heritage and is a product of biological evolution [23]. Biophilic design in working and living environments could provide more chances of exposure to natural elements while indoors [24], thus increasing performance at work [25] or the health and well-being of inhabitants [26]. Thus, it is likely that indoor environments with biophilic intervention could help individuals reduce stress and anxiety during quarantine.

There are different attributes of biophilic design, e.g., green plants, long distance, natural view, biomorphic shapes, natural analogues, and 14 patterns, prioritizing the most prominent nature–health relationships in the built environment [14,19,27]. Research has found that plant placement in space [28], geometries [29,30], and natural light, as well as material and patterns [14], have significant influence on the user's satisfaction and health recovery. Out of these, plants are affordable, easily accessible, and more relevant to indoor environments, and they require only small areas of indoor space, such as shelves and desks. In addition, plants have been identified as key biophilic elements that can be incorporated into indoor environments and are regarded as the most obvious and powerful additions for creating a positive indoor environment [17,31]. Therefore, indoor plants are usually the focus of most studies on biophilic design. Moreover, it was reported that the most noticeable effect of indoor plants on people was their ability to increase positive emotions and reduce stress [32]. For example, the presence of indoor plants was shown to be associated with a reduction in pain, fear, unhappiness, and aggressiveness [33]. Additionally, being in indoor environments with plants was reported to lower levels of stress compared with indoor environments without plants [34,35]. Moreover, having plants at home was reported to be associated with positive emotions while in confinement during the COVID-19 pandemic [36]. Individuals were also reported to prefer working in an office with indoor plants, as they could not only enhance health and well-being but also give higher satisfaction [37,38]. The presence of greenery indoors, which includes the number of houseplants in the home and the proportion of exterior greenery visible from inside, has been shown to significantly enhance the restorative quality of the home environment during the COVID-19 quarantine [39]. Overall, existing evidence highlights the psychological benefits of biophilic design with indoor plants, although little is known about the number of indoor plants that are needed to give these health and well-being outcomes. Furthermore, it is largely unclear how different levels of biophilic design with indoor plants contribute to preference, perceived restorativeness, and satisfaction while in quarantine. In addition, it is not known whether indoor plants have an impact on individuals' willingness-to-pay (WTP) for indoor environments during quarantine in healthcare settings. Research on exploring the effect of a varying quantity of indoor plants on individuals' stress reduction, satisfaction, and WTP is important for both research purposes and government control measurement practice.

Previous studies used a Contingent Valuation Method (CVM) to assess the monetary value of green spaces based on people's willingness-to-pay for use or conservation of urban green spaces [40–42]. Notably, the CVM is commonly used in cost–benefit analysis and environmental impact assessment because it is relatively simple to implement and applies to a wide range of value categories [43]. For instance, Latinopoulos et al. [44] used the CVM to estimate the WTP by local residents for the provision of a new park in the city of Thessaloniki, Greece. Additionally, Majumdar et al. [42] used the CVM to examine tourists' WTP for urban forests in Savannah, Georgia, USA. Moreover, Chen and Qi [40] assessed the recreational use and amenities of the Fuzhou National Forest Park, Fuzhou, China and estimated the monetary value of the Fuzhou National Forest Park to the visitors. The above studies similarly found that a majority of participants were willing to pay for the provision, use, or improvement of urban green spaces. However, all these studies solely focused on estimating the value of outdoor green spaces. Therefore, the economic value of indoor nature remains largely unclear. Furthermore, few studies have been conducted on the economic value of biophilic indoor environments using the CVM.

The CVM uses a questionnaire to obtain people's preference, expressed in monetary terms. In this method, an institutional context is established based on a hypothetical change in the quantity or quality of environmental assets or services. Participants are then asked to give responses on the maximum amount of money they are willing to pay for the hypothetical scenario change (WTP) or the minimum amount of money they are willing to accept to compensate for the change (WTA) [41]. Although the CVM approach is widely used to assess the monetary value of green spaces, Spangenberg and Settele [45] criticized this method, since it does not account for the multifaceted concept of value. Additionally, studies assessing the monetary value of green spaces using CVM often focus on the attached value, without paying enough attention to the underlying value [46]. Moreover, recent research suggested that the CVM, as a monetary valuation approach, should be used along with nonmonetary strategies (e.g., the measurement of individual cognitive attachment to nature) to estimate the value of urban green spaces under various institutional contexts [46,47]. Therefore, the present study combined CVM and nonmonetary approaches to examine this subject.

This study aimed to assess the impact of biophilic indoor intervention in healthcare settings on people's perceived outcomes and their WTP. The results from this study, therefore, provide insights on creating a positive indoor environment for people quarantined in healthcare settings. The study answered the following questions: (1) Do various levels of biophilic indoor environments have different impacts on preference, perceived restorativeness, satisfaction, and WTP? (2) Which level of biophilic intervention is better in improving people's preference, perceived restorativeness, satisfaction, and WTP? (3) Do preference, perceived restorativeness, and satisfaction have an impact on WTP?

2. Materials and Methods

2.1. Study Design

The study used a randomized crossover design to investigate differences among participants' ratings of preference, perceived restorativeness, satisfaction, and WTP for rooms with different levels of biophilic indoor designs. This approach could control the potential time-invariant confounding factors and increase statistical power. In addition, participants acted as their own controls, and their ratings were measured repeatedly. All respondents gave their ratings on rooms with varying levels of biophilic indoor interventions, with the order randomized.

2.2. Stimuli

The purpose of this study was to assess the effects of a biophilic indoor design in a healthcare setting. Therefore, a panoramic picture of an actual room, which represented a healthcare room used for quarantine during the pandemic, was selected and used as the base to create the three-dimensional indoor room model. In addition, the three-dimensional indoor room environment was further modified with biophilic elements to create three other versions of indoor rooms (low indoor green, medium indoor green, and high indoor green) with varying levels of the biophilic design intervention. These modifications were based on real indoor environments from an architectural design firm and photos on the Internet. Notably, the low indoor green room focused on adding pot plants on the desk. On the other hand, the medium indoor green room was based on the low indoor green room, although more potted plants were added on the ground. Finally, the living wall was incorporated into the medium indoor green room to make the high indoor green room. Photos of the four indoor rooms (Figure 1) were also presented in the questionnaires to give the respondents an easier time. Furthermore, a link for each indoor room was provided, where a three-dimensional model was present, allowing for a more comprehensive view of the indoor environments in all directions.

2.3. Measure

The questionnaires were divided into three parts, including ratings of perceived outcomes, WTP for the biophilic indoor room, and demographic information. They were developed based on existing guidelines on CVM [43,48] and the valuation of green spaces through monetary and nonmonetary approaches [46]. After receiving explanations on the purpose of the present study, participants were asked to imagine that they were under quarantine for 14 days to complete medical observation due to disease prevention policies. Thereafter, a picture and a link of the biophilic indoor environments were presented to the participants. Additionally, the participants were informed that they would be kept in quarantine in the present room for 14 days, and they could access all the directions of the indoor room via the link. This approach was borrowed from a study by Andrade and Devlin [49], who asked participants to imagine a hospitalization scenario, after which they gave their responses regarding their perception of stress. The approach was also similar to that used in previous studies on restorativeness, where respondents were asked to imagine themselves in a fatigued mind before viewing nature, after which they provided their restorative perceptions [50,51]. Moreover, this approach has been validated to accurately simulate real environments [52,53].

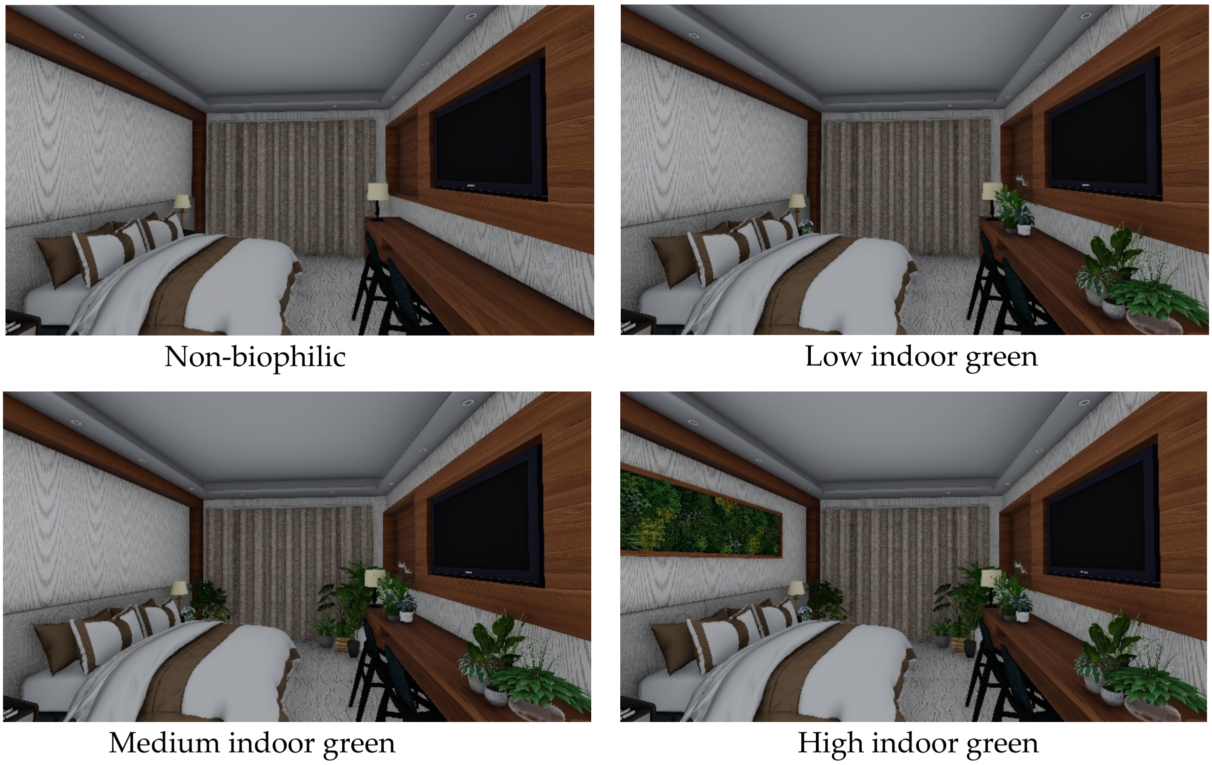

Figure 1. The four indoor rooms layouts.

To alleviate fatigue in respondents and increase their willingness to participate in this study, the three outcomes, i.e., preference, perceived restorativeness, and satisfaction, were measured using only one item, respectively. The single-item measure of preference, perceived restorativeness, and satisfaction has previously been used by studies on restorative benefits and satisfaction from green spaces [50,54,55]. In addition, the three variables were measured using the following questions: "How much do you agree that you like the present indoor room environment?", "Overall, how much do you agree that the present indoor room environment would help to facilitate your psychological restoration during the quarantine?", and "How much do you agree that you are satisfied with the present indoor room environment?". The participants gave their responses for these items on a 7-point Likert scale anchored at "1 = Not at all" and "7 = Very much so". The three variables were also treated as nonmonetary approaches to estimate the value of indoor green environments and used to assess their association with WTP.

The second part involved assessing the respondents' WTP by taking them through the three biophilic indoor rooms, and the CVM was applied in the process. It is noteworthy that CVM has been criticized due to methodological flaws and the potential pitfalls involve hypothetical bias, elicitation and starting point biases, and sequencing and information effects, as well as failure of the scope test. However, these biases can be overcome through careful study design and implementation [56]. To address these potential biases, several measures were implemented in the present study, including presenting the four scenarios with pictures and using a three-dimensional model to improve the intelligibility. We also used a randomized order and payment cards, which respondents were familiar with, as they already existed. Moreover, pictures of both non-biophilic and the proposed biophilic indoor rooms were included in the questionnaires, with a brief description of the comparison between these two indoor room environments (e.g., "Compared to the indoor room with a non-biophilic design, the low indoor green room includes potted plants on the tables."). Following this, respondents were asked whether they were willing to pay the extra fee for the specific biophilic indoor room compared with the one with a non-biophilic design. If the response was positive, a payment card with different listed amounts (0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 RMB; USD = CNY 6.43) was shown, and participants were asked to circle the highest amount they would be willing to pay. On the other hand, participants who were unwilling to pay were asked to give their reasons for the same. Finally, the third part focused on participants' demographic information, which included gender, age group, level of education, monthly income, and area of residence.

2.4. Survey Procedure and Participants

The survey was conducted online through Wechat v7.0.20, QQ v9.2.3, email, and Sina Weibo v10.0.0 from May to November 2020. Notably, the online survey was cheaper and could easily be accessed by participants, particularly during the pandemic. Online surveys were also used in previous studies [54,57], and their validity was proven by Roth [58]. In addition, the study applied a snowball sampling method to recruit participants, and the survey was initiated by twenty graduates from different parts of China. Moreover, over six hundred Chinese adults from different parts of China with a wide demographic range filled out the questionnaire. The participants were first required to read the explanation and instructions, after which they watched an indoor room scenario and then responded to the questions. The four scenarios were presented randomly. Finally, participants were asked to give their demographic information. It took about eight minutes to complete a questionnaire.

A total of 632 responses were obtained. After excluding invalid responses (e.g., omission of some questions or providing the same response for most of the questions), 498 responses were left, including 244 responses from males and 254 from females. The majority of the participants were between 18 to 29 years of age (38.76%), and the second largest number of participants were between 30–39 years old (36.95%). Additionally, most of the participants had a bachelor's degree (78.71%), with a smaller representation of other education backgrounds. With regards to occupation, 29.32% were company staff, while 7.4% were official or university employees. Moreover, around sixty percent of the participants' monthly income was less than CNY 5000, and 17.6% had a monthly income of more than CNY 10,000.

2.5. Data Processing

This study used ANOVA to examine the effects of the indoor environmental conditions (non-biophilic, low indoor green, medium indoor green, and high indoor green) on the outcomes (preference, perceived restorativeness, and satisfaction). If significant differences were obtained, post hoc comparisons were made using Tukey's Honestly Significant Difference (HSD) to ascertain where the differences occurred. Additionally, the nonparametric Kruskal–Wallis test was employed to examine whether respondents varied in their WTP for the three biophilic indoor room environments. Before conducting this analysis, protest zeros were detected and excluded from further analysis, since their zero WTP responses did not reveal their real WTP. Notably, protest zero respondents were those who had a positive WTP higher than zero but refused to pay due to either the CVM scenario or disagreeing with the payment vehicle [59]. In the present study, the following reasons as to why participants were unable to pay were identified as protest zeros: "I cannot afford extra room fees", "The indoor plants should be supplied freely", "The healthcare indoor room should be decorated with indoor plants", "Too much indoor greens make me feel uneasy", and "It is not worth paying for a few potted plants". On the other hand, true zero responses included such answers as "I do not like indoor plants" and "I do not care about the indoor green environments" and were separated from the protest zero responses. Finally, an interval regression analysis was performed to investigate the effect of demographic variables and the measured outcome variables on WTP. The method used the interval between the highest amount the participants were willing to pay and the next largest amount, supposing that respondents' real WTP lay somewhere between the two amounts. All the analyses were conducted using SPSS 24 and Stata 16.

3. Results

3.1. Comparison of Preference, Perceived Restorativeness, and Satisfaction among Different Biophilic Design Interventions

Descriptive statistics of the ratings of preference, perceived restorativeness, and satisfaction from each room are presented in Table 1. Rooms with the most indoor greens had the highest ratings of preference, restorativeness, and satisfaction. In addition, the original room without any biophilic design intervention obtained the lowest ratings of preference, restorativeness, and satisfaction. Bivariate correlation analysis also showed that the average ratings were positively correlated with the intensity of biophilic intervention (preference: r = 0.312, $p < 0.001$; restorativeness: r = 0.303, $p < 0.001$; satisfaction: r = 0.325, $p < 0.001$, r indicated Spearman's rho). Additionally, the results from ANOVA revealed that the average ratings of preference, restorativeness, and satisfaction were significantly different across the four images (Table 1). Furthermore, the results from post hoc comparisons revealed significant differences between any two biophilic interventions, except for between the high indoor green and medium indoor green rooms (Table 2).

Table 1. Descriptive results of the ratings of preference, perceived restorativeness, and satisfaction from each indoor room.

	Preference			Perceived Restorativeness			Satisfaction		
	Mean	**SD**	**95% CI**	**Mean**	**SD**	**95% CI**	**Mean**	**SD**	**95% CI**
Original	4.02	1.14	3.92 to 4.12	3.99	1.34	3.88 to 4.11	4.00	1.13	3.90 to 4.10
Low indoor green	4.53	1.02	4.44 to 4.62	4.61	1.15	4.51 to 4.71	4.42	1.06	4.33 to 4.52
Medium indoor green	4.83	1.12	4.73 to 4.93	4.86	1.20	4.76 to 4.97	4.85	1.10	4.75 to 4.95
High indoor green	4.98	1.31	4.87 to 5.10	5.05	1.27	4.94 to 5.17	4.98	1.30	4.86 to 5.09
	$F (3,1988) = 68.281, p < 0.001$			$F (3,1988) = 68.513, p < 0.001$			$F (3,1988) = 74.299, p < 0.001$		

Table 2. Post hoc comparisons of preference, perceived restorativeness and preference between any two rooms.

I	J	Preference		Perceived Restorativeness		Satisfaction	
		MD	**95% CI**	**MD**	**95% CI**	**MD**	**95% CI**
High indoor green	Non-biophilic	0.97 ***	0.78 to 1.15	1.06 ***	0.86 to 1.26	0.98 ***	0.79 to 1.17
	Low indoor green	0.45 ***	0.26 to 0.64	0.44 ***	0.24 to 0.65	0.55 ***	0.37 to 0.74
	Medium indoor green	0.15	−0.04 to 0.34	0.19	−0.01 to 0.39	0.13	−0.06 to 0.32
Medium indoor green	Non-biophilic	0.82 ***	0.63 to 1.00	0.87 ***	0.67 to 1.07	0.85 ***	0.66 to 1.04
	Low indoor green	0.30 ***	0.12 to 0.49	0.25 **	0.05 to 0.46	0.43 ***	0.24 to 0.61
Low indoor green	Non-biophilic	0.51 ***	0.33 to 0.70	0.62 ***	0.41 to 0.82	0.43 ***	0.24 to 0.61

Note: I and J were participants' mean ratings for a picture with a particular intensity of biophilic design. MD: Mean difference (I-J), CI: Confidence interval, **: $p \leq 0.01$, ***: $p \leq 0.001$.

3.2. Marginal Effects of Biophilic Design Intensity on Preference, Restorativeness, and Satisfaction

The marginal effects of the three biophilic interventions were calculated to ascertain which biophilic design had more power to improve the measured outcomes. The results in Figure 2 show that the marginal effects on preference and restorativeness decreased with an increase in the level of biophilic intervention. Additionally, the marginal effects on satisfaction of the medium indoor green (0.43) design were equal to those of low indoor green (0.43) but higher than those of high indoor green (0.13). These results therefore suggest that the low indoor green design had much more power to improve participants' ratings of preference, restorativeness, and satisfaction, while the high indoor green had the least power.

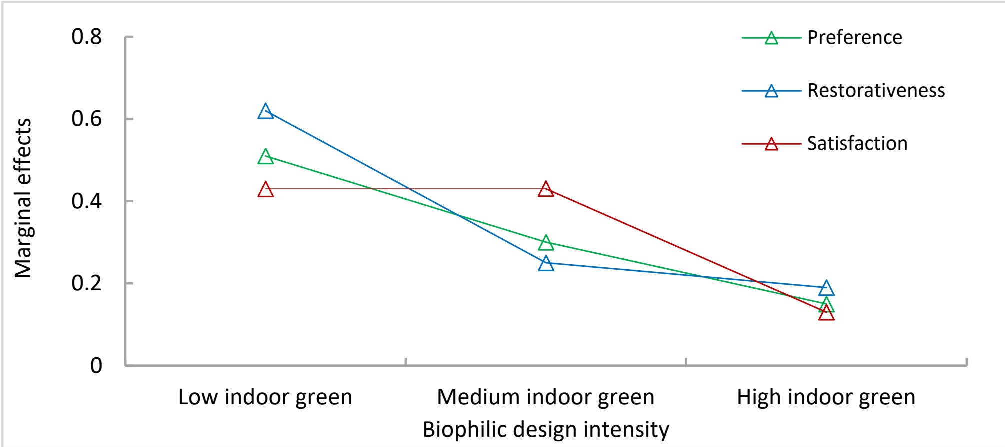

Figure 2. The average marginal effects of three biophilic design interventions on measured outcomes.

3.3. Comparison of WTP for Different Design Intensities

Table 3 shows the distribution of respondents with positive and zero WTP for the three rooms with different levels of biophilic designs. Over 85% of respondents were willing to pay for all three rooms with different levels of biophilic interventions, with small differences between the rooms. Among those with zero WTP for the three rooms, only a few (less than 10%) were protest zeros. In addition, the medium indoor green room had the least number of total zeros and protest zeros, while the high indoor green room had the most. With regards to the reason for protesting, respondents protesting the low indoor green mostly reported that there was no need to spend more for only a few potted plants. On the other hand, respondents protesting the medium indoor green room stated that too much indoor greenery made them feel uncomfortable. Finally, all the respondents that protested the high indoor green room similarly said that too much indoor greenery, especially on the wall, made them feel frightened and uncomfortable. Moreover, all the protest responses were recorded, and the real mean WTP for the three rooms with biophilic designs was calculated. As a result, the real mean WTP for the low indoor green, medium indoor green, and high indoor green rooms was CNY 25.68, CNY 32.14, and CNY 36.21, respectively.

Table 3. Number and percentage of respondents with positive and zero WTP along with the numbers of protest and real zeroes for the three rooms. N = 498 for each room.

	Low Indoor Green (%)	**Medium Indoor Green (%)**	**High Indoor Green (%)**
Number of respondents with WTP > 0 (percentage of the total sample)	425 (85.34)	446 (89.56)	438 (87.95)
Number of the total zeros (percentage of the total sample)	73 (14.66)	52 (10.44)	60 (12.05)
Number of protest zeros (percentage of the total zeroes)	14 (19.18)	12 (23.08)	18 (30)
Number of real zeroes (percentage of the total zeroes)	59 (80.82)	40 (76.92)	42 (70)

Results from the Kruskal–Wallis test (Table 4) further revealed that the mean WTP of all the participants was significantly different ($\chi2(2) = 38.35$, $p < 0.001$). Moreover, post hoc comparisons indicated that the participants' WTP for the medium indoor green and high indoor green rooms was significantly higher than that of the low indoor green room. Although the participants' WTP for the high indoor green room was higher than that of the medium indoor green room, the difference was significant.

Table 4. The Kruskal-Wallis Test results for WTP.

Respondents	N	Chi-Square	df	Mean Rank			*p*	Real Mean Values		
				Low	Medium	High		Low	Medium	High
Total	1450	38.347	2	634.96	746.19	795.85	<0.001	25.68	32.14	36.21

3.4. Factors Affecting the Willingness-to-Pay for Biophilic Indoor Design

Table 5 shows the interval regression results for the three rooms with different levels of biophilic interventions. The results reveal a significant correlation between satisfaction and WTP for the high indoor green room and between restorativeness and WTP for all three rooms. This suggested that if the respondents were more satisfied with the high indoor green room, they were more likely to pay extra room fees. The results also show that their perceived restorativeness on the three rooms positively influenced their WTP. Additionally, the coefficients of education in the low indoor green room and income in the low and high indoor green rooms were significantly correlated with WTP. This indicated that participants with a higher income were more willing to pay an extra fee for the low and high indoor green rooms. On the other hand, participants without college education were more willing to pay an extra fee for the indoor green rooms. All the other variables were, however, not related to WTP for the three rooms with different levels of biophilic designs.

Table 5. Interval regression results for WTP for the three levels of biophilic design.

Variable	Low Indoor Green (N = 484)		Medium Indoor Green (N = 486)		High Indoor Green (N = 480)	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
Preference	2.60	1.38	3.06	1.60	3.05	1.71
Satisfaction	2.48	1.41	1.41	1.54	3.82 *	1.76
Restorativeness	2.23 *	1.10	4.85 ***	1.41	3.67 **	1.39
Gender	0.45	1.95	1.63	2.11	1.10	2.28
Age_dum1	−2.06	3.54	−0.42	3.82	−2.66	4.15
Age_dum2	0.64	3.48	0.35	3.78	0.49	4.07
Age_dum3	-	-	-	-	-	-
Edu_dum	−5.44 *	2.42	−4.57	2.61	−3.76	2.83
Income_dum1	−7.89 **	2.97	−5.69	3.28	−7.44 **	3.59
Income_dum2	−4.74	3.16	−6.24	3.46	−7.21	3.77
Income_dum3	−0.29	3.08	0.05	3.33	−0.35	3.63
Income_dum4	-	-	-	-	-	-
Constant	6.06	6.73	−2.09	7.52	−4.32	7.61
Sigma	20.94	0.69	22.79	0.74	24.54	0.80
Log likelihood	−1048.83		−1093.81		−1115.36	

Note: Gender = 1 if the respondent was male or = 0 if otherwise; Age_dum1 = 1 if the respondents' age ≤ 30 or = 0 if otherwise, Age_dum2 = 1 if the age of respondents > 30 and ≤50 or = 0 if otherwise; Age_dum3 = 1 if the respondents' age > 50 or = 0 if otherwise; Edu_dum = 1 if the highest level of education achieved by respondents was higher than college or = 0 if otherwise; Income_dum1 = 1 if the respondents' monthly income was lower than CNY 3000 or = 0 if otherwise; Income_dum2 = 1 if CNY 3000 ≤ the respondents' monthly income <CNY 5000 or = 0 if otherwise; Income_dum3 = 1 if CNY 5000 ≤ the respondents' monthly income <CNY 10,000 or = 0 if otherwise; Income_dum4 = 1 if CNY 10,000 ≤ the respondents' monthly income or = 0 if otherwise. *: $p \leq 0.05$, **: $p \leq 0.01$, ***: $p \leq 0.001$.

4. Discussion

4.1. Biophilic Indoor Intervention in Relation to Perceived Outcomes and WTP

Previous studies showed that biophilic indoor environments are beneficial in reducing stress and anxiety [14,32,60] and influencing preference [61] as well as satisfaction [62]. In addition, indoor spaces with plants are thought to have a more restorative potential [63]. The present study showed that biophilic intervention with indoor plants in healthcare setting rooms resulted in higher preference, perceived restorativeness, and satisfaction, corroborating previous findings. The health benefits of indoor nature have been investigated in various settings, including a hospitalization setting, a work office scenario, a home setup while in confinement during the COVID-19 pandemic [36,49,64], and a healthcare room scenario in the present study. All these studies confirmed the positive effects of indoor plants on psychological restoration or affective response. Therefore, these findings further support the biophilic hypothesis, which posits that humans have an inclination to nature [21,22]. Conversely, this also confirmed that the approach used in this study, in which participants were asked to imagine being quarantined in a healthcare setting indoor room, was valid.

Suppakittpaisarn et al. [65] conducted a survey on the levels of vegetation density in green infrastructure in relation to landscape preference. Their study revealed a power-curve relationship between tree density and preference and understory vegetation density and preference. Additionally, Jiang et al. [66] explored the amount of tree cover associated with stress reduction. Their findings showed that there was an increase in stress recovery with an increase in tree cover from 1.7% to 24%. However, recovery remained constant when the tree cover increased from 24% to 34% and slowed down when the tree cover was above 34%, indicating a quadratic relationship between tree cover and stress recovery. The present study similarly showed that the participants' ratings of preference, restorativeness, and satisfaction towards the indoor rooms increased from the original room without plants to the room with high indoor greens. There was also a decrease in the marginal effect of the biophilic design (except satisfaction). Moreover, there was no significant difference between the high indoor green and medium indoor green rooms, although the participants' preference, perceived restorativeness, and satisfaction were the highest towards the high indoor green room. Notably, some protest zeros reported that they were not willing to pay, since the room with high indoor greens made them feel uneasy. A previous study on preference and intensity of landscape design (defined as "the amount of the original landscape changed and the degree of artificiality of added elements to the landscape by design) showed that a moderate design had a better marginal effect on promoting aesthetic preference. The study, therefore, recommended the moderate designs should be implemented [57]. Additionally, Pérez-Urrestarazu et al. [36] reported that a few indoor plants rather than a high number of plants, placed in strategic positions at home, were preferred. Furthermore, Chiang et al. [67] showed that a high density of vegetation was associated with better attention restoration effects, although a medium density of vegetation was more preferred. Rooms with a high number of indoor greens were also shown to be more likely to result in overdesigning [68]. The above findings, therefore, suggest that a room with a moderate number of indoor greens may be more helpful in improving preference, psychological restoration, and satisfaction.

Additionally, the results show that participants were willing to pay for all three biophilic indoor environments, supporting previous findings that rooms with natural scenic views were more expensive [69]. Moreover, participants had more WTP for the high indoor green room. However, there was no significant difference between the WTP for high indoor green and medium indoor green rooms. This may further indicate that a medium indoor green room is more suitable.

4.2. Perceived Outcome Variables in Relation to WTP

A previous study examined the restorative experience triggered by empowerment features in augmented reality in relation to the willingness of online tourists to pay a price premium during the prepurchase phase. The results indicate that generating a restorative experience resulted in a higher willingness to pay [70]. The present study similarly showed that the perceived restorativeness of biophilic indoor room environments was positively associated with WTP in all three scenarios. The positive relationship between perceived restorativeness and WTP was also shown by previous studies on perceived restorativeness and attitudes or behaviors. For instance, Barbiero and Berto [71] proposed that perceived restorativeness improved individuals' environmental concerns and further resulted in a proenvironmental behavior. In addition, Hartig et al. [72] reported that perceptions of restorative qualities predicted 23% of the differences in ecological behavior. Moreover, perceived restorativeness was shown to play a mediating role between perceived bird biodiversity and emotional well-being, as well as in perceived naturalness in emotional well-being [73]. Given that participants were under an imagined quarantine situation, it is likely that people attached more importance to health-related problems and their well-being, changing their attitude or behavior towards biophilic indoor environments. Therefore, biophilic indoor environments may elicit higher perceived restorativeness, further resulting in a higher willingness to pay. Additionally, it should be noted that the effect of perceived restorativeness on WTP for biophilic indoor room environments varied according to different scenarios. The highest positive coefficient between perceived restorativeness and WTP was observed in rooms with medium indoor greens. This suggested that participants' perceived restorativeness plays a stronger role in medium indoor green environments compared with the other two biophilic indoor rooms. This is reasonable, because no other variables were found to be associated with the WTP for a high indoor green room. This may also indicate that rooms with medium indoor greens were more preferred by the participants, since their gender, age, education, and income had no correlation with WTP.

In contrast, the results show that a higher preference for biophilic indoor environments did not translate to a higher WTP in all the three scenarios. Although previous studies showed a significant relationship between preference and WTP [74], this may not apply to the present study, since an imagined quarantine scenario may have caused the respondents to put more focus on psychological restoration rather than their preference. In addition, the significant positive contribution of perceived restorativeness on WTP in all three biophilic rooms supports this suggestion. Moreover, satisfaction and perceived restoration were found to have a positive effect on the WTP for high indoor green environments. This was in line with previous findings, which showed that respondents' WTP was significantly associated with their satisfaction with forest park facilities and services [40]. This also supports the idea that WTP represents an attitude rather than economic preference [75,76]. It is therefore possible that in a quarantine situation, respondents pay more attention to the restorative benefits of biophilic indoor environments rather than their preference or satisfaction. This is because preference was not associated with WTP, while satisfaction was only correlated with WTP for high indoor green environments. It is also noteworthy that gender and age were not related to WTP for the three rooms with different levels of biophilic interventions. This indicated that males and females, as well as participants across different age groups, had a similar WTP for biophilic indoor environments. The results further highlight the positive effects of biophilic indoor environments on the general public.

4.3. Practical Application

The results from the present study have important implications. Although several factors are involved, such as location, distance, and price, the indoor room environments should be considered by the government when determining a healthcare setting for quarantine. Additionally, indoor rooms with biophilic interventions should be treated as a priority when the other conditions are similar. Moreover, biophilic elements, e.g., indoor plants, should be added into the indoor room environments of the healthcare settings. Generally, providing moderate amounts of indoor plants would be the best alternative. However, the characteristics of each individual should also be taken into account. In addition, information on the benefits of using indoor plants to alleviate stress, anxiety, or other related symptoms should be made easily available to people in quarantine and the general public. This will in turn help the public increase their knowledge on coping with the negative effects of the pandemic and help them go through stressful events. For healthcare setting managers, decorating indoor room environments with biophilic elements, particularly with indoor plants, could help improve the satisfaction of their guests, and this may help them benefit more. Furthermore, a medium level of biophilic intervention would be necessary to enhance stress recovery and avoid overdesigning. Determining a moderate biophilic intervention can indeed be challenging, but a thoughtful approach that considers plant selection, plant density, green elements distribution, wall and floor coverage, and user feedbacks, along with comparisons among different indoor design proposals, can help identify the most suitable option. By carefully evaluating these aspects, designers can create a balanced and appealing green space that aligns with the needs and preferences of the intended users.

4.4. Limitations and Future Work

Although the present study provides some eye-opening findings, it has some limitations. First, following a previous study [50,54,55] and given the time limitation, the current study only used one item to measure respondents' ratings of preference, perceived restorativeness, and satisfaction, which may have resulted in bias. Future studies should therefore adopt a more comprehensive method to measure these outcome variables. Second, the study employed an online survey and focused on psychological restoration and therefore did not measure physiological indicators, such as variability in heart rate, heart rate, blood pressure, and skin conductance. This means that it was not possible to analyze the impact of different biophilic interventions on physiological state. An experimental study that replicates the stimuli and combines a subjective and objective approach to measure psychological and physiological indicators would make it possible to compare both psychological and physiological responses. Third, the study mainly focused on the biophilic elements of indoor plants. Future studies should therefore take into account other biophilic elements like natural analogues, symmetries, fractals, colors, and water, as well as natural light, and explore how to integrate these elements in the design process. This could lead to a better level of psychological and physiological restoration.

5. Conclusions

This study investigated the effect of different biophilic interventions in healthcare setting indoor room environments on people's preference, perceived restorativeness, satisfaction, and WTP under an imagined quarantine situation. The findings generally suggested that rooms with biophilic intervention had larger effects on preference, perceived restorativeness, satisfaction, and WTP compared with those with non-biophilic interventions. Additionally, the effects differed among the three different levels of biophilic intervention, with the high indoor green environment having the highest effect and the low indoor green setup having the lowest. Moreover, perceived restorativeness consistently contributed to WTP across the three biophilic indoor rooms. The study used CVM and measured perceived outcomes to quantify the monetary and nonmonetary values attached to biophilic interventions in healthcare setting indoor room environments. This, therefore, provided new insights on the values of biophilic intervention in indoor environments. The results also show that a medium level of biophilic intervention may be more useful for psychological restoration and should be recommended for practice. This can help designers in selecting proper biophilic interventions to create better indoor restorative environments. Given that the present study was conducted in China, similar studies involving respondents from other parts of the world with different cultural backgrounds could help validate the present findings and conclusions.

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