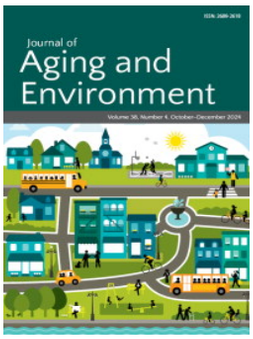

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Applying a Participatory Design Model-Making Engagement Activity to Understand How Different Stakeholders Envision Senior-Friendly Outdoor Gyms in Parks

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ABSTRACT

Purpose: Population aging has led to an increased focus on creating outdoor gyms in parks for seniors. Twenty-five participants from a broad age spectrum, with different education levels, and with different role identities participated in the model-making engagement activity and semi-structured interviews in parks and university settings. Themes associated with participants' choice of exercise apparatus, supportive environmental design, and spatial arrangement in the outdoor exercise space were identified. The three-dimensional models created by the participants provided visual insights into their envisioned senior-friendly outdoor gyms. The findings of this study provide valuable guidance for designing senior-friendly outdoor gyms in parks.

KEYWORDS
Participatory design; engagement technique; model-making; outdoor gym; parks

Introduction

Historically, less attention has been given to designing specific outdoor exercise spaces for older adults than for children. However, in the last

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decade, the phenomenon of population aging has led to an increased focus on creating outdoor exercise spaces for seniors. No standard terminology for senior-friendly outdoor exercise spaces has been established, but the literature has referred to such spaces as "seniors' playgrounds," "geriatric parks," "golden age gyms," and "senior exercise parks"(Lee & Ho, 2021). The design of these spaces varies across regions. Some designers make the spaces senior-friendly by installing low-impact exercise equipment, while others ensure a supportive environment that has adequate lighting, handrails, and benches for resting (Hamström, 2009).

Research on older adults' perceptions of senior-friendly outdoor gyms and their behavior within them has increased in recent years (Chow, 2013; Chow & Wu, 2019; Lee & Ho, 2021). The functions of these gyms have been found to go beyond the attainment of physical fitness. An outdoor gym with low-impact exercise equipment offers a special space in which both able and less able older adults can engage in manageable activities. It is also a space in which they can learn from, support, and interact with each other outside their homes.

Although creative qualitative methods such as participatory design have been used to incorporate children's views into the design of children's playgrounds (Caro et al., 2016; Menconi & Grohmann, 2018), few studies have investigated older adults' visions for outdoor gyms designed specifically for them. In recent years, participatory research methodologies have become popular for gathering insights from groups, such as children and older adults, who may find it challenging to express their opinions verbally or through reading and writing (Brookfield et al., 2020; Simoncini et al., 2017). Participatory research methods are more inclusive and use non-verbal techniques to help groups who are less confident in speaking and writing express their ideas. Participatory research involves the participant as the generator of data, who works with academic and industry experts as equal partners to co-create a solution. Common participatory research methods include photovoice, participatory mapping, drawing, and model-making (Brookfield et al., 2020).

Participatory research methods have been increasingly used in the past decade to improve the quality of life of older adults. It has been applied to assess their mobility issues (Cinderby et al., 2018), age-friendly community development (Buffel, 2018), and e-health services (Scandurra & Sjölinder, 2013). Cumulative evidence suggests that input from older adults is important to the development of services, products, and communities tailored toward them, and that they can become deeply engaged in participatory design activities (Scandurra & Sjölinder, 2013). Thus, participatory research represents a valuable tool that can help researchers understand the perceptions of participants (Hatton et al., 2020). Some scholars have suggested

that older adults provide creative input when they are involved in participatory design activities, they make better critics of existing designs than originators of new designs (Brookfield et al., 2020). Among various types of the participatory design engagement activities, model-making can enable older adults to present complex ideas quickly and directly. The making process can create a playful atmosphere and unlock creativity in older adults (Brookfield et al., 2020). The aim of the study is to describe the application of model-making activities to elicit stakeholders' visions for senior-friendly outdoor gyms in public parks in Hong Kong, and identify common features that a diverse group of stakeholders perceive as important. This research is positioned at the intersection of four disciplines: exercise and wellness, gerontology, design, and participatory arts. It has the following specific objectives: 1) to describe the acceptability of a participatory design model-making activity through a short survey; 2) to identify the features that affect stakeholders' selection of exercise apparatus when designing a senior-friendly outdoor gym; 3) to identify the important environmental support features of a senior-friendly outdoor gym for stakeholders; and 4) to identify the important spatial design features for stakeholders of a senior-friendly outdoor gym.

Materials and methods

Design

This is a qualitative study adopting participatory research approach which advocates the active involvement of stakeholders (Slocum-Bradley, 2003).

Participants

Purposive maximum variation and convenience sampling were applied to recruit participants. The adoption of maximum variation sampling allowed the research to identify important common patterns that are common across the diversity. Stakeholders of senior-friendly outdoor gyms including older adults with various health conditions, caregivers, current users and non-users were recruited. The recruitment strategies included directly approaching participants in public parks, posting recruitment posters at the first author's university, and sending emails to non-government organization which provide services to older adults. Recruitment poster remarked that older adults with various health conditions and caregivers were welcome to sign up for the research. Participant recruitment period took place from August 2023 to December 2023. The participants were required to be adults aged 18 years or above and either current users or potential users of senior-friendly outdoor gyms. Adults who are cognitive impaired or suffered from aphasia, which

made them unable to participate in model-making activities and concurrent verbal interviews were excluded from the study.

Ethical statement

This study obtained ethics approval from the Institutional Review Board of The Hong Kong Polytechnic University (approval number: HSEARS20221129001). Information sheets with details of the study and issues regarding voluntary participation, confidentiality and potential risks, and benefits were provided and explained to the participants before the commencement of data collection, and written consent was obtained.

The toolkit: contextually-relevant tailor-made models and make-ready models

The second author, who has an education background in product design, resized color-printed images of common exercise apparatus found in Hong Kong to 1:25 using Photoshop and stuck the images on foamboard to make them three-dimensional. An 84×60 cm image of a safety rubber mat commonly found in outdoor exercise spaces in Hong Kong was printed on cardboard. Miniatures of trees, benches, plants, and a Chinese-style pavilion were bought as ready-made materials (Supplementary file 1 provides the full list of exercise apparatus).

The participatory design model-making protocol

Model-making is an activity that encourages non-designer participants to provide concrete input into a topic by using different tools (Brandt et al., 2012). "Making" is part of a method that enables participants to create "things that describe future objects or views on future experience" (Sanders & Stappers, 2014). No stringent protocol was applied in the model-making process, and it was observed that the participants were unable to immediately engage in model-making activities. Thus, we began with a discussion of the participants' experiences and perceptions of the outdoor gym, and the researcher then explained the model-making toolkit and the functions of all of the available exercise apparatus. During the exercise apparatus selection activity, the participants were invited to mention any benefits that they would like to obtain, and the researcher then suggested appropriate exercise apparatus that they could incorporate into the model. During and after the model-making procedure, they were invited to explain their design ideas (Table 1 illustrates the model-making protocol, and the interview guide used along the activity). The model-making activities were conducted

Table 1. The model-making protocol and interview guide.

Protocol	Interview guide	Facilitation by researcher
1. Selecting exercise apparatus that you perceive to be important and decide how you would like to place it in the exercise space 2. Design the supporting environment of the exercise space (e.g., trees, plants, bench, pavilion)	• What makes you select these exercise apparatuses? (Do you want to suggest any modification on the exercise apparatuses?) • What makes you design the space in this way? How will this design facilitate the activities in the space? • Is there any environmental design feature(s) that will facilitate your experience in the senior-friendly outdoor exercise space?	• Researcher explain the functions of the exercise equipment to participants • If needed, some groups are given sticky notes to express their wish

both individually and in group format. The determination of format is based on co-ordination convenience.

Data collection procedure

Data were collected from August 2023 to December 2024. Approximately half of the model-making activity and the interviews were conducted in parks in sheltered spaces like pavilions, and half of the participatory engagement activity was conducted in a classroom of a university. The participatory engagement activity and interviews were conducted by the first author and a research assistant in Chinese. The first author is an experienced female physical activity researcher with a Ph.D. qualification and seven years of experience of conducting qualitative research. The research assistant is an undergraduate occupational therapy student who received interview skills training from the first author before the commencement of the study. She worked with the first author on two parallel sessions before conducting the activities and interviews alone. The model-making process and interviews were audio and video recorded, and the senior-friendly outdoor gym model was photo-recorded.

Data analysis

Audio data were transcribed by a third party into Chinese. Illustrative quotations were translated by first author into English and edited by professional editing during manuscript writing stage. NVivo Version 14 (QSR International Pty Ltd) was used to code and manage the data. The aim of the data analysis was to generate straightforward and pragmatic insights to inform the outdoor gym literature. Therefore, a descriptive qualitative methodology was adopted (Sandelowski, 2000). A framework analysis (Ritchie et al., 2013) was applied, in which the data were inductively coded and deductively mapped onto a framework comprising 1) the elements affecting

stakeholders' choices of exercise apparatus; 2) the environmental support features important for senior-friendly outdoor gyms; and 3) the spatial design features important for senior-friendly outdoor gyms. As the research aimed to identify common patterns across diverse stakeholder groups, therefore a comparison-focused analytic approach was not used. Instead, quotations from various stakeholders were organized according to this framework without further subgroup analysis. The models created by the participants were not analyzed but helped the researchers understand the participants' views. The first author was the main analyst who coded and analyzed the data. For the first ten sets of model-making and interviews data, the first author discussed the findings with the second author and agreed on the analytical framework. In addition, comments solicited from two conference presentations based on the first ten set of data confirmed the direction of analysis. Employing a codebook based on MacQueen and colleagues' team coding approach (MacQueen et al., 2008) (Supplementary file 2), the first author and second author independently code all the data. This process reduces researcher bias and ensure reliability of the coding process. The interrater reliability was 86% between first and second author. Discrepancy in coding was resolved through discussion. The other four coauthors, who have backgrounds in landscape architecture, town planning, rehabilitation, and expressive arts, reviewed the themes, subthemes, and the illustrative quotations prepared by the first author and second author with background in physical activity research and design respectively. Feedback from the other four coauthors were incorporated directly if there were no conflicts of opinions between all the authors. Discrepancies between authors were resolved through discussion. After one round of feedback and discussion, the themes, subthemes and illustrative quotations were confirmed.

Credibility, transferability, dependability, and confirmability.

The following measures were taken to ensure the study's credibility, transferability, dependability and confirmability (LoBiondo-Wood & Haber, 2006). Analysts from multiple disciplines reviewed the theme tables and illustrative quotations. The interpretations were guided by triangulation and produced evidence that offered practical insights. Various demographic and contextual characteristics of the participants were collected to ensure that the findings of the study could be transferred to contexts beyond the research. The audio and video recordings and the transcriptions ensured dependability and confirmability.

Results

Fourteen sessions of engagement activities were conducted. Twenty-five participants aged 29 to 93 (mean: 65.12 ± 13.12) took part in the study,

Table 2. Participants' characteristics.

Code	Age	Background	Educational attainment	Model-making format
1	93	User approached in a park	Secondary level	Individual
2	71	User approached in a park	Secondary level	Individual
G1	67	Users approached in a park	Primary level	Group
	73	Users approached in a park	Less than primary level	
5	74	User approached in a park	Primary level	Individual
6	75	User approached in a park	Primary level	Individual
7	65	User approached in a park	Secondary level	Individual
G2	60	Users approached in a park	Less than primary level	Group
	61	Users approached in a park	Primary level	
	62	Users approached in a park	Less than primary level	
	63	Users approached in a park	Primary level	
G3	60	Users approached in a park	Secondary level	Group
	62	Users approached in a park	Secondary level	
8	64	Stroke survivor	University level	Individual
9	66	Community-dwelling older adult	Secondary level	Individual
G4	65	Stroke survivor	Less than primary level	Group
	60	Caregiver of community-dwelling older adult	Secondary level	
G5	29	Caregiver of community-dwelling older adult	Above University level	Group
	70	Community-dwelling older adult	Secondary level	
G6	64	Parkinson's disease patient	Secondary level	Group
	64	Caregiver of Parkinson's disease patient	Secondary level	
	62	Community-dwelling older adult	Primary level	
G7	66	Community-dwelling older adult	Above University level	Group
	35	Caregiver of community-dwelling older adult	University level	

either individually or in group format. The majority were female (n = 18, 72%). In terms of education, 16% of them had not completed primary school education, 28% had only attained primary school level, and the remainder had attained secondary school level or above (n = 14, 56%). Most lived in public or subsidized housing (n = 15, 60%) and with family members (n = 22, 88%). The majority of them reported an "average" perceived health status (n = 14, 56%), were totally independent (n = 22, 88%), and could walk unaided (n = 21, 88%). Almost half visited outdoor gyms in parks in Hong Kong five to seven days per week (n = 12, 48%), spent more than 60 minutes at the facilities (n = 21, 32%), and were physically active, engaging in at least 150 minutes of moderate-to-vigorous physical activity per week (n = 19, 76%) (Table 2 gives the key demographic and contextual characteristics of the participants).

Participants' perspectives on the model-making activity

A survey applied in a previous study of engagement techniques was used in the current study (Brookfield et al., 2020). This short survey revealed that the majority of the participants agreed or strongly agreed that they enjoyed the model-making activity, that the activity was easy to understand, that the activity provided opportunities for them to highlight topics that they felt were important to the design of the environment, and that the activity was an effective method of exploring their views on the design of the environment (Table 3).

Table 3. Participants' perspectives on the participatory design model-making activity (n = 25).

	Agreement with statement: 1, strongly disagree, to 5, strongly agree				
Item	1	2	3	4	5
I enjoyed taking part.			4%	16%	80%
The activity was easy to understand				20%	80%
It was easy to take part in the activity				12%	88%
The activity provided opportunities for me to highlight topics that I feel are important to the design of environments.				24%	76%
The activity was an effective method of exploring my views on the design of environments.			8.3%	16.7%	75%

Themes associated with participants' choice of exercise apparatus in senior-friendly outdoor gyms

When participants were asked to choose exercise equipment for their ideal senior-friendly outdoor gyms, they emphasized the importance of selecting apparatus that can be used by individuals with varying health conditions, from the fitter to the frailer. They also highlighted the importance of the equipment's health and rehabilitation benefits. Additionally, safety features and digital elements were important factors they considered when selecting exercise equipment for their ideal outdoor gym.

"A wide variety of people can utilize it," "health and rehabilitation benefits," "safety," and "digital elements" are the four themes associated with participants' selection of equipment (Table 4).

Themes associated with supportive environmental design

When participants were asked to design supportive environmental features for the outdoor gym, they suggested including storage for personal belongings, drinking facilities, handrails, resting areas, natural elements, and pathways. "Baggage," "drinking facilities," "handrail," "shelter," "resting facilities," "natural elements," and "path" were themes associated with supportive environmental design (Table 5).

Themes associated with spatial arrangement in the exercise space

When participants were asked to design a supportive spatial arrangement, they suggested clustering exercise equipment into different boundaries and zones. These areas would be organized based on exercise function, type, intensity, and age-appropriate categories (Figure 1). Passageways should accommodate wheelchair users. The placement of exercise equipment should consider the dynamics of movement (Figure 2) and encourage social

Table 4. Themes associated with participants' selection of exercise equipment.

Themes	Subthemes	Exemplar quotes
A wide variety of people can utilize it	• Various health conditions • Family caregiver • Recovery from stroke • Individuals with mobility issues • Challenging intensity • Light intensity	"This can be used for stretching the calves or training muscles. Many people can use it." (7; outdoor gym user approached in a park) "This can be used by the younger ones. When they bring senior members in their family to use the equipment, they can also exercise." (G5; caregiver of older adult) "This is essential, some stroke survivors cannot walk, they can sit on it [to exercise]. I saw some users who had survived a stroke and were wheelchair-bound. They did not have much strength, if they had this [equipment], maybe they could use it. There is no need to have strong hands, the hands only need to hold [the bar], the legs can push." (1; older adult's outdoor gym user approached in a park) "This is good for those who have mobility issues. The movement is not vigorous." (G2; older adult's outdoor gym user approached in a park)
Health and rehabilitation benefits	• Suspicious of health benefits • Lower limbs training and walking ability • Fall prevention • Spine health • Lower back • Cardiorespiratory function • Frozen shoulder • Joint health • Muscle-toning • Back exercise • Co-ordination	"If the older adults can walk quite steadily, this is not that useful, because the step is not too high. But these are good for those who need wheelchairs to assist with their walking. They can make use of this step to move their legs a bit. In this case, this is useful." (G4; stroke survivor and caregiver of older adult) "This pull-up is very challenging. I think it is difficult … if this is for older adults, I think it is too challenging … " (G7; caregiver of older adult, older adults) "The one that is light is always used by many users, but the one that is heavy is not used by most users." (1; older adults' outdoor gym user approached in a park) "This is good, I used this in my physiotherapy session too. Healthy people can also use it." (8; stroke survivor) "This is too simple. You just hold onto it, looks like you cannot train for anything" (G5; older adult and caregiver of older adult) "[Using this equipment for training] ensures that we do not easily fall, because we have to raise our legs up, and if our legs get used [to the leg raising movement], we won't fall. Other people also tell me [after doing this for exercise] they are not easily prone to falling now." (G1; older adults' outdoor gym user approached in a park) "I like this. It is good for the younger users too. Twisting is good. [If we do not twist] our body, it can easily get injured. It is good to loosen up the lower back. In the past, when I was in my forties and fifties, I sat and sewed, and my lower back was always painful. Finally, the doctor advised me to do a twisting exercise every morning, and since that I have not had any pain." (G2; older adults' outdoor gym user approached in a park) "[we need] the rider, it can train the back" (7; older adult's outdoor gym user approached in a park) "Because [my] legs are not good … most older adults cannot walk very well, cannot co-ordinate well. So, I think it is best to have [equipment] to train the legs. Especially if we suffer from Parkinson's disease, it is important to exercise the legs." (G7; older adult and caregiver of older adults)

(*continued*)

Table 4. Continued.

Themes	Subthemes	Exemplar quotes
Safety	• Safe design • Unsafe design • Perceived unsafe exercise movement	"This looks very safe, there is a handrail on both sides." (G5; older adult and caregiver of older adults) "If there is a need to reduce exercise equipment, take away the twister, [because] if the user cannot twist well, it is easy to get injured." (7; older adult and caregiver of older adults) "Looks like it is not very safe [to use], as there is a certain distance between the bike and the handle bar. Not aware that this handle bar is for assistance. Reluctant to use it because the spine cannot keep straight. Many people cannot keep their spine straight. Not safe enough and it is easy to slip over. For those who are not good with balance, it is easy to slip." (G7; older adult and caregiver of older adults)
Digital element	• Education • Automation	"The most important thing is that there is someone teaching older adults. Sometimes I saw that people used it incorrectly. If there is a QR code to use, we can just [scan it] and watch the video clips. The words [text] in the video clips have to be big enough and not too fancy." (G4: stroke survivor, older adult) "Can we add a digital element? For example, when the older adult walks close to the equipment, the equipment could offer help." (G5; older adult and caregiver of older adults)

interaction. Seating arrangements should allow users to rest, queue for equipment, and be easily monitored by caregivers (Figures 1 and 4)."Set boundary and zone according to function, type, intensity and age-appropriate category," "spacing that consider wheelchair user," and "spacing exercise apparatus according to the dynamism of the exercise movement," "placement of exercise equipment that allow interaction," and "seating arrangement that allows rest, lining up for equipment and monitoring by caregiver" are themes associated with the spatial arrangement of the exercise space (Table 6).

Observations and reflection

Participants' previous outdoor gym experience

The participatory design model-making activity was inevitably affected by whether the participants had experience of using outdoor gym equipment. Figures 2 and 3 present senior-friendly outdoor gym models designed by those who visited the parks. Their selection of exercise apparatus and overall design were similar to those available in the parks where the interviews took place. Figures 1 and 4 illustrate outdoor gym models created by participants recruited from the university, who had no previous experience of outdoor gym equipment. These designs did not resemble any existing designs and may therefore have been more creative.

Table 5. Themes associated with supportive amenities.

Themes	Subthemes	Exemplar quotes
Storage for personal belongings		"There is no place for bags. There was one time I put my bag aside and I forgot it. [Now] I hang my bag on the equipment, I bring the hanger myself. Or I put it onto the chair beside the equipment." (G1; older adults' outdoor gym users approached in a park)
Drinking facilities		"It is better to have drinking facilities. [We prefer] those [vending machines] that need payment. It will be convenient for people to drink water." (5; older adults' outdoor gym user approached in a park)
Handrail		"There should be handrails everywhere, for wheelchair users or those with walking sticks." (8; stroke survivor) "There should be handrails in the surroundings, to assist those with mobility issues to stand up." (G4; stroke survivor and caregiver of older adult)
Shelter		"It is best to have a shelter to cover the seats." (6; older adults' outdoor gym user approached in a park) "It is important to have trees, the presence of trees enables fresher air and shelter." (7; older adults' outdoor gym user approached in a park) "If there is shelter from the trees, both morning and afternoon people can use it" (G4; stroke survivor and caregiver of older adults)
Resting facilities	• Appropriate amount • Place around facilities to allow resting and appreciation of scenery	"[we don't care about] having many seats … they are for resting for a while when we feel tired after exercise." (G2; older adults' outdoor gym users approached in a park) "Seats should be installed around [the exercise equipment], we can then look at the activity, and there is a place to rest." (7; older adult's outdoor gym user approached in a park)
Natural elements	• Air quality • Esthetics • Pleasant feelings • Fallen leaves • Exercise spaces do not need vegetation	" … to make a place esthetically pleasant you need trees, flowers, and greenery. Apart from inhaling oxygen, it gives you a pleasant feeling" (G5; older adult and caregiver of older adults) "Maple trees will not be good, as [in either] spring or fall there will be lots of fallen leaves. Even if the tree is in the corner, the wind will blow [the leaves up]. It will be slippery if there are many fallen leaves. Pine trees will attract insects and mice." (8; stroke survivor) "It is important to have vegetation, [we] will then have a pleasant feeling" (G2; older adults' outdoor gym users approached in a park) "The park already has vegetation. There is no need for the exercise space to have vegetation." (9; older adult) "Having vegetation will improve the esthetics. It is important to have vegetation, but not to put it inside (the exercise zone)." (G6; Parkinson's disease patient, caregiver of Parkinson's disease patient, older adult) "Allow more resting places, because users should not sit on the exercise machines and take a rest there." (G5; older adult and caregiver of older adults)
Path	• Leisure walks	"Paths for people to leisurely walk on, some space for people to walk." (2; older adults' outdoor gym user approached in a park) "[Exercise equipment] is for the hands and legs, [a path] can be used for leisure walking. You can allow people to walk in a circular pattern." (G7; older adult and caregiver of older adult)

Figure 1. Selected senior-friendly outdoor gym model illustrating that exercise apparatus should be grouped according to upper limb and lower limb exercises and resting facilities should be placed near each group of exercise facilities.

Figure 2. Selected senior-friendly outdoor gym model illustrating that exercise apparatus should be spaced out in a way that reflects the dynamism of exercise movement.

Figure 3. Selected senior-friendly outdoor gym model illustrating the desire for a pavilion near the exercise area.

Figure 4. Selected senior-friendly outdoor gym model illustrating that the pavilion should be placed in the middle so that all users can see around them and can rest.

Table 6. Themes associated with spatial arrangement in the exercise space.

Themes	Subthemes	Exemplar quotes
Set boundary and zone according to function, type, intensity and age-appropriate category	• Fitness, rehabilitation and health management continuum • Intensity • Type • Age-appropriateness • Upper limbs and lower limbs • Children	"Place low intensity equipment in a group; high intensity equipment in a group; and stretching equipment in a group." (7; older adult's user approached at park) "Like those in the promenade, they have different zones. They have a categorization method, for certain parts, equipment is for older adults who can walk and move, some for high-end are for normal people. They have different zones … Need to separate [the exercise equipment], for this side, it is suitable for those with health conditions, for this side, it is for healthy individuals. Zoning is important, I will know what is suitable for me." (G4; stroke survivors and caregiver of older adults) "Upper limbs [exercise equipment] place in one side, lower limbs [exercise equipment] place in another side." (G6; Parkinson disease patient, caregiver of Parkinson disease patient, older adults)
Spacing that consider wheelchair user	• Space to park wheelchairs • Space for wheelchair users to pass through	"There is a need to have adequate spacing between equipment, because sometimes [older adults] need to use the wheelchair … when the older adults leave the wheelchair, the wheelchair has to be put aside, when the older adult is tired, he/she can rest, so there is a need to have larger space." (G5; caregiver of older adults and older adults) Trees should space out a bit, because there is chance that older adults require wheelchair to help them, if it is too dense, it is not convenient for them to move freely by themselves through the [dense] passage. Of course, the wheelchair can be passed through if someone is pushing [the wheelchair]. I arrange this way will allow them to move freely, there is flexibility (9; older adults)
Spacing exercise apparatus according to the dynamism of movement	• Optimize space usage • Ensure safety and comfort for all users	"For those exercise equipment that necessitates larger bodily movement, you need to space it out. If that equipment necessitates smaller movement, you can place it closer together. This arrangement will save space. Those requires swinging legs would necessitates larger space, for cycling, you just sit on it and cycle, you won't affect others. Large movement will affect others. Rider, twister and leg swinging necessitates big bodily movement. Stretching necessitates large bodily movement too. For those [equipment] exercise in a standing position or seated position, you can place it closer. For those which only exercise the upper limbs can place closer together." (G2; outdoor gym users approached at parks) "Don't place the exercise equipment too close to each other, space it out will allow them to have adequate space for stretching. Allow them to slowly navigate [the space], complete the exercise one by one." (G7; caregiver of older adult and older adult)

(*continued*)

Table 6. Continued.

Themes	Subthemes	Exemplar quotes
Placement of exercise apparatus that allows interaction		"Talk while exercising. Exercise equipment should be placed in pairs." (5; outdoor gym user approached at parks) "If the exercise equipment is from the same category, it should be placed together in a total of three [allowing social interaction]. The placement should allow users to communicate." (9; older adults)
Seating arrangement that allows rest, lining up for equipment and monitoring by caregiver		"For example, parents can look after children or family member look after senior family member. [The seats] should allow [family member] to face the user. Family members can easily see each other. The seats must be at the center, after you exercise, you can walk to the center and rest." (G7; caregiver of older adults and older adults)

Engagement level and power dynamics

Participatory design model-making aims to empower participants and engage them, encouraging them to express their visions and opinions. However, the participants in the current study were not familiar with this research method. Most of them were not used to being empowered. They cannot immediately engage in the model-making activity like children. After a warm-up discussion, the participants started to create a model with the help of the researcher. Some participants were initially hesitant about whether their views or opinions would be useful, as they felt that they were not "experts."

Discussion

To the best of our knowledge, this is the first paper to describe the application of a novel participatory model-making engagement activity, with the aim of understanding how different stakeholders envision and visualize their ideal senior-friendly outdoor gym in a public park setting. Previous studies have investigated users' preferences regarding outdoor exercise equipment and the environmental design features that facilitate exercise behavior using surveys, onsite counting, and community observation tools based on mobile internet and computer vision (Fernández-Rodríguez et al., 2020; Liu et al., 2023; Stride et al., 2017; Zhai et al., 2020). However, our study applies the novel creative qualitative method of participatory model-making to elicit in-depth insights from older adults with various health conditions, and their caregivers. The findings of this study complement previous research and provide valuable guidance for designing outdoor gyms in parks to enhance the health and well-being of older citizens.

Important spatial design features for senior-friendly outdoor gyms

This study is the first to identify important spatial design features perceived by stakeholders as essential for facilitating exercise behavior and social interactions in outdoor gym areas. Previous research teams in Australia (Levinger et al., 2018; Scott et al., 2014) proposed that design features such as accessibility, well-lit and maintained walkways, and shelter are important for senior-friendly outdoor gyms. However, the details of other spatial design features have never been fully explored. The participants in the current study were given the opportunity to design a senior-friendly outdoor gym, and they emphasized the importance of clustering exercise apparatus based on its function, type, intensity, or age-appropriateness to enable users to select the apparatus best suited to their specific needs. In addition, by recognizing that potential users may include those who use wheelchairs, the participants highlighted the need for adequate space and paths that allow for navigation between exercise equipment. This perspective has not previously been reported in the outdoor gym literature.

The perception of safety, which has been identified as a critical design feature affecting outdoor gym usage (Fernández-Rodríguez et al., 2020; Levinger et al., 2018; Scott et al., 2014) was further emphasized by the participants in this research. They suggested that the exercise apparatus should be spaced out to leave room for dynamic exercise movements. For example, equipment for exercise involving large movements, such as swinging the legs, should be adequately spaced to ensure both safety and comfort among users. The need to facilitate social interaction, as highlighted in previous research on outdoor gym users' experiences (Chow, 2013; Lee & Ho, 2021) was also emphasized by our participants. They noted that the exercise apparatus should be placed in pairs or clusters to allow social interaction among users, as this is a significant component of the exercise experience.

Important elements influencing stakeholders' choices of exercise apparatus

Previous research has attempted to identify users' favorite outdoor exercise equipment through surveys (Nałęcz et al., 2018; Stride et al., 2017). For instance, Stride et al. (2017) found that the back pull-down, elliptical trainer, and chest press were the most frequently used equipment, while a study set in Warsaw (Nałęcz et al., 2018) identified the bench, the Roman bench, the stepper, elliptical trainer, bikes, the press machine, and the rowing machine as favorites. While the identification of favorite apparatus is important, these studies did not explore the reasons behind such preferences, and thus they provide limited practical implications for the planning and design of outdoor exercise spaces. After being given the power to design an exercise space through model-making, the participants in our

study considered not only the specific purposes of the fitness equipment, as identified in previous research (Marcos-Pardo et al., 2023; Scott et al., 2014), but also the potential rehabilitation and functional value. They emphasized that exercise equipment should improve rehabilitation and functional outcomes, such as walking ability, fall prevention, and the alleviation of frozen shoulder and lower back pain. This finding aligns with the literature indicating that outdoor gym users often supplement the rehabilitation treatment provided by the health system by using the gym facilities (Copeland et al., 2017; Lee & Ho, 2021; McCormack et al., 2010; Nałęcz et al., 2018).

Stride and colleagues found in their survey study (2017) that access to a variety of equipment types was an important enabling factor for outdoor gym use. Similarly, the participants in the current study suggested that the equipment installed should be usable by a variety of people. For instance, individuals with various health conditions, family caregivers, those recovering from strokes, and those with mobility issues should be able to find some equipment they can use in an outdoor gym environment.

Not only was safety regarded as an important consideration in spatial arrangement, as discussed above, safety perception also had an important influence on the participants' selection of exercise equipment. Echoing previous research indicating that safety can be strongly and positively associated with park use and physical activity (McCormack et al., 2010), the participants in the current study also regarded safety as an important feature when choosing exercise equipment for their envisioned outdoor exercise space. They considered whether the design of the equipment would ensure safe usage and whether the equipment would induce uncontrolled movement that might place users at a higher risk of injury.

Echoing previous research on outdoor gyms, participants in this study agreed that having instructors or more exercise instructions in the outdoor gym environment is important (Fernández-Rodríguez et al., 2020; Levinger et al., 2018; Nałęcz et al., 2018; Scott et al., 2014). They provided a new perspective on how instructions or education could be delivered to users. Some participants suggested that outdoor exercise equipment could provide exercise instructions digitally, through the scanning of a QR code. This also reinforced the notion that the participants perceived a need for education.

Important environmental support features for users of senior-friendly outdoor gyms

The literature has provided guidelines for various environmental features that can support senior-friendly parks or exercise spaces (Hamström, 2009; Loukaitou-Sideris et al., 2014). The current research reinforces the

importance of these supportive features and provides more insights into how these features could enhance users' exercise experience.

Resting facilities

Previous research revealed that resting facilities in outdoor gym sites are an important factor that influences usage and satisfaction (Liu et al., 2023). The model-making activity in the current study provided additional information on how the design of resting facilities could enhance the exercise experience. Apart from enabling rest after exercise, these facilities can also be of help when people line up to use the exercise equipment and can make them more visible to caregivers, who can then effectively monitor their care recipients.

Shelter

Extending previous research indicating that shade or shelter is an important enabling factor for outdoor gym usage (Fernández-Rodríguez et al., 2020; Scott et al., 2014; Stride et al., 2017), the participants in the current study suggested that it is also important for the resting facilities to be sheltered. They also suggested that a carefully designed exercise area should have trees that provide shade.

Path

Zhai and colleagues (2020) found that a trail was significantly associated with park users' physical activity, and similarly, "path" emerged as a theme during the model-making activity in the current study. The participants mentioned that it is important to have a path that allows users to engage in leisure walking.

Natural elements

Zhai and colleagues (2020) found that natural elements such as water and lawns were significantly associated with park users' physical activity. Similarly, when we prompted users by offering them miniature flowers and asked them whether they would like to place them in their models, some suggested that natural elements like flowers and grass improve esthetics and thus induce pleasant feelings. However, some felt that adding many natural elements within the exercise zone is not necessary.

Drinking facilities

In line with Levinger and colleagues (2018), who noted that water fountains are an important design feature in outdoor gyms, the participants in this study also suggested that drinking facilities are important.

Handrail

The study's findings also build on the knowledge that handrails are an important feature in a senior-friendly outdoor gym (Hamström, 2009; Loukaitou-Sideris et al., 2014). The participants emphasized the importance of handrails as a safety feature for users with mobility issues. One specifically noted that handrails are essential for enabling frail users to stand up from a seated exercise position.

Storage for personal belongings

Storage for personal belongings has not been addressed in previous guidelines or research. However, some of the participants in this study highlighted the importance of having a place to hang their personal items. This suggestion is noteworthy because older adults often carry medication, bottled water, and umbrellas when they go out. Their bags tend to be heavier than those of younger individuals and thus are impractical to carry while exercising. Addressing this may improve older adults' exercise experiences in outdoor gyms.

Designing senior-friendly outdoor gyms: Concrete examples for practical implementation

The authors of this study, with expertise in physical activity research, rehabilitation, product design, landscape design, town planning, and expressive arts, offer concretes examples for designing senior-friendly outdoor gyms based on our findings.

Selection and inclusion of exercise equipment

Unlike indoor gyms that typically serve healthier individuals, outdoor gym spaces must accommodate a wider range of needs. Designers should consider different types of exercises equipment, such as aerobic, strength, flexibility, and balance training, as well as varying intensity levels for different user groups. For instance, installing bench steppers with two or three height levels can accommodate users with different fitness levels. It's also beneficial to include versatile equipment that serves multiple purposes. For example, an outdoor climbing ladder can be used by fitter individuals for body weight-bearing exercises and by those who are frailer for assisted stretching and balance activities. A balanced mix of seated and standing equipment ensures that users with diverse health conditions and abilities can participate.

Environmental support features

Enhancing the exercise experience can be achieved by including storage for personal belongings, drinking facilities, handrails near exercise equipment, resting areas, shelters, natural elements, and well-designed pathways.

Spatial arrangement

Exercise equipment should be arranged to naturally guide users based on their needs. For example, grouping equipment by intensity (light or high) or by focus (upper or lower limb) can help direct users to appropriate areas. Equipment spacing should accommodate dynamic movements; for instance, air-walking machines with large leg swings need ample space. Equipment for wheelchair users should be spaced to allow easy navigation for both users and their caregivers. Resting areas should consider the needs of frailer adults, providing seating where they can wait for equipment and caregivers can attend to them.

Strengths

This is the first study to develop a novel model-making toolkit and protocol that can be used to elicit perspectives from individuals from a wide age spectrum and with different education levels and role identities (e.g., older adults, caregivers, patients). The study elicited novel findings that make valuable contributions to the senior-friendly outdoor gym literature. The three-dimensional models created by the participants provided visual insights and helped the researchers better understand their perspectives. Second, the toolkit included contextually tailored exercise apparatus, which made participation more relevant for these stakeholders and allowed them to better relate the apparatus to their lives and to express relevant and practical ideas (Melles et al., 2021).

Limitations

However, the current study had several limitations. First, the model-making activity was conducted both individually and in a group format, with the latter requiring the participants to work on their models with others. This design process may lead to conflicts and tensions, which can influence the creative space and thus complicate the process (Göttgens & Oertelt-Prigione, 2021). Dominant speakers inevitably affect other group members when expressing their views. Second, the model-making activity was time-consuming and resource-intensive. Due to the limited budget available for organizing manpower to set up the model-making activity, arranging space

for model-making, and negotiating available timeslots with different stakeholders, it was impossible to recruit a larger number of participants (Moore et al., 2019). These budget and resource constraints also led us to recruit our participants through convenience sampling, although we applied maximum variation. The participants were recruited via posters at a university and by approaching people in public parks nearby. Thus, the sampling rigor may have been compromised. Fourth, some participants found it difficult to make a decision about the selection of exercise apparatus based on the models prepared in the toolkit. Although the exercise apparatus was developed for the context and mimicked the equipment commonly seen in Hong Kong, most of the participants were not aware of the functions of the equipment and they required explanations from the facilitating researcher. Fifth, although participatory design offers a relatively literacy-inclusive methodology, it still requires participants to have a certain level of cognitive and verbal skills to engage meaningfully in the activity and in the discussions with the researcher. In the current research, individuals with cognitive impairments or aphasia, who were unable to participate in model-making activities and verbal discussions, were excluded. This exclusion introduced a level of selection bias, as the views of those with cognitive impairments or aphasia were not collected.

Conclusion and implications for future research

This study provides novel insights into the design of senior-friendly outdoor gyms by emphasizing the importance of spatial design, equipment selection, and environmental support features. Its findings can inform future designs and thus help to enhance the health and well-being of older adults in public parks. In addition, the participatory design model-making activity validated an alternative approach to generating important perspectives from stakeholders regarding the design of outdoor gyms. To scale up the participatory design project in future studies, researchers could consider developing a digitalized three-dimensional model that can be operated using a tablet computer, to enable perspectives and views to be collected from a larger sample.

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Authors' contributions

JLC conceptualized the study, collected, analyzed the data and wrote the manuscript. KLL made the models for the participatory design model-making activity, and triangulated data

analysis, RTH provided advice in how to execute the participatory art-making procedure. KL shared experience on participatory design engagement activity at the early stage. KLL, SLS, KL, AYL, RTH reviewed the themes developed, PHF provided input into future research direction using innovative digital methods. All authors provided critical comments to the final version of the manuscripts. All authors read and approved the final manuscripts.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Ethical approval and informed consent statements

This study was approved by the Institutional Review Board of The Hong Kong Polytechnic University (approval number: HSEARS20221129001). All individual participants provided informed consent before the interviews and home visits.

Confidentiality

Any information obtained in this study will remain strictly confidential and be used for research purposes only. Codes, not names, are used on all reports and publications related to this study to protect confidentiality. All collected questionnaires will be kept in locked cabinets. The electronic dataset will be stored in encrypted computer storage. Data containing personal identifiers will be kept for a maximum of 3 years after publication of the first paper upon the end of study.

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Data availability statement

Data analyzed in the current study are available from the corresponding author on reasonable request.

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