

Proposal title: The Presence of Humanoid Robot with Older Adults at Homes

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Background

Population ageing is rising rapidly across the globe. According to the Hong Kong Census and Statistics report, by 2021, one out of six Hong Kong people (15.7%) will be aged 65 or over.¹ This number will be doubled to 2.37 million (31.1%) in 2036.² According to the 2016 Hong Kong census³, about 150,000 adults aged 65 and above lived alone, and almost 300,000 lived with their older spouse. Older adults experience significant physical, cognitive and environmental losses in their later life. A recent survey in Hong Kong has shown that 75% of local adults aged 65 or over, and 45% of soon-to-be-aged people in the 45 to 64 age groups are suffering from one or more chronic diseases.⁴ Older adults are vulnerable to loneliness due to their health deterioration and age-related losses, which prevent them from participating in social activities and engaging in interpersonal relationships.⁵ Moreover, the experiences of loneliness can be worsened for older adults when they live alone or only with their spouses (who are also older adults). By 2040, the number of older people, who need support is expected to more than double, with the direct cost of this “ageing care” rising from HK\$38.8 billion (US\$5 billion) in 2018 to HK\$126 billion in 2040, and HK\$222.4 billion by 2060.⁶

In the field of gerontological nursing, person-centered holistic care highlights the importance of enabling older people and their significant others (such as older spouse or other family caregivers) to establish healthful relationships so to improve older adults’ physical, psychological, mental and social wellbeing⁷. Communications within the family and with friends is crucial for the ageing population and it has impacts on older adults’ psychological and mental health.⁸

Social robots are robotic technologies that are designed to interact autonomously with people, with a variety of application features, by using the same repertoire of social signals used by humans.⁹ Research on the use of robots addressing older adults’ loneliness is given increasing attention in the globe, but most of them were focused on aiding older adults who are living with dementia or residing in nursing homes,⁵ while very limited studies have been undertaken in Chinese population. Self-supported aging-in-place has positive benefits for social connection, social inclusion and the quality of life for older people¹⁰. Studies suggest that social robot and digital communication

technologies can contribute to the reduction of loneliness and social isolation in old age and such technology becomes a kind of social capital at their own homes.^{11 12} A recent study showed that older Chinese adults had high interests in having social robots during dining and entertainment in home-based aged care.¹³ Evidence showed that age, gender, education and computer experience on robot could impact on the acceptance of robot among older people.¹⁴ Another research in Hong Kong reported that individual attributes, such as gerontechnology self-efficacy and anxiety, health and ability characteristics, also affect the acceptance.¹⁵ However, more evidences are needed to examine the acceptance and feasibility of putting a social robot at home – investigation should be made to find out whether older adults, their spouses or other family caregivers at their homes accept, use and even live with these robots. Their experiences and perspectives on the use of the robots would be valuable to determine the use of technology in supporting ageing-in-place among older adults in the community.

Humanoid Robot ‘HUMANE’



The humanoid robot is developed for integrating technology with human-like engagement, to support the wellbeing of older people and sustainability when aging-in-place by enriching an interactional environment, improving older adults' social and emotional engagement and delivering person-centered care. The robot has five main features:

1. Games and Quiz

The robot provides assessment and training in cognition. Quizzes and games are tailor-made according to different levels of cognitive abilities.



2. Personalized services – story telling, music playing, event reminder

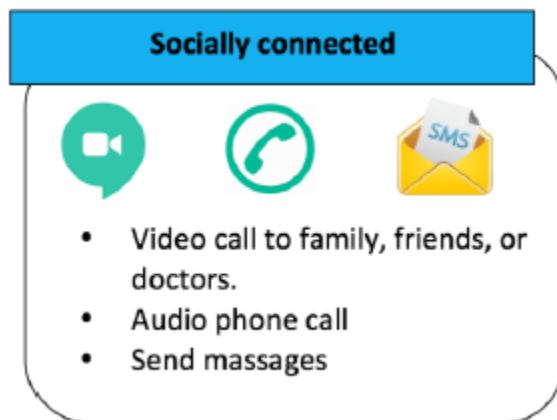
The robot can tell stories, play music (according to older adults' preference) and remind older adults about date and time of the social events/health activities. Quizzes can be tailor-made by family members according to older adults' understanding and cognitive ability.



3. Socially connect to family members or friends: making phone calls

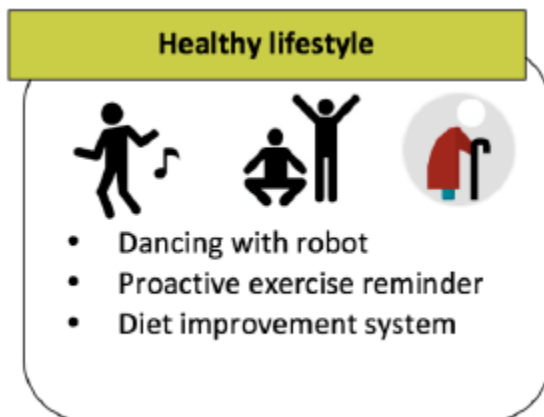
This feature provides connectivity services to reduce older people's social isolation and help foster connections with family, friends and community. The phone application

inside the robot connects the older adults with family members, relatives and friends, extending their social connections.



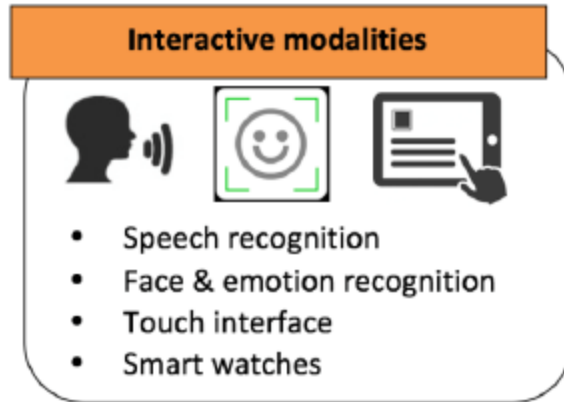
4. Promoting Healthy Lifestyle

The robot has an exercise system which encourages older people to exercise regularly. It will remind the older adults about daily health-related activities: drinking water, doing exercise and reading books.



Interactive modalities

The robot can talk, sing, play games, report weather and read the news. Older people can communicate with the robot via voice commands or a touch panel.



Aims of the study

This study aims to investigate the feasibility and acceptability of home-based physical robot HUMANE by community-dwelling Chinese older adults and soon-to-be-aged adults.

Objectives of the study

The objectives of the study are:

1. To investigate the feasibility of using different features of this robot HUMANE at home within 6 weeks;
2. To investigate the acceptability of the robot at home by older adults, their spouse, and other family members;
3. To assess the preliminary efficacy of this robot on loneliness, depression and mood and calculate the effect size of the use of the robot at home for a full RCT.

Methods

Study design

This study will employ a two-arm pilot randomized control trial with qualitative interviews.

Participants

The participants of this study are people aged 50 or above who are receiving home care from family members. Purposive sampling will be adopted in recruitment. We purposively look for people with different gender, age groups (20 people per each age

group: 50-60 years; 60-70 years; and 70-80 years), educational backgrounds and occupations, to reflect a diversity of views from the aged population. We will also recruit six computer ambassadors from a non-government organization in Hong Kong; these ambassadors have at least one-year experience in computer use. The ambassadors will be trained to support the study participants to use the robot during the intervention period.

As a pilot RCT study, a minimum sample size between 24 and 50 have been recommended.^{16 17} In this study, a total of **60 community-dwelling soon-to-be-aged or older adults** will be recruited. They would be randomized to two groups (intervention group, IG, and control group, CG), that is, 30 adults will be randomized to IG while the other 30 adults will be assigned to CG. Thirty family caregivers will also be recruited through participants assigned in IG group.

The inclusion criteria

1.1 For community-dwelling soon-to-be-aged or older adults

- Ethnic Chinese aged 50 years and above;
- Need home-based care from family caregiver, including spouses;
- Live with at least one family caregiver at his/her own home (not in residential care homes) in Hong Kong;
- Are able to communicate in Cantonese or Putonghua.

1.2 For family caregivers

- Live with the participating older adult in the same household or in other household but with regular contacts (at least once per week) with the participating older adults
- Are able to communicate in Cantonese or Putonghua

The exclusion criterion for the participants are those:

- With acute mental disorders or disabling diseases that may limit the practice of engaging with robot; and
- have limited access to electricity and this makes them hard to use technology at home.

Intervention

The robot HUMANE will be used by the IG (30 participants) for an 6-week trial. Project team will set up a physical robot at their homes. Each participant will be given a protocol to engage with different features of the robot every day. Participants are asked to complete the assigned daily tasks at their own homes. **Table 1** shows the 6-week tasks with the robot HUMANE.

Phone counselling will be given to support the study participants by the trained ambassadors. A training workshop will be given to the ambassadors by the technical team before the intervention starts. A hotline will be set up for the participants and volunteers during the trial period to provide technical support. Participants will be encouraged to contact the ambassadors if they need support and when they had completed daily tasks. The ambassadors will contact the assigned participants (one ambassadors will be assigned with 5 participants) every three days by phone to ensure continued participation and to follow up on their progress.

Table 1. 6-week tasks of engaging with the robot HUMANE

Days	Tasks
Week 1	<ul style="list-style-type: none">• Set up the robot• Complete the baseline assessment[#]
Week 2	<ul style="list-style-type: none">• Explore the features of the robot with the caregiver• Talk to the robot
Week 3	<ul style="list-style-type: none">• Communicate with two relatives using the robot• Record the appointments in the next 2 months
Week 4	<ul style="list-style-type: none">• Check the calendar, weather forecast and read news• Search and listen music with the robot• Do 30-minute exercises with the robot
Week 5	<ul style="list-style-type: none">• Check the calendar, weather forecast and read news• Play games with the caregiver on the robot• Communicate with a friend using the robot• Perform a task according to the calendar• Play cognitive training games with the robot
Week 6	<ul style="list-style-type: none">• Check the calendar, weather forecast and read news• Share at least one interesting news to the caregiver• Play cognitive training games with the robot

[#]Assessment: 6-item Chinese De Jong Gierveld loneliness scale, the Chinese version of the 2Q questionnaire, The Chinese version of the General Self-Efficacy Scale, the Chinese version of the social capital scale, the Chinese version of mutuality scale and the 5-item Abbreviated Memory Inventory for the Chinese (AMIC)

Outcome measures of feasibility and acceptability study

The measures in the feasibility and acceptability study include: 1) recruitment rate of participants, 2) completion rate of the assigned tasks, 3) retention rate of the participants and 4) experiences for using the robot.

Quantitative method

Demographic data will be collected at baseline before intervention. Upon completing each session, login frequency and durations of engaging each feature of robots will be collected and counted via the robotic management system to examine home care receivers' compliance of engaging the robot HUMANE and preferences of specific features. 'Video capture' function of the HUMANE will be utilized to capture the situation when a home care receiver is using the robot on some time slots. The usability of robot will be assessed by the Chinese version of the system usability scale (SUS)¹⁸ upon the completion of the intervention. The System Usability Scale (SUS) is a widely used instrument that measures the subjective usability of products and systems. The Chinese SUS has been tested and showed to be reliable, effective and sensitive. The scale contains 10 questions based on the Likert five-point scale; questions 1, 3, 5, 7, and 9 are positive and questions 2, 4, 6, 8, and 10 are negative. The 10 questions are closely related and are employed for the comprehensive evaluation of a product. A higher SUS score indicates better product usability.

Qualitative method

The perspectives and experience of using home-based robot HUMANE will be collected from home care receivers and their family caregivers through a 30mins in-depth individual interview. The questions that will be asked are framed with reference to the guideline on feasibility studies for intervention trials¹⁹. The guiding questions are as follows: 1) Acceptability: what do you think about the acceptability or satisfaction of using the robot at home? 2) Integration: what do you think if the robot can be integrated into the normal routine of your life? 3) Practicality: what are the practical concern regarding the robot? 4) Efficacy: what changes do you have after you have engaged with the robot (for family caregiver: what changes do you observe the family member have after engaged with the robot)? The interview will be ceased until research team were satisfied that thematic saturation²⁰ was reached.

Recruitment Rate

Research assistant will maintain a detailed record of the total number of target population accessed, recruited and retained. The study costs, human resources, the time taken for recruitment, the number of contacts, visits, the challenges encountered, reasons for withdrawal from the study, and factors that influenced recruitment and study completion rates will be recorded accordingly.

Outcome measures in pilot RCT

The following outcomes will be measured: 1) loneliness, 2) cognitive function, 3) emotional status, 4) self-efficacy, 5) social capital and 6) mutuality. The measurements will be utilized at baseline (day-1) and immediately post-intervention (week-6) to examine preliminary effect of using robot at home.

Loneliness

The loneliness status of participants will be explored to inform the selection of outcome measures in a full RCT to assess the effectiveness of the intervention. The 6-item Chinese de Jong Gierveld Loneliness Scale ²¹ consists of emotional loneliness and social loneliness two subscales, each of them contains three items. They are three response categories for each item: “no”, “more or less”, and “yes.” The scale has been validated and recommended as a reliable (Cronbach’s α of the 6-item scale was 0.76, the intra-class correlation coefficients ranged from 0.98 to 1.00) and valid (the content validity was high as shown by the results of the Delphi panel) measure of loneliness in older Chinese ²¹.

Cognitive function

In this study, a 5-item Abbreviated Memory Inventory for the Chinese (AMIC) 16 will be used to assess participants’ cognitive function. AMIC is an abbreviated version of the original 27-item Memory Inventory for Chinese people, with a sensitivity of 54.6%-65.3% and specificity of 57.4%. There are five items: “Do you always forget where you put your stuff?”, “Do you feel that your memory is worse than your peers?”, “Do you always forget what you want to say during a conversation?”, “Do you always fail to find the appropriate word to express your idea during a conversation?”, and “Do you forget your acquaintances’ names when you meet them?”. AMIC scores range from 0-5 (1 point for each item; 0-best to 5-worse). An AMIC score ≥ 3 is predictive of MCI.

Emotion status

The Chinese version of 2Q questionnaire was chosen because of the high sensitivity and that it was simple to use²². The 2Q was derived from the Primary Care Evaluation of Mental Disorders Procedure (PRIME-MD). The questionnaire includes two questions about depressed mood and anhedonia: "During the past month, have you often been bothered by feeling down, depressed, or hopeless?" and "During the past month, have you often been bothered by little interest or pleasure in doing things?" It is recommended a useful measure for screening depression in primary care in Hong Kong²².

Self-efficacy

The Chinese version of the General Self-Efficacy Scale is a reliable and valid scale that can be used with confidence in community Chinese soon-to-be-aged adults²³. The CGSE Scale consists of 10 items that measure a generalized sense of competence. All items are rated on a 4-point Likert scale ranging from 1='Not at all true' to 4='Exactly true'. The higher the score, the greater self-efficacy the respondents possess.

Social capital

Social capital will be evaluated using the social capital scale to cover the two dimensions of social capital (social cohesion and social interaction) developed by Mujahid²⁴. The social cohesion subscale consists of 4 items: 1) People around here are willing to help their neighbors, 2) People in my neighborhood generally get along with each other, 3) People in my neighborhood can be trusted, 4) People in my neighborhood share the same values. Each item ranged from 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree). Cronbach's alpha was 0.81 among the Chinese community-dwelling older adults²⁵.

Mutuality

Mutuality was assessed with the Chinese version of the Mutuality Scale, which consisted of questions related to love, shared activities, values, and reciprocity²⁶. Each item was rated with a 5-point Likert scale ranging from 0 ("not at all") to 4 ("a great deal"); the total score was the mean of all items (ranging from 0 to 4). Higher scores implied greater

mutuality. Cronbach's alpha was 0.96 for dementia patients and 0.94 for caregivers respectively²⁶.

Data analysis

SPSS Statistics 26 will be adopted for all analyses. Descriptive statistics will be used to summarize the participant characteristics. Differences between the intervention and control groups in relation to outcome measures will be compared across multiple time points using generalized estimating equations (GEE) models or generalized linear mixed model (GLMM). The effect size will be computed to show the magnitude and direction of the effect of the intervention group relative to the control condition for each outcome variable. The usage statistics will be calculated and used to reflect the feasibility of the intervention. A deductive content analysis approach will be used to analyze the transcribed interview verbatim in relation to the feasibility of the intervention, which is considered suitable for a detailed analysis of the four indicators of the feasibility of the intervention: acceptability, integration, practicality, and efficacy¹⁹.

Ethical and safety considerations

Ethics approval and permission will be obtained from the study university before study undertaken. The research participants' privacy, safety, health, social sensitivities, and welfare will be adequately protected according to the university ethics' requirements. There will be no serious risks anticipated for this research. The surveys and interviews were not designed to place participants in an uncomfortable position. Researchers will provide participants with contact details for the study if they have any concerns.

Before enrolment into this study, all participants will give written informed consent and they will be free to refuse to any assessments and withdraw from the study at any time. All study documents will be stored in a locked filing cabinet at the study university. Only the project team members have access to the consent forms. All study relevant data will be permanently deleted by the primary researcher after 7 years. Confidentiality will be maintained through replacing all names of individuals with pseudonyms and changing any potentially identifiable details in the transcripts and any reports, presentations, or publications arising from the research.

Study timeline

month	1	2	3	4	5	6	7	8	9	10	11	12
Recruit research staff	x											
IRB submission and approval	x											
Recruit 60 participants	x											
Training for 6 ambassadors	x	x										
6-week trial for using the robot (1-10 participants)			x	x	x							
6-week trial for using the robot (11-20 participants)					x	x	x					
6-week trial for using the robot (21-30 participants)							x	x	x			
Baseline assessment			x		x		x					
Post-intervention assessment					x		x		x			
Qualitative interviews			x	x	x	x	x	x				
Data analysis				x	x	x	x	x	x	x	x	
Report preparation and results dissemination										x	x	x

Reference

1. Census and Statistics Department. Population by Sex and Age Group 2021 [Available from: https://www.censtatd.gov.hk/en/web_table.html?id=1A accessed 30 October 2021.
2. Census and Statistic Department. Population Projections Census and Statistic Department Web site2017 [Available from: <https://www.censtatd.gov.hk/en/EIndexbySubject.html?pcode=FA100061&scode=190> accessed 30 October 2021.
3. Census and Statistic Department. Domestic Households in Hong Kong. Retrieved from HKSAR Census and Statistic Department Web site2016 [Available from: <https://www.bycensus2016.gov.hk/en/Snapshot-04.html> accessed 30 October 2021.
4. Elderly Commission. Report on Healthy Ageing Executive Summary 2021 [Available from: <https://www.elderlycommission.gov.hk/en/library/Ex-sum.htm> accessed 23 Nov 2021.
5. Gasteiger N, et al. Older adults' experiences and perceptions of living with Bomy, an assistive daycare robot: a qualitative study. *Assistive Technology* 2021 doi: 10.1080/10400435.2021.1877210
6. Moncreiffe E. As Hong Kong ages, carers of elderly relatives need more support at work, at home and for their own old age Hong Kong: South China Morning Post; 2019 [Available from: <https://www.scmp.com/comment/insight-opinion/article/3009572/hong-kong-ages-carers-elderly-relatives-need-more-support> accessed 23 Nov 2021.
7. World Health Organization. Integrated care for older people: guidelines on community-level interventions to manage declines in intrinsic capacity. Geneva, 2017.

8. He AJW, Tang VFY. Integration of health services for the elderly in Asia: A scoping review of Hong Kong, Singapore, Malaysia, Indonesia. *Health Policy* 2021;125(3):351-62. doi: <https://doi.org/10.1016/j.healthpol.2020.12.020>
9. Vollmer A-L, Read R, Trippas D, et al. Children conform, adults resist: A robot group induced peer pressure on normative social conformity. *Science Robotics* 2018;3(21):eaat7111.
10. Barrett P, Hale B, Gauld R. Social inclusion through ageing-in-place with care? *Ageing & Society* 2012;32(3):361–78. doi: <https://doi.org/10.1017/S0144686X11000341>
11. Chen S, Moyle W, Jones C, et al. A social robot intervention on depression, loneliness, and quality of life for Taiwanese older adults in long-term care. *International Psychogeriatrics* 2020;32(8):981-91. doi: 10.1017/S1041610220000459
12. Barbosa Neves B, Franz R, Judges R, et al. Can Digital Technology Enhance Social Connectedness Among Older Adults? A Feasibility Study. *Journal of Applied Gerontology* 2019;38(1):49-72. doi: 10.1177/0733464817741369
13. Chen N, Song J, Bin L. Providing Aging Adults Social Robots' Companionship in Home-Based Elder Care. *Journal of Healthcare Engineering* 2019 doi: 10.1155/2019/2726837
14. Heerink M. Exploring the influence of age, gender, education and computer experience on robot acceptance by older adults. 6th ACM/IEEE International Conference on Human-Robot Interaction (HRI), 2011:147-48.
15. Chen K, Chan AHS. Gerontechnology acceptance by elderly Hong Kong Chinese: a senior technology acceptance model (STAM). *Ergonomics* 2014;57(5):635-52. doi: 10.1080/00140139.2014.895855
16. Julious SA. Sample size of 12 per group rule of thumb for a pilot study. *Pharm Stat* 2005;4(4):287-91. doi: 10.1002/pst.185
17. Hooper R. Justifying sample size for a feasibility study: research design service. London: NIHR 2014.
18. Wang YH, Lei T, Liu XX. Chinese System Usability Scale: Translation, Revision, Psychological Measurement. *International Journal of Human-computer interaction* 2020;36(10):953-63. doi: 10.1080/10447318.2019.1700644
19. O'Cathain A, Hoddinott P, Lewin S. Maximising the impact of qualitative research in feasibility studies for randomised controlled trials: guidance for researchers. *Pilot Feasibility Stud* 2015;1(32) doi: 10.1186/s40814-015-0026-y
20. Saunders B, Sim J, Kingstone T, et al. Saturation in qualitative research: exploring its conceptualization and operationalization. *Qual Quant* 2018;52:1893-907.
21. Leung GT, de Jong Gierveld J, Lam LC. Validation of the Chinese translation of the 6-item De Jong Gierveld Loneliness Scale in elderly Chinese. *Int Psychogeriatr* 2008;20(6):1262-72. doi: 10.1017/S1041610208007552
22. Cheng CM, Cheng M. To validate the Chinese version of the 2Q and PHQ-9 questionnaires in Hong Kong Chinese patients. *The Journal of the Hong Kong College of Family Physicians* 2007;29:381-90.
23. Leung DYP, Leung AYM. Factor structure and gender invariance of the Chinese General Self-Efficacy Scale among soon-to-be-aged adults. *Journal of Advanced Nursing* 2011;67(6):1383-92. doi: 10.1111/j.1365-2648.2010.05529.x
24. Mujahid MS, Diez Roux AV, Morenoff JD, et al. Assessing the measurement properties of neighborhood scales: from psychometrics to econometrics. *Am J Epidemiol* 2007;165:858–67.
25. Wang LQ, Li JP, Wang ZZ, et al. Social capital and cognitive decline: Does sleep duration mediate the association? *PLOS ONE* 2021 doi: 10.1371/journal.pone.0252208

26. Shyu Y-Y, Yang C-T, Huang C-C, et al. Influence of mutuality, preparedness, and balance on caregivers of patients with dementia. *J Nurs Res* 2010;18:155–63.