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Effects of an active arcade gaming intervention on psychosocial outcomes for homebound older adults: a pilot randomised controlled trial

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Abstract

Background With the rapidly ageing population across the globe, there is a great need for innovative interventions that can improve ageing in place by attenuating psychosocial burden and improving the quality of life of older adults. Although gaming interventions have been observed to be associated with improved psychosocial outcomes among other age groups, its use in the homebound adult population has received limited attention. This study aimed to examine the feasibility and preliminary effects of an Active Arcade gaming intervention on psychosocial outcomes for homebound older adults in Hong Kong.

Methods A pilot randomized controlled trial approach was employed. The participants in the intervention group were paired up to play the game together in scheduled time slots on weekly basis over an 8-week period. The participants in the control group could not access the paired gaming intervention but were encouraged to interact with their caregivers and other family members as usual. Also, two social calls were placed over the 8-week period. There were four sets of outcomes and outcome measures in addition to socio-demographic data: depression, anxiety, loneliness, perceived social support, and quality of life. Analysis of Covariance (ANCOVA) was employed to ascertain the effects of the intervention.

Results Sixty older adults participated in the study. Overall, it was feasible to deliver a gaming intervention with no significant challenges regarding recruitment and low attrition rates. Participants in the intervention group demonstrated improved scores regarding social loneliness compared to the control group $F(1, 53) = 31.48$ ($p < 0.05$). No statistically significant findings were however observed regarding emotional loneliness, overall loneliness, depression, and anxiety. For social support, statistically significant findings were only observed regarding objective support $F(1, 53) = 17.56$ ($p < 0.05$). Also, regarding quality of life, statistically significant finding was observed regarding the physical component, $F(1, 53) = 23.01$ ($p < 0.05$).

Conclusion Implementing a gaming intervention for homebound older adults is feasible and may be beneficial in improving their social loneliness, objective support, and physical component of quality of life. Including such

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innovative intervention in community-based programs for homebound older adults may be helpful to improve psychosocial outcomes.

Trial registration [Thai Clinical Trials Registry TCTR20250905004]<https://www.thaiclinicaltrials.org/show/TCTR20250905004> [Retrospectively registered on 5th September 2025].

Keywords Active Arcade, Gaming, Homebound, Older Adults

Background

Globally, the proportion of persons aged ≥ 60 is projected to reach 21.1% (> 2 billion) by 2050 [1]. Hong Kong is not immune to this trend, as several studies have highlighted a substantial increase in the number of older adults in the region [2–4]. Although the trend suggests longevity both locally and internationally, the increase in the older population has also led to a rise in the proportion of homebound older adults [5]. Defined as older adults who are unable to go outdoors less than twice per week [6] or requiring substantial effort or assistance to leave their homes due to physical restrictions, homebound older adults experience varied psychosocial limitations [7, 8].

Homebound older adults often experience limited social interactions with limited recreational opportunities due to being confined to their homes [9]. These social limitations have been reported to be significantly correlated not only with their overall well-being, but also with psychological issues such as loneliness [10]. Epidemiologic and community-based studies over the past decades have consistently found that homebound older adults often experience anxiety and major depressive disorder (MDD) or clinically significant depressive symptoms at a rate two to three times higher than that of ambulatory older adults [11–13]. Subsyndromal depressive symptoms may also be present, and they, like MDD, are associated with significantly increased functional and psychosocial impairments [14]. Regardless of its severity, undetected and untreated depression and anxiety among the homebound older adult population has serious adverse effects, including a decline in cognitive functioning and functional abilities, and higher rates of healthcare service utilisation, institutionalization, mortality, and suicide attempts [10, 15]. What is more, elevated loneliness, social isolation, and depression can put homebound older adults at risk of suicide [16, 17]. There is therefore a great need to institute measures to minimize the occurrence of loneliness, depression, and anxiety among homebound older adults to curb their adverse effects.

In Hong Kong, the latest by-census survey showed that the number of households with only one elderly occupant has surged 54% compared to a decade ago [18], which may suggest that loneliness, isolation, and poor psychological well-being are becoming increasingly prevalent [19]. In fact, Hong Kong ranked highest in life expectancy

in the recent Global Study of Elderly Health, with older adults faring well in most aspects of physical health. However, the region ranked 79th out of 97 countries in psychosocial well-being. The findings from a recent local study conducted by the Jockey Club provide support for this assertion as psychosocial well-being was not only rated the poorest performing indicator in the health domain among older adults, but has also been observed to be deteriorating over the past years [20].

Strategies such as the telecare case management approach [21] and video-based mHealth programme [22] have been reported in existing studies on providing professional support for homebound older adults in Hong Kong. However, these studies have focused significantly on physical issues (such as activities and instrumental activities of daily living) with limited attention paid to psychosocial limitations, creating a critical gap in the subject of how homebound older adults can be supported. Although it is acknowledged that managing psychosocial issues such as loneliness, isolation, anxiety, and depression among homebound older adults is challenging, the following three key strategies have been highlighted by the Hong Kong Legislative Council: bridging the digital divide through digital literacy such as smartphones/ mobile tablets, creating living environments to promote connectedness, and harnessing remote/ technological innovations. These strategies are congruent with those posited by the World Health Organization on how to tackle psychosocial issues affecting homebound older adults and with the wider peer-reviewed literature highlighting the potential of using interactive video games as a technological innovation to promote social connectedness [23–26].

Gaming programmes such as card games have been reported to offer significant cognitive, emotional, and social benefits to adults albeit they do not provide a diverse gaming experience for players [27]. Gaming interventions such as Nintendo Wii and Active Arcade have been used extensively in the past ten years to improve biopsychosocial outcomes among persons of all age groups, including community-dwelling older adults. For example, the Nintendo Wii game has been reported to improve both static and performance-related balance parameters when combined with neuro-developmental treatment in children with mild cerebral palsy [28, 29]. Also, completion of a 12-week Nintendo Wii exercise

programme has been observed to be associated with reduction in fear of falling among community-dwelling older adults [30].

The Active Arcade game is particularly worth mentioning because it is considered a social activity that provides a digital playground, puts the players inside the game, and uses their natural body movements as the controller of the game [31]. The multiple player platform, which is packed with fun reaction games, intense game actions, and music rhythm, provides a one-stop, digital immersive platform for the players to have fun and interact with others within the comfort of their homes [32]. Players can socialize with other players using the multiplayer modification [32], which may help to improve their psychosocial well-being. The fun-filled activities, and socially active and non-aggressive nature of the game have been observed to minimize loneliness, anxiety, and depression scores among adults when compared to persons actively engaged in watching television or movies [33]. In addition, playing digital games is increasingly becoming a means of social interaction [33]. A study has highlighted that the use of digital games significantly improved the well-being, affect, social functioning, and depression of older adults who regularly played it [34]. Playing on a weekly basis for an hour over an 8-week period has been reported to improve depression levels and quality of life among older persons with dementia [35]. Thus, gaming may have positive effects on older adults that are actively engaged in it and may help to improve psychosocial outcomes.

Despite its notable potential, gaming interventions have received limited to no attention among this vulnerable populace, and it is unclear if it is even feasible to implement such an intervention. However, the emerging evidence suggests that homebound older adults are able to participate in video-based activities and online computer programmes if equipped with the requisite skills. As a step to resolving the identified gap, this study aimed to ascertain the feasibility of implementing an Active Arcade gaming intervention and its preliminary effects on social (loneliness and perceived social support), psychological (anxiety and depression) outcomes, and quality of life among homebound older adults.

Theoretical framework

The study is guided by Social Network Theory, which posits that individuals are embedded within webs of social relationships that shape their behaviors, access to resources, and psychosocial outcomes [36, 37]. Rather than viewing individuals as isolated units, the theory emphasizes the structure and quality of their social ties—both strong and weak—and the interactional processes through which these ties are formed, maintained, or weakened [38, 39]. A central premise is that social

networks are sustained through ongoing exchanges, shared activities, and repeated interactions, which in turn foster trust, reciprocity, and a sense of belonging [40].

For homebound older adults, limited mobility and reduced community participation often lead to shrinking networks, fewer opportunities for interaction, and the erosion of both strong and weak ties [41]. Social Network Theory suggests that when interactional opportunities diminish, ties weaken due to reduced contact frequency, lower reciprocity, and fewer shared experiences. Interventions that create structured opportunities for interaction can therefore serve as mechanisms for activating dormant ties, strengthening existing ones, or facilitating the formation of new connections [38].

Within this framework, the Active Arcade gaming intervention is conceptualized as a network-promoting structure, that is, a setting that enables repeated, meaningful social interactions. Social Network Theory highlights that shared activities, especially those involving cooperation, mutual engagement, or co-presence, can enhance relational closeness and embed individuals more deeply within a social network [42]. By providing a playful, low-barrier, and engaging activity, the Active Arcade program creates conditions for increasing interaction frequency [39], shared experiences [38], reciprocal exchanges [40], and network activation [42]. Through these mechanisms, the gaming intervention is theorized to enhance participants' sense of social connectedness and reduce feelings of loneliness and isolation; outcomes strongly linked to network structure and function in older adults [42]. The immersive and enjoyable nature of the gaming experience may further amplify these effects by promoting positive emotions, lowering social barriers, and encouraging sustained participation. In this way, the Active Arcade program aligns with Social Network Theory's emphasis on the relational and structural conditions that support social integration and psychosocial well-being.

Materials and methods

Study design

A 2-arm pilot randomised controlled trial approach was employed for this study and reported according to the 2010 CONSORT extension for randomised pilot trials [43]. This involved 1:1 allocation to either control or intervention groups. This pilot trial was registered retrospectively with the Thai Clinical Trials Registry (TCTR20250905004).

Participants, recruitment, and sample size

As inclusion criteria, potential participants were aged ≥ 60 , a smartphone user, and homebound defined as older adults who went outdoors less than twice per week or required substantial support to go outdoors based on

existing literature [6–8]. Older adults who were unable to consent or already engaged in a similar programme were excluded. All participants were recruited in collaboration with the Ma Tau Wai Lutheran Elderly Centre in Hong Kong. The rule on sample sizes for pilot studies as suggested by Whitehead, Julious [44], which is 25 participants per arm, was used for this study. Considering a potential attrition rate of 20%, we will include 5 more participants per group, for a total of 60 participants (30 per arm).

Recruitment, sampling, screening, randomisation, allocation, and blinding

To recruit the participants, our collaborating community centre compiled a tentative list of homebound older adults within their catchment area, following which simple random sampling was employed to recruit potential participants. Telephone calls were made to invite potential participants to consider participating in the study. Following recruitment, a research assistant screened the potential participants. Homebound older adults who (1) have been diagnosed with dementia; (2) are unable to hear, see, or communicate; (3) are completely bed-bound; (4) have an active psychiatric illness for which they had recently been hospitalized within the previous 6 months; and (5) are residing in an area with no internet coverage were excluded from the study. Participants meeting the inclusion criteria (aged 60 or over, a smartphone user, and homebound defined as older adults who went outdoors less than twice per week or required substantial support to go outdoors based on existing literature [6–8]) were randomized to either the intervention or control group, using predetermined randomized numbers in sealed envelopes. This random assignment was carried out by the principal investigator, who was not involved in collecting data or delivering the intervention. Randomization and allocation will continue until the required sample size is attained.

Setting

The study was undertaken in Hong Kong, in collaboration with the Ma Tau Wai Elderly Centre.

Intervention

Participants in the Active Arcade group had access to a tablet provided by the elderly centre with the gaming console installed, following which a 1-day one-on-one training session was delivered by a trained research team at the collaborating community centre. The training focused on introducing participants and/or carer (if any) to the game and teaching them how to use the controls of the game. Staff members from the community centre were also offered training in how to operate the game so

that they could offer troubleshooting support to the participants during gaming episodes.

The participants in the intervention group were paired up to play the game together in scheduled time slots on weekly basis. The research team created two pairs of the same numbers in a sealed envelope. Participants were required to randomly select a number from the envelope. Participants who picked the same number were considered a pair (example, 1–1, 2–2, etc.). Following the pairing, a research team member compiled a list of pairs and arranged the schedule for the weekly gaming sessions with the pairs.

A research assistant placed a voice call to each paired participants at least 24 h before their scheduled game to ensure their arrival at the elderly centre. Each gaming session included 5 min of warm up and 30 min of the main gaming intervention per week over an 8-week period. The 5-minute warm-up period offered the participants some time to navigate their way through the gaming platform before playing the actual game. The choice of game for the paired participants was flexible with only a list serving as a guide to the available choices for the older adults to select from. The choices include Space Pong, Whack a Mole, Party Fowl, Bunny Hop, and Strike a Pose. The Space Pong game mimics tennis and required the players to move their upper limbs to strike a ball or save the ball from moving beyond their virtual goal post. For all games, the tablet or iPad was anchored to a table or desk and did not require the older adult to hold it. They sat or stood (if they are able with support) few meters away from the tablet. Prior to each session, the gaming console helped the older adult to adjust and be positioned in a way that all bodily movements could be detected or sensed before commencement of the actual gaming activity (see Figs. 1, 2). Whack a Mole involved the players to hit a mole using their hand movements once the mole appears in a hole. In addition to the moles, other poisonous agents also emerged which if struck will lead to a loss. Thus, the players remained attentive to strike a mole only in order to gain points. For the Bunny Hop game, players were required to move a rabbit across a ladder using their bodily movements. All gaming episodes were supervised by two assistants who had been trained in basic troubleshooting. If one of the paired older adults missed a session, the other older adult was encouraged to continue to play the game with one of the helpers.

Control group

The participants in the control group could not access the paired gaming intervention but were encouraged to interact with their caregivers and other family members as usual. Also, two social calls were placed over the 8-week period.

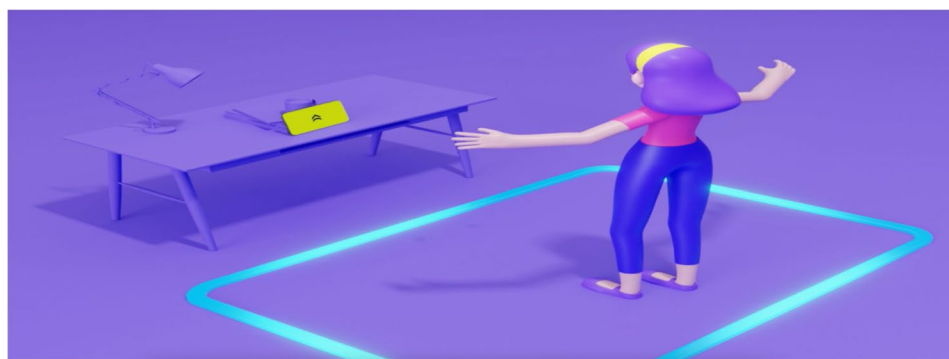


Fig. 1 Positioning of tablet or iPad. Source: Available in public domain via <https://www.activearcade.ai/>

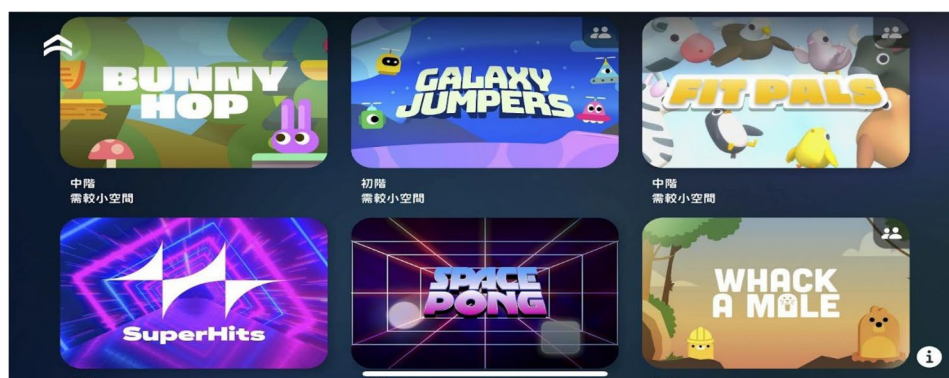


Fig. 2 Sample gaming interface. Source: Authors' own gaming session

Data collection

All outcomes were assessed by two trained student helpers at baseline (T0) (i.e., after they have completed the consent process) and at T1 (following the completion of the intervention at 8 weeks).

Outcomes and outcome measures

In addition to the feasibility outcomes, there were four sets of outcomes and outcome measures in addition to socio-demographic data: depression, anxiety, loneliness, perceived social support, and quality of life. All questionnaires used in this study have already been published as shown by the references provided.

Feasibility outcomes Feasibility outcomes included recruitment and training, attrition, retention, adherence to the intervention, and safety.

Loneliness

This outcome was assessed using the 6-item De Jong Gierveld Loneliness Scale for Chinese older people [45]. The instrument comprises of 3 questions encompassing emotional loneliness and 3 representing social loneliness. The Cronbach's alpha of the 6-item scale was 0.76 [45]. Each item on this scale uses a three-point response format with three response categories: yes, more or less,

and no [45]. Importantly, the scale contains a mix of positively worded items (indicating social connectedness) and negatively worded items (indicating loneliness). These are scored differently. For the negatively worded items, yes is scored as 1, more or less is scored as 1 and no is scored as 0. For the positively worded items, yes is scored as 0, more or less is scored as 1 and no is scored as 1. Each subscale score ranges from 0 to 3, with higher scores indicating greater loneliness. The total loneliness score is the sum of all six items ranging from 0 to 6, with higher scores meaning greater overall loneliness.

Depression

The Chinese version of the Geriatric Depression Scale (GDS) was used to assess depression in this study [46]. The instrument has 15 items with four subscales: positive and negative mood, energy level, inferiority, and disinterested. The responses are dichotomous: yes or no. The Cronbach's alphas for the subscales are as follows: positive and negative mood- 0.76; energy level- 0.60; inferiority- 0.47; and disinterested- 0.55. Each item is scored as 0 or 1, depending on whether the response indicates depressive symptomatology: depressive response – 1, and non-depressive response-0. The direction of scoring varies by item wording: Negatively worded items - Yes = 1, No = 0; and positively worded items - Yes = 0, No = 1.

Overall scores range from 0 to 15 with higher scores indicating more severe depressive symptoms. Scores of 0–4 are considered normal, depending on age, education, and complaints; 5–8 indicate mild depression; 9–11 indicate moderate depression; and 12–15 indicate severe depression [46].

Anxiety

The Chinese version of the 7-item Generalized Anxiety Disorder scale was used to assess the presence of anxiety among participants [47]. Each of the 7 items asks how often the respondent has been bothered by a specific anxiety symptom in the past two weeks. Responses use a 4-point Likert scale with the following response categories: not at all (0), several days (1), more than half the days (2), and nearly every day (3). Each of the item is scored 0–3 based on the response option. All items are positively keyed (i.e., higher scores consistently indicate greater anxiety). The total GAD-7 score is the sum of all 7 items with possible scores ranging from 0 to 21. Scores of 5, 10, and 15 represent cut points for mild, moderate, and severe anxiety, respectively. When screening for anxiety disorders, a recommended cut point for further evaluation is a score of 10 or greater [47]. The scale has Cronbach's alpha of 0.895, indicating excellent internal consistency [47].

Social support

Perceived availability of support was evaluated using the Chinese version of the Social Support Rating Scale (SRSS) [48, 49]. The scale has 10 questions designed to measure three dimensions: objective support (items 2, 6, 7), subjective support (items 1, 3–5), and support utilization (items 8–10) [50]. Across items 1–4 and 8–10, respondents choose one of four ordered categories ranging from 1 to 4. Item 5 allows the participants to select how often they obtain support and help from family members scored as none, rarely, normally, or full support. Items 6 and 7 focus on the source of economic support or practical problem-solving help from a range of options and comfort and caring respectively. The total SSRS score is the sum of all 10 items with scores ranging from 12 to 66. Higher scores across each subscale and total score indicate greater overall social support. Total scores are often categorized into levels of support: low (≤ 22), moderate (23–44), and high (≥ 45) [50]. The scale has good internal consistency of 0.69 [51].

Quality of life

The Chinese version of SF-36 was used to assess this outcome [52]. The scale has been translated and proven reliable for use among the Hong Kong Chinese older adults. The overall Cronbach α is reported as 0.87 (8 scales range: 0.85–0.87), showing good internal consistency reliability

[53]. The split-half reliability coefficient of the SF-36 is 0.814, indicating good reliability [53]. The SF-36 uses multiple response formats, depending on the item. Each item is recoded to a 0–100 scale with 0 and 100 representing worst health and best health respectively. Details regarding the computation have been reported in a previous study [54]. The 36 items assess eight core domains of physical and mental health: physical functioning, role limitations due to physical health, bodily pain, general health perceptions, vitality, social functioning, role limitations due to emotional problems, and mental health. These domains are then summarized into two composite scores based on the Hong Kong population norms: physical component summary (PCS) and mental component summary (MCS).

Data analysis

Feasibility outcomes such as attrition were analyzed using the count function. For statistical analysis, we employed descriptive statistics (such as mean and standard deviation) to ascertain the distribution of the data using SPSS version 26. For loneliness, social support, and quality of life outcomes, the subscales were calculated before computing the overall score. For depression and anxiety scores, the overall total was computed directly as they did not have any subscales. Both mean and standard deviation were calculated for each outcome (including subscales where applicable) as they were all considered to be continuous variables. Participant characteristics at baseline were compared using an independent t-test and a Chi square test for continuous and categorical data, respectively. Analysis of covariance (ANCOVA) was employed by controlling for the baseline scores as covariates, while the post-test scores were employed as the dependent variables. Following verification that the assumption of homogeneity of regression was not violated, the post-test scores of the two groups were analysed using the ANCOVA approach. All statistical tests were undertaken at the 0.05 significance level. Due to the low drop-out rate, intention to treat analysis was employed.

Human ethics and consent to participate

The study was ethically approved by the Institutional Review Board of the Hong Kong Polytechnic University (HSEARS20230323005). All participants willingly participated and were not coerced. To ensure participant's safety, all gaming sessions were completed under the supervision of at least two trained student helpers and a social worker at the collaborating elderly centre.

Results

Baseline characteristics

Sixty older adults were randomized to the intervention ($n=30$) and the control ($n=30$) arms. More females ($n=49$) than males ($n=11$) participated in the programme as shown in Table 1. The mean age was computed as 77.6 (SD=7.93) ranging from 61 to 92. Majority of the participants are living alone ($n=32$) and retired ($n=49$).

Feasibility outcomes

Recruitment and training

The main recruitment channel for this study was an elderly centre that within the Ma Tau Wai catchment area. With their assistance, we were able to identify, reach out, and invite potential homebound older adults to participate in the study. There was no significant challenge in reaching out to the potential homebound older adults as most were reachable via phone. A total of 79 homebound older adults were reached to consider participating in the study. 10 homebound adults refused to participate in the study, 2 participants signed up but withdrew, 1 participant did not meet the inclusion criteria, and 6 participants did not respond to the invitation. There was a median of 9 days between randomization and the first gaming session; there were some difficulties with arranging group sessions with common availability. However, it was noted that late afternoon slots worked better for most of the participants with few older adults preferring the morning slots. Thus, pairing was done based on their availability across both morning and late afternoon slots. There were no difficulties with training the participants and centre staff to use the gaming platform and to undertake basic troubleshooting.

Attrition and retention

Five participants dropped out of the study which is considered low considering the research population. The lost participants comprised of 1 from the intervention group and 4 from the control group (see Fig. 3).

Adherence

Throughout the period of implementing the intervention, there were 11 sessions wherein a paired player was unable to attend due to ill-health and other personal engagements. Based on the study protocol, the other player was paired with either another older adult or a student helper. Also, there were five sessions wherein both pairs did not attend which were re-scheduled for a later date based on their availability. For each session, the gaming protocol for the intervention arm was duly adhered to with occasional breaks for the participants.

Safety

Given the vulnerability of the home bound older adult population, it was critical to ascertain the safety of the gaming intervention. During the delivery of the intervention, the participants were monitored closely to ascertain any potential problems. A nurse and a social worker were available onsite to provide urgent support. However, no adverse event was reported during the delivery of the intervention.

Outcome assessment

Table 2 presents a comparison between the two groups on all outcomes at baseline and post-intervention. To ensure compliance with the requirements for ANCOVA, it was ensured that both tests for homogeneity and regression homogeneity were not violated before proceeding. Regarding loneliness, the ANCOVA result presented in Table 3 showed that only the social component demonstrated statistically significant results between the intervention and control groups as shown in Table 3 below, $F(1, 53)=31.48$ ($p<0.05$). All other aspects of the loneliness outcome were statistically insignificant. Both anxiety and depression outcomes were also statistically insignificant (see Table 2). Regarding social support, only objective support showed statistical significance, $F(1, 53)=17.56$ ($p<0.05$). Also, for quality of life, statistically significant findings were observed regarding the PCS measure, $F(1, 53)=23.01$ ($p<0.05$).

Discussion

With the rapidly ageing population across the globe, there is a great need for innovative interventions that can improve ageing in place by attenuating psychosocial burden and improving the quality of life of older adults. In line with this assertion, the current study examined the preliminary effects of the Active Arcade gaming

Table 1 Socio-demographic characteristics

Variables		Intervention ($n=30$)	Percent (%)	Control ($n=30$)	Percent (%)
Gender	Male	6	20	5	16.7
	Female	24	80	25	83.3
Marital status	Unmarried	3	10	4	13.3
	Married	14	46.7	12	40
	Divorced	2	6.7	2	6.7
	Widowed	11	36.6	12	40
Educational level	No formal education	4	13.3	6	20
	Primary	18	60	14	46.7
	Secondary	6	20	6	20
	Tertiary	2	6.7	4	13.3
Living condition	Living alone	15	50	14	46.7
	Living with a spouse	8	26.7	6	20
	Living with family	7	23.3	10	33.3

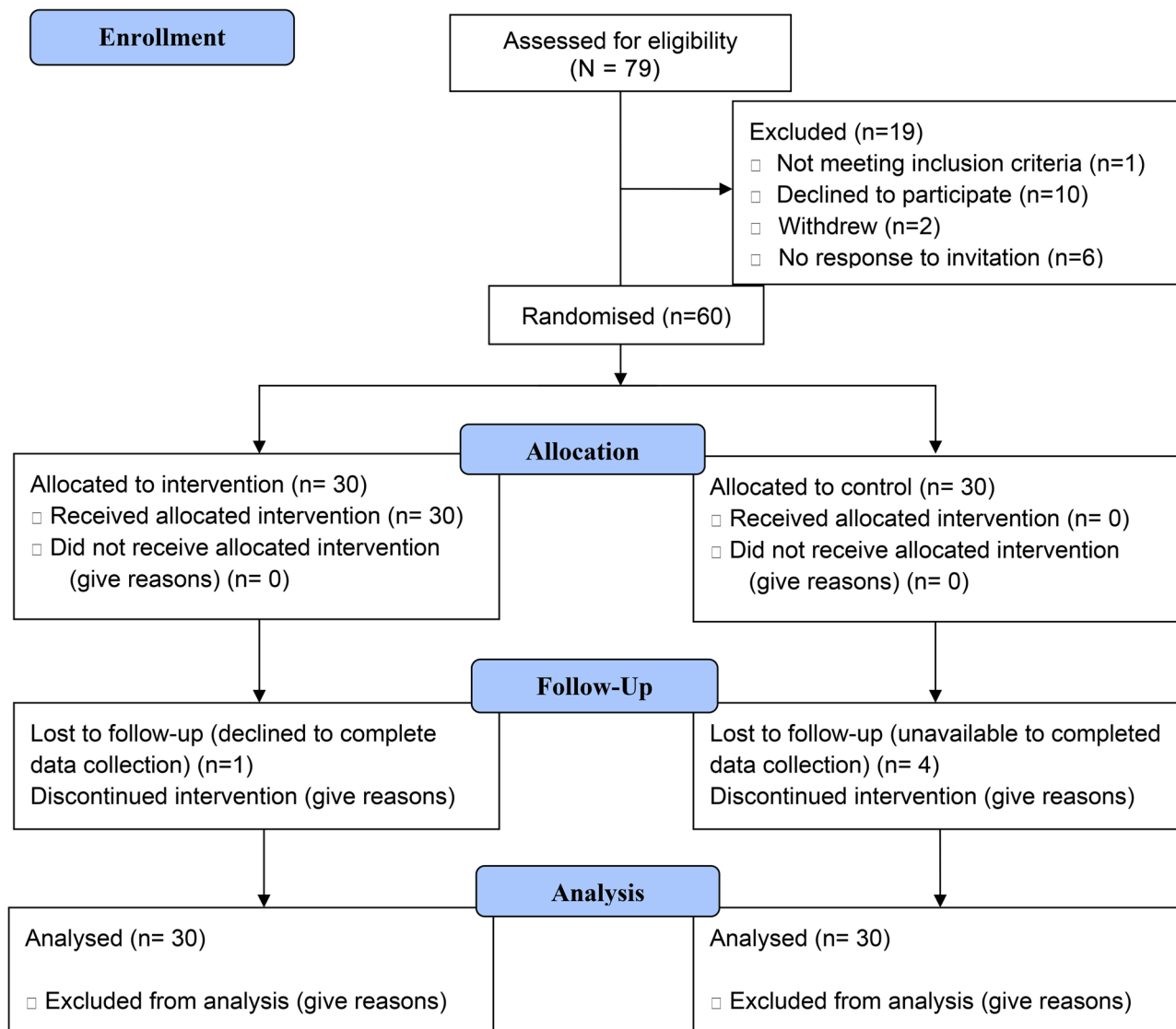


Fig. 3 Consort flow diagram for enrolment, allocation, and follow-up

intervention. The study findings demonstrate that pairing older adults to play various games together which involves bodily movements and ongoing social interactions can be beneficial in improving social loneliness, objective support, and physical component of quality of life. The findings regarding feasibility also suggest that the intervention can be delivered with no adverse issues observed. While the findings need to be interpreted with caution, the preliminary findings observed may offer support to streamline gaming interventions which facilitate social interactions in the routine social care of homebound older adults. The findings also offer insights into the design of large-scale randomised trial to ascertain the effects of the intervention, targeting both physical and psychosocial outcomes using a powered sample size.

Undoubtedly, loneliness and social isolation remain critical issues impacting the homebound older adult

population. At the core of the Social Network Theory is the notion of structures that promote interactions between people [32]. For older adults limited to the confines of their homes, ongoing social interactions may be problematic which can contribute to the trend of loneliness and social isolation. Situating the Active Arcade gaming intervention in the Social Network Theory, it was conceptualized that pairing older adults and facilitating social interactions as they played the game together could be beneficial. The statistically significant results observed regarding the social loneliness subscale suggest that the pairing process may have contributed to expanding the social network of the homebound older adult as they had a partner to interact with and play a game together. Such increment in the social network of the homebound older adult and the need to play the game together also facilitated ongoing social interactions among participants

Table 2 Comparing outcomes at baseline and post-intervention Baseline ($n=60$) post-intervention ($n=55$)

Variable	Intervention ($n=30$)		Control ($n=30$)		Intervention ($n=29$)		Control ($n=26$)	
	M	SD	M	SD	M	SD	M	SD
Loneliness								
Emotional	6.39	1.73	6.82	2.41	3.420.18		6.152.11	
Social	5.00	1.92	4.93	2.28	3.370.12		4.771.86	
Total	11.32	2.89	11.82	1.99	7.792.86		9.924.86	
Depression								
Anxiety	4.30	1.79	4.37	2.01	3.531.17		4.01 1.98	
Social support	4.58	1.16	5.20	1.79	3.191.01		5.18 1.76	
Objective support	5.15	2.26	5.18	2.88	6.28 3.92		3.381.08	
Subjective support	8.50	3.06	7.89	3.59	9.204.01		5.732.56	
Support utilization	7.47	2.27	6.79	2.17	8.86 3.13		6.782.27	
Total score	18.98	6.50	18.20	6.01				
Quality of life								
MCS	39.88	10.24	39.01	10.11	25.90 7.22		18.645.99	
PCS	41.22	10.42	40.85	10.31	42.50 11.2		39.6913.9	
					46.80 11.6		41.01 14.2	

Table 3 ANCOVA Study Results comparing the intervention and control groups

Variable		Group	N	Mean	SD	Adjusted Mean	Std. Error	F	η^2
Loneliness	Emotional	Intervention	29	3.42	0.18	3.36	0.06	27.66	0.120
		Control	26	6.15	2.11	5.59	0.56		
	Social	Intervention	29	3.37	0.12	3.25	0.12	31.48**	0.230
		Control	26	4.77	1.86	4.03	0.74		
	Total	Intervention	29	7.79	2.86	7.28	0.51	28.19	0.175
		Control	26	9.92	4.86	9.79	0.13		
Depression	Intervention	29	3.53	1.17	3.41	0.12	18.23	0.011	
	Control	26	4.01	1.98	3.55	0.46			
Anxiety	Intervention	29	3.19	1.01	3.16	0.03	21.03	0.210	
	Control	26	5.18	1.76	5.11	0.07			
Social support	Objective support	Intervention	29	6.28	3.92	6.33	0.05	17.56**	0.130
		Control	26	3.38	1.08	3.48	0.10		
	Subjective support	Intervention	29	9.20	4.01	9.28	0.08	18.99	0.250
		Control	26	5.73	2.56	5.74	0.01		
	Support utilization	Intervention	29	8.86	3.13	8.88	0.02	20.33	0.292
		Control	26	6.78	2.27	6.83	0.05		
	Total	Intervention	29	25.90	7.22	25.92	0.02	21.65	0.110
		Control	26	18.64	5.99	18.67	0.03		
Quality of life	MCS	Intervention	29	42.50	11.2	42.55	0.05	22.41	0.223
		Control	26	39.69	13.9	39.72	0.03		
	PCS	Intervention	29	46.80	11.6	46.84	0.04	23.01**	0.281
		Control	26	41.01	14.2	41.06	0.05		

** $p < 0.05$

even after the game session had ended. Such an occurrence may have contributed to creating a sense of social connectedness and attenuating the feelings of social isolation among the homebound older adults. Despite these observations, the improvement in the physical component of the quality-of-life scale goes beyond the confines of the Social Network Theory albeit suggesting that improving the social network of homebound older adults to play games together may have some physical benefits, in addition to the psychosocial benefits.

Homebound older adults are disproportionately affected by loneliness due to age-related losses [55]. Risk factors associated with loneliness include poor mental well-being, limited social relationships, and limited social engagement [56–58]. Similar risk factors have been reported in Hong Kong with ongoing calls for interventions that enhance social engagement for older adults [59, 60]. The Active Arcade gaming programme offered a platform that promotes interactions between older adults. The purposeful engagement, immersive experience, and

social interactions associated with the game inarguably provide a potential pathway to providing a platform for human-to-human interactions, and offering a sense of pleasure, social connectedness, and positive emotions for the homebound older adults [61]. This gaming console, different from traditional music and video content, are highly interactive media that continuously react to the input of users [62]. This interactivity can naturally accommodate mechanisms for the real-time adaptation of game content aimed at adjusting player experience and realizing affective interaction. These features provided a platform that facilitated ongoing interactions and active engagement with other users, which may have contributed to the improvements observed regarding social loneliness and overall loneliness scores. Though the pairing approach and interactive gaming platform may have facilitated a connection to a broader social network, the current study observed statistically non-significant findings regarding emotional loneliness and overall loneliness scores. Recent evidence aligns with these findings. A study that implemented an 18-week individualized, motion-based video-game intervention for community-dwelling older adults reported no statistically significant reduction in social isolation [63]. Similarly, an evaluation of the *Talking Tech* program for homebound older adults found no statistically significant improvement in loneliness, despite increased access to technology and structured engagement opportunities [64]. Together, these studies highlight the persistent challenge of reducing loneliness and social isolation through technology-mediated or activity-based interventions alone. Emotional loneliness reflects the absence of close, intimate relationships, which extend beyond casual social interaction [65]. Such bonds are complex, slow to develop, and may require far more time than the eight-week duration of the current study. This may also help explain the non-significant findings for subjective support, support utilization, and overall social support, with only the objective support subscale showing significant improvement. Future research may need to adopt longer intervention periods to determine whether emotional loneliness and broader social support indicators eventually improve alongside social loneliness.

Pairing older adults to play together has been described as particularly helpful in promoting connectedness and interactions based on the game's interface [66–68]. Also, the combination of affective interaction and sensory stimulation from these video-based games have been postulated to arouse the autonomic nervous system, which can induce a sense of psychological well-being and generate positive feelings, thus interrupting the development of psychological problems such as anxiety and depression [69, 70]. Conversely, the current study did not observe statistically significant findings regarding

anxiety, depression, and the mental component summary of the quality-of-life scale. This pattern is consistent with emerging evidence on technology-supported interventions for older adults. A recent systematic review and meta-analysis of 17 studies involving 1,280 older adults found that digital serious games reduced depressive symptoms only when the intervention incorporated physical activity [71]. In contrast, another systematic review and meta-analysis of 20 randomized controlled trials (1,309 older adults) reported that while mobile games were generally ineffective for reducing depression and digital interactive technologies did not significantly influence anxiety, digital games showed meaningful benefits for older adults without underlying health conditions [72]. These findings suggest that the mental-health impact of digital interventions may depend on the type of technology used, the inclusion of physical activity, and the health status of participants. They also highlight the difficulty of achieving measurable improvements in anxiety and depression through short-term, technology-mediated interventions alone.

Despite the non-significant findings regarding mental health outcomes and other subscales of the social support scale, the current study observed improvements across the objective support subscale. These findings may be related to the pairing approach which facilitated interactions and concerted efforts to win game sessions. Such interactions may have continued even at the end of a gaming session, offering the older adults access to a wider social network and support [73]. The presence of a research assistant during the gaming sessions alongside their ongoing interactions may also have provided participants with a sense of ongoing support and reassurance. While it may seem counterintuitive, the gaming intervention encourages physical activity and a sense of independence. Its motion-sensing nature will require players to perform some physical movements (such as moving their arms or legs) to control the game. For homebound older adults, who may have limited opportunities for physical exercise, these games may have the potential of encouraging physical activity and physical health by promoting movement and coordination albeit with assistance as required. Though no specific physical activity outcomes in the current study, the improvements in the physical component summary of the quality-of-life scale may suggest that bodily movement during a gaming session may have some benefits warranting further exploration. Future full-scale trials must therefore consider including specific physical activity outcomes to ascertain the effect of the gaming intervention.

Implications for future studies

Improving the feasibility and effectiveness of technology-supported social interventions for homebound older

adults requires attention to several methodological and design considerations. First, future trials should consider extending the intervention duration. Emotional loneliness, subjective support, and deeper relational bonds develop slowly, and shorter interventions may be insufficient to produce measurable change. Longer exposure may allow participants to build more meaningful connections and experience sustained psychosocial benefits. Second, the feasibility of the intervention may be enhanced by refining the pairing process. Matching participants based on characteristics such as functional abilities may strengthen rapport, increase engagement, and enhance the internal validity of the study findings. Third, the motion-based nature of the Active Arcade platform inherently encourages bodily movement, yet the current study did not directly measure physical activity. Including objective measures such as step counts, movement intensity, or functional mobility assessments would clarify the extent to which physical engagement contributes to improvements in physical quality-of-life domains. Finally, future large-scale RCTs should employ adequately powered sample sizes and include stratified analyses to examine whether intervention effects differ by health status, baseline loneliness severity, or digital familiarity. Such analyses would help identify subgroups most likely to benefit and inform targeted implementation strategies.

Limitations

While the study implements an innovative approach to improving psychosocial outcomes among homebound older adults, some limitations are worth highlighting. Firstly, despite the broad nature of the homebound adult population, the current study only focused on smartphone users within a specific location. Thus, the study findings cannot be generalized to the entire homebound older adult population. Secondly, this study only presents preliminary findings which should be interpreted with caution given the nature of the intervention and complexities associated with working with the homebound adult population. Additionally, though the flexibility regarding the choice of games was helpful to avoid boredom, it made it quite challenging to ensure uniformity across all pairs. Also, while the gaming intervention may have facilitated interactions among paired participants, the observed outcomes may have resulted from the increased social interactions rather than the game itself warranting further testing in larger trials. Furthermore, the control group design is worth highlighting as a limitation of the study. Although control participants did not receive the Active Arcade Gaming intervention, they were provided with two social calls from student helpers. Consequently, we were unable to isolate the effects of the gaming technology from the general effects of novel social contact. Furthermore, the quality and quantity of

the control group's routine social interactions were not monitored, introducing potential confounding variables. To more precisely attribute outcomes to the intervention itself, future trials may consider employing an active control group that matches the intervention group for non-specific factors, particularly the dose and nature of social contact (e.g., a group that engages in a different, non-gaming social activity). Also, future trials may consider systematically tracking and measuring all forms of social interactions across the groups throughout the trial period to account for this potential confounder.

Conclusion

This study demonstrates that an interactive, motion-based gaming intervention can be delivered safely and acceptably to homebound older adults, with encouraging preliminary effects on social loneliness, objective social support, and the physical component of quality of life. Feasibility outcomes were generally positive, and the findings suggest that pairing homebound older adults to engage in interactive gaming is both feasible and potentially beneficial. At the same time, the absence of significant changes in emotional loneliness, mental health outcomes, and several social support subscales highlights the complexity of addressing deeper psychosocial needs through short-term, technology-mediated interventions alone. Taken together, these results support the viability of conducting a fully powered trial to more rigorously evaluate the intervention's effects. Future studies should consider longer intervention durations, incorporate objective physical activity measures, and refine pairing and scheduling strategies.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12877-026-07426-6>.

Supplementary Material 1.

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Authors' contributions

JB and KCAW conceptualised the study, obtained funding, collected data, analyzed the dataset, drafted the manuscript, and reviewed it critically; PA contributed to statistical analysis and interpretation of findings; FKYW contributed to study conceptualization, interpreting the results, and reviewing the draft manuscript; KKSC participated in data collection and manuscript review.

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Data availability

Available on reasonable request to the corresponding author.

Declarations

Ethics approval and consent to participate

The study was ethically approved by the Institutional Review Board of the Hong Kong Polytechnic University (HSEARS20230323005). Informed consent was obtained from all participants. The study adhered to the Declaration of Helsinki.

Competing interests

The authors declare no competing interests.

Consent for publication

Not applicable.

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