Understanding Chinese Adults' Attitudes Towards IoT Home Care Technologies

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ABSTRACT

Internet of Things (IoT) technology provides innovative solutions for home care. This study investigates Chinese adults' preferences and influencing sociodemographic factors of using IoT home care technologies. A total of 512 Chinese (Mean age = 46.1 years, SD = 18.1 years) were investigated about their use and interest in 26 types of IoT home care technologies, overall willingness to use the technologies, and sociodemographic information using an online survey. Stepwise regression was used to identify predictors for ownership of IoT home care technologies and willingness to use IoT technologies. This study found that the overall ownership of IoT home care technologies was not high (Mean number of IoT technologies 'already in use' = 8.1 among the 26 selected technologies, SD = 5.0). Chinese users generally had a positive attitude towards such technologies. Their concern focused on home safety and health. People who were younger, more competent with housework, had a monthly disposable income of over 3000 Chinese Yuan (CNY), had more communication with neighbours, lived in a city, had better self-reported health status, lived in a villa and with Internet connection had higher overall scores for ownership of IoT technology. People with better communication skills, who were younger, lived in a city, had a monthly disposable income of 5000–10000 CNY, were more competent with housework and continued to work were more willing to use IoT home care technologies. This study helps stakeholders and policymakers understand the sociodemographic diversity the requirements for IoT home care among Chinese adults.

Keywords: Ageing in place, Gerontechnology, Individual differences, Internet of Things

INTRODUCTION

The Internet of Things (IoT) smart home provides innovative solutions for home care (Chen, 2020; Javaid and Khan, 2021). IoT technology refers to a modern technology that can connect devices (mobile phones, computers, sensors, voice assistants, etc.) and people in an intelligent way anytime, anywhere (Lee et al., 2020). It was estimated that the IoT market in China would surpass $300 billion in 2025, according to an industry report (Xinhua, 2021).

Sociodemographic factors influence IoT home care technologies' adoption. Wilkowska *et al.* (2021) found that health status and gender affected German older participants' opinions to assistive technologies the most among individual factors. Arthanat, Wilcox and Macuch (2019) found those who were female, 60–70 years old, living in a two-level home, physically impaired, with a history of falls, experienced in information and communication (ICT) technology were likely to be smart home 'brisk adopters'. Marital status, home security and overall ICT ownership are predictors of smart home ownership, while being female, concern over home security and perceived independence predict readiness to use smart home technology. He *et al.* (2022) found that Chinese adults with good health skills had better utilisation of smart home technologies, while Huang *et al.* (2022) found that older adults' age, number of children, frequency of children visiting parents, adequate senior care, self-reported health, chronic disease, smartphone use and attitude toward smart senior care were significantly associated with willingness to choose smart senior care. Zeng and Chen (2023) found that the future older adults in China have a positive and open attitude toward smart homes, whereas they have worries about the use of smart home at present.

This study reports the results of a survey study to understand Chinese adults' attitudes towards IoT home care technologies. This study aims at answering the following questions: **RQ1.** *What kind of IoT home care technologies are preferred among Chinese users?* **RQ2.** *Who are more willing to use IoT home care technologies among Chinese users?* This study provides the following contributions. First, it highlights the priority of IoT technologies that are needed by Chinese adults. Second, it identifies sociodemographic predictors of IoT technology ownership and willingness to use IoT home care technologies.

This paper is structured as follows. Section 1 presents the background and research questions of this study. Section 2 describes the method of this study including questionnaire design, participants, and data analysis. Section 3 presents our results. Section 4 discusses what these results indicate, as well as their implications and limitations. Section 5 gives a summary of this study.

METHOD

Questionnaire Design

A questionnaire was designed with 58 questions. Participants were invited to report their use and interest in 26 types of IoT home care technologies, their expectations, overall willingness to use IoT home care technologies, and sociodemographic information with an online survey. The original IoT devices were selected from previous literature (Arthanat et al., 2018; Li et al., 2017; Tiersen et al., 2021). The research team members discussed and deleted devices that were not commonly used in China, for example, backup generator and auto-shutoff stove (Arthanat et al., 2018). The research team also added some devices that were not mentioned in previously reviewed literature, for example, smart pill box, smart massage chair and smart makeup mirror. The devices were primarily divided into four categories: smart home; health care; security; and entertainment (see **Figure 1**), with reference to a previous study (Lee et al., 2020). Participants' level of interest in IoT technologies was evaluated using a three-point scale: 'already in use'; 'never used

but interested in using it'; and 'never used and not interested in using it'. The willingness to use IoT home care technology services consisted of seven questions measured by a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree): 'I am able to use the Internet', 'I would like to use the Internet', 'I am able to use a smartphone', 'I would like to use a smartphone', 'I have heard of the Internet of Things', 'I am currently using IoT technology' and 'I would like to use IoT home health services'.

Participants

Chinese adults from 28 provinces or municipalities were invited to complete the online questionnaires. Those interested in the study were allowed to fill in the online questionnaire. Participants were recruited through community, social media, and word of mouth. Older adults unable to use smartphones or computers were allowed to complete the questionnaire with the help of their children or grandchildren. The participants were paid for their participation in the survey.

Questionnaires are distributed through https://www.wjx.cn/. The participants were informed about the objective of the questionnaire and assured of the anonymity of data collection at the beginning of the questionnaire. The authors' university approved the study ethics. The survey ran from 22 January 2022 to 13 February 2022. A total of 550 questionnaires were received, of which 512 were valid (93.1%). We excluded questionnaires using the following methods: (1) speeders (those who answered unreasonably quickly) who finished the survey at an average speed of less than two seconds per question (Zhang and Conrad, 2014); (2) the participant did not complete the questionnaire; and (3) participants who reported an age that did not match their birth year asked.

A total of 512 Chinese adults (Mean age = 46.1 years, SD = 18.1 years, 56.6% female) participated in the study. More than half (56.6%) of the participants had some college education and higher. 76.6% of the participants reported residence in a city and 23.4% rurally. Nearly half (49.3%) of the sample had a disposable income per month of less than 3000 CNY (US $ 446.1) and 50.9% had a disposable income per month of more than 3000 CNY; around China's per capita disposable income. More than half (52.5%) of the participants lived in an apartment. Most of the participants lived with others, while 7.4% lived alone.

Data Analysis

The study first used descriptive statistics to analyse the use of IoT technology. The 26 IoT technologies selected for the study were coded according to the responses of the participants: 2 = already in use; 1 = never used but interested in using it; 0 = never used and not interested in using it. Therefore, the overall acceptance score for IoT technology ranged from 52 (owning all 26 devices) to 0 (not using or interested in using any of the devices). The willingness to use IoT home care technologies was calculated as the average value of the seven questions mentioned before, ranging from 5 (highest willingness) to 1 (lowest willingness). The Cronbach's alpha for the willingness to use IoT home care technologies was 0.948.

A multiple stepwise regression was used to determine the predictors of IoT technology ownership and willingness to use IoT home care technologies. The dependent variables were IoT ownership and willingness to use IoT home care technologies. The independent variables were the sociodemographic factors of the participants, including age, gender, education, residence, disposable income per month, residential housing, who they lived with, Internet access, whether there was a disease, number of falls, self-reported health status, self-reported mental status, whether there was medical insurance, medication, whether using assistive equipment, vision, hearing, communication, competent with housework, marital status, communication with children, communication with neighbours, communication help, and working status. These variables were chosen because they were likely to affect the IoT technologies that participants owned and their willingness to use IoT home care technologies. The categorial variables (e.g. gender, education, residence) were set as dummy variables. Multicollinearity was verified. Any predictor variable with tolerance less than 0.1 and a variance inflation factor above 5 was removed from the model.

Data analysis was conducted using IBM SPSS v.26. The level of statistical significance (p) was set to 5%. The data to support the study findings are available from the corresponding author upon request.

Figure 1: Selected IoT devices in this study.

RESULTS

IoT Experience and Preferences Among Chinese Users

The overall ownership of IoT devices was not high. The average number of IoT home care technologies 'already in use' was eight ($SD = 5.0$). Only

six IoT devices (smartphone, smart TV, personal computer, smart washing machine, tablet and personal health devices) exceeded the ownership rate (i.e. already in use) of 50%. However, most participants showed an interest in using IoT devices, indicating an overall positive attitude towards such technologies. The top five devices that had not been used but which participants were interested in using were emergency SOS (75.4%), smart home control system (67.8%), water leakage detector (66.6%), home security system (65.4%) and smart thermostat (65.4%). The top five devices that had never been used or that they were interested in using were smart makeup mirrors (47.7%), somatosensory devices (37.3%), smart pill boxes (31.1%), smart watches (29.1%) and water leakage detector (27.1%).

Predictors of IoT Technology Ownership and Willingness to Use IoT Home Care Technologies

The stepwise regression results are presented in Table 1. The average IoT ownership score was 28.7 ($SD = 8.9$). Predictors entered into the model to predict the IoT ownership score were: age; competent with housework; disposable income; communication with neighbours; residence in city; self-reported health status; residential housing; and connected to the Internet. This indicated that people who were more competent with housework, had a monthly disposable income of over 3000 CNY, had more communication with neighbours, lived in a city, had better self-reported health status, lived in a villa and with Internet connection had higher overall scores for ownership of IoT technology (ps < 0.05). Increasing age and living in a nursing home were negative predictors of IoT ownership score (ps < 0.05). The model explained 36% of the total variance.

The average willingness to use IoT home care technologies was 4.3 ($SD = 0.9$), indicating that the participants had a positive attitude towards such technologies. Predictors of the willingness to use IoT home care technologies were: communication skill; age; residence in a city; disposable income; competent with housework; working status. This indicates that people with better communication skills, who were younger, lived in a city, had a monthly disposable income of 5000–10000 CNY, were more competent with housework and continued to work were more willing to use IoT home care technology (ps < 0.05). Increasing age was a negative predictor of willingness to use IoT home care technologies (ps < 0.05). The model explained 22% of the total variance.

Table 1. Standardised coefficient of stepwise regression: IoT ownership score and willingness to use IoT home care technologies.

Independent Variables	IoT Ownership Score	Willingness to Use IoT Home Care Technologies
Age	−0.39**	−0.18**
Competent with housework[a]	0.11*	0.12*
Disposable income[b]		
10000 CNY and above	0.26**	*n.s.*

(Continued)

Table 1. Continued

Independent variables	IoT ownership score	Willingness to use IoT home care technologies
5000–10000 CNY	0.28∗∗	0.11∗
3000–5000 CNY	0.17∗∗	*n.s.*
Communication with neighbours[c]	0.17∗∗	*n.s.*
Communication skill[d]		0.21∗∗
Residence in city[e]	0.14∗∗	0.13∗∗
Self-reported health status[f]	0.10∗	*n.s.*
Residential housing[g]		
Villa	0.09∗	*n.s.*
Nursing home	−0.08∗	*n.s.*
Connected to the Internet[h]	0.07∗	*n.s.*
Continue to work[i]	*n.s.*	0.12∗

Note: n.s. = not significant.
Measured by Likert scale: 1 = strongly disagree, 5 = strongly agree
Reference group: 500 CNY and below
0 = no neighbours, 1 = no communication at all, 2 = monthly communication, 3 = weekly communication, 4 = daily communication
Measured by Likert scale: 1 = very bad, 5 = very good
Reference group: Residence in rural
Measured by Likert scale: 1 = very bad, 5 = very good
Reference group: Apartment
Reference group: No connection to the Internet
Reference group: Retirement

DISCUSSION

For **RQ1**, the overall ownership of IoT home care devices was not high ($M = 8.1$, $SD = 5.0$), but users had a positive attitude towards this technology. IoT devices with higher ownership rates included smartphones, smart TVs, PCs, smart washing machines and tablets. The top five devices that had not been used but which participants were interested in using were: emergency SOS (75.4%), smart home control system (67.8%), water leakage detector (66.6%), home security system (65.4%) and smart thermostat (65.4%). This reflects the participants' concern for home safety and health, which can be used as a focus of future IoT home care technology promotion.

The IoT home health technologies required by the Chinese were different from people in the US (Arthanat, Wilcox and Macuch, 2019). Chinese users were more concerned about safety-related services (such as emergency call systems), similar to the study by Lee et al. (2020). In a previous study on Chinese adults' preferences concerning smart home voice assistants, we also found that people gave a high score for emergency services (Mean = 4.7/5) in relation to smart home voice assistants (Zhong *et al.*, 2022). This result indicates the potential of including safety-related services in the current IoT home care design. However, the popularity of such services is not high at present. Taking the emergency call system as an example, only 6.4% of users

were already using them, but a considerable proportion of users expressed interest in using them. Therefore, the preferred services in this study could be promoted and invested with more stakeholders' attention, and used as a key to resolving smart home concerns in the future.

For **RQ2**, people who were working, had higher incomes, were younger, communicated more with neighbours, had better self-assessment of health status and lived in cities had higher overall ownership scores of IoT technologies. People who were working, had strong communication skills, lived in cities, had higher education levels and better self-assessed health status were more willing to use IoT home care technology. Most of the factors identified in this study were similar to previous studies (He *et al.*, 2022; Huang *et al.*, 2022). Gender (Arthanat, Wilcox and Macuch, 2019; Wilkowska *et al.*, 2021) and marital status (Arthanat, Wilcox and Macuch, 2019), which were found to be significant factors influencing IoT use in previous studies, were not significant factors in this study. We also found that communicating with neighbours was a significant factor that influenced the ownership of IoT technologies. In addition, communication skills were a significant factor influencing the willingness to use IoT technologies. The results revealed that keeping socially active and communication with others may play an important role in adoption of IoT technologies.

While many IoT home health services benefit older adults, adults with better socio-economic status and better health have higher levels of ownership of such services. This shows that there is a 'digital divide' in the use of IoT home care technology. Consistent with the 'reverse information approach' proposed by (Shen *et al.*, 2017), those who need them most use services less and thus gain less from the development of health-related ICTs. From the perspective of market popularity, it is easier to popularise and promote to younger and middle-aged adults. Older adults need social support because it is difficult for them to learn such technology services. In practice, the government could popularise IoT home care technologies through community support and training activities. Older residents could also improve their technology literacy through communication with their children and neighbours.

This study has several limitations. First, the study was conducted during the COVID-19 period (in January-February 2022). So the results indicates Chinese adults' attitude towards IoT home care technologies in this period and the generation of the results needs caution. Second, the proportion of older adults over 60 years old in this study was relatively small because it was relatively difficult for them to complete the online questionnaire. Future study could investigate the attitudes of Chinese adults towards IoT home care technologies after the COVID-19 to make a comparison. Future study may expand the recruitment channel of older adults, such as using offline recruitment and paper-pencil questionnaire.

CONCLUSION

This study investigated Chinese adults' attitudes towards IoT home care technologies via an online survey. The results revealed that Chinese users generally have positive attitudes towards such technologies. The top IoT devices that

the participants had not used but were interested in using were: emergency SOS (75.4%), smart home control system (67.8%), water leakage detector (66.6%), home security system (65.4%) and smart thermostat (65.4%). This indicates the participants' concern for home safety and health. People who were younger, more competent with housework, had a monthly disposable income of over 3000 CNY, had more communication with neighbours, lived in a city, had better self-reported health status, lived in a villa and with Internet connection had higher overall scores for ownership of IoT technology. People with better communication skills, who were younger, lived in a city, had a monthly disposable income of 5000–10000 CNY, were more competent with housework and continued to work were more willing to use IoT home care technology. This study helps stakeholders and policymakers understand the sociodemographic diversity in requirements for IoT home care among Chinese adults.

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