Acceptance of long-term care from intelligent robots: a study of attitudes among the elderly in China

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Research article

Keywords: Long-term care, Intelligent robots, Acceptance, Elderly, China

Posted Date: November 8th, 2019

DOI: https://doi.org/10.21203/rs.2.17062/v1

Version of Record: A version of this preprint was published at Journal of Intelligent & Fuzzy Systems on June 7th, 2021. See the published version at https://doi.org/10.3233/JIFS-219030.

Abstract

Background China has the world's largest elderly population, as well as the largest population of disabled elderly. Existing literature shows that there have been increased efforts to develop intelligent robots to address the shortage of caregivers for the elderly. However, there has been little research on elders' acceptance of care from intelligent robots.

Aims The purpose of this study was to examine the acceptance of intelligent robots among disabled elderly in need of long-term care.

Methods We used structured questionnaire and interview methods during a social survey. In total, 3060 questionnaires and 50 interviews were collected.

Results An overwhelming majority of the 3060 participants (79.39%) indicated that they would reject robot care. Discussion In further research, should consider more about the background of interviewees, the influence of the economy and social development across different regions, and distinguish the impact of each type of basic information on the acceptance of intelligent machines by the elderly.

Conclusions Most elderly adults were reluctant to allow robots to provide services that involved physical contact. Therefore, the development and design of robots should consider elderly individuals' attitudes toward non-human services, in addition to broadening the scope of activities that intelligent robots could cover, and providing intelligent tools and products that the elderly would be more likely to gradually accept.

Background

China has the world's largest elderly population, as well as the largest population of disabled elderly [1]. One important characteristic of the population in China is that the proportion of elderly residents over 80 and the disabled elderly presents a trend of synchronous rapid growth. From 2010–2030, the number of people aged 60 years or older will grow from 178 million to 329 million, with an average annual growth rate of 3.12%. Similarly, the ratio of the elderly population, working-age population and young population is estimated to change from 1:4.36:1.58 in 2010 to 1:2.31:0.91 by 2030. The number of people in the super-aged population (80 years of age or older) will grow from 13.4798 million to 113.4319 million, with an average annual growth rate of 11.24% [2]. The super-aged population is a group that frequently has disabilities. Therefore, the increase of the super-aged population will be accompanied by a rapid increase in the number of disabled elders.

By the end of 2018, there were 44 million disabled and semi-disabled elderly in China. Consequently, there has been a relatively high demand for long-term care. Existing research shows that China has 4 million caregivers for the elderly [3]. Best practices internationally identify the need for at least one caregiver for every four disabled elder adults. Therefore, China has a shortage of tens of millions of caregivers. The heavy workloads and low pay have exacerbated the problem of a shortage of both home and institutional caregivers for the elderly; this has also contributed to high turnover rates.

The long-term care needs of the elderly in China are relatively high, and represent a serious practical problem for the country. The disabled elderly are primarily concerned about who will take care of them and how the shortage of caregivers may be resolved. For the past few years, the shortage of caregivers has been met with the call from academia to develop elderly care robots. According to Zhang and Chen [4], developing elderly care robots as substitutes for human caregivers could effectively lighten the burden placed on both families and societies of

providing for the aged, efficiently mitigate the shortage of elderly caregivers, and achieve the goal of “providing for the elderly”. Thus, there is high market potential in this field. Deng and Cheng [5] have pointed out that developing elderly care robots is of vital significance for the improvement of the quality of life for disabled elders as well as for guaranteeing social stability in China. Chen et al. [6] reported that robots are currently used in the areas of maintenance, transport, cleaning, security, rescue, and surveillance. Li [7] has asserted that intelligent service robots have seen initial development in China and have been extensively applied in home-based elderly care, community service, edutainment.

The existing literature shows a trend of developing intelligent robots to fill the shortage of caregivers for the elderly. The purpose of this paper is to present the findings of a study on the acceptance of robots for care of disabled elderly people in China.

Methods

Study design

We used a social survey to collect data concerning elderly people in China using structured questionnaires and interviews.

Structured questionnaires

Structured questionnaires are also called standardized questionnaires. This method of data collection was pioneered by Francis Galton [8]. It has many advantages in terms of collecting data, such as its high efficiency, objectivity, consistency, and wide range [9]. All questions in the structured questionnaire were designed within a standard framework. The format, question content, and order of the questionnaire were all fixed and used to collect information from respondents.

The structural questionnaire adopted in this paper includes two parts: basic information and robot acceptance. Basic information includes age, gender, marital status, education level, health status, and housing arrangements. The robot acceptance questions addressed personal acceptance of robot services, and what types of services they were able to receive from the robot.

Structured interviews

Structured interviews, also known as standardized interviews, are interviews conducted according to unified design requirements. In a structured interview, the entire research project is highly standardized during the design, implementation, and data analysis stages. Specifically, structured interviews have uniform requirements with respect to the criteria and methods of selecting interviewees, the designed questions asked during the interview, the manner and sequence of questioning, the manner in which the interviewees answer, and the manner in which the interview is recorded. Sometimes even the time, place, surroundings, and other external conditions of interviews are kept consistent across all interviews. Control of irrelevant variables is emphasized [10].

Structured interviews have specific advantages. First, they can reduce the number of “I don’t know” responses and refusals to answer, and they are suitable for research into sensitive questions. Second, through structured interviews, researchers can observe the words and nonverbal responses of interviewees, which is impossible in questionnaires.

Third, the recovery rate and efficiency of survey interviews are much higher than that of questionnaires filled out by the respondents [10].

During the social surveys, certain elderly people expressed their views on the degree of robot acceptance and provided their specific reasons. Investigators conducted structured interviews with these elderly individuals who were willing to undergo the interview and recorded these participants as typical cases.

Stratified random sampling

We used stratified random sampling to sample the elderly in different areas. Stratified random sampling stratifies the survey population according to a certain standard. We then used simple random sampling to collect samples from each stratum for investigation. The samples in this paper are divided into four layers. We selected urban population size as the basis of the first layer of stratification, districts as the second layer, streets as the third, and communities and institutions as the forth layer.

During the first stage of stratified random sampling, random sampling was performed in mega-cities, XL cities, and I cities. During the second stage, random sampling was performed in urban districts (counties). During the third stage, streets were randomly sampled, and in the final stage, sampling was performed in communities and nursing homes. The samples included people 60 years of age or older.

This paper used Feng's sample size formula [12]:

[Due to technical limitations, please see the formula in the supplementary files.]

In this formula, is the sample size, is the critical value corresponding to confidence, and is the allowable sampling error. The confidence interval in social research typically is 95%; thus, $t = 1.96$. When the population exceeds 500,000, the sample size should be greater than 800, . To keep the sample error to a minimum, we determined that a sample size of 3000 would be needed ($e = 1.83\%$). Therefore, we surveyed 3060 individuals to assure that attrition, incomplete data, and invalid responses would not lower the total number of surveys to less than 3000 (Fig. 1).

Survey implementation

Due to the large amount of information to be collected and the large geographic distances between the investigated cities, the survey was conducted in August 2015 and July 2016. The investigation team contacted each local government in advance, and the local government helped coordinate with the communities and the relevant personnel at the pension institutions. They allowed the investigation team to conduct the social survey but they did not inform the participants in advance so they would not prepare answers to the questionnaires. During the investigation, the participants were informed that this investigation had been approved by the government.

From August 15 to 23, 2015, the research team conducted surveys in Suzhou, Xi'an and Baoji. A total of 1546 elderly people received the structured questionnaire; 20 structured interviews were completed, and 23 elderly people declined to take the survey.

From July 20–28, 2016, the research team carried out 1534 structured questionnaires in Beijing, Nanjing and Yulin; 30 structured interviews were compeled, and 45 elderly people refused to take the survey. The reasons that the elderly

declined to accept the structured questionnaire generally included the following: they did not want to reveal any private personal information or they did not know about service robots.

In the social survey, we recruited 40 investigators, including undergraduates, postgraduates, and doctoral students who had social survey experience as interviewers and whose own research field was also elderly service. Each investigator was paid. They were trained before the survey to unify their knowledge of each question. During the social survey, each investigation team had two members, one of whom asked the questions using the questionnaire and filled in the respondents' answers. The other investigator recorded the question-and-answer process, including which questions the participants were confused about and which questions turned out to be ambiguous. Structural questionnaires were usually conducted outdoors, and some participants were willing to participate in household surveys and underwent structural interviews in their homes. Investigators gave older people small gifts, such as soap or towels, to encourage them to answer questions.

At the end of each day, the team organized the data according to the recorders' records. Invalid answers were removed and the valid answers were retained. The specific survey times, places, and number of surveys collected are shown in Table 1.

Table 1 Survey implementation

Time	Place	Quantity of sample
August, 2015	Suzhou Xi'an and Baoji	1546 participants
July, 2016	Beijing, Nanjing, and Yulin	1534 participants

Data analysis

The statistical software SPSS (Statistical Product and Service Solutions) was used for data entry and data analysis. Descriptive statistical analysis data are used to identify the proportion of age, gender, marital status, level of education, health status and housing arrangements of the elderly, as well as the acceptance rate of the elderly to the robot.

Results

Basic characteristics of samples

The demographic data collected from the questionnaires included age, gender, marital status, level of education, health status and housing arrangements (Table 2). The following section presents the main findings from the data collected.

Table 2 Basic characteristics of the samples

Variable	Proportion
Age	
60–69	46.1%
70–79	33.1%
80+	20.8%
Gender	
Male	41.8%
Female	58.2%
Marital status	
Married	74.6%
Divorced	0.9%
Widowed	23.1%
Unmarried	1.4%
Education level	
Illiterate	26.9%
Primary education	28.9%
Junior high school education	21.6%
Technical secondary education	13.1%
College education	4.4%
Bachelor’s degree or higher	5.2%
Health status	
Non-disabled elderly	74%
Semi-disabled elderly	13.2%
Disabled elderly	12.8%

Housing arrangements	
Living alone	12.2%
Living with a spouse	45.8%
Living with children	11.9%
Living with spouses, children, and grandchildren	26.8%
Living with their parents	3.1%

Elderly acceptance of intelligent robots is low

The survey helped to reveal that 79.39% of the 3,060 respondents (Fig. 2) would refuse and only 20.61% would be willing to be cared for by intelligent robots. We also investigated the specific care services that the respondents would be willing to receive from intelligent robots. Among the respondents who would be willing to be cared for by intelligent robots, 82.87% indicated that they would be willing to be fed and have meals cooked by intelligent robots. The vast majority of individuals (75.52%) also stated that they would be willing to receive cleaning services from intelligent robots. However, most of the respondents expressed concerns about being touched or engaging in activities in close proximity to the robots. More than half of the respondents (61.54%) noted that they would not want robots help them dress. More than two-thirds of the respondents (69.93%) would be reluctant to let a robot help them get in and out of bed or use the toilet (71.68%). The majority of the respondents would not want robots to help them walk (62.94%) or bathe (52.80%).

Typical cases

(1) Shortage of caregivers leads to poor care in nursing homes

Mr. Tian, an 81-year-old disabled man living in a nursing home in Xianyang, told our interviewer, “I live in a total-care room. The problem is that there are too few caregivers for too many elderly people here. In fact, there are only a dozen caregivers, who are only capable of taking care of our daily routines, meals, and sleep. Sometimes they can’t even respond timeously to our bed callers... Once, while we were enjoying some sunshine outside, it suddenly rained, and they were not able to move us inside quickly, so some of us got wet in the rain.

(2) Difficulties in finding home caregivers for disabled elders

Mr. Li, an interviewee from a community in Baoji, told our interviewer that he had an 86-year-old mother confined to bed by cerebral infarction who was suffering from incontinence and that she had to rely on a gastric tube. Due to the shortage of beds in welfare homes, they were in urgent need of an experienced, professional nurse for home care, but their offer of a monthly salary of 3,000 RMB failed to result in any positive response from home care service companies. The shortage of caregivers has led to rising wages.

Conclusion

The survey results showed that the elderly adults were not very receptive to services provided by intelligent robots. Moreover, most elderly adults were reluctant to allow robots to provide services that involved physical contact. However, in both China and the rest of the world, people have increasingly turned to robots to address a shortage of caregivers. Therefore, the development and design of robots should consider elderly individuals' attitudes toward non-human services, in addition to broadening the scope of activities that intelligent robots could cover, and providing intelligent tools and products that the elderly would be more likely to gradually accept. For example, intelligent tools like the cleaning robot, smart bracelet, and intelligent speaker, as well as intelligent services like the intelligent assistance and health monitoring would be beneficial.

Fig. 2 Acceptance of intelligent robots by the elderly

Limitations and prospects

First, questions for structured questionnaires and structured interviews were designed in a standardized way, and the respondents' answers may have been limited by the standard frame. As a result, investigators had less opportunity to explore the reasons and background revealed by the interviewees' answers. Second, because this study was conducted to assess the degree of acceptance of intelligent machines by the elderly, the survey's scope with respect to both time and geography was large. The influence of the economy and social development across different time periods and the effect on the elderly was not taken into account in this work.

This paper included basic population information in the design of the questionnaire but did not distinguish the impact of each type of basic information on the acceptance of intelligent machines by the elderly. This should be addressed in further research.

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Declarations

- Ethics approval and consent to participate

This research has been performed in accordance with the Declaration of Helsinki and has been approved by The Ethics Committee of Xi'an Jiaotong University Health Science Center, approval number is 2015–1199.

All the interviewees clearly know the purpose of this survey and all the questionnaires and interviews have been approved by the interviewees.

- Consent to publish

All the authors have signed in the consent form, which has been uploaded.

- Availability of data and materials

All data generated or analyzed during this study are included in this published article.

- Competing interests

The authors declare that they have no conflict of interest.

- Funding (State the role of the funding body on the study)

The China Postdoctoral Science Foundation funded this research (Grant No: 2019M653687)

Key Project of Chinese National Social Science Fund (16AZD028)

- Authors' Contributions

Zhang Zehao, Zhang Sifeng contributed to the conception of the study.

Zhang Zehao, Xie Linling contributed significantly to analysis and manuscript preparation; Zhang Zehao, Xie Linling performed the data analyses and wrote the manuscript;

Zhang Sifeng helped perform the analysis with constructive discussions.

- Acknowledgements

The authors want to thank all of the survey investigators and respondents who participated in this survey. We would also like to thank local government in surveyed areas. We would like to thank LetPub (www.letpub.com) for providing linguistic assistance during the preparation of this manuscript.

Footnotes

1. In China, cities have different designations depending on their size. Those with an urban resident population between three and five million are labeled I cities. Cities with populations of more than five million but less than ten million are considered XL cities. Cities with 10 million residents or more are known as megacities [11].
2. In China, some communities and pension institutions are run by the government, while others are run by multiple entities. We drew a distinction in the sample population based on the nature of the communities and institutions included.

Figures

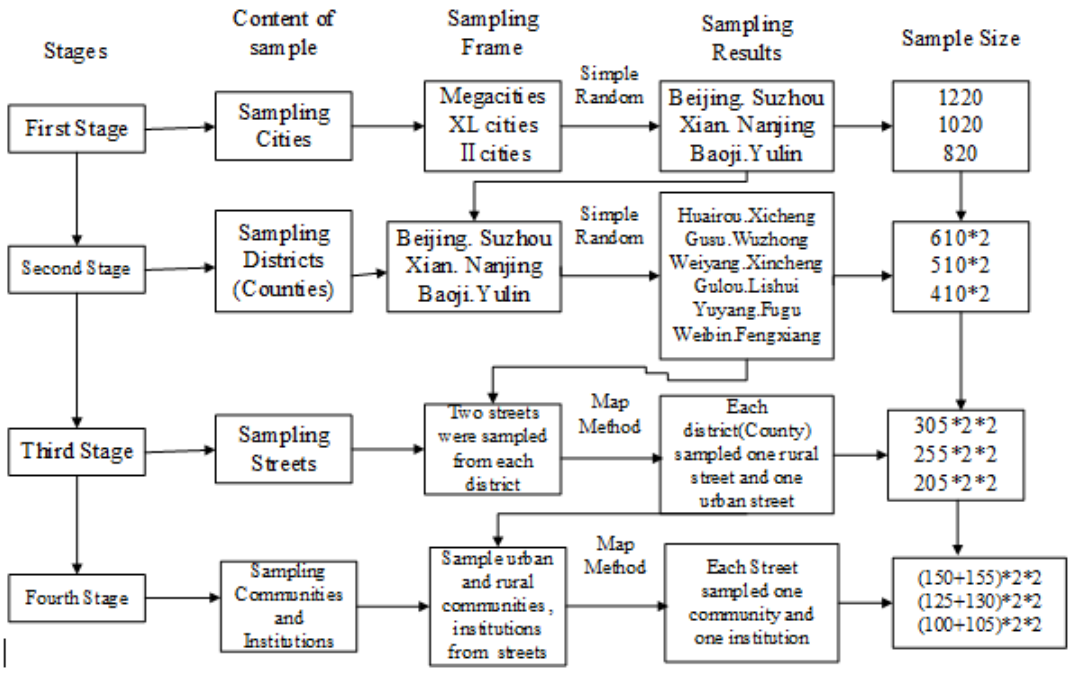

Figure 1

Sampling process

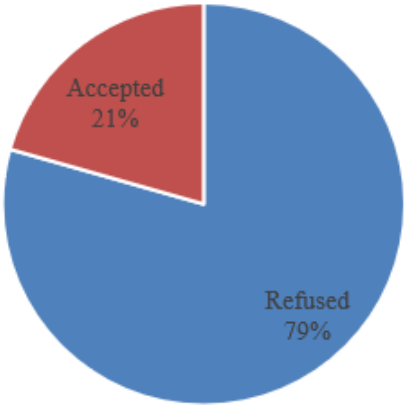

Figure 2

Acceptance of intelligent robots by the elderly

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Methodsformula.docx
- checklist.docx