Usage and perception of urban green space of older adults in the high-density city of Hong Kong

Kevin Ka-Lun Lau [a,b,c,*], Cheryl Ching-Yu Yung [a], Zheng Tan [d]

[a] *Institute of Future Cities, The Chinese University of Hong Kong, Hong Kong*
[b] *CUHK Jockey Club Institute of Ageing, The Chinese University of Hong Kong, Hong Kong*
[c] *Institute of Environment, Energy and Sustainability, The Chinese University of Hong Kong, Hong Kong*
[d] *Université Catholique de Lille, France*

ABSTRACT

Urban green space (UGS) is critical to both physical and mental health of older adults. While older adults tend to live in cities rather in rural areas for better social support, their usage and perception of UGS in high-density areas have not been widely studied. The present study aims to investigate the inter-relationships between older adults' perception and usage of UGS, as well as how the perception and usage of UGS are related to older adults' self-rated health in three different types of UGS in Hong Kong, namely green spaces in public housing estates, street parks and district parks. A total of 462 UGS users aged ≥ 60 in Hong Kong were interviewed about their usage pattern, perception on facilities, aesthetics, accessibility and safety aspects of UGS, and their health conditions, using the SF12v2 Health Survey. Binomial logistic regression shows that perceived proximity to UGS is associated with frequency of visit and duration of stay. Longer exposure to UGS is also associated with better perceived physical and mental well-being. Influences on usage of UGS, however, is not limited to physical attributes of the space. Design and management of UGS can take into account the results of this research, to create a better environment for elderly in high density area. Future research on UGS should also focus on factors outside the geographic boundary of the space, characteristics of the community and cultural reasons could be influential to users' behaviour and experience.

1. Introduction

The rate of population ageing is increasing rapidly in the world (United Nations, 2019; Bloom et al., 2008). In Hong Kong, the proportion of population over 65 will exceed 30 % by the end of 2034 (Planning Department, 2016a). Such a change in demographic structure resulted in a wide range of challenges on the health of older adults, including health problems, social isolation, and needs for recreational spaces (Loukaitou-Sideris et al., 2014). Urban green space (UGS) is an important element in urban planning and design. It improves the environmental quality of urban areas by regulating microclimate and reducing heat stress (Bowler et al., 2010; Shashua-Bar et al., 2010), reducing atmospheric carbon dioxide (Nowak et al., 2002, 2014), removing air pollutants (Morakinyo et al., 2016) and enhancing biodiversity (Seto et al., 2012; Gunnarsson et al., 2017) and improving physical and mental health of urban residents, also older adults (Kabisch et al., 2017, 2021;

Enssle and Kabisch, 2020).

UGS is widely recognised for its various benefits to the living quality of urban areas as it promotes physical and mental health of urban dwellers (De Vries et al., 2003). Exposure to UGS is associated with higher level of physical activity (James et al., 2015), especially for walking type of physical activity in Hong Kong (Lin et al., 2020). In addition, exercising with a view of naturalness has a relatively greater effect on lowering blood pressure (Pretty et al., 2005). Kabisch et al. (2021) found that visiting a UGS with higher level of naturalness has protective effects on cardiovascular health of "young-old" (age 55–70) population. Neighbourhood green space is associated with lower risk of developing cardiometabolic (Kardan et al., 2015) and respiratory diseases (Alcock et al., 2017), diabetes (Astell-Burt et al., 2014), certain types of cancers (Demoury et al., 2017), and mortality (Wang et al., 2017). Living in a neighbourhood with higher percentage of green space shows improvement in frailty status among older adults (Yu et al.,

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2018). It is also related to lower anxiety disorder and depression prevalence rate (Maas et al., 2009b). The significance of UGS is higher to the elderly population, as older adults often spend considerable amount of time in green spaces (Yung et al., 2017). In contrast, lack of green nature leads to deteriorated mental well-being and less opportunities to recover from mental stress (Pretty, 2004), which is a strong predictor of mortality (Rainford et al., 2000).

UGS can serve as a place of encounter and social activities as well as exercise and physical activities. Barton et al. suggests that exercise in outdoor green space is effective in the recovery of mental illness, in which the associated social network and connection play a key role (Barton et al., 2012). Another study also shows the effect of UGS to enable the creation of social network among older people (Enssle and Kabisch, 2020). Having higher level of greenspace proximate from home is associated with less loneliness, less shortage of social support for elderly (Maas et al., 2009a).

Perception of UGS is closely associated with user behaviour and reflect the motives, preference and attitudes towards UGS and health-related quality of life (Crewe, 2001; Hunter, 2001; Tan et al., 2019). Subjective variables are stronger predictors than objectively measured quantity of residential UGS when predicting their usage (Flowers et al., 2016; Bloemsma et al., 2018). People appreciate and aspire for different benefits of UGS, but insecurity and crime may prevent them from using them or affect the usage pattern (Jim and Shan, 2013). Perceived safety of the UGS visited is found to be associated with physical health in older adults (Tan et al., 2019). Attractiveness, pleasantness and safety encourage people to use the UGS (Bell et al., 2003; Thompson et al., 2005) while perception of safety and accessibility of UGS affect its usage of older adults and their self-reported health (Finlay et al., 2015). Lo and Jim (2010) found that residents living in denser area preferred a single large park than the residents living in suburbs. In Hong Kong, high-rise residential development is common in suburbs, it is less compact and has a higher provision of green spaces. Residents in suburban areas also showed relatively low park usage and had different preferences regarding park design features.

Grahn and Stigsdotter (2010) identified eight perceived sensory dimensions (PSDs) to evaluate the recreational qualities of UGS, including "serene", "nature", "rich in species", "space", "prospect", "refuge", "social" and "culture". There are mixed views on the popularity of a green space and the PSDs it encompasses. Peschardt and Stigsdotter (2013) suggested that the more PSDs were recognised in a green space, the more preferred it would be; while Qiu and Nielsen (2015) found that users identified different PSDs in different green spaces, but it is not necessarily associated with users' preference to them. Many studies focused on the stress restorativeness and the sensory dimensions of the green space. Serene and social dimensions were found to be associated to users' perceived restorativeness of the UGS among average users; nature dimension is more important for stressed users (Peschardt and Stigsdotter, 2013).

In high-density cities, UGS is generally regarded as the extended living room for residents (Lau et al., 2005) with older adults spending a considerable amount of time there (Yung et al., 2017). With a population of approximately 7.3 million residing in slightly more than 1100 km² of land, the provision of UGS in Hong Kong is a challenging issue to urban planners and landscape designers due to the limited land resources. Yet urban densification has threatened the availability of UGS, and the quality of UGS is not improved to compensate for the decrease in quantity (Haaland and van Den Bosch, 2015). Provision of UGS in Hong Kong varies in different urban settings (Gong et al., 2016). UGS like street parks and those situated in public housing estates are scattered and usually smaller in size in dense urban areas, resulting in higher accessibility for older adults. On the contrary, UGS in suburbs like district parks are larger in size but are less connected with the neighbourhood. In compact urban areas, the development of new UGS is difficult and infill development made UGS provision in urban areas much harder (Jim, 2004). Moreover, with increasing urbanisation, it

becomes more difficult for urban dwellers to leave the city and visit relatively larger natural environment (Fuller and Gaston, 2009). Improving the quality of existing UGS can compensate for the reduced quantity of UGS from both the social and ecological perspectives (Bolleter and Ramalho, 2014).

The objectives of this study are to investigate older adults' frequency and duration of visit of UGS and their perceived quality of UGS, as well as to determine the relationship between the perceived quality and frequency and duration of visit of UGS in three common types of UGS in Hong Kong (green spaces in public housing estates, street parks and district parks). Findings of this study will provide insights to the design and management of UGS in order to better cater the need for active ageing in high-density communities. Specific research questions of the present study include:

1 Does perceived quality of UGS affect the frequency and duration of visit of UGS?
2 Is perceived quality, as well as the frequency and duration of visit associated with self-rated physical and mental health of older adults?

The two hypotheses of the study were 1) frequency and duration of UGS visits are positively associated with perceived qualities of the UGS in the older adult population; 2) perceived quality, the frequency and duration of visit are associated with self-rated physical and mental health of older adults

2. Methods

2.1. Site context and description

Hong Kong is located on the southern coast of China, with a total population of over 7.3 million and the population density of 27,330 persons per km² in urban areas (Census and Statistics Department, 2019). This study focuses on three common types of UGS in Hong Kong, including green spaces in public housing estates, street parks and district parks, which cover the majority of UGS in Hong Kong (Fig. 1). Street parks and district parks are managed by the Leisure and Cultural Services Department (LCSD). There are 26 district parks and 1583 street parks in Hong Kong (Leisure and Cultural Services Department, 2020), covering a total of 1048.8 hectares of open spaces (Lai, 2017). Street parks are situated alongside local roads or narrow streets, in close proximity to other amenities. Some are also found in private residential areas with individual residential buildings. Comparing to the other two types of UGS, they are usually smaller in size with only sitting benches and very limited facilities to space users. District parks are larger parks serving a broad community in the local districts. There are generally more facilities including jogging tracks, courts for ball games, water features, public toilets. They are provided according to the Hong Kong Planning Standards and Guidelines (HKPSG) which was first published by the Planning Department in 1981. It offers guidance for the provision of open space in designated areas of Hong Kong. In urban areas, the requirements of open spaces per person increased from 1.5m² in 1981 to 2m² in 2002. The provision of open spaces includes 1m² per person for Local Open Space (LOS), which are minimum 500m² in size, and 1m² per person for District Open Space (DOS), which are minimum 1 ha in size. In the strategic planning document, *Hong Kong 2030+: Towards a Planning Vision and Strategy Transcending 2030* (Planning Department, 2016b), it was proposed to be increased to 2.5m². While tree planting in these open spaces is encouraged, there is no specific design guideline given in the HKPSG on the amount and types of urban greening.

Green spaces in public housing estates, managed by the Hong Kong Housing Authority (HKHA), are located within the precinct of public housing estates which are generally composed of high-rise residential towers and self-contained with shopping centres and community facilities. Lai (2017) reported that green spaces in public housing estates cover 670.8 ha of open spaces managed by HKHA. This type of UGS is

(a) District parks

(b) Street parks

(c) Green spaces in public housing estates

(d) Questionnaire survey conducted by trained students

Fig. 1. Three types of UGS: (a) District parks, (b) Street parks, and (c) Green spaces in public housing estates. (d) Questionnaire survey was conducted by trained students (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

usually equipped with leisure and gymnastic facilities, as well as resting areas for the residents. In the *Sustainability Report 2017/18* (Hong Kong Housing Authority, 2019), the HKHA established green design guidelines that newly built estates have to include 20 % of the estate area and 30 % for sites over two hectares for greening. Within the area of public housing estates, the HKPSG suggests that $1m^2$ per person of open space should be provided, which is counted as LOS. In fact, 57 % of LOS are located within public housing estates (Lai, 2017). The average open space provided in Hong Kong as of 2012 is $2.7m^2$ per person (Planning department, 2016a). However, among all 18 districts in Hong Kong, there are insufficient LOS and DOS in four and six districts respectively.

2.2. Questionnaire survey

On-site questionnaire survey was conducted by trained students at 16 sites in different districts (Fig. 2). It was carried out from 05:00 to 18:00 on 31 days between January and December 2019. The interviewers covered all accessible areas including walking paths, resting areas, and park amenities. Respondents were randomly selected inside the UGS and the interview was voluntary and anonymous, with written consent forms signed to comply with the requirements of the university on the survey and behavioural research ethics. Prior to the survey, the respondents were asked if they were aged 60 years old or above, explained on the objectives of the study and questions that they would be asked.

Structured questionnaire was conducted to acquire information about the usage pattern and perception of UGS of older adults in Hong Kong. The first part of the questionnaire aims at understanding respondents' usage pattern of UGS, including the frequency, length and

time of their visits, as well as their usual activities in the UGS. The second part covers questions on a 5-point Likert scale (from very unsatisfied to very satisfied with a neutral option at mid-point) about their perception of nine qualities of UGS, including spaciousness, shading, proximity, aesthetics, maintenance, air quality, acoustics, cleanliness, overall perception of the UGS that they usually visit, based on the PSD approach suggested by Grahn and Stigsdotter (2010). In the third part, respondents' self-reported health conditions were acquired using Short Form-12 Version 2 Health Survey (SF12v2), which evaluates eight domains of respondents' health status, including self-rated general health status, physical functioning, physical role, bodily pain, vitality, social functioning, emotional role, and mental health (Ware et al., 2002). The traditional Chinese version, which was previously validated in Hong Kong (Wong et al., 2018), was adopted in the present study. Demographic and socio-economic information was collected in the fourth part of the questionnaire, including gender, age, education, and living arrangement.

2.3. Statistical analysis

Binomial logistic regression was conducted to examine how much the types of UGS and perceived environmental quality explains the frequency of visit and duration of stay. Two cut-off values in the frequency of visit were used. Users visiting more than once a week and users visiting everyday were analysed to examine the threshold of how frequent older adults visited the UGS is significantly associated with the perceived quality of UGS. For duration of stay, the cut-off values are "more than one hour" and "half a day". Respondents with missing data were excluded from the statistical analysis.
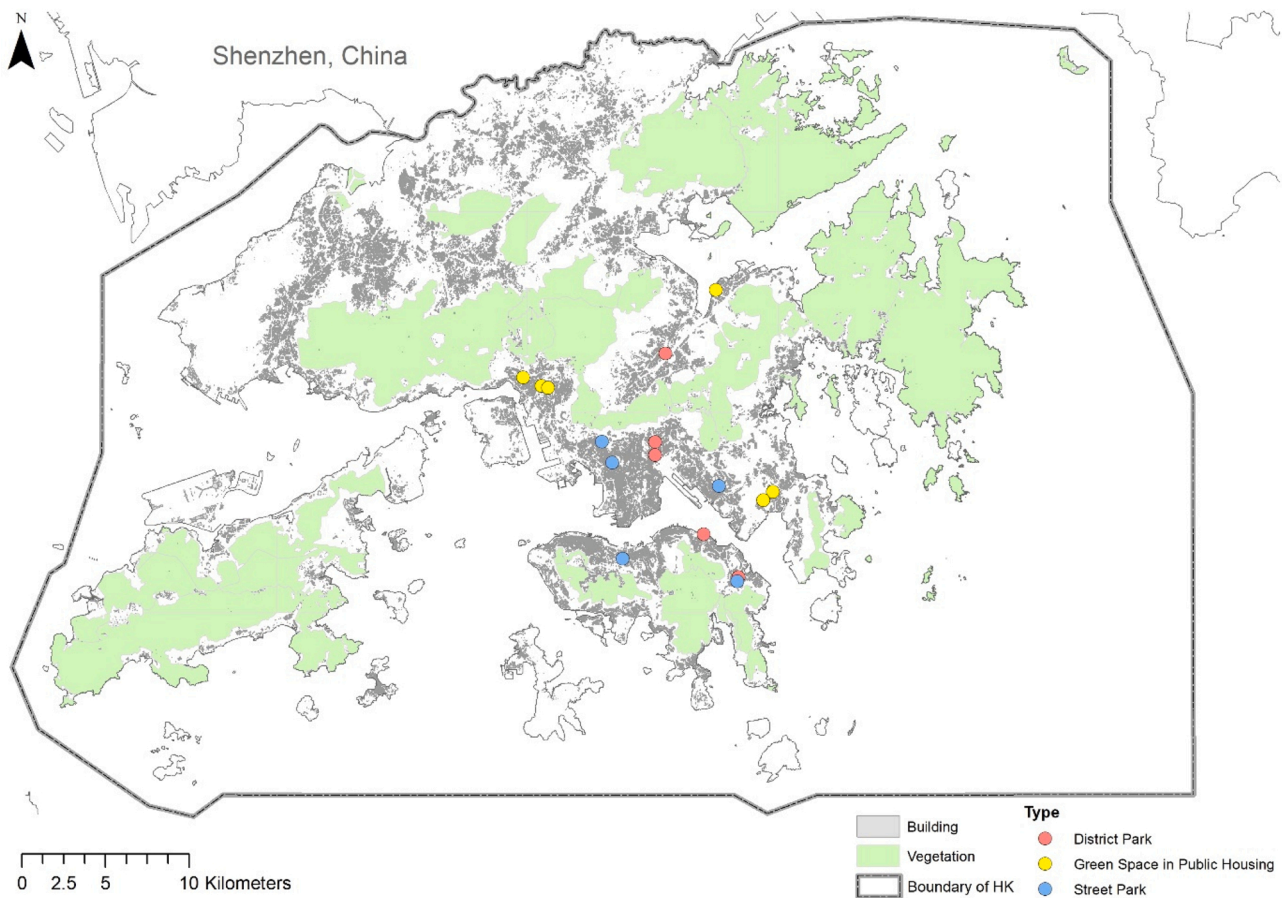
Fig. 2. Locations of the 16 sites where the survey was conducted.

ANOVA test was conducted to determine whether there are significant differences in perceived environmental quality between the types of UGS. Post-hoc Tukey's test was also conducted to determine pairs of UGS types which are significantly different in scores of perceived environmental qualities. The statistical analysis was conducted using IBM SPSS Version 22.

Binomial logistic regression was used to investigate the relationship between the usage and perceived qualities of UGS, and self-rated health conditions of the respondents, i.e. the physical component summary (PCS) and mental component summary (MCS) scores of the SF12v2 health survey. Three models, consisting of different combinations of independent variables, were used. Model 1 adjusted for the usage pattern of UGS including frequency of visit and duration of stay while Model 2 adjusted for the perceived qualities of the UGS. Model 3 adjusted for both sets of variables in order to examine any potential interactions between the usage and perception of UGS. All models were adjusted for socio-demographic conditions of the respondents, including sex, age, education, and living arrangement.

3. Results

3.1. Usage pattern of UGS

The characteristics of respondents are presented in Table 1. Older adults are frequent UGS users in Hong Kong as there were over 70 % of the respondents visiting the UGS on daily basis (Table 2). However, only 39.8 % of the respondents in street parks visited UGS every day. 17.1 % of the respondents visited the UGS more than once a week while 10.4 % of them visited once a week or less. Most of the respondents stayed in the UGS for half an hour to one hour and one to two hours. Respondents in

Table 1
Demographic information of the respondents.

	Public Housing	Street Park	District Park	Total	%
Gender					
Male	132	43	39	214	49.08%
Female	137	37	32	206	47.25%
Missing	16	0	0	16	3.67%
Age					
60−69	53	21	16	90	20.64%
70−79	102	34	24	160	36.70 %
80−89	84	24	25	133	30.50%
≥90	22	1	5	28	6.42%
Missing	24	0	1	25	5.73%
Education					
No formal education	69	15	15	99	22.71%
Primary	98	39	15	152	34.86%
Secondary	69	22	25	116	26.61%
Post-secondary	2	2	4	8	1.83%
Tertiary	7	1	3	11	2.52%
Missing	40	1	9	50	11.47%
Living Arrangement					
Living alone	46	19	11	76	17.43%
With family	193	57	54	304	69.72%
Others	13	3	2	18	4.13%
Missing	33	1	4	38	8.72%

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Table 2
Usage pattern of the respondents.

	Public Housing	Street Park	District Park	Total	%
Frequency of Visit					
Less than once a month	3	13	0	16	3.5%
Once a month	7	4	0	11	2.4%
Once a week	10	9	2	21	4.5%
Multiple times a week	34	30	15	79	17.1%
Everyday	235	37	55	327	70.8%
Missing	5	0	3	8	1.7%
Duration of Stay					
Less than 20 min	31	14	3	48	10.4%
Half to one hour	87	39	30	156	33.8%
One to two hours	132	28	35	195	42.2%
Half a day	30	7	7	44	9.5%
Missing	14	5	0	19	4.1%
Visit More than Once a Day					
Yes	109	12	2	123	26.6%
No	185	59	18	262	56.7%
Missing	0	22	55	77	16.7%
Accompany					
Alone	176	63	44	283	61.3%
With friends or neighbours	67	14	18	99	21.4%
With their family or housemaids	34	8	9	51	11.0%
Others	13	8	4	25	5.4%
Missing	4	0	0	4	0.9%
Usual Activities					
Sitting or resting	118	52	14	184	39.8%
Chat with others	116	23	17	156	33.8%
Doing exercise	108	23	50	181	39.2%
Playing chess	13	6	3	22	4.8%
Looking after kids	11	6	0	17	3.7%
Nearest UGS					
Yes	266	55	64	385	83.3%
No	24	37	11	72	15.6%
Missing	4	1	0	5	1.1%

street parks had a slightly shorter period of stay. Few respondents spent half a day in the UGS and most of them were above 90 years of age. Nonetheless, only 26.6 % of the respondents indicated that they visited UGS more than once a day.

The majority of the respondents usually visited UGS alone. 21.4 % of the respondents were accompanied by friends or neighbours while 11.0 % of them visited UGS with their family or housemaids. The distribution is consistent in the three types of UGS in this study. The pattern of the usual activities of the respondents varies considerably across the three types of the UGS. In green spaces in public housing estates, 40.1 % of the

respondents usually sat or rested in the UGS while 39.5 % of them chatted with others. 36.7 % of the respondents did exercise owing to the availability of age-friendly gymnastic facilities that allow them to do light exercise. In street parks, due to the limited facilities, over half of the respondents sat or rested there. In contrast, two-third of the respondents usually did exercise in the district parks because there are more facilities and jogging tracks available to park users. Only less than 20 % of them sat or rested in district parks. Furthermore, over 80 % of the respondents indicated that the UGS they normally visited is the nearest one available.

The type of UGS was also found to be associated with the frequency and duration of the visit (Table 3). The results of the binomial logistic regression analysis showed that respondents in street parks were less likely to visit UGS more than once a week than those in public housing. There are no significant associations in usage between public housing and district parks. However, respondents in the district parks were approximately 10 times more likely to visit UGS more than once a week than those in street parks and they are also more likely to visit UGS everyday than those in street parks. The results of duration of stay were also consistent with the frequency of visit. Respondents in street parks were less likely to stay for more than one hour than those in public housing. On the other hand, respondents in district parks were more likely to stay longer than one hour due to the availability of facilities there.

3.2. Perceived quality of UGS

The respondents were asked to rate the satisfaction level of nine perceived qualities of UGS. In general, they were satisfied with the proximity of the UGS that they usually visited with the highest mean values, with respondents in green spaces in public housing estates having the highest rating. It was followed by the spaciousness, air quality, cleanliness and overall perception with mean values from 3.73 to 3.79. Among the three types of UGS, respondents in district parks generally had the highest rating while those in street parks showed slightly lower scores than those in public housing. Maintenance and acoustics were generally less satisfactory and the lowest rating was found in shading in the UGS that they visited. In particular, respondents in street parks were least satisfied with air quality and acoustics of the UGS.

ANOVA test was conducted to test the significance of the mean of perceived qualities between the three types of UGS concerned in this study (Table 4). The results showed that most of the means of the perceived qualities were significantly different among the UGS ($\alpha = 0.05$), except shading and acoustics. Post-hoc Tukey's test was conducted to determine the significantly different pairs of UGS. In general, the differences between green spaces in public housing estates and street parks were not significant, except proximity and air quality. In contrast, all perceived qualities for public housing and district parks were significantly different, suggesting that the physical environment and corresponding authorities of management may play a significant role.

Perceived qualities were found to be associated with the frequency and duration of the visit (Table 5). Proximity to UGS was the predominant factor affecting the usage pattern since it was significantly

Table 3
Odds ratios and the 95 % confidence interval of the binomial logistic regression analyses for the relationship between types of UGS and usage pattern. Bold values indicate associations that are statistically significant at the 0.05 level.

	Frequency (> once a week)		Frequency (Everyday)		Duration (> 1 h)		Duration (Half a day)	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Ref (Public Housing)								
Street Parks	**0.20**	(0.10, 0.40)	**0.16**	(0.10, 0.28)	**0.50**	(0.30, 0.83)	0.73	(0.30, 1.76)
District Parks	2.24	(0.50, 10.02)	0.61	(0.32, 1.18)	0.99	(0.56, 1.75)	0.94	(0.39, 2.26)
Ref (Street Parks)								
District Parks	**10.54**	(2.38, 46.70)	**3.81**	(1.84, 7.89)	**1.73**	(1.00, 3.58)	1.33	(0.43, 4.05)

Table 4
Mean values and ANOVA with post-hoc Tukey's test about the perception of the nine perceived qualities in three types of UGS (1: green spaces in public housing estates, 2: street parks, 3: district parks).

Perceived Quality	Public Housing	Street Parks	District Parks	Overall	F-stats	P-value	Post-hoc Tukey
Spaciousness	3.70	3.75	4.16	3.78	8.46	<0.001	1vs3, 2vs3
Shading	3.36	3.42	3.46	3.39	0.31	0.7322	
Proximity	4.46	3.38	4.01	4.17	31.56	<0.001	1vs2, 1vs3, 2vs3
Aesthetics	3.60	3.43	4.12	3.65	17.00	<0.001	1vs3, 2vs3
Maintenance	3.34	3.47	3.67	3.42	3.19	<0.05	1vs3
Air Quality	3.84	3.33	3.96	3.75	14.15	<0.001	1vs2, 1vs3
Acoustics	3.44	3.37	3.54	3.44	0.54	0.5820	
Cleanliness	3.69	3.67	3.97	3.73	3.41	<0.05	1vs3
Overall	3.77	3.58	4.16	3.79	14.16	<0.001	1vs3, 2vs3

Table 5
Odds ratios and the 95 % confidence interval of the binomial logistic regression analyses for the association between perceived qualities and usage pattern of UGS. Bold values indicate associations that are statistically significant at the 0.05 level.

	Frequency (> once a week)		Frequency (Everyday)		Duration (> 1 h)		Duration (Half a day)	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Spaciousness	2.20	(0.84, 5.76)	1.07	(0.47, 2.46)	0.93	(0.43, 2.01)	0.42	(0.16, 1.11)
Shading	1.28	(0.61, 2.68)	1.15	(0.67, 1.96)	0.79	(0.48, 1.31)	0.49	(0.24, 1.01)
Proximity	**9.96***	(4.86, 20.43)	**4.73***	(2.50, 8.97)	**2.54***	(1.36, 4.78)	6.99	(0.93, 52.33)
Aesthetics	2.10	(0.80, 5.51)	1.82	(0.84, 3.96)	1.54	(0.71, 3.38)	0.50	(0.18, 1.40)
Maintenance	0.40	(0.14, 1.18)	0.59	(0.31, 1.09)	0.96	(0.56, 1.65)	0.53	(0.25, 1.12)
Air Quality	**2.41***	(1.02, 5.70)	1.94	(0.96, 3.91)	1.17	(0.59, 2.35)	0.78	(0.28, 2.16)
Acoustic	1.41	(0.67, 2.99)	1.31	(0.75, 2.27)	0.94	(0.56, 1.58)	0.97	(0.42, 2.23)
Cleanliness	0.91	(0.26, 3.16)	0.72	(0.29, 1.77)	1.86	(0.84, 4.14)	0.69	(0.22, 2.13)
Overall	1.94	(0.38, 9.89)	1.39	(0.37, 5.30)	2.38	(0.57, 9.96)	0.36	(0.07, 1.93)

associated with both frequency of visit and duration of stay. Respondents who were satisfied with the proximity were found to be more likely to visit UGS more than once a week and everyday. They were also more likely to stay for more than one hour in the UGS if they opined that the UGS is close to their homes. However, proximity was not significantly associated with longer stay in the UGS. Air quality was significantly associated with the duration of stay. Respondents who perceived good air quality were more likely to visit UGS more than once a week.

3.3. UGS usage, perception and health

Self-rated physical health was found to be associated with exposure to green spaces (Table 6). Model 1 showed that respondents staying in the UGS for more than an hour during their regular visit were more likely to have PCS score higher than 53.54 (the highest quintile) than those staying there less than one hour (OR: 2.01, 95 % CI: 1.08, 3.73, R^2-adj: 0.52). None of the associations between perceived qualities of UGS and PCS were significant after adjustment. In the multivariate model adjusting for both usage pattern and perceived qualities of UGS, the association between high PCS score and longer duration of stay remained significant (OR: 2.11, 95 % CI: 1.11, 4.02, R^2-adj: 0.41) but none of the perceived qualities were significantly associated with higher PCS score. It indicates that there were no additive interactions between the satisfaction of perceived qualities of UGS and the physical health of the respondents.

The results of binomial logistic regression showed that mental health of the respondents was associated with duration of stay in UGS. As shown in Model 1, respondents staying in the UGS for more than two hours during their regular visit were likely to be in the highest quintile (20 %) of the MCS score (OR: 2.88, 95 % CI: 1.26, 6.55, R^2-adj: 0.34). When the model was adjusted for perceived qualities of UGS (Model 2), higher MCS score was found to be significantly associated with satisfaction of the acoustic environment (OR: 3.50, 95 % CI: 1.38, 8.91, R^2-adj: 0.48), indicating that respondents satisfied with the acoustic environment were likely to have higher MCS score. Model 3 showed that higher MCS score was associated with longer duration of stay (OR: 3.17, 95 % CI: 1.34, 7.49, R^2-adj: 0.51) and satisfaction of the acoustic

environment (OR: 3.42, 95 % CI: 1.33, 8.75, R^2-adj: 0.31). It implies that there were interaction effects in the relationship between better mental health and longer exposure of UGS.

4. Discussion

The usage and perception of UGS of older adults in Hong Kong were investigated by using structured questionnaire conducted at the study sites. Adults above 70 years of age, i.e. "old-old", made up most of our respondents. This may be due to their physical constraints which prevents them from travelling or having other activities. Going to UGS nearby may be the most convenient option to spend their leisure time outside home (van der Meer, 2008). Few respondents mentioned that they were involved in daily chores while some were even accompanied by housemaids. On the contrary, "young old" may have more options for activities in the community such as volunteering work, community services (Choi and Chou, 2010). Younger respondents are more likely to have other duties, including preparing meals for family, picking up children from school, and bringing children to parks (Sonti et al., 2020). They may travel to UGS between these errands and hence tend to stay for shorter periods, thus less of them is included in the study.

Usage pattern of UGS varied across different types of UGS. Respondents visited UGS in public housing estates more frequently and spent longer time there. It echoes the findings of similar studies that living closer to green spaces predicts higher frequency of visit while the number of visit decreases as the distance between their homes and green spaces increases (Fongar et al., 2019). Respondents in district parks were younger in general. The higher satisfaction level of perceived quality in district parks was likely the reason for "young-old" to travel a longer distance. In Hong Kong, district parks are usually not in close proximity to residential areas. Due to limited land resources, they are only one to two large urban park(s) in each district. However, the Hong Kong Planning Standards and Guidelines specifies that local open spaces (i.e. street parks) are required to be located within approximately 400 m from residential areas. A previous study suggested that older people's priority of environmental attributes may vary by factors such as their degree of mobility and living status (Aspinall et al., 2010).

Table 6

Odds ratios and the 95 % confidence interval of the binomial logistic regression analyses for the association between PCS and MCS, and usage pattern and perceived qualities of the UGS. Bold values indicate associations that are statistically significant at the 0.05 level.

	Model 1		Model 2		Model 3	
	OR	95 % CI	OR	95 % CI	OR	95 % CI
Physical Component Summary						
Frequency (more than once a week)	0.87	(0.35, 2.18)			0.72	(0.26, 2.04)
Duration (more than one hour)	**2.01***	(1.08, 3.73)			**2.11***	(1.11, 4.02)
Duration (half a day)	1.23	(0.53, 2.88)			1.37	(0.57, 3.30)
Spaciousness			2.53	(0.54, 11.96)	2.06	(0.42, 10.11)
Shading			1.37	(0.63, 3.00)	1.62	(0.69, 3.82)
Proximity			1.91	(0.74, 4.96)	1.48	(0.51, 4.31)
Aesthetics			1.36	(0.31, 5.95)	1.01	(0.23, 4.40)
Maintenance			1.78	(0.73, 4.30)	2.01	(0.76, 5.32)
Air Quality			1.21	(0.34, 4.36)	1.08	(0.29, 4.04)
Acoustics			0.92	(0.44, 1.89)	0.78	(0.37, 1.64)
Cleanliness			0.95	(0.27, 3.37)	0.65	(0.18, 2.38)
Overall			0.50	(0.08, 3.16)	1.44	(0.70, 2.96)
Mental Component Summary						
Frequency (more than once a week)	1.37	(0.54, 3.49)			1.57	(0.55, 4.46)
Duration (more than one hour)	0.66	(0.36, 1.23)			0.71	(0.37, 1.36)
Duration (half a day)	**2.88***	(1.26, 6.55)			**3.17***	(1.34, 7.49)
Spaciousness			0.78	(0.24, 2.53)	0.73	(0.21, 2.47)
Shading			1.43	(0.67, 3.07)	1.74	(0.77, 3.95)
Proximity			0.85	(0.38, 1.86)	0.67	(0.27, 1.63)
Aesthetics			1.21	(0.32, 4.55)	1.34	(0.34, 5.30)
Maintenance			0.86	(0.40, 1.86)	1.03	(0.45, 2.36)
Air Quality			0.60	(0.19, 1.94)	0.50	(0.15, 1.68)
Acoustics			**3.50***	(1.38, 8.91)	**3.42***	(1.33, 8.75)
Cleanliness			1.00	(0.31, 3.23)	0.86	(0.27, 2.80)
Overall			1.13	(0.57, 2.24)	1.07	(0.53, 2.16)

Perceived qualities of UGS were different across the types of UGS. District parks were significantly different from the other two types of UGS due to their sizes and locations, as they are generally larger in size and distant from residential areas. Maintenance and cleanliness were found to be different between district parks and public housing estates. This is likely the result of different maintenance and cleaning intensity of the two types of UGS. District parks were managed by Leisure and Cultural Services Department which has a more frequent maintenance and cleaning schedule while UGS in public housing estates were managed by Housing Department which is responsible for the entire public housing estates in general. Moreover, poor air quality and acoustics were important perceived qualities in street parks and public housing estates because of the exposure of vehicle traffic, implying that the location of UGS is also an important consideration for users'

experience.

One of the hypotheses of this study is that the frequency of visit to UGS and duration of stay of the respondents are affected by the perceived qualities of the UGS. Results showed that proximity to the UGS was the predominant perceived quality associated with the frequency of visit and duration of stay. Respondents were more likely to visit the UGS more frequently if they were more satisfied with the proximity to the UGS that they regularly visit. It is consistent with previous studies that the distance from people's home to neighbourhood green spaces is a determining factor to their willingness of visiting open and green spaces (Schipperijn et al., 2010; Coombes et al., 2010), especially for older adults with limited mobility (Portegijs et al., 2014). Satisfaction of air quality in the UGS was also found to be associated with the frequency of visit. A Norwegian study found that people who visited UGS less than once a month assessed the place as lower in quality than those who visited more frequently (Fongar et al., 2019). Other studies suggested that size, shading, air quality and maintenance all have a positive influence on park use (McCormack et al., 2010; Grilli et al., 2020). The present study, however, does not show a similar result for these qualities.

There are a number of reasons that explain the findings of this study. Firstly, a large proportion of the elderly population in Hong Kong lives in high-density urban areas, usually in small apartment flats with limited spaces. They usually do not have their own gardens in the backyards, unlike those who live in rural areas. As such, UGS becomes the primary venue where they can seek to be with nature or open spaces for various activities including exercise and socializing with others. Lo and Jim (2010) suggested that UGS in Hong Kong is culturally perceived as a place for social interactions rather than a tranquil sanctuary as in western countries. Neal et al. (2015) illustrated that encounter in green space may create affinity for the place and connection with other people even without interaction. A Dutch study also found that urban park users enjoy being at UGS even if they do not expect intensive interaction with strangers and hence might stimulate social cohesion (Peters et al., 2010). This echoes our result that the majority of older adult enjoy going to UGS without a particular companion, although they may socialize if they meet friends and neighbours at the UGS. Visitors may be less sensitive to the physical features of the UGS and continue to pay regular visit to such an extension of their living space. Instead of attributes of the UGS, they suggested that people's connections to the neighbourhood and their sense of belonging exerted a stronger effect on their usage pattern. This requires further investigation to determine the relationship between older adults' sense of community and belonging, and the corresponding effect on their usage pattern of open spaces. Positive perception of the community could also motivate park visits (Lo and Jim, 2010; Seaman et al., 2010). As older adults are more likely to live in the neighbourhood which they are more familiar with, they may have stronger bonding to the place and people there, which is also a reason for their frequent visit to such UGS.

The second reason is the uniformity of the UGS which older adults usually visit. During the interview, very few respondents provided suggestions when they were asked how they would like the UGS to improve. In street parks and public housing, some of the respondents expressed that the spaces were too small to add more facilities and there were not many possibilities for UGS to improve as they were arguably the same everywhere. These parks are mainly operated by Leisure and Cultural Services Department and Housing Department with similar designs and management guidelines. As such, older adults in Hong Kong might have low expectations for UGS. The high intensity of UGS usage may be driven primarily by the high demand for greenery and open spaces in the neighbourhood, rather than their positive perception of specific features of UGS.

Results of this study showed that both better physical and mental well-being were associated with longer duration of stay in UGS. Vice versa, the impact of exposure to greenery on a better health was reported in previous studies that longer exposure to greenery in the

neighbourhood leads to better health conditions of the residents, indicating the interplay between physical and mental health and exposure to greenery (Shanahan et al., 2016). A study in Greece found that resident's perceived quality of UGS in their municipality was linked with their satisfaction in life (Karanikola et al., 2016). The perceived acoustic environment is associated with the mental health of respondents. Visitors seeking for stress relief do not prefer crowded greenspace (Campagnaro et al., 2020), which might associate with an unpleasant acoustic environment. Grahn and Stigsdotter (2010) found in their study that serene, together with nature, rich in species and refuge dimensions were positively correlated with stress restoration. A subsequent study also found that serenity was rated as the most preferred dimension in stress reduction (Stigsdotter et al., 2017).

The findings of this study are limited by the fact that the survey was conducted in the period when the UGS were relatively crowded in order to obtain a higher response rate. Since there were many older adults in the UGS, it is possible to acquire a biased sample towards those enjoy socializing with others in UGS, and less likely to interview those prefer a quiet environment in the UGS. Another limitation concerns the self-reported nature of SF12v2. Respondents might inaccurately estimate their health or reluctant to reveal their genuine health status to the interviewers. In addition, the survey was conducted in outdoor spaces and older adults who do not or less frequently visit were not covered. The results of the present study may not be readily applied to this group of older adults. A larger sample size, especially in street and district parks, would provide more reliable results in certain aspects and have a more balanced profile of socio-demographic background of the respondents.

5. Conclusions

Understanding how elderly perceive and use urban green space is essential in designing and managing urban green space, especially in high-density and ageing cities. The research investigated the linkage between perception and usage of three types of UGS (green spaces in public housing estates, street parks and district parks) in elderly people living in Hong Kong. Our results show that elderly's usage pattern varies across age and types of UGS they visit. Among all the perceived qualities we examine in the survey, perceived proximity is the predominant factor affecting UGS usage. Combined with the compact urban form and cultural reasons, physical attributes of the space may play a less significant role than other factors, such as social and community factors, in motivating UGS use. Our results also found that longer exposure to UGS leads to better physical and mental well-being. Designer and management of UGS can take into account the result of this research, to create better environment for elderly in high density areas. Future research on UGS should also focus on factors beyond physical green space, i.e., characteristics of the community and cultural reasons could be influential to users' behaviour and experience.

Authorship contributions

Conception and design of study: K.K.L. Lau; C.C.Y. Yung; Z. Tan
Acquisition of data: C.C.Y. Yung; Z. Tan
Analysis and/or interpretation of data: K.K.L. Lau; C.C.Y. Yung
Drafting the manuscript: K.K.L. Lau; C.C.Y. Yung
Revising the manuscript critically for important intellectual content: K.K.L. Lau; C.C.Y. Yung; Z. Tan
Approval of the version of the manuscript to be published: K.K.L. Lau; C.C.Y. Yung; Z. Tan

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.

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