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Visiting urban green space as a climate-change adaptation strategy: Exploring push factors in a push–pull framework

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ABSTRACT

Urban green space (UGS) offers users multiple ecosystem services and amenities. This study investigated whether residents used UGS visitation in summer as a sustainable measure to tackle hot weather and associated climate-change impacts in humid-subtropical Hong Kong. Attributes of the indoor residential environment, seldom examined in park-visitation studies, were evaluated as push factors to visit UGS through a push–pull theoretical framework. A questionnaire survey of 483 respondents targeted urban park users. The results indicated that UGS visit frequency and stay duration were relatively low in hot summer. Ordinal multiple regression showed that indoor living conditions, residence location, living routine, and habit and personal health impacts were significantly correlated with UGS visits. Interdependence between push and pull factors was detected, demonstrating that intrinsic UGS environmental conditions could constrain UGS visits despite the motivations of push factors. The results indicated the need to improve the microclimate-regulating function in UGS. It could be achieved mainly by optimizing the nature-based design to promote UGS as an adaptive measure to combat the thermal stress brought by climate change. The findings yielded hints to shape visiting habits and suggestions to improve UGS management.

1. Introduction

Climate change has raised the temperature in cities to high records in recent years, as indicated by the rising incidence of hot days and hot nights (Papalexiou et al., 2018). Many places have experienced increasing warmth, especially in cities where the urban heat island (UHI) effect has accentuated the climate-change impacts.

Hong Kong's residential indoor temperature in summer generally exceeds the neutral physiological thermal comfort temperature (Yoshino et al., 2006), ranging from 25.4 °C to 28 °C (Cheng et al., 2012; Chow et al., 2010; Ng and Cheng, 2012). Overheating in the indoor space would lead to thermal discomfort and other health concerns (Beckmann et al., 2021; Brown et al., 2015; Folkerts et al., 2021). Visiting urban green spaces (UGS) or urban parks can serve as an adaptation measure to avoid hot indoor environments. Some studies have demonstrated UGS contributions to regulating microclimate and cooling down the environment by evapotranspiration

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and shading (Aram et al., 2020; Brown et al., 2015; Jaganmohan et al., 2016; Liao et al., 2015; Xiao et al., 2018). Chen and Ng (2013) reported the cooling functions of trees and grass in UGS in Hong Kong that could achieve thermal comfort for visitors.

The studies on UGS use often investigated the factors and their relationships, such as determinants of visits, visitor preferences, proximity and accessibility of UGS to residence (Campbell et al., 2016; McCormack et al., 2010; McCormack et al., 2014; Van Cauwenberg et al., 2015), safety (Conedera et al., 2015; Sakip et al., 2015; Stigsdotter et al., 2010; Mak and Jim, 2018), vegetation and wildlife (Carter and Horwitz, 2014; Conedera et al., 2015), cleanliness and naturalness (Herzog et al., 2000; Jim and Chen, 2006; Rupprecht and Byrne, 2014), presence of amenities (Donahue et al., 2018), general quality (Dallimer et al., 2014), and socio-demographic characteristics of visitors (Home et al., 2012; Liu et al., 2017; Payne et al., 2002; Schipperijn et al., 2010). These studies mainly focused on the attractions and conditions of the UGS, referred to as pull factors.

The push–pull theoretical framework (Dann, 1977) has been adopted in tourism and leisure studies to investigate decision-making and motivation of travel behavior (Chen and Chen, 2015; Kassean and Gassita, 2013; Mohamed and Othman, 2012; Mohammad and Som, 2010; Pesonen et al., 2011). The pull factor denotes the external site conditions that attract people to a destination. The push factor is the internal motivation that drives people to visit a destination (Uysal and Hagan, 1993; Uysal and Jurowski, 1994). The push–pull dichotomy could also represent the demand and supply dimensions in decision-making (Kim and Lee, 2002). Analyzing both factors jointly may enhance understanding of people's complex behavioral decisions (Kim et al., 2003). More importantly, as the push factor precedes the pull factor (Dann, 1981), understanding individual behavior would be logically and analytically incomplete if only one side is examined.

This study has adopted the dualistic push–pull theoretical framework to identify and define the variables influencing UGS visits and use. The factors commonly evaluated in related studies tend to focus on pull factors. The equally important push factor has received inadequate attention. In particular, the contributions of the indoor living environment as a push factor have been largely neglected. The indoor milieu regarding thermal comfort and associated health concerns, climate change, and UHI impacts could have motivated individuals to go outdoors and visit UGS. The low-income group trapped in substandard housing is particularly prone to environmental injustice, not to mention other socio-economic inequalities commonly found in UGS distribution and quality (Wang and Lan, 2019). Given the looming climate-change impacts, such push factors could become increasingly important to deserve deep exploration.

Another group of UGS studies paid more attention to park use patterns, including the frequency (Tyrväinen, 2001; Tyrväinen et al., 2007), duration (Wong, 2009), and purpose of visits (Home et al., 2012; Irvine et al., 2013; McCormack et al., 2010; Peschardt et al., 2012). However, the relevant literature did not consider seasonal use variations (Conedera et al., 2015; Tyrväinen et al., 2007). Given the distinctive seasons and associated temporal changes in indoor and outdoor conditions, this study focuses on the visitation patterns in summer to better understand high-temperature impacts aggravated recently by climate change. Despite the worsening thermal discomfort in indoor environments and general knowledge of the cooling relief offered by UGS, few studies have attempted to piece them together to enhance understanding of UGS use. The results may inform the design and management of UGS in cities to cope with the changing climate and socio-demographic characteristics.

The objectives of this study were: (1) To find out the patterns of UGS use in summer; (2) To analyse whether push factors of indoor living environment can serve as determinants of UGS use and the underlying inter-variable relationships; and (3) To derive from the findings the implications and recommendations to improve UGS design and management and promote UGS as a sustainable adaptation to summer heat stress.

2. Literature review

2.1. Climate-related benefits of UGS

The multiple benefits of UGS, including ecological, environmental, social, cultural, mental and physical health, have been widely documented (Donovan et al., 2021; Oliveira et al., 2020). In particular, the climate regulation benefits contribute to improving the overall climatic environment of cities, enhancing physical health, lowering disease risks, and raising thermal comfort (Huang et al., 2021; Kondo et al., 2018; Liao et al., 2015; Xiao et al., 2018). Huang et al. (2021) found that optimizing green space in Beijing, China, can reduce climate-related health hazards like respiratory and cardiovascular diseases associated with urban heat island effects. From the thermal comfort perspective, Chen and Ng (2013) showed that UGS cooling functions of vegetation could promote visitors' thermal comfort.

2.2. Activity preference and purpose of using UGS

Preference of activities or purpose to use UGS, often involving similar factors, have been investigated. Exploring these issues can help design and manage facilities and enhance the recreational experience. The following review provides an overview of some popular activities of UGS users.

Walking, jogging, and strolling are amongst the most prevalent and highly-rated activities stated by UGS users in many studies (Campbell et al., 2016; Giles-Corti et al., 2005; Home et al., 2012; Lo and Jim, 2012; McCormack et al., 2014). Giles-Corti et al. (2005) observed that 64 % of UGS users in Perth, Australia, were walking or jogging. McCormack et al. (2014) found that 28.1—58.5 % of visitors in three urban parks in Canada were walking, the most popular activity.

Resting and refreshing are popular pursuits (Campbell et al., 2016; Home et al., 2012; Irvine et al., 2013; Lo and Jim, 2010b; Peschardt et al., 2012). Lo and Jim (2010b) found that relishing fresh air was the second most reported purpose in Hong Kong. Peschardt et al. (2012) studied Copenhagen UGS and found that 31.6 % of users identified rest and restitution as the most prevalent visitation reason.

Fewer studies reported enjoying nature (Tyrväinen, 2001; Zhang et al., 2014) and socializing with others as primary purposes (Campbell et al., 2016; Peschardt et al., 2012; Tyrväinen, 2001). For example, Tyrväinen (2001) indicated that enjoying nature's benefits was the most preferred in urban forest parks in two towns in Finland. In Peschardt et al. (2012), socializing ranked second after resting.

2.3. Push factors as determinants of UGS visitation

Under the push-full framework of Dann (1977), pull factors are the attributes of a destination that attract individuals to visit, often called tangible features such as facilities. Push factors are usually intangible and related to the intrinsic desire of an individual, e.g., perceptions and wishes (Uysal and Hagan, 1993). Common push factors in recreational studies include self-esteem, prestige, health, and interests (Uysal et al., 2008). Push factors denote the socio-psychological variable of individuals and their environment, which may predispose the participation of individuals in traveling behavior or leisure activities (Uysal et al., 2008).

Regarding the influence of perception of living conditions and residence location on using UGS, proximity to UGS has been widely assessed (Carter and Horwitz, 2014; Conedera et al., 2015; Dallimer et al., 2014; Giles-Corti et al., 2005; Jim and Chen, 2006; Liu et al., 2017; McCormack et al., 2010; Van Cauwenberg et al., 2015; Wong, 2009). For instance, Conedera et al. (2015) found that residents living closer to UGS in southern Switzerland demonstrated a significantly higher park visitation rate than those living farther away. Dallimer et al. (2014) showed that the travel time to UGS was negatively correlated with the visit frequency in Sheffield, UK. By measuring proximity in terms of perceived distance or travel time to UGS, these studies captured residents' personal experiences and perceptions of the proximity of residence to UGS. This variable, therefore, serves as a push factor.

The influence of users' indoor living conditions on UGS visit frequency was rarely investigated. Lo and Jim (2010a) discovered that flat size in Hong Kong is an age-dependent factor for UGS visit frequency. Indoor living conditions were not significantly correlated with visit frequency using samples of all ages. However, a significant correlation was displayed when residents aged 50 or above were isolated and analyzed separately. On the contrary, Zhang et al. (2014) found that in Hangzhou, China, the correlations of house size with UGS use and recreational needs were not significant.

Many studies have verified the physical and mental health promotion benefits of UGS on people (Bedimo-Rung et al., 2005; Kaczynski et al., 2014; Payne et al., 2005; Sacker and Cable, 2005). Nevertheless, the studies rarely investigated how users' personal health concerns could serve as a push factor, with only a few exceptions (Lo and Jim, 2010b, 2012).

Better microclimate and air quality in UGS have been identified as visit motivations. Payne et al. (2005) studied urban park uses in the USA and reported that cooling the environment and body was crucial. Good air quality, amelioration of air pollution, and air purification were important benefits for Hong Kong's UGS users (Lo and Jim, 2010b, 2012). These benefit-generating conditions were often inadequate in their own homes. On the other hand, Tyrväinen (2001) and Tyrväinen et al. (2007) showed that UGS microclimate benefits were only moderately important drivers of using UGS.

These studies did not directly capture the influence of climatic and air quality as push factors. Rather, they provided clues on how UGS conditions compared with residents' living conditions may drive UGS visits. Due to the lack of microclimatic studies, the link between UGS use and microclimate relative to indoor conditions (i.e., a cooler environment in UGS outdoor ambiance compared to a hot indoor environment) has remained mostly unexplored. More importantly, the perceptions of indoor conditions as determinants of UGS use are yet to be evaluated. Zhang et al. (2014) hinted that extreme indoor heat would drive more frequent UGS visits, relieving heat stress and improving physical well-being.

2.4. Socio-demographic characteristics as determinants of UGS visiting frequency

The relationship between socio-demographic characteristics and UGS use, widely examined, has generated rather mixed results. Common factors, including age, education, and income, were not significant predictors of visit frequency (Abercrombie et al., 2008; Conedera et al., 2015; Dallimer et al., 2014; Jennings and Gaither, 2015; Liu et al., 2017). However, Home et al. (2012) found that these three factors were important determinants of visiting rate. Other studies identified the correlations of particular factors with visit frequencies. Payne et al. (2002) reported a negative correlation between UGS participation and age. Likewise, Yilmaz et al. (2007) found that younger citizens were Turkey's dominant urban park users.

In contrast, Schipperijn et al. (2010) explored the UGS visit pattern of Danish citizens through a socio-demographic model and indicated that older users were more frequent visitors. Regarding education level, Yilmaz et al. (2007) found that university-level users had the highest visit frequency. In contrast, Zhang et al. (2014) identified a negative correlation between education level and UGS use. Regarding economic status, Scott and Munson (1994) found that lower-income households visited UGS more frequently than higher-income ones, whereas Zhang et al. (2014) found an opposite relationship. The underlying variations in cultural and socio-economic push factors are likely to have induced such divergence in visiting patterns.

2.5. Socio-demographic characteristics as determinants of UGS visiting purpose

Most studies on the purpose of using UGS have remained exploratory. Few attempts have been made to investigate the determinants shaping the visiting purposes. A few studies assessed the influence of socio-demographic variables on the purposes of using UGS. Baran et al. (2014) found that elderly citizens tended to prefer strongly sedentary activities, including picnicking and socializing. A similar result was identified by Conedera et al. (2015), with older users most frequently visiting UGS to socialize with other users. In contrast, younger people showed a more diverse array of preferred purposes, including taking breaks, reading and studying, and relieving stress. The study of Payne et al. (2002) also agreed that the preference for outdoor recreational and physical activities in UGS would decrease with age.

3. Methods

3.1. Study area

Hong Kong is located on the South China coast. The city has a population of 7.5 million packed in a small area of 1,100 km^2. As the territory is dominated by steep hill slopes, land suitable for urban development is inadequate, thus limiting the built-up areas to merely 24 % of the total land area. The urban development mode is exceptionally dense and high-rise, leaving little street-level space for urban greening. Urban open space in Hong Kong was limited to an inordinately low supply of < 3 m^2 per person (Jim and Chan, 2016).

3.2. Questionnaire design

The questionnaire was divided into three sections. The first part divided the UGS visit frequency into six intervals, from daily to monthly or more. The stay duration options ranged from $1 - 15$ min to up to 2 h. Five items were included in the purpose of the visit, including "Exercise and stroll", "Breathe fresh air", "Enjoy natural scenery", "Cool off and refresh", and "Meet and socialize with friends". These items were included based on previous studies, with the addition of "Cool off and refresh". The above items were designed with reference to previous local studies on UGS (Lo and Jim, 2010a, 2010b; Wong, 2009).

The second part included ten push factors in four aspects, namely "indoor living environment", "location of residence", "living routine and habit", and "personal health impacts". The "indoor living environment" assessed the respondent's quality of the indoor environment and perceived comfort level. They included the perception of indoor temperature, the number of cooling devices available at home, and the flat size. The "location of residence" indicated the proximity to the closest UGS, estimated by walking time. The "living routine and habits" probed the respondent's home-staying duration (hour) and air-conditioner use habits. These behaviors indicated the respondent's motivation to stay in or away from their indoor living environment and reflected the potential extent of the climate-change impact on respondents. The last group gleaned the personal health impacts faced by the respondent during their homestay. The respondent's experience of heat syncope and heat stress symptoms at home was assessed as health impacts, reflecting the tendency and motivation to visit a cooler place. The items in this part were developed with reference to the reviewed push factors of UGS use in Section 2.3, with adaptations to match this study's context. The questionnaire's last part collected the respondent's socio-demographic information, including age, education level, and household income.

3.3. Questionnaire survey

The Centre of Communication and Public Opinion of the Chinese University of Hong Kong was commissioned to conduct a household telephone survey. The Centre's professionally trained interviewers implemented the surveys. Individuals aged 15 or above from local Hong Kong households were selected as target respondents. The respondents' participation in the questionnaire survey was voluntary without compensation or rewards. Each survey, conducted in Cantonese, the local dialect, took around 15 min. Random sampling was adopted by transforming residential landline telephone directories into a sampling frame, randomly selecting transformed household numbers. A pilot survey was conducted to refine the content and language. The survey collected 483 completed questionnaires, and 499 interview attempts were either rejected or failed to complete (49.2 % response rate).

3.4. Data analysis

Lo and Jim (2010a) and Wong (2009) previously investigated UGS use patterns in Hong Kong by visit frequency, stay duration, and visit purpose. Our results were compared with previous findings to identify changes over time and discrepancies between use patterns in summer vis-à-vis throughout the year. Ordinal multiple regression analysis was employed to examine the relationship between the determinants of socio-demographic variables and push factors with use frequency. The statistical package SPSS 24.0 was used for data analysis.

4. Results

4.1. Socio-demographic profile of respondents

More female respondents (58.8 %) participated in the survey than male (41.2 %). Age groups of respondents were relatively equally distributed, with around 15.3 % to 17 % in each group, except the larger 45—54 group (22.6 %) and the smaller 25—34 group (9.7 %). Respondents with secondary education formed the dominant group (47.4 %), followed by the undergraduate or above group (31.3 %). Primary level or below took up merely 8.1 %. By household income, the moderate group at HKD20,000—59,999/month (48.4 %) was dominant. Other income groups ranged from 5.0 % to 8.1 %.

(Table 1).

4.2. Patterns of UGS use

UGS use patterns included three parameters: visit frequency, stay duration, and visit purpose (Figs. 1 and 2, Table 2). Frequent UGS visitors (12 % every day, 17.4 % 2——6 times a week, 11.6 % once a week) comprised 41 % of respondents. The least frequent visitors (i.e., less than once a month) at 45.3 % was similar to frequent visitors (Fig. 1). Compared to previous studies, the UGS visit frequency was much lower in the present study. The most evident discrepancy was the 45.3 % of users who visited less than once a month compared to only 15 % in past studies (Table 2).

The majority of respondents had a short stay duration. About 22.2 % and 28.9 % of respondents reported stays of 1–15 min and 16–30 min, respectively. It was rather uncommon to stay over an hour, as only 19.5 % and 1.9 % reported staying for 1–2 h or over 2 h, respectively (Fig. 2).

Compared to a previous study (Wong, 2009), more respondents in the present study reported a short stay of less than 30 min (46.9 % vs. 19.0 % in 2009). Compared to the previous study, fewer users stayed for longer durations, mainly 30 min to 2 h and with few staying for an extended duration over 2 h (Table 3).

4.3. Purpose of UGS visit

The most common visiting purpose was to exercise and stroll. This result is consistent with other studies, as most people identified walking, strolling, and jogging as the dominant visiting motive (Campbell et al., 2016; Giles-Corti et al., 2005; Home et al., 2012; Lo and Jim, 2012). The purpose ranked second was to breathe fresh air in UGS, another commonly suggested conventional purpose of visiting UGS in other studies (Campbell et al., 2016; Home et al., 2012; Irvine et al., 2013; Peschardt et al., 2012). Respondents were less inclined to visit UGS to enjoy the natural scenery, cool off, and refresh, ranked only third and fourth (Table 4).

Lo and Jim (2010b) and Wong (2009) discovered that exercising and strolling were the most popular visit purposes in Hong Kong. Lo and Jim (2010b) reported that relishing fresh air ranked second, followed by enjoying the natural landscape. The most preferred visit purpose was generally similar across the past and present studies (Table 5).

4.4. Multiple regression analysis of push factors

Ordinal multiple regression analyses explored the relationships between the push factors (indoor living conditions, residence location, living routine and habit, and personal health impacts) and socio-demographic factors with UGS visit frequency (Table 6). The bivariate correlation test examined multicollinearity between predictor variables. As all computed coefficients were below 0.8, multicollinearity was not detected (Franke, 2010). The assumption of proportional odds of ordinal regression was evaluated by the test of parallel lines, with the null hypothesis that the slope coefficients were the same across categories. The calculated significance of $p = 0.70$ did not reject the null hypothesis. Hence, the assumption could be upheld.

In terms of indoor living conditions, the respondents' home temperature without using air-conditioning was compared to the outdoor environment ($p < 0.05$) and domestic flat area ($p < 0.05$). They both showed a significant positive correlation with visit frequency. The proximity of respondents' residence to UGS ($p < 0.05$) was negatively correlated with visit frequency. The relationship indicated that shorter walking time to the closest UGS generated more frequent visits. This result aligned with past studies (Carter and Horwitz, 2014; Conedera et al., 2015; Dallimer et al., 2014; Liu et al., 2017). Regarding the living routine and habits, respondents who stayed at home longer on weekdays tended to visit UGS more frequently, indicating a positive correlation ($p < 0.05$). Personal health concern regarding the experience of heat syncope at home was another positive predictor ($p < 0.05$) of visit frequency.

The three socio-demographic determinants had no significant relationship with education level and household income. However, a strong and significant positive correlation ($p < 0.001$) was found between age and visit frequency. This result agreed with the study of

Table 1
The demographic characteristics of respondents who were UGS visitors.

Gender	*n*	%	Age group	*n*	%
Male	199	41.2	15–24	74	15.3
Female	284	58.8	25–34	47	9.7
			35–44	82	17.0
			45–54	109	22.6
Household income (HKD)[a]			55–64	82	17.0
≤ 9,999	39	8.1	≥ 65	80	16.6
10,000–19,999	56	11.6	No response	9	1.8
20,000–29,999	74	15.4			
30,000–39,999	70	14.5	**Education level**		
40,000–59,999	89	18.5	Primary or lower	39	8.1
60,000–79,999	32	6.7	Secondary	229	47.4
80,000–99,999	24	5.0	Senior secondary	61	12.6
≥ 100,000	35	7.3	Undergraduate or above	151	31.3
No response	62	12.9	No response	3	0.6
			Total (*N*)	**483**	**100**

[a] The officially pegged exchange rate is USD1.00 = HKD7.80.

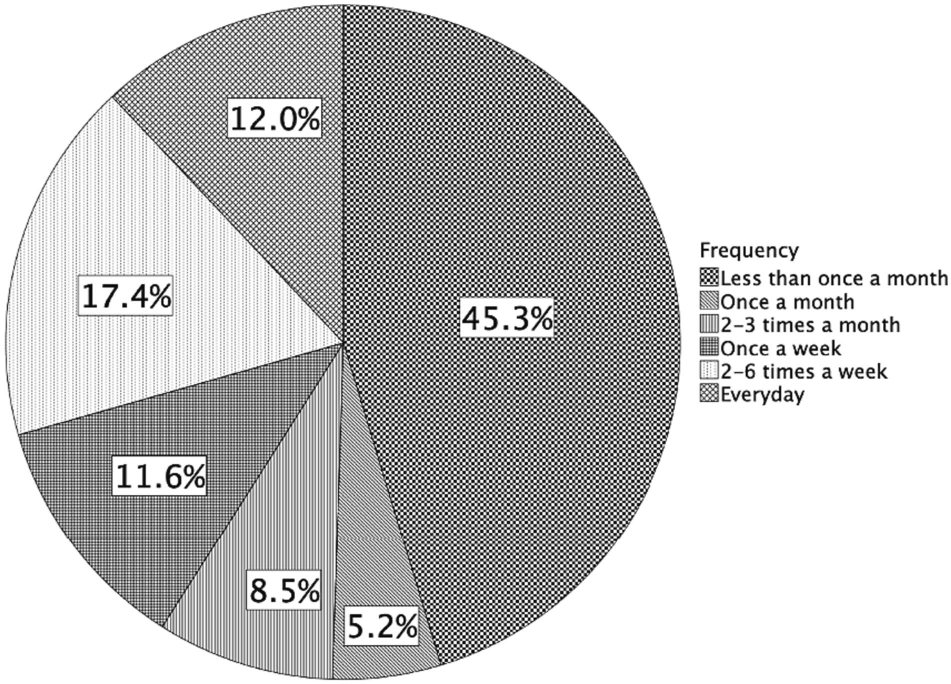

Fig. 1. Respondent proportion (%) by UGS visit frequency.

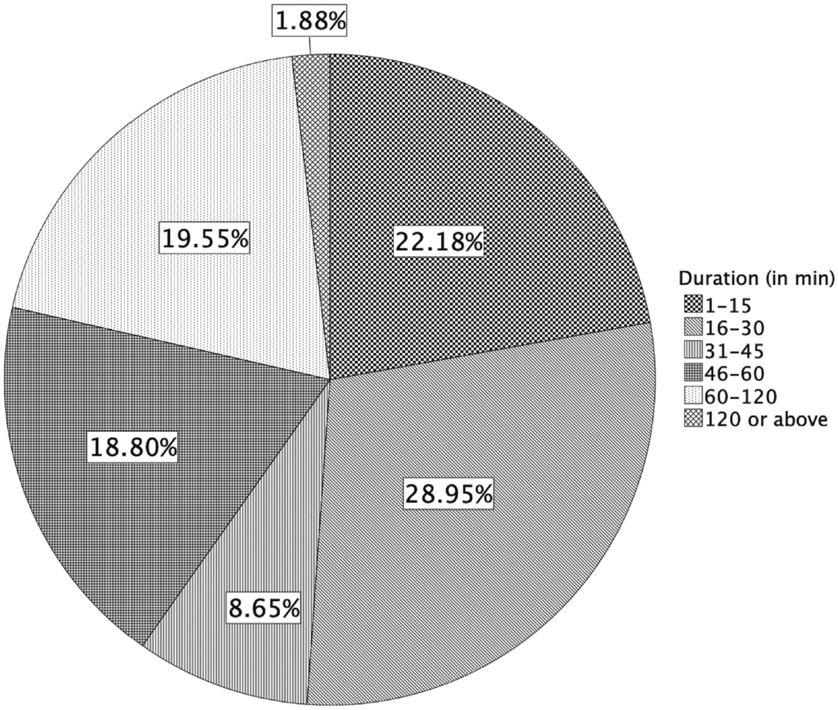

Fig. 2. Respondent proportion (%) by UGS stay duration.

Table 2
Comparing the UGS visit frequency (as a percent of respondents) between the present and two past studies.

Study	Daily	2–6 times a week	Weekly	Monthly	Less than once a month
Wong (2009)	18	21	26	21	N/A[a]
Lo and Jim (2010a and 2010b)	22.8	25.3	24	12.9	14.9
Present study	12	17.4	11.6	13.7[b]	45.3

[a] In Wong's (2009) study, the option of "Less than once a month" was not provided. The remaining 14% of respondents reported that they "frequently" visited UGS but did not specify their frequency.
[b] The options of "2 – 3 times each month" and "Once a month" in the present study were combined into "Monthly" for comparison to past results.

Table 3
Comparing the UGS stay duration (as a percent of respondents) of the present and a past study.

Study	< 0.5 h	0.5–2 h	≥ 2 h
Wong (2009)	19	72	10
Present study	46.9[a]	51.1[b]	1.9

[a] The options "1–15 min" and "16–30 min" were combined into " less than 0.5 h".
[b] The options "31–45 min", "46–60 min" and "60–120 min" were combined into "0.5–2 h".

Table 4
Five primary UGS visit purposes and their visit frequencies.

	Visit frequency level (respondent %)[a]				
Purpose of visit	Seldom	Sometimes	Often	Mean (S.D.)	Ranking
Exercise and stroll	36.1	24.8	39.1	2.030 (0.875)	1
Relish fresh air	44.0	31.6	24.4	1.804 (0.718)	2
Enjoy the natural scenery	56.8	27.8	15.4	1.586 (0.555)	3
Cool off and refresh	71.8	18.0	10.2	1.384 (0.771)	4
Meet and socialize with friends	79.4	17.3	3.4	1.242 (0.824)	5

[a] The three visit frequency levels, "seldom, sometimes, often", are represented by scores of 1, 2 and 3, respectively.

Table 5
Comparing the UGS visit purposes of the present study with two past studies.

Ranking	Wong (2009)	Lo and Jim (2010b)	Present study
Highest	Doing exercise	Physical exercise or strolling	Exercise or stroll
	Leisure walk	Relish fresh air	Breathe fresh air
	Playing with children	Enjoy peace and relaxation	Enjoy natural scenery
	Passive enjoyment	Enjoy natural landscape	Cool off and refresh
	Social activities	Chat and gather with friends	Meet and socialize with friends
	Enjoying the natural environment	Take children to playground	
	Enjoying open space	While away time	
Lowest		Enjoy the cool environment	

Schipperijn et al. (2010) but contradicted others.

5. Discussion

5.1. Nature-based solutions to cool UGS and enhance UGS use

The current study observed lower visit frequency and shorter stay duration than previous local studies, revealing discrepancies between the summer and the year's visitation patterns. Other contextual push factors may explain such behaviors. Despite the UGS cooling function to mitigate the impacts of warming weather, the summer temperature in UGS may still exceed the thermal comfort range. Wong's (2009) evaluation of Hong Kong people's barriers to UGS use found that over 70 % adopted "watching TV" and "shopping" as major passive leisure activities conducted at home or shopping malls with air-conditioning. A survey in Hong Kong (Green Sense, 2017) revealed that 90 % of respondents used air-conditioners at home in the summer. Moreover, nearly 75 % of respondents used an air-conditioner every day, and one-third of them used air-conditioning 9–12 h a day. Not surprisingly, air-conditioning accounts for 30 % of electricity consumption in residential buildings, and 80 % of homes are equipped with air-conditioners (Lam, 2000; Electrical and Mechanical Services Department, 2022). Another report (Green Sense, 2016) showed that some shopping malls in Hong Kong set the indoor temperature to as low as 19–20 °C. Chow and Fung (1995) concluded that local

Table 6
The summary of the ordinal multiple regression analysis explaining the influence of five groups of push factors on UGS visit frequency ($N = 483$).

Push factor variable[a]	Estimate	Standard error	Significance[b]	95 % Confidence interval
Indoor living conditions				
Q1. Temperature at home without using air-conditioning in summer compared to the outdoor environment	0.182	0.082	0.027*	(0.021, 0.342)
Q2. Number of fans at home	−0.107	0.065	0.100	(-0.234, 0.020)
Q3. Number of air-conditioners at home	0.018	0.107	0.868	(-0.192, 0.227)
Q4. Area of flat	0.103	0.047	0.027*	(0.012, 0.195)
Location of residence				
Q5. Proximity to the closest park (in terms of walking time)	−0.235	0.096	0.014*	(-0.422, −0.047)
Living routine and habit				
Q6. Hour spent at home on weekdays in summer	0.193	0.079	0.014*	(-0.039, 0.347)
Q7. Hour spent at home on weekends in summer	−0.124	0.084	0.139	(-0.289, 0.040)
Q8. Duration of use of air-conditioner in summer	−0.012	0.018	0.496	(-0.048, 0.023)
Personal health impact				
Q9. Experience of heat syncope (dizziness) in summer at home	0.312	0.142	0.028*	(0.033, 0.592)
Q10. Experience of heat stress symptoms in summer at home	−0.239	0.289	0.407	(-0.805, 0.327)
Demographic characteristics				
Age	0.299	0.067	0.000***	(0.168, 0.430)
Education level	0.004	0.182	0.982	(-0.353, 0.361)
Household income	0.019	0.043	0.659	(-0.065, 0.102)
Nagelkerke R^2	0.134			
Goodness-of-Fit	**−2 Log Likelihood**	**Chi-square**	**df**	**Significance**
Pearson		2338.70	2483	0.981
Model fitting				
Intercept only	1307.65			
Final model	1250.31	57.33	13	0.000

[a] Dependent variable: UGS visit frequency.
[b] *$p < 0.05$; *** $p < 0.001$.

residents are accustomed to a relatively low-temperature range of 20–24 °C in malls. Thus, the relatively hot UGS outdoor environment pales considerably compared to the well, if not excessively cooled, indoor milieu.

The above findings suggest the heavy dependence of tropical urbanites on air-conditioning in communities with economic means. This commonly harbored inertia or near-addiction to air-conditioning might have retained people indoors and discouraged UGS use in summer, thus depressing visit frequency and stay duration. Circumscribed by such an ingrained habit, the increasingly warm weather is expected to keep more people in artificially cooled indoor spaces to reduce park patronage further.

Countermeasures aligned with nature-based solutions could be introduced to arrest the trend. They include improving UGS design and landscape planning to substantially increase vegetation coverage and density. Establishing a high tree and woodland cover with an interlocking overhead canopy is critical for an attractive, naturally shaded, and well-cooled outdoor ambiance in a tropical context (Lin and Lin, 2010; Fung and Jim, 2019). The quality of UGS can be enhanced by implementing the principles and practices of climate-responsive landscape and urban design. Such naturalistic ingredients could be accompanied by public education and promotion to reduce over-reliance on air-conditioning to enhance people's use of UGS as a space for climate-change adaptation and steer people towards a more sustainable lifestyle.

5.2. Enhancing other attractions of UGS

Regardless of the season, exercising, strolling, and relishing fresh air were the primary UGS visit purposes, while enjoying the natural scenery was consistently a middle-ranked purpose. UGS may not be generally perceived as an effective cooling mechanism in summer, so residents may not consider cooling a key visit purpose. In comparison, enjoying the cool UGS environment was rated the least expressed purpose by Lo and Jim (2010b). Local UGS venues could not provide sufficient dense overhead greenery to create a cool summer ambiance. Such an impression has been deeply etched in the collective belief of residents. The persistence of using an open-parkland design with scattered trees, adopted nearly 180 years ago when the city was founded, perpetuated this perception.

Summer may bring another concern that could deter people from using UGS, related to mosquitoes as the vector of existing and emergent life-threatening infectious diseases, including malaria, dengue hemorrhagic fever, and Japanese encephalitis (FEHD, 2022). People often perceive vegetation in urban greening sites as mosquito breeding grounds, bringing uncomfortable bites and latent health risks (Byrne and Yang, 2009; Elmqvist et al., 2013; Wong and Jim, 2017). Thus, to promote the use of UGS, mosquito-sensitive UGS design, planning, and management should not be neglected.

5.3. Importance of push factors in UGS patronage

Besides UGS visitation patterns, this study attempted a pioneering investigation of push factors (i.e., indoor living conditions) of park use. Three significant determinants have been identified concerning the indoor living ambiance in summer and people's motivation to escape from the stresses. They include the oppressive temperature at home without air-conditioning compared to the outdoor environment (Cheung and Jim, 2019), the hours spent at home on weekdays, and the experience of heat syncope, all positively correlated with visit frequency. The adverse indoor conditions at home, especially for the low-income group living in tiny homes with poor ventilation and limited air-conditioning (Civic Exchange, 2018), could have generated a centripetal force urging people to find relief in nearly UGS. They, therefore, constitute the main beneficiaries if parks can bring good-quality cooling benefits. These three underlying indoor circumstances have driven some people to visit UGS more frequently to seek respite from the summer heat.

These results suggest that indoor living conditions as push factors have influenced UGS use in summer. They indicated that visiting UGS could solve the indoor heat stress problem, particularly relevant to low-income groups (Civic Exchange, 2018). Thus, well-designed UGS with good cooling capability in low-income neighborhoods could redress the significant social injustice of unequal access to heat-stress relief (Lee et al., 2019). These nature-based and socially inclusive solutions are particularly relevant to the increasing urbanization trend, especially in developing economies. UGS can be strategically dispersed in cities close to residential areas to provide a sustainable alternative for adaptation to the heat. These essential public amenities can satisfy demands for outdoor leisure activities. They could reduce energy-consuming and environmentally threatening maladaptation to the hot indoor environment, such as over-reliance on energy-intensive air-conditioning.

5.4. The push–pull framework in the context of urban green space

Our empirical data support adopting the push–pull framework in urban green space studies to explore push factors. The perception and experience of substandard indoor living conditions have significantly pushed people to use UGS. However, cooling-off and refreshing were not rated highly, suggesting that the push factor effects can be, to a certain extent, constrained by the strength of the pull factors (i.e., the temperature and thermal comfort of UGS), as the two sets of factors are never independent (Kim et al., 2003). The pull factors of a destination could be appropriately refined to match the corresponding expectations of push factors (Oh et al., 1995) to enhance the synergies of the two groups of factors. This interpretation implies that people's motivation to visit UGS could be hindered and limited by the shortcomings in UGS intrinsic environmental conditions that fail to address the specific needs of push factors. Accordingly, UGS management and design could be improved with reference to residents' needs and motivations to promote UGS visits in summer.

Enhancing UGS's environmental conditions and thermal comfort can provide a cooler and more comfortable environment, particularly in summer. The microclimate of UGS can be optimized by improving the landscape design of such spaces (Petri et al., 2019). Fragmentation and lack of connectivity between UGS have long been an issue in UGS worldwide, including Hong Kong (Tian et al., 2011). Linking small and fragmented UGS by green connectors can synergistically amplify overall microclimate regulation functions (Jim, 2004) to enhance their cooling function and attractiveness. The paved surface is prevalent in Hong Kong's UGS, echoing the administration's ingrained practice of covering the ground extensively with concrete and other impermeable surfaces. Such hard and dry surfaces often aggravate the UHI and raise the air temperature in UGS (Wong and Yu, 2005). Switching to natural surfaces like vegetation or water could bring notable relief.

Overall, the results indicated that the influence of push factors could be curtailed if not suppressed by other variables, e.g., the intrinsic UGS environment conditions, which this study has not explored explicitly. Future studies may develop a model to include these two key variables for a more holistic examination of the determinants of UGS use. Research can be extended to ascertain the predictive capacity of these variables.

5.5. Limitations and recommendations for future studies

The current study investigated UGS use in summer as an adaptive behavior under the climate-change backdrop. It should be noted that adaptation measures and their implications may diverge temporally. For instance, a different visitation pattern may be expressed in winter. The purpose of visiting UGS could vary between daytime and nighttime. Our research did not evaluate such variations. Future studies may explore a wider range of temporal settings of UGS visits to identify other adaptative UGS uses.

In examining the influence of push factors in UGS use, this study primarily focused on linking these factors to residents' visitation patterns. The data of pull factors were not collected and analyzed. Therefore, the integrated effects of push and pull factors were not fully demonstrated. Future studies can incorporate both factors to more holistically assess how joint push–pull factors may shape UGS use.

To further improve the validity and reliability of questionnaire items developed in this study based on the local context and existing literature, future studies may adopt and test similar items to develop a standard and widely applicable research framework in due course.

6. Conclusion

This study attempted a new approach to closely explore the visitation patterns of urban green space in summer as a climate adaptation measure. The push factors of indoor living conditions, habits, and personal health impacts were explored instead of the environmental, personal, or psychological determinants commonly examined in previous studies. A difference in visitation patterns was observed between this study and others in Hong Kong, demonstrating the marked influence of season on UGS use. Ordinal multiple regression results have confirmed that indoor living conditions, living habits, health concerns, proximity to UGS, flat size, and respondent age are significant predictors of UGS use. In particular, the positive correlation between UGS visit frequency and severity of indoor living conditions, and conversely, cooling as a visit purpose, signified the interdependence of push and pull factors.

The new insights on push factors could be explored in other cities to deepen understanding of this somewhat latent and neglected motivation. Considering push factors permits a more holistic assessment of enhancing urban parks' social-cultural functions in the greater green space development scheme (Loughran, 2018). Planning and management can better facilitate UGS usage considering the local characteristics of the urban indoor environment, spatial demographic patterns, thermal perception, and people's habits in UGS design. The enhanced solutions with more natural ingredients can offer a sustainable alternative to energy-intensive climate adaptive measures in cities.

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CRediT authorship contribution statement

Gwendolyn K.L. Wong: Data curation, Investigation, Methodology, Writing – review & editing. **Anson T.H. Ma:** Data curation, Formal analysis, Methodology, Writing – original draft. **Lewis T.O. Cheung:** Investigation, Methodology, Writing – review & editing. **Alex Y. Lo:** Investigation, Methodology, Writing – review & editing. **C.Y. Jim:** Conceptualisation, Data curation, Investigation, Methodology, Supervision, Funding acquisition, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A

Questionnaire survey on the use of urban green space and climate-change adaptation strategy in Hong Kong

Part 1. Visitation pattern of UGS and location of residence

1. ***How often do you visit UGS in your neighborhood during the summer?***

□ At least once everyday □ Two to six times a week □ Once a week
□ Once a month □ Less than once every month

2. ***On average, how long would you spend in UGS during each visit?***

Number of minutes: _______

3. ***How long does it take to travel from your home to the nearest UGS?***

Number of minutes: ___________

4. ***How often do you visit UGS for the following purposes?***

4a. Exercise and stroll
□ Often □ Sometimes □ Seldom □ Never

4b. Relish fresh air
□ Often □ Sometimes □ Seldom □ Never

4c. Enjoy natural scenery
□ Often □ Sometimes □ Seldom □ Never

4d. Cool off and refresh
□ Often □ Sometimes □ Seldom □ Never

4e. Meet and socialize with friends
□ Often □ Sometimes □ Seldom □ Never

Part 2. Indoor living conditions, living routine and habit, & personal health impacts

5. ***Do you have the following devices at your home? If yes, how many?***

	No	Yes	(Please indicate how many)
1a. Electric fan	□	□	(Number of fan(s): ____)
1b. Air conditioner	□	□	(Number of air conditioner(s): ____)

6. ***What is the size of your flat?***

Size of flat: _________ sq. feet

7. ***On average, how long would you stay at home during the summer (June to August)?***

Weekday: ______hours Weekend: ______hours

8. ***On average, how long would you be using the air-conditioner at home during the summer?***

Number of hours: _________

9. ***During the summer, how do you feel about the temperature at your home when compared to the outside environment?***

□ A lot hotter □ Slight hotter □ Not much difference □Slight cooler □ A lot cooler

10. ***How often do you experience the following symptoms at home during the summer?***

10a. Heat syncope (dizziness)

□ Often □ Sometimes □ Seldom □ Never

10b. Heat stress symptoms (including, excessive sweating, rising body temperature, extreme thirstiness, low blood pressure and rate of ventilation, muscle cramps, headache, nausea)

□ Often □ Sometimes □ Seldom □ Never

Part 3. Socio-demographic information

11. ***Age:***

□ 15–24 □ 25–34 □ 35–44 □ 45–54 □ 55–64 □ ≥ 65 □ No response

12. ***Level of education:***

□ Primary or lower □ Secondary □ Senior secondary
□ Undergraduate or above □ No response

13. ***Income (HKD):***

□ ≤ 9,999 □ 10,000–19,999 □ 20,000–29,999 □ 30,000–39,999 □ 40,000–59,999
□ 60,000–79,999 □ 80,000–99,999 □ ≥ 100,000 □ No response

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