# Analysis of Factors Influencing the Willingness of Chinese Older Adults to Use Mobile Health Devices - A Nationwide Cross-Sectional Survey

Mengyao Yan, Wendi Sun, Cheng tan, Yibo Wu, Yuanli Liu

Submitted to: Journal of Medical Internet Research
on: October 11, 2024

# *Table of Contents*

# Analysis of Factors Influencing the Willingness of Chinese Older Adults to Use Mobile Health Devices - A Nationwide Cross-Sectional Survey

Mengyao Yan[1]; Wendi Sun[2]; Cheng tan[3]; Yibo Wu[4]; Yuanli Liu[1]

[1]Chinese Academy of Medical Sciences & Peking Union Medical College beijing CN
[2]School of Humanities and Management ,Zhejiang Chinese Medical University Zhejiang CN
[3]School of Government, Peking University,China Beijing CN
[4]School of Public Health, Peking University, Beijing , China Beijing CN

**Corresponding Author:**
Yuanli Liu
Chinese Academy of Medical Sciences & Peking Union Medical College
No.9, Dongdan Sanjie, Dongcheng District, Beijing
beijing
CN

## *Abstract*

**Background:** Mobile medical devices have proved to be an effective tool for managing the health of older persons and an important complement to traditional geriatric care services. However, little is known about the willingness of older persons in China to use these devices and the factors that influence their adoption.

**Objective:** This study aims to investigate the determinants of mobile health device usage among older adults in China at individual, social, and familial levels.

**Methods:** Utilizing the Andersen Healthcare Utilization Model, this study examines how predisposing characteristics, enabling resources, and need variables impact the willingness of older adults to use mobile health devices. Data for this study were drawn from the Psychology and Behavior Investigation of Chinese Residents survey database, collected between June 20 and August 31, 2022, across 148 cities in China. In order to initially explore the relationship between each potential explanatory variable and the willingness to use mobile health devices among elderly people, therefore, the survey data were subjected to univariate analysis and collinearity diagnosis, followed by the application of a joint model of Binary logistic regression and Chaid decision tree to identity the factors associated with the willingness of elderly people to use mobile health devices. Potential explanatory variables analyzed included gender, ethnicity, educational level, perceived social status, average monthly household income per capita, depression, anxiety, loneliness, social support (measured using the Perceived Social Support Scale), self-efficacy, family health (assessed through the Family Health Short Scale), family communication, health literacy (evaluated by the Short Health Literacy Questionnaire), quality of life, identity bubble, and insurance coverage.

**Results:** A total of 4085 older adults participated in the survey. The mean score for willingness to use mobile health devices, measured on a scale from 0 to 100, was 63.70±25.11. The results of the binary logistic regression showed that living region (central region:OR=0.793,P=0.028; western region:OR=0.826,P=0.018), whether children living together ?Not living with children:OR=1.217,P=0.010),health literacy (high health literacy:OR=1.372,P=0.000),self-efficacy(high self-efficacy:OR=1.182,P=0.050), per capita monthly income of the household (>4000 yuan:OR=1.204,P=0.016), perceived social support (middle perceived social support:OR=1.556,P=0.001; high perceived social support:OR=2.172,P=0.000), family communication (OR=0.979,P=0.002), identity bubble (OR=1.011,P=0.000), quality of life (high quality of life:OR=1.810,P=0.000), chronic disease conditions (Having chronic diseases unrelated to mobile health devices:OR=0.816,P=0.035), loneliness (alone:OR=1.199,P=0.033) and depression severity (mild depression:OR=0.787,P=0.014) were associated with elderly peoples' willingness to use mobile health devices. And the results of the Chaid decision tree model showed that quality of life (?2=79.094,P=0.000), identity bubble (?2=45.850,P=0.000), health literacy (?2=49.719,P=0.000), living region (?2=13.967,P=0.001), chronic disease conditions (?2=14.777,P=0.000), family communication (?2=13.344,P=0.046) and social status (?2=19.052,P=0.000) are the main factors influencing mobile health devices willingness among elderly people. The results of the two models can be corroborated with each other to provide a comprehensive and accurate picture of the factors influencing elderly people's mobile health devices.

**Conclusions:** The findings indicate a generally positive attitude toward the use of mobile health devices among older adults in

China, with an average willingness score of 63.70 out of 100. Interestingly, positive family communication dynamics were found to reduce the willingness to adopt these devices. This suggests a particular need to focus on isolated and widowed elderly individuals, where the absence of family communication may translate into a higher receptiveness and dependence on mobile health devices. Therefore, policy should prioritize providing free or subsidized health devices to these populations. Moreover, in designing promotional strategies, it is crucial to balance family communication with technology acceptance, while enhancing digital health education within families. This will facilitate the integration of technology in a way that enhances rather than detracts from family health management and emotional bonds, contributing to the closing of gaps in elder care services and improving health management capabilities. Ultimately, this approach aims to achieve a harmonious coexistence of technology and humanistic care. Clinical Trial: registration no ChiCTR2200061046

(JMIR Preprints 11/10/2024:66804)
DOI: https://doi.org/10.2196/preprints.66804

## Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**
Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.
Only make the preprint title and abstract visible.
No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**
Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain v
Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <a href="http

# Original Manuscript

# Analysis of Factors Influencing the Willingness of Chinese Older Adults to Use Mobile Health Devices - A Nationwide Cross-Sectional Survey


## Abstract:

**Background** Mobile medical devices have proved to be an effective tool for managing the health of older persons and an important complement to traditional geriatric care services. However, little is known about the willingness of older persons in China to use these devices and the factors that influence their adoption.

**Objective:** This study aims to investigate the determinants of mobile health device usage among older adults in China at individual, social, and familial levels.

**Methods:** Utilizing the Andersen Healthcare Utilization Model, this study examines how predisposing characteristics, enabling resources, and need variables impact the willingness of older adults to use mobile health devices. Data for this study were drawn from the Psychology and Behavior Investigation of Chinese Residents survey database, collected between June 20 and August 31, 2022, across 148 cities in China. In order to initially explore the relationship between each potential explanatory variable and the willingness to use mobile health devices among elderly people, therefore, the survey data were subjected to univariate analysis and collinearity diagnosis, followed by the application of a joint model of Binary logistic regression and Chaid decision tree to identity the factors associated with the willingness of elderly people to use mobile health devices. Potential explanatory variables analyzed included gender, ethnicity, educational level, perceived social status, average monthly household income per capita, depression, anxiety, loneliness, social support (measured using the Perceived Social Support Scale), self-efficacy, family health (assessed through the Family Health Short Scale), family communication, health literacy (evaluated by the Short Health Literacy Questionnaire), quality of life, identity bubble, and insurance coverage.

**Results:** A total of 4085 older adults participated in the survey. The mean score for willingness to use mobile health devices, measured on a scale from 0 to 100, was 63.70±25.11. The results of the binary logistic regression showed that living region (central region:OR=0.793,P=0.028; western region:OR=0.826,P=0.018), whether children living together （Not living with children:OR=1.217,P=0.010),health literacy (high health literacy:OR=1.372,P=0.000),self-efficacy(high self-efficacy:OR=1.182,P=0.050), per capita monthly income of the household (>4000 yuan:OR=1.204,P=0.016), perceived social support (middle perceived social support:OR=1.556,P=0.001; high perceived social support:OR=2.172,P=0.000), family communication (OR=0.979,P=0.002), identity bubble (OR=1.011,P=0.000), quality of life (high quality of life:OR=1.810,P=0.000), chronic disease conditions (Having chronic diseases unrelated to mobile health devices:OR=0.816,P=0.035), loneliness (alone:OR=1.199,P=0.033) and depression severity (mild depression:OR=0.787,P=0.014) were associated with elderly peoples' willingness to use mobile health devices. And the results of the Chaid decision tree model showed that quality of life ($\chi^2$=79.094,P=0.000), identity bubble ($\chi^2$=45.850,P=0.000), health literacy ($\chi^2$=49.719,P=0.000), living region ($\chi^2$=13.967,P=0.001), chronic disease conditions ($\chi^2$=14.777,P=0.000), family communication ($\chi^2$=13.344,P=0.046) and social status ($\chi^2$=19.052,P=0.000) are the main factors influencing mobile health devices willingness among elderly people. The results of the two models can be corroborated with each other to provide a comprehensive and accurate picture of the factors influencing elderly people's mobile health devices.

**Conclusion:** The findings indicate a generally positive attitude toward the use of mobile health devices among older adults in China, with an average willingness score of 63.70 out of 100. Interestingly, positive family communication dynamics were found to reduce the willingness to adopt these devices. This suggests a particular need to focus on isolated and widowed elderly individuals, where the absence of family communication may translate into a higher receptiveness and dependence on mobile health devices. Therefore, policy should prioritize providing free or subsidized health devices to these populations. Moreover, in designing promotional strategies, it is crucial to

balance family communication with technology acceptance, while enhancing digital health education within families. This will facilitate the integration of technology in a way that enhances rather than detracts from family health management and emotional bonds, contributing to the closing of gaps in elder care services and improving health management capabilities. Ultimately, this approach aims to achieve a harmonious coexistence of technology and humanistic care.

**Keywords:** older adults; mobile health devices; health management; medical services

## Introduction

In the context of the rapidly advancing global demographic shift towards aging and the exponential growth of mobile health technology (mHealth), mobile health devices have emerged as pivotal instruments for augmenting the quality of life of seniors, fostering proactive health self-management, and mitigating the effects of aging. As the nation harboring the world’s largest elderly population, China confronts the imperative of harnessing mHealth technology efficiently to cater to the extensive needs of its aging populace.According to statistics from the National Bureau of Statistics of China by December 2023（National Bureau of Statistics,2024.）, China was home to 296.97 million individuals aged 60 years and over, constituting 21.1% of the national population, with 216.76 million of these being 65 years and older, representing 15.4%. This pervasive aging trend is concurrent with a surge in the incidence of chronic diseases (Peng et al., 2023), as more than two-thirds of Chinese seniors aged 65 and above contend with multiple comorbidities. However, in 2022, China recorded a physician-to-population ratio of 3.15

practicing (assistant) physicians per 1,000 individuals, alongside a ratio of 3.71 registered nurses per 1,000 population—figures that, while placing the country in the middle tier internationally(Global Burden of Disease Collaborative Network 2016), nonetheless present a formidable challenge to the effective management of chronic conditions and the provision of comprehensive public health services. These circumstances significantly strain the nation’s capacity to manage chronic illnesses and deliver robust public health services.

The World Health Organization’s Draft Global strategy on digital health 2020-2025 underscores the strategic importance of digital health within global healthcare systems. The Chinese government actively promotes an “ internet + medical service” development model, vigorously driving forward initiatives for intelligent health and elderly care services. The clinical practice of 2023 hypertension guidelines update. has been released, for the first time incorporating wearable devices into its recommendations, presenting them as a novel modality for blood pressure measurement, working in conjunction with traditional methods such as home blood pressure monitoring to fortify the health defense against hypertension.Mobile health (mHealth), as a novel paradigm facilitating the exchange and management of healthcare information via mobile devices, assumes a crucial role in health management, demonstrating immense potential in domains such as chronic disease management, fall prevention(Bay alarm medical,2024), activity monitoring  Morawski K,2018), and individual health behavior tracking(Ma C,2021). It offers personalized and precision healthcare services (Sun & Buijsen, 2022), enabling the creation of individualized health profiles through integration

with hospital systems. This, in turn, helps alleviate issues related to unequal distribution of medical resources and healthcare services(Zhang, X,2017). An example is the HUAWEI WATCH D, which, having secured Class II Medical Device Registration Certification from national authorities and undergone international standard validations, garners endorsement.

Moreover, against the backdrop of increasing empty-nest syndrome among the elderly population and the integration of medical and elderly care services in China, mobile health devices can be synergistically combined with healthcare services to enhance the quality and efficiency of eldercare provision. Data from the 2022 National Report on the the development of national undertakings for the aged by the National Bureau of Statistics of China reveal that, as of the end of 2022, China boasted a total of 387,000 elderly care institutions and facilities nationwide, housing 8.294 million beds dedicated to eldercare services. Even with a conservative estimate adhering to the national standard ratio of one caregiver per four seniors, there is a pressing need for at least 2.075 million caregivers. However, the current workforce comprises only approximately 300,000 caregivers, leaving a substantial shortfall(Ministry of Civil Affairs.2023).Mobile health devices can, to a certain extent, mitigate this shortage of personnel. For instance, Apple’s iOS 16 and watchOS 9 now come bundled with a medication reminder app within their native “Health” software, assisting seniors with medication adherence. In Beijing’s Xicheng District, authorities have installed smart caregiving mattresses in elderly homes, continuously monitoring vital signs such as heart rate and respiratory patterns,

as well as bed entry and exit times, thereby augmenting care provision without direct human intervention.

In the field of commercial layout, the market size of smart wearable devices is expanding, and will still maintain rapid growth in the next few years.IDC's latest Quarterly Tracking Report on China's Wearable Devices Market shows that China's wearable devices market shipped 34.7 million units in the third quarter of 2023, a year-on-year increase of 7.5%, and the overall market continues to grow.IDC expects that, in 2024, the number of adult smart watches will grow 11% driven by product differentiation layout(IDC.2023)

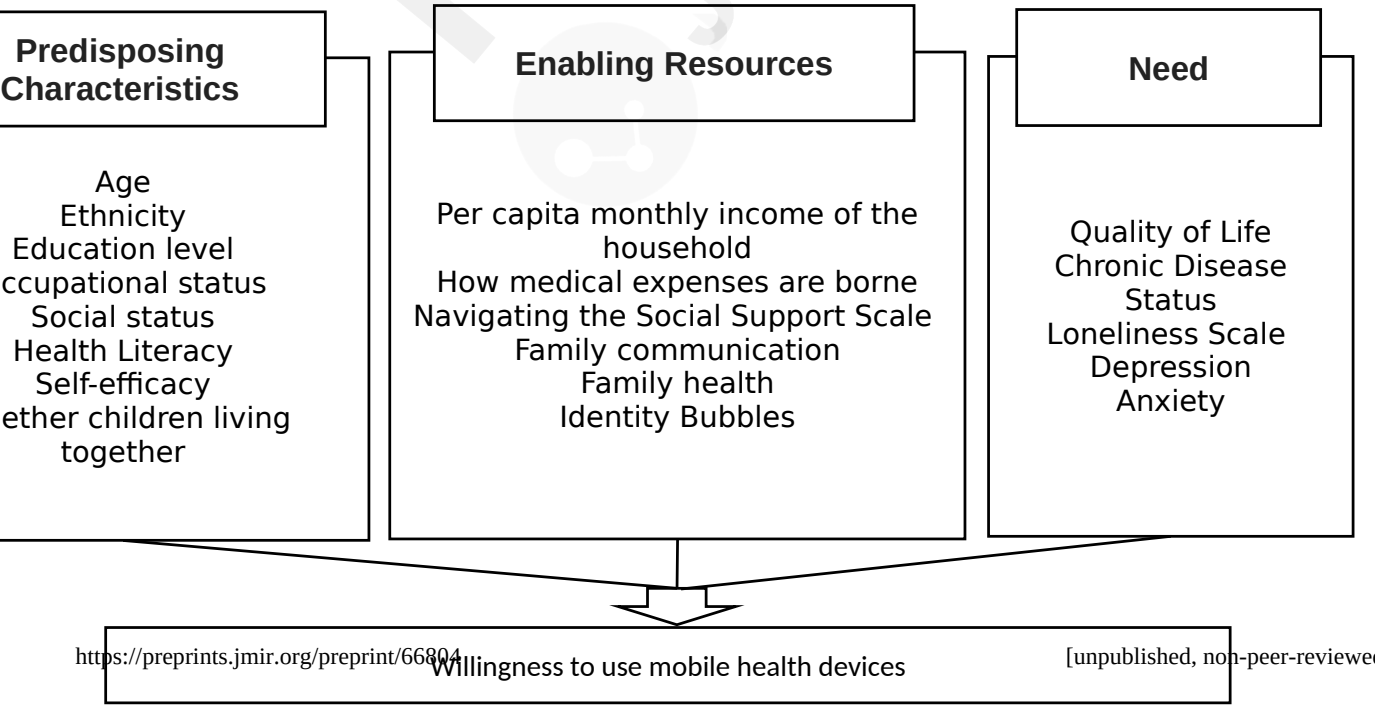
Despite the multitude of benefits associated with mHealth, several critical challenges persist in its practical implementation, particularly when it comes to engaging the elderly population. Pervasive disparities in digital literacy, health literacy, technological aptitude, social support networks, and prevailing attitudes towards lifestyle among older adults hinder the full realization of mHealth’s potential within this demographic. Furthermore, concerns over data security and accuracy  GUO,2021), affordability of devices and associated services, equitable access (Sim,2019), insufficient age-appropriateness of products, anxiety induced by data-driven insights, and marginalization of certain functionalities, such as fall detection, all contribute to a less-than-ideal adoption scenario.Particularly in China, studies have shown that the elderly and chronically ill groups, who are the potential main users, are not very receptive to mHealth services(Zhang,2017).

In summary, mHealth devices exist in more roles and are vigorously developed on the supply side, while demand-side research on the willingness to

use mHealth devices mainly focuses on the perceived usefulness of the products, innovativeness, privacy protection, as well as the self-efficacy of the population, self-perceived aging, and health awareness, and there is a significant lack of a large-scale sample of the elderly population. Therefore, in this dissertation, a large-scale cross-sectional survey was conducted nationwide with the aim of revealing the current status of Chinese older adults' willingness to use mHealth devices and the key influencing factors behind it. This is of great significance for the global understanding of the characteristics of the acceptance of new technologies among the elderly population, enhancing the effectiveness of digital health interventions and promoting the development of the smart aging industry, as well as providing a valuable empirical basis for international health equity and policy making for an aging society.

## *Theories and Hypotheses*

The Anderson Behavioral Model of Health Services Use (BMHSU) is the model of choice in the field of health services to explain and predict health care behaviors and analyze the factors influencing health services utilization



behaviors of different households. Among them, Predisposing Characteristics, Enabling Resources, and Need as factors influencing health service utilization [Andersen, 2007].This contributes to the systematic analysis of factors influencing individual health service utilization behavior and the evaluation of the accessibility of health service utilization[Bass,1987].From the viewpoint of the population to which the study applies, the Anderson model is applicable to the study of the health care service utilization behavior of the general population as well as the study of the health care service utilization behavior of special populations such as the elderly, women, low-income earners, children, and HIV-infected people. In terms of the scope of application, the model is applicable to the study of the entire process of individual health service utilization behavior, including the study of factors influencing the choice of individual health care modality, medical costs, disease screening, drug use, and so on[Lederle,2021&Li,2017).This study views mHealth device use as a form of health service delivery and therefore utilizes the Anderson Health Service Utilization Model to explore the impact of different factors on mHealth device use. The specific model is shown in Figure 1.

Figure 1. A model of factors influencing the willingness of older adults to use mobile health devices

Based on this hypothesis, the following propositions are made, informed by theory and existing research.

H1: Older people will be more likely to be willing to use mHealth devices than non-older people

H2: Older people will be more likely to be willing to use mHealth devices than non-older people

## Methods

### Participants

The data for this study came from the Psychology and Behavior Investigation of Chinese Residents database.The present study was carried out across an extensive geographical expanse within China, encompassing 148 cities, 202 districts, 390 townships, towns, and streets, as well as 780 communities and villages, between June 20th and August 31st, 2022. The sampling strategy employed for this survey was multistage, meticulously informed by quota attributes derived from China's seventh national census data at the city level. These attributes included sex, age, and urban-rural distribution, ensuring a representative and stratified selection of participants. The detailed application of the quota method has been thoroughly documented in a preceding investigation by Wang and colleagues. This study was registered in the China Clinical Trial Registry (registration no ChiCTR2200061046).

The study employed the web-based Questionnaire Star platform for questionnaire distribution. Participants were eligible if they were Chinese nationals aged 12 years or older, voluntarily participating, comprehending each questionnaire item, and completing the questionnaire independently. For those with limited mobility but intact cognitive function, investigators conducted one-on-one interviews, offering necessary assistance without influencing responses, thereby ensuring inclusivity and data integrity.

### *Self-administered questionnaires*

The self-administered portion of the questionnaire investigated the demographic characteristics of the participants. The demographic characteristics included gender (male, female), age (60-74 years old, 75 years old and above), income (4,000yuan and below, 4,000yuan and above), place of residence (eastern region, central region, western region), education level (Senior high school and below, Junior college and bachelor degree, Postgraduate

degree and above), occupational status (employed, retired, unemployed (unemployed, unemployed/unemployed, no regular occupation)), healthcare cost bearing method (purely health insurance, purely commercial insurance, mixed insurance, no health insurance), chronic disease status (no chronic disease, chronic disease). The dependent variable measured was willingness to use mHealth devices (from a score of 0 = not accepted to 100 = very accepted).

**standard scale**

***Health Literacy Questionnaire （HLS-SF 9 ）***

In 2013, Sørensen and other scholars developed The 47-item European Health Literacy Questionnaire (HLS-EU-Q47), and in 2019, DUONG and other scholars simplified their HLS-EU-Q47 to form a 12-item scale suitable for assessing public health literacy in Asian countries Entry Health Literacy Scale（short-form health literacy survey questionnaire（HLS-SF12）。In 2023, Sun Xiaonan and other Chinese scholars sinicized HLS-SF12 using translation, reverse translation and cultural debugging procedures.2023 Sun S. N. et al. applied the Mokken model in item response theory, CTT (Classical Test Theory) to simplify HLS-SF12 (simplified to HLS-SF9).In this study, namely, the HLS-SF9 was used to measure the respondents' health literacy (HL). The scale consists of three dimensions: health care, disease prevention, and health promotion, with a total of nine entries, each of which is rated on a 4-point scale (1=very difficult, 2=difficult, 3=easy, 4=very easy), and the standardized HL index (i.e., the total score of the scale) was calculated using the formula, which ranges from 0-50, with the higher the index representing the higher level of health literacy. The formula was calculated as, Index = (Mean - 1) x (50/3), where mean is the average of the scores of all the entries for each individual, 1 is the smallest

possible value of the mean (at which point the minimum value of the index is 0), 3 is the range of the mean, and 50 is the maximum value of the index. The higher the index, the higher the level of health literacy of the respondent. The Cronbach's α coefficient of the scale was 0.923.

### *The new General Self-Efficacy Scale（NGSES）*

The new General Self-Efficacy Scale was developed by Chen G（2021） and other scholars on the basis of the General Self-Efficacy Scale, developed in 2001。The members of the project team of the "2022 Survey of Psychology and Behavior of the Chinese Population" applied the Mokken model of Item Response Theory (IRT) and Classical Test Theory (CTT) to simplify the NGSES-8, reducing the original 8 items to 3 items, and forming a new general self-efficacy scale. The new NGSES-8 was simplified from the original 8 items to 3 items to form the new General Self-Efficacy Scale(Wu,2022).In this study, respondents' self-efficacy was measured by the NGSES-3, which contains 3 entries on a 5-point Likert scale (1=strongly disagree; 5=strongly agree; the total scale score is the sum of the 3 entries, and the range of scale scores is from 3-15, with higher scores indicating higher levels of self-efficacy among respondents). Includes 3 entries on whether or not they can accomplish difficult tasks, whether or not they can successfully overcome many challenges, and whether or not they have the confidence to accomplish many different tasks effectively. The Cronbach's α coefficient of the scale was 0.912.

### *The Perceived Social Support Scale （PSSS）*

The Perceived Social Support Scale (PSSS) is used to assess participants' perceptions of social support （Li（2020）. The PSSS consisted of 3 parsimonious

items in this study, assessing perceived emotional support from friends, family, and significant others. It has been validated to be well-correlated with the original items' scale, and the factor structure, reliability, and validity have also been well-established(Wu,2022) . Each item is scored on a 7-point scale of 1 to 7 (1="strongly disagree" to 7="strongly agree"). The summed scores on the PSSS range from 3 to 21 points, with higher scores representing greater perceived social support. The Cronbach's α coefficient of the scale was 0.902.

### *The Family Communication Scale（FCS-10）*

The Family Communication Scale was used to evaluate the respondents' family communication. The scale was developed by Olson and Barnes in 2015 and was sinicized by Guo N and other scholars in 2021(Kwon,2015&Guo，2021).The Family Communication Scale consists of 10 entries on a five-point Likert scale (1=strongly disagree; 5=strongly agree; the total scale score is the sum of the 10 entries, and the scale score ranges from 10-50, with higher scores indicating that the respondent's family communication is better). The purpose of the scale is to measure the quality of communication among family members with regard to the exchange of ideas, information, level of concern, openness, confidence and emotions among family members. The Cronbach's α coefficient of the scale was 0.957.

### *The Health Effect Values Visual Analog Score （EQ-5D-VAS）*

The Health Effect Values Visual Analog Score (EQ-5D-VAS) is part of the European Five-Dimensional Health Scale (EQ-5D-5L).In this study, respondents rated the goodness of their health using the EQ-5D-VAS. The scale consists of a scale with numbers from 0 to 100 on it, with 100 representing one's imagined

best health condition; 0 representing one's imagined worst health condition, and respondents fill in whole numbers between 0 and 100 based on their self-assessed health condition.

### *The Identity Bubble Reinforcement Scale （IBRS-6）*

The Identity Bubble Reinforcement Scale focuses on the social and information homogenization tendency brought about by identity-driven social media use from a psychosocial point of view. It is mainly used to measure the tendency of social media users to get involved in identity-driven online bubbles (Bubble: refers to homogenized information environments), and to emphasize the impact of identity-driven online social activities on social media on individual behavior. The scale consists of nine entries divided into three dimensions: social identity (three entries), homogenization (three entries), and information bias (three entries), and is based on a ten-point scale ranging from 1 (not at all like me) to 10 (not at all like me), with higher scores representing a more significant tendency to homogenize an individual's identity-driven social media activities(Kaakinen,2020). The Cronbach’s α coefficient of the scale was 0.948.

## Data Exclusion

The specific data selection process is shown in Figure 2.The total sample size of the PBICR database in 2022 was 21916, of which 2 participants' ID abroad and unknown place of residence for the last three months and 390 participants filled in information that was illogical. So a total of 392 participants were excluded and 21524 participants were retained. Among these 21524 participants, 17439 participants were < 60 years old and 4085 participants were ≥ 60 years old.

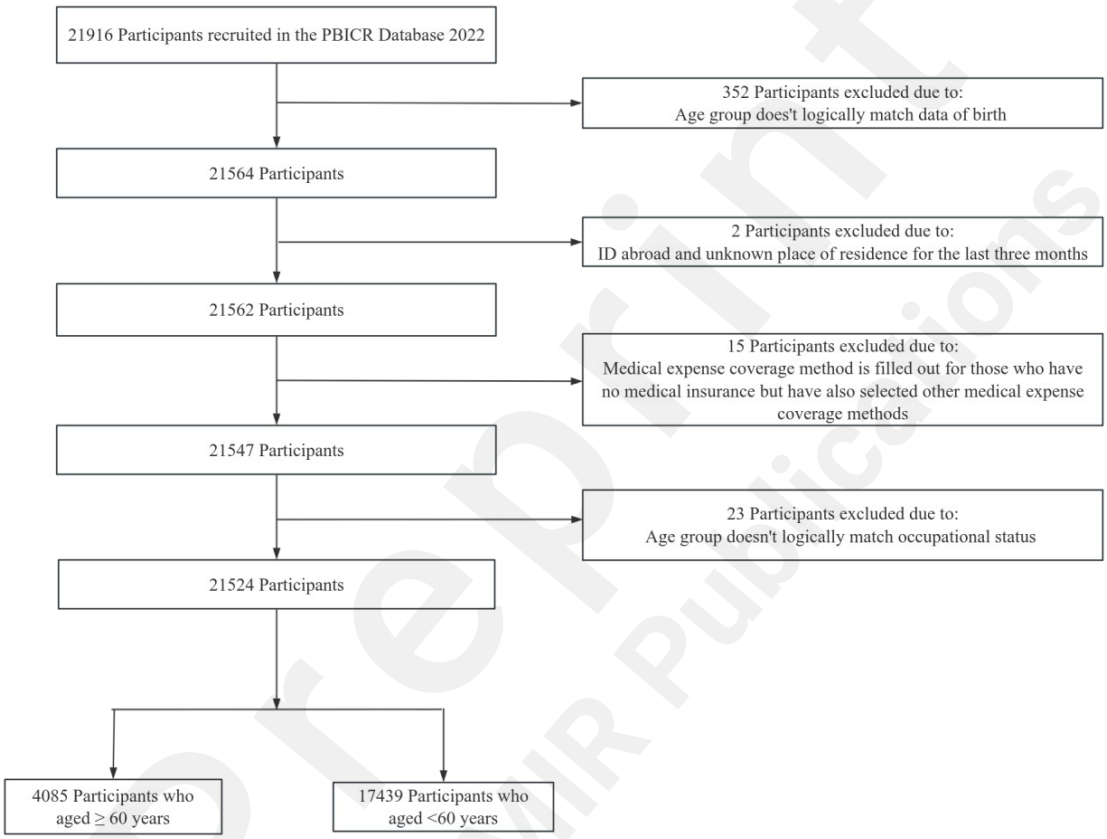



Figure 2. Flow chart of sample selection.

## Statistical Analysis

Data analysis were mainly conducted using SPSS 26.0, and all comparisons were two-tailed, with p-values <0.05 considered statistically significant. The basic information of the participants, the scores of the respondents in the scales of quality of life scale, family communication ccale, health literacy scale, and the participants' willingness to use mobile health devices were firstly analyzed descriptively, followed by univariate analysis of each potential explanatory

variables (continuous variables: independent samples t-test, categorical variables: chi-square test) and collinearity diagnosis, and based on the results, a model consisting of a Binary logistic regression model and Chaid decision tree model to explore the influencing factors affecting the willingness to use mobile health devices among the elderly, and the performance of the two models was tested and evaluated using ROC curves.

## Results

### Characteristics of participants

A total of 21916 samples were collected in this study, and 392 sets of abnormal data were excluded by logical checking, while 21524 sets of valid data were retained. The overall sample consisted of 4085 (18.98%) elderly respondents (age ≥60 years) and 17439 (81.02%) non-elderly respondents (age<60 years). The mean score of all respondents' willingness to use mobile health devices was 68.14, with non-elderly respondents (69.18) having a higher mean score of willingness to use mobile health devices than elderly respondents(63.70).

There were 2039 (49.91%) males and 3709 (90.80%) Han Chinese in the sample of elderly, with a preponderance of younger elderly people below the age of 75 and above the age of 60 (82.82%), the majority of respondents' per capita monthly income of the household were less than or equal to 4000 yuan (62.67%), most respondents with senior high school and below (86.24%), 2257 (55.25%) respondents are currently retired, 1692 (41.42%) respondents are not currently employed, and only 136 (3.33%) respondents are still employed, 1471 (36.01%) respondents have lived in the eastern region for the last 3 months, 1948 (47.69%) respondents have lived in the western region for the last 3

months, and 666 (16.30%) respondents have lived in the central region for the last 3 months.

## Each scale scores of participants

4085 respondents had a mean score of 69.86±18.55 for quality of life (EQ-VAS scale), 29.74±9.85 for health literacy (HLS-SF9 scale), 35.40±12.05 for identity bubble (IBRS-6 scale), 14.79±3.63 for perceived social support (PSSS scale), 10.51±2.42 for self-efficacy(NGSES scale), 4.44±1.54 for loneliness (T-ILS scale), and 36.92±7.63 for family communication (FCS-10 scale).

## Willingness to use mobile health devices among Chinese order adults

The mean score of the elderly population’s willingness to use mobile health devices in this study was 63.70, the median was 65, and the standard deviation was 25.112. In order to investigate whether there is any difference in the willingness to use mobile health devices among the elderly population, a normal histogram of the 4085 elderly population’s willingness to use mobile health devices was drawn(Figure 3). According to Figure 3, it can be seen that the overall trend of elderly population’s willingness to use mobile health devices shows a normal distribution, but there were also three distinct extremes,on no willingness to use mobile health devices at all (scored 0), moderate willingness to use mobile health devices (scored 50) and strong willingness to use mobile health devices (scored 100), 51 elderly people had no willingness to use mobile health devices at all, 121 elderly people had a moderate willingness to use mobile health devices and 467 elderly people had a strong willingness to use mobile health devices.

## Segmentation of high mobile health devices intention group and low mobile health devices intention group

In order to qualitatively study the elderly population willingness to use mobile health devices, K-means cluster analysis was chosen to transform continuous variables into binary variables. Respondents were categorized into high mobile health devices usage willingness group (score ≥60) and low mobile health devices usage willingness group (score <60) according to their mobile health devices usage willingness scores. 2405 people with high willingness to use mobile health devices and 1680 people with low willingness to use mobile health devices, and then descriptive statistics were performed on the demographic and sociological information of the elderly population with high mobile health devices usage willingness and low mobile health devices usage willingness (Table1). According to Table 1, it can be seen that the proportion of male respondents with high willingness to use mobile health devices (60.18%) is higher than that of female respondents (57.58%), the proportion of Han Chinese respondents (58.45%) with high willingness to use mobile health devices is lower than that of ethnic minority respondents (63.03%), The proportion of respondents with high willingness to use mobile health devices is higher among the younger elderly population (59.65%) than among the older elderly population (55.13%), and the proportion of respondents with high willingness to use mobile health devices is higher among respondents with higher education level, and the proportion of respondents with high willingness to use mobile health devices is highest among those who reside in the eastern region (64.24%), followed by those who live in the western region (56.57%), and is lowest in the central region (53.75%), and the proportion of those who are retired (62.21%) had a higher willingness to use mobile health devices than

those who were employed (58.09%) and umemployment (54.49%).

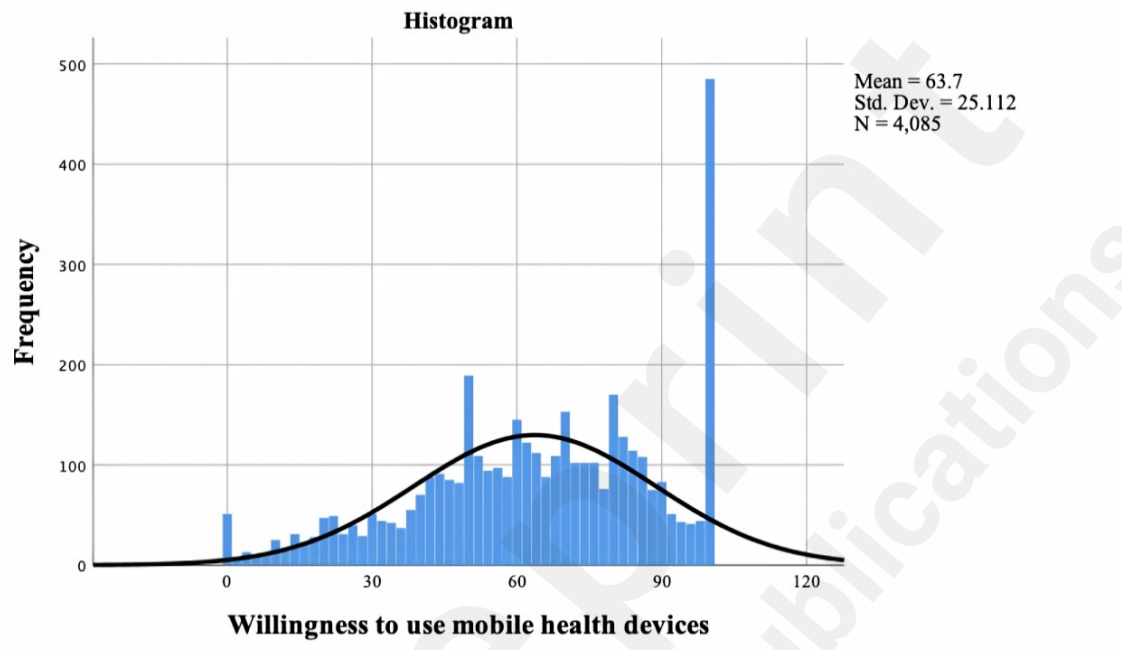



Figure 3. Normal histogram results

Table 1. Descriptive statistics

| Variables | Number (n,%) | Low willingness to use mobile health devices | High willingness to use mobile health devices |
|---|---|---|---|

| | | | | (n,%) | (n,%) |
|---|---|---|---|---|---|
| Predisposing Characteristics | Gender | Male | 2039 (49.91%) | 812 (39.82%) | 1227 (60.18%) |
| | | Female | 2046 (50.09%) | 868 (42.42%) | 1178 (57.58%) |
| | Ethnicity | Han | 3709 (90.80%) | 1541 (41.55%) | 2168 (58.45%) |
| | | Minority | 376 (9.20%) | 139 (36.97%) | 237 (63.03%) |
| | Age group | 60□74 | 3383 (82.82%) | 1365 (40.35%) | 2018 (59.65%) |
| | | ≥75 | 702 (17.18%) | 315 (44.87%) | 387 (55.13%) |
| | Education level | Senior high school and below | 3523 (86.24%) | 1500 (42.58%) | 2023 (57.42%) |
| | | Junior | 504 | 170 | 334 |

| | | | | |
|---|---|---|---|---|
| | college and bachelor degree | (12.34%) | (33.73%) | (66.27%) |
| | Postgraduate degree and above | 58 (1.42%) | 10 (17.24%) | 48 (82.76%) |
| Living region | Eastern region | 1471 (36.01%) | 526 (35.76%) | 945 (64.24%) |
| | Central region | 666 (16.30%) | 308 (46.25%) | 358 (53.75%) |
| | Western region | 1948 (47.69%) | 846 (43.43%) | 1102 (56.57%) |
| Occupational status | Employed | 136 (3.33%) | 57 (41.91%) | 79 (58.09%) |
| | Retired | 2257 (55.25%) | 853 (37.79%) | 1404 (62.21%) |
| | Unemploy | 1692 | 770 | 922 |

| | | | | |
|---|---|---|---|---|
| | ment | (41.42%) | (45.51%) | (54.49%) |
| | Low social status | 180 (4.41%) | 81 (45.00%) | 99 (55.00%) |
| Social status | Medium social status | 3099 (75.86%) | 1375 (44.37%) | 1724 (55.63%) |
| | High social status | 806 (19.73%) | 224 (27.79%) | 582 (72.21%) |
| Health literacy | Low health literacy | 2315 (56.67%) | 1095 (47.30%) | 1220 (52.70%) |
| | High health literacy | 1770 (43.33%) | 585 (33.05%) | 1185 (66.95%) |
| Self-efficacy | Low self-efficacy | 2269 (55.54%) | 1066 (46.98%) | 1203 (53.02%) |
| | High self-efficacy | 1816 (44.46%) | 614 (33.81%) | 1202 (66.19%) |
| Whether | Yes | 1786 | 710 | 1076 |

| | | | | | |
|---|---|---|---|---|---|
| | | | (43.72%) | (39.75%) | (60.25%) |
| | children living together | No | 1525 (37.33%) | 655 (42.95%) | 870 (57.05%) |
| | | Not filled | 774 (18.95%) | 315 (40.70%) | 459 (59.30%) |
| | Per capita monthly income of the household | ≤4,000 yuan | 2560 (62.67%) | 1138 (44.45%) | 1422 (55.55%) |
| | | >4,000 yuan | 1525 (37.33%) | 542 (35.54%) | 983 (64.46%) |
| Enabling Resources | How medical expenses are borne | Medical health insurance only | 3175 (77.72%) | 1344 (42.33%) | 1831 (57.67%) |
| | | Commercial health insurance only | 91 (2.23%) | 32 (35.16%) | 59 (64.84%) |
| | | Hybrid insurance | 587 (14.37% | 215 (36.63% | 372 (63.37% |

| | | | | |
|---|---|---|---|---|
| | | ) | ) | ) |
| | None | 232 (5.68%) | 89 (38.36%) | 143 (61.64%) |
| | Low perceived social support | 338 (8.27%) | 179 (52.96%) | 159 (47.04%) |
| Perceived social support | Middle perceived social support | 2025 (49.57%) | 939 (46.37%) | 1086 (53.63%) |
| | High perceived social support | 1722 (42.15%) | 562 (32.64%) | 1160 (67.36%) |
| | Poor family health | 1237 (30.28%) | 578 (46.73%) | 659 (53.27%) |
| Family health | Moderate family health | 1471 (36.01%) | 596 (40.52%) | 875 (59.48%) |
| | Excellent family | 1377 (33.71% | 506 (36.75% | 871 (63.25% |

| | | | | | |
|---|---|---|---|---|---|
| | | health | ) | ) | ) |
| | | Low quality of life | 2864 (70.11%) | 1346 (47.00%) | 1518 (53.00%) |
| | Quality of life | High quality of life | 1221 (29.89%) | 334 (27.35%) | 887 (72.65%) |
| | | Having chronic diseases related to mobile health devices | 1682 (41.18%) | 729 (43.34%) | 953 (56.66%) |
| Need | | | | | |
| | Chronic diseases conditions | Having chronic diseases unrelated to mobile health devices | 672 (16.45%) | 321 (47.77%) | 351 (52.23%) |
| | | Not having chronic | 1731 (42.37%) | 630 (36.40%) | 1101 (63.60%) |

| | | | | |
|---|---|---|---|---|
| | diseases | | | |
| Loneliness | Not alone | 2832 (69.33%) | 1135 (40.08%) | 1697 (59.92%) |
| | Alone | 1253 (30.67%) | 545 (43.50%) | 708 (56.50%) |
| Depression severity | No depression | 1894 (46.36%) | 676 (35.69%) | 1218 (64.31%) |
| | Mild depression | 1363 (33.37%) | 632 (46.37%) | 731 (53.63%) |
| | Moderate depression | 559 (13.68%) | 259 (46.33%) | 300 (53.67%) |
| | Moderate to severe depression | 218 (5.34%) | 98 (44.95%) | 120 (55.05%) |
| | Severe depression | 51 (1.25%) | 15 (29.41%) | 36 (70.59%) |
| Anxiety | No anxiety | 2282 | 873 | 1409 |

| | | | | |
|---|---|---|---|---|
| | | (55.86%) | (38.26%) | (61.74%) |
| severity | Mild anxiety | 1324 (32.41%) | 601 (45.39%) | 723 (54.61%) |
| | Moderate anxiety | 414 (10.13%) | 184 (44.44%) | 230 (55.56%) |
| | Severe anxiety | 65 (1.59%) | 22 (33.85%) | 43 (66.15%) |

## Univariate analysis and collinearity diagnosis of the willingness of elderly population to use mobile health devices:

Independent samples T-test (Table2) was conducted for continuous variables (identity bubble and family communication) and chi-square test (Table3) was conducted for categorical variables, and according to the statistical principle of “strict in, strict out”, the factors with P-value less than 0.05 were selected, and those with significant effects on the willingness of the elderly to use mobile health devices were retained. According to Table2, it can be seen that the willingness to use mobile health devices is significantly higher among elderly population with high identity bubble and high levels of family communication than among elderly population with low identity bubble and low levels of family

communication (P-values < 0.05). According to Table3, it can be seen that the P-value of gender (P=0.091), ethnicity (P=0.086) and whether children living together (P=0.170) is greater than 0.05 and less than 0.20, which indicates that there was no statistically significant difference on the willingness to use mobile health devices among the elderly people by gender, ethnicity and whether children living together. However, it is not certain that gender, ethnicity and whether children living together are completely unrelated to the willingness of the elderly people to use mobile health devices, and it is possible that these three variables may interact with the remaining statistically significant variables. Therefore, it is considered including these three variables separately in the multivariate analysis along with the statistically significant variables.

Table 2. Independent samples T-test results for continuous variables

| Variables | Mean（SD） | Mean Difference（95%CI） | T-Statistics (df) | Statistical Significance |
|---|---|---|---|---|
| Identity Bubble (Equal variances assumed) | 33.35 (11.646)[0]<br>36.83 (12.122)[1] | -3.484 (-4.228，-2.741) | -9.186 (4083) | P=0.000*** (<0.001) |
| Family communication | 36.05 (7.730)[0] | -1.467 (-1.941，- | -6.076 (4083) | P=0.000*** (<0.001) |

| | | |
|---|---|---|
| (Equal variances not assumed) | 37.52 (7.500)[1] | 0.994) |

Table 3. Results of the chi-square test for categorical variables

| Variables | Low willingness to use mobile health devices□%□ | High willingness to use mobile health devices □%□ | $\chi^2$ | P value |
|---|---|---|---|---|
| Gender | | | 2.853 | 0.091 |
| Male | 812(39.82%) | 1227(60.18%) | | |
| Female | 868(42.42%) | 1178(57.58%) | | |
| Ethnicity | | | 2.957 | 0.086 |
| Han | 1541(41.55%) | 2168(58.45%) | | |
| Minority | 139(36.97%) | 237(63.03%) | | |
| Age group | | | 4.912 | 0.027 |
| 60□74 | 1365(40.35%) | 2018(59.65%) | | |
| ≥75 | 315(44.87%) | 387(55.13%) | | |
| Education level | | | 28.116 | 0.000 |

| | | | | |
|---|---|---|---|---|
| Senior high school and below | 1500(42.58%) | 2023(57.42%) | | |
| Junior college and bachelor degree | 170(33.73%) | 334(66.27%) | | |
| Postgraduate degree and above | 10(17.24%) | 48(82.76%) | | |
| Living region | | | 28.986 | 0.000 |
| Eastern region | 526(35.76%) | 945(64.24%) | | |
| Central region | 308(46.25%) | 358(53.75%) | | |
| Western region | 846(43.43%) | 1102(56.57%) | | |
| Occupational status | | | 23.807 | 0.000 |
| Employed | 57(41.91%) | 79(58.09%) | | |
| Retired | 853(37.79%) | 1404(62.21%) | | |
| Unemployment | 770(45.51%) | 922(54.49%) | | |
| Social status | | | 73.767 | 0.000 |
| Low social status | 81(45.00%) | 99(55.00%) | | |
| Medium social status | 1375(44.37%) | 1724(55.63%) | | |

| | | | | |
|---|---|---|---|---|
| High social status | 224(27.79%) | 582(72.21%) | | |
| Health literacy | | | 84.117 | 0.000 |
| Low health literacy | 1095(47.30%) | 1220(52.70%) | | |
| High health literacy | 585(33.05%) | 1185(66.95%) | | |
| Self-efficacy | | | 72.264 | 0.000 |
| Low self-efficacy | 1066(46.98%) | 1203(53.02%) | | |
| High self-efficacy | 614(33.81%) | 1202(66.19%) | | |
| Whether children living together | | | 3.545 | 0.170 |
| Yes | 710(39.75%) | 1076(60.25%) | | |
| No | 655(42.95%) | 870(57.05%) | | |
| Not filled | 315(40.70%) | 459(59.30%) | | |
| Per capita monthly income of the household | | | 31.350 | 0.000 |
| ≤4,000 yuan | 1138(44.45%) | 1422(55.55%) | | |
| >4,000 yuan | 542(35.54%) | 983(64.46%) | | |
| How medical expenses are | | | 8.878 | 0.031 |

| | | | | |
|---|---|---|---|---|
| borne | | | | |
| Medical health insurance only | 1344(42.33%) | 1831(57.67%) | | |
| Commercial health insurance only | 32(35.16%) | 59(64.84%) | | |
| Hybrid insurance | 215(36.63%) | 372(63.37%) | | |
| None | 89(38.36%) | 143(61.64%) | | |
| Perceived social support | | | 93.805 | 0.000 |
| Low perceived social support | 179(52.96%) | 159(47.04%) | | |
| Middle perceived social support | 939(46.37%) | 1086(53.63%) | | |
| High perceived social support | 562(32.64%) | 1160(67.36%) | | |
| Family health | | | 27.155 | 0.000 |
| Poor family health status | 578(46.73%) | 659(53.27%) | | |
| Moderate family health status | 596(40.52%) | 875(59.48%) | | |
| Excellent family health status | 506(36.75%) | 871(63.25%) | | |

| | | | | |
|---|---|---|---|---|
| Quality of life | | | 136.412 | 0.000 |
| Low quality of life | 1346(47.00%) | 1518(53.00%) | | |
| High quality of life | 334(27.35%) | 887(72.65%) | | |
| Chronic diseases conditions | | | 31.653 | 0.000 |
| Having chronic diseases related to mobile health devices | 729(43.34%) | 953(56.66%) | | |
| Having chronic diseases unrelated to mobile health devices | 321(47.77%) | 351(52.23%) | | |
| Not having chronic diseases | 630(36.40%) | 1101(63.60%) | | |
| Loneliness | | | 4.191 | 0.041 |
| Not alone | 1135(40.08%) | 1697(59.92%) | | |
| Alone | 545(43.50%) | 708(56.50%) | | |
| Depression | | | 49.04 | 0.00 |

| | | | | |
|---|---|---|---|---|
| severity | | | 0 | 0 |
| No depression | 676(35.69%) | 1218(64.31%) | | |
| Mild depression | 632(46.37%) | 731(53.63%) | | |
| Moderate depression | 259(46.33%) | 300(53.67%) | | |
| Moderate to severe depression | 98(45.00%) | 120(55.00%) | | |
| Severe depression | 15(29.41%) | 36(70.59%) | | |
| Anxiety severity | | | 21.024 | 0.000 |
| No anxiety | 873(38.26%) | 1409(61.74%) | | |
| Mild anxiety | 601(45.39%) | 723(54.61%) | | |
| Moderate anxiety | 184(44.44%) | 230(55.56%) | | |
| Severe anxiety | 22(33.85%) | 43(66.15%) | | |

In order to ensure the stability and accuracy of the binary logistic regression model, the data were therefore subjected to collinearity diagnosis after univariate analysis (Table 4), which showed that the VIF values of each variable were less than 10, passing the collinearity diagnosis.

Table 4. Collinearity diagnosis results

| Model | Unstandardiz | Standardi | T | P | Collinearity |
|---|---|---|---|---|---|

| | ed coefficients | | zed coefficients | | value | statistics | |
|---|---|---|---|---|---|---|---|
| | B | Std.error | β | | | Tolerance | VIF |
| Constant | 0.350 | 0.055 | | 6.327 | 0.000 | | |
| Gender | 0.015 | 0.015 | 0.015 | 0.977 | 0.329 | 0.983 | 1.017 |
| Ethnicity | 0.044 | 0.026 | 0.026 | 1.698 | 0.090 | 0.964 | 1.038 |
| Age group | -0.014 | 0.020 | -0.011 | -0.707 | 0.480 | 0.944 | 1.059 |
| Education level | 0.026 | 0.020 | 0.021 | 1.312 | 0.190 | 0.858 | 1.166 |
| Living region | -0.026 | 0.009 | -0.048 | -2.977 | 0.003 | 0.871 | 1.147 |
| Occupational status | -0.010 | 0.015 | -0.011 | -0.660 | 0.509 | 0.847 | 1.180 |
| Social status | 0.076 | 0.016 | 0.072 | 4.600 | 0.000 | 0.929 | 1.076 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Health literacy | 0.070 | 0.018 | 0.071 | 3.974 | 0.000 | 0.713 | 1.403 |
| Whether children living together | 0.026 | 0.011 | 0.038 | 2.428 | 0.015 | 0.916 | 1.092 |
| Self-efficacy | 0.040 | 0.019 | 0.040 | 2.129 | 0.033 | 0.635 | 1.575 |
| Per capita monthly income of the household | 0.046 | 0.017 | 0.045 | 2.773 | 0.006 | 0.845 | 1.183 |
| How medical expenses are borne | 0.006 | 0.008 | 0.012 | 0.778 | 0.436 | 0.933 | 1.072 |
| Perceived social support | 0.082 | 0.016 | 0.104 | 5.130 | 0.000 | 0.553 | 1.807 |
| Family communication | -0.005 | 0.001 | -0.076 | -3.394 | 0.001 | 0.451 | 2.216 |
| Family | 0.01 | 0.012 | 0.026 | 1.29 | 0.19 | 0.571 | 1.7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| health | 6 | | | 5 | 5 | | 51 |
| Identity Bubble | 0.003 | 0.001 | 0.066 | 4.005 | 0.000 | 0.824 | 1.214 |
| Quality of life | 0.132 | 0.017 | 0.122 | 7.613 | 0.000 | 0.875 | 1.143 |
| Chronic diseases conditions | 0.013 | 0.008 | 0.024 | 1.553 | 0.120 | 0.918 | 1.090 |
| Loneliness | 0.033 | 0.019 | 0.030 | 1.741 | 0.082 | 0.738 | 1.355 |
| Depression severity | -0.024 | 0.012 | -0.046 | -1.930 | 0.054 | 0.393 | 2.542 |
| Anxiety severity | 0.013 | 0.016 | 0.019 | 0.788 | 0.431 | 0.380 | 2.631 |

## What are the factors influencing the willingness to use mobile health devices among Chinese elderly people?

## Factors influencing the willingness to use mobile health devices among Chinese elderly people based on binary logistic regression

A binary logistic regression model was constructed using the variables retained after univariate analysis and collinearity diagnosis as independent variables and the results are shown in Table5. The P-value of the model is 0.000

(< 0.05), which passed the Omnibus test, proving that the model is meaningful in general, while the P-value of the model is 0.071 (>0.05) in the Hosmer and Lemeshow test, indicating that the model has a better fitting status. According to Table5, it can be seen that the P-value of living region, health literacy, self-efficacy, whether children living together, per capita monthly income of the household, perceived social support, family communication, identity bubble, quality of life, chronic diseases conditions, loneliness and depression severity are all less than 0.05, which is statistically significant, and these twelve variables were the main factors influencing the high level of willingness of the elderly to use mobile health devices.

Among the two continuous variables (identity bubble and family communication), the OR value of identity bubble is 1.011 (>1.00), while the OR value of family communication is 0.979 (<1.00), which indicates that the level of identity bubble is positively correlated with the willingness of elderly people to use mobile health devices, and the level of family communication is negatively correlated with the willingness of elderly people to use mobile health devices. That is, the higher identity bubble, the higher willingness to use mobile health devices,and conversely, the higher level of family communication, the lower willingness to use mobile health devices. Among the five ordinal dichotomous variables (quality of life, health literacy, self-efficacy, loneliness, and per capita monthly income of the household), their OR value were all greater than 1, indicating that as the degree of the independent variables increased, the elderly people's willingness to use mobile health devices also increased in the same direction. That is, elderly people with higher quality of life, higher health

literacy, higher self-efficacy, higher loneliness, or higher per capita monthly household income had higher willingness to use mobile health devices. Among the two ordinal multicategorical variables (perceived social support and depression severity), elderly people with higher levels of perceived social support have a higher willingness to use mobile health devices, and elderly people with mild depression were significantly less likely to use mobile health devices than elderly people without depression. Among the three unordered multicategorical variables (Whether children living together, Chronic diseases conditions and living region), elderly people living with children were less likely to use mobile health devices than elderly people not living with children, elderly people with chronic illnesses unrelated to mobile health devices have a significantly lower willingness to use mobile health devices than elderly people with chronic illnesses related to mobile health devices, elderly people living in the central or western regions were significantly less likely to use mobile health devices than elderly people living in the eastern regions.

Table 5. Binary logistic regression results

| | Categories | B (SE) | Wald | Df | P | OR | 95%CI Lower | 95%CI Upper |
|---|---|---|---|---|---|---|---|---|
| Constant | | -0.516 (0.341) | 2.287 | 1 | 0.130 | 0.597 | | |
| Age group | 60□74 (Ref) | | | | | | | |
| | ≥75 | -0.091 | 1.01 | 1 | 0.3 | 0.9 | 0.76 | 1.09 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | (0.091) | 7 | | 13 | 13 | 4 | 0 |
| Education level | | | 3.669 | 2 | 0.160 | | | |
| | Senior high school and below (Ref) | | | | | | | |
| | Junior college and bachelor degree | 0.043 (0.111) | 0.147 | 1 | 0.702 | 1.044 | 0.839 | 1.298 |
| | Postgraduate degree and above | 0.704 (0.371) | 3.614 | 1 | 0.057 | 2.023 | 0.978 | 4.181 |
| Living region | | | 7.061 | 2 | 0.029 | | | |
| | Eastern region (Ref) | | | | | | | |
| | Central region | -0.232 (0.105) | 4.850 | 1 | 0.028 | 0.793 | 0.645 | 0.975 |
| | Western | -0.191 | 5.621 | 1 | 0.018 | 0.826 | 0.705 | 0.967 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | region | (0.081) | 2 | 18 | 26 | 6 | 7 |
| Occupational status | | | 5.462 | 0.065 | 2 | | |
| | Employed(Ref) | | | | | | |
| | Retired | 0.365 (0.192) | 3.591 | 0.058 | 1.440 | 0.988 | 2.100 |
| | Unemployment | 0.241 (0.196) | 1.518 | 0.218 | 1.273 | 0.867 | 1.868 |
| Social status | | | 33.870 | 0.000 | 2 | | |
| | Low social status (Ref) | | | | | | |
| | Medium social status | -0.184 (0.163) | 1.280 | 0.258 | 1 | 0.832 | 0.605 | 1.144 |
| | High social status | 0.347 (0.180) | 3.703 | 0.054 | 1 | 1.415 | 0.994 | 2.014 |
| Health literacy | Low health literacy (Ref) | | | | | | |
| | High health | 0.317 (0.080) | 15.668 | 0.000 | 1 | 1.372 | 1.173 | 1.605 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | literacy | | | | | | |
| Whether children living together | | | | | | | |
| | Yes (Ref) | | 7.405 | 2 | 0.025 | | |
| | No | 0.196 (0.076) | 6.689 | 1 | 0.010 | 1.217 | 1.049 | 1.412 |
| | Not filled | 0.188 (0.099) | 3.614 | 1 | 0.057 | 1.207 | 0.994 | 1.465 |
| Self-efficacy | Low self-efficacy (Ref) | | | | | | | |
| | High self-efficacy | 0.167 (0.085) | 3.854 | 1 | 0.050 | 1.182 | 1.000 | 1.396 |
| Per capita monthly income of the household | ≤4,000 yuan (Ref) | | | | | | | |
| | >4,000 yuan | 0.185 (0.077) | 5.761 | 1 | 0.016 | 1.204 | 1.035 | 1.401 |
| How | | | 3.443 | 3 | 0.3 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| medical expenses are borne | | | 2 | 28 | | | |
| | Medical health insurance only(Ref) | | | | | | |
| | Commercial health insurance only | 0.422 (0.244) | 2.992 | 1 | 0.084 | 1.525 | 0.945 | 2.460 |
| | Hybrid insurance | 0.078 (0.100) | 0.608 | 1 | 0.436 | 1.081 | 0.889 | 1.314 |
| | None | -0.002 (0.151) | 0.000 | 1 | 0.991 | 0.998 | 0.743 | 1.342 |
| Perceived social support | | | 26.394 | 2 | 0.000 | | | |
| | Low perceived social support (Ref) | | | | | | | |
| | Middle | 0.442 | 10.5 | 1 | 0.0 | 1.5 | 1.19 | 2.03 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | perceived social support | (0.136) | 37 | 01 | 56 | 2 | 2 |
| | High perceived social support | 0.776 (0.158) | 24.195 | 1 0.000 | 2.172 | 1.595 | 2.959 |
| Family communication | | -0.021 (0.007) | 9.768 | 1 0.002 | 0.979 | 0.966 | 0.992 |
| Family health | | | 2.994 | 2 0.224 | | | |
| | Poor family health status (Ref) | | | | | | |
| | Moderate family health status | 0.040 (0.100) | 0.157 | 1 0.692 | 1.040 | 0.856 | 1.265 |
| | Excellent family health | 0.168 (0.112) | 2.239 | 1 0.135 | 1.183 | 0.949 | 1.474 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | status | | | | | | | |
| Identity Bubble | | 0.011 (0.003) | 13.546 | 1 | 0.000 | 1.011 | 1.005 | 1.017 |
| Quality of life | Low quality of life (Ref) | | | | | | | |
| | High quality of life | 0.593 (0.081) | 54.057 | 1 | 0.000 | 1.810 | 1.545 | 2.120 |
| Chronic diseases conditions | | | 11.281 | 2 | 0.004 | | | |
| | Having chronic diseases related to mobile health devices (Ref) | | | | | | | |
| | Having chronic diseases | -0.204 (-0.097) | 4.459 | 1 | 0.035 | 0.816 | 0.675 | 0.985 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | unrelated to mobile health devices | | | | | | |
| | Not having chronic diseases | 0.124 (0.077) | 2.610 | 1 | 0.106 | 1.132 | 0.974 | 1.316 |
| Loneliness | Not alone (Ref) | | | | | | | |
| | Alone | 0.181 (0.085) | 4.549 | 1 | 0.033 | 1.199 | 1.015 | 1.416 |
| Depression severity | | | 7.223 | 4 | 0.125 | | | |
| | No depression (Ref) | | | | | | | |
| | Mild depression | -0.240 (0.097) | 6.080 | 1 | 0.014 | 0.787 | 0.650 | 0.952 |
| | Moderate depression | -0.231 (0.136) | 2.858 | 1 | 0.091 | 0.794 | 0.608 | 1.037 |
| | Moderate to severe depression | -0.381 (0.201) | 3.594 | 1 | 0.058 | 0.683 | 0.461 | 1.013 |
| | Severe | -0.192 | 0.21 | 1 | 0.6 | 0.8 | 0.36 | 1.87 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | depression | (0.417) | 1 | 46 | 26 | 4 | 1 |
| Anxiety severity | | | 0.682 | 3 0.877 | | | |
| | No anxiety (Ref) | | | | | | |
| | Mild anxiety | 0.075 (0.099) | 0.575 | 1 0.448 | 1.078 | 0.888 | 1.309 |
| | Moderate anxiety | 0.095 (0.163) | 0.339 | 1 0.561 | 1.110 | 0.798 | 1.515 |
| | Severe anxiety | 0.159 (0.368) | 0.187 | 1 0.665 | 1.173 | 0.570 | 2.411 |

## Factors influencing the willingness to use mobile health devices among Chinese elderly people based on Chaid decision tree model

The factors retained after univariate analysis and collinearity diagnosis were incorporated into the independent variables of Chaid decision tree model, and the ratio of training samples to test samples was 70%:30%, the final results are shown in Figure 4.The maximum tree depth of the Chaid decision tree model was 3, and there were a total of 19 nodes,11 of which are terminal nodes. According to Figure 4, it can be seen that quality of life, identity bubble, health literacy, living region, chronic diseases conditions, family communication and social status as the seven main factors influencing the willingness to use mobile health devices among the elderly population. Among them, quality of life ($P=0.000,\chi^2=79.094$) is the most decisive influencing factor, and the willingness

to use mobile health devices is significantly higher for elderly population with high quality of life (76.1%) than for those with low quality of life (51.0%). For elderly population with low quality of life, identity bubble (P=0.000,$\chi^2$=45.850) is the main factor influencing their willingness to use mobile health devices, with the highest proportion of high willingness to use mobile health devices among elderly people with indentity bubble scores in the (36,42] range (58.6%) ,followed by elderly people with scores in the (42,60](58.4%) range, and the lowest proportion of high willingness to use mobile health devices among elderly people with indentity bubble scores in the [6,36) range(44.7%). For elderly population with high quality of life, health literacy (P=0.000,$\chi^2$=49.719) is the main factor influencing their willingness to use mobile health devices, a significantly higher proportion of elder population with high health literacy (79.2%) than those with low health literacy(72.0%).

For elderly people with low quality of life and identity bubble scores in the [6,36], living region (P=0.001,$\chi^2$=13.967) is the main factor influencing their willingness to use mobile health devices, a higher proportion of elderly people living in the Eastern region (47.4%) had a high willingness to use mobile health devices than those living in the Central region and Western region (43.1%); for elderly people with low quality of life and identity bubble scores in the (36, 42] range, health literacy (P=0.015,$\chi^2$=5.921) is the main factor influencing their willingness to use mobile health devices, a significantly higher proportion of elderly people with high health literacy (64.5%) had a high willingness to use mobile health devices than those with low health literacy (55.1%). For elderly people with low quality of life and identity bubble scores in the (42, 60] range,

chronic diseases conditions (P=0.000,$\chi^2$=14.777) is the main factor influencing their willingness to use mobile health devices, a significantly lower proportion of elderly people having chronic diseases related to mobile health devices and having chronic diseases unrelated to mobile health devices (56.1%) than those with not having chronic diseases (61.5%) had a high willingness to use mobile health devices. For elderly people with high quality of life and low health literacy, family communication (P=0.046,$\chi^2$=13.344) is the main factor influencing elderly people willingness to use mobile health devices, with significant higher proportions of elderly people with high willingness to use mobile health devices among elderly people with low family communication(FCS scale score in the range of (10,33]) (77.8%) and those with high family communication(FCS scale score in the range of (39,50]) (75.0%) is significantly higher than the proportion of elderly people with medium family communication(FCS scale score in the range of(33,39]) (62.2%). For the elderly people with high quality of life and high health literacy, social status (P=0.000,$\chi^2$=19.052) is the main factor influencing the willingness of elderly people to use mobile health devices. The proportion of elderly people with high social status (89.7%) is significantly higher than that of the elderly people with low and medium social status (73.6%).

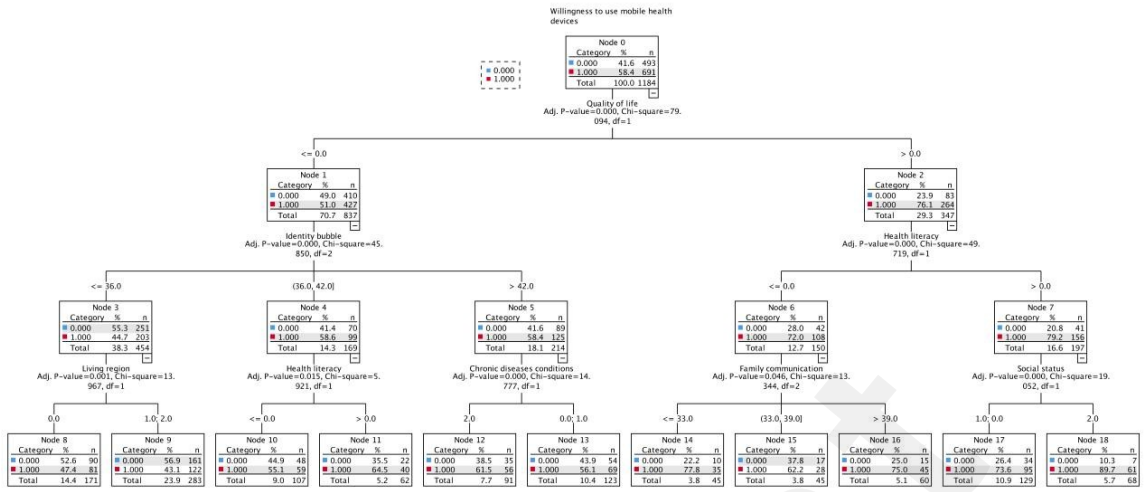



Figure 4. Chaid decision tree results

## ROC curves for Binary logistic regression model and Chaid decision tree model:

The main factors affecting the willingness of elderly population to use mobile health devices that we obtained through the binary logistic regression model are living region, health literacy, self-efficacy, whether children living together, per capita monthly income of the household, perceived social support, family communication, identity bubble, quality of life, chronic diseases conditions, loneliness and depression severity. The main factors affecting the willingness of elderly population to use mobile health devices that we obtained through the Chaid Decision Tree Model are quality of life, identity bubble, health literacy, living region, chronic diseases conditions, family communication and social status, and the overlapping factors diagnosed by the two models are quality of life, identity bubble, chronic diseases conditions, family communication, living region and health literacy. In order to analyze the performance of the two models, therefore, the predicted values of the binary logistic regression model and the Chaid decision tree model were used as the

test variables, and the willingness of elderly population to use mobile health devices was used as the status variable, and the value of the status variable was set to 1 (elderly population with high willingness to use mobile health devices), and the binary logistic regression model and the Chaid decision tree model were plotted as the ROC curves, and the final results are shown in Figure 5. The P-value of both ROC curves is 0.000 (<0.05), indicating that there is a difference between the classification results and random classification results of the two models.Meanwhile, the AUC area of the binary logistic regression model is 0.674, with a standard error of 0.008, and that of the Chaid decision tree model is 0.652, with a standard error of 0.009, thus indicating that the accuracy of the binary logistic regression model is slightly more accurate than the Chaid decision tree model, but there is no significant difference in performance between the two.

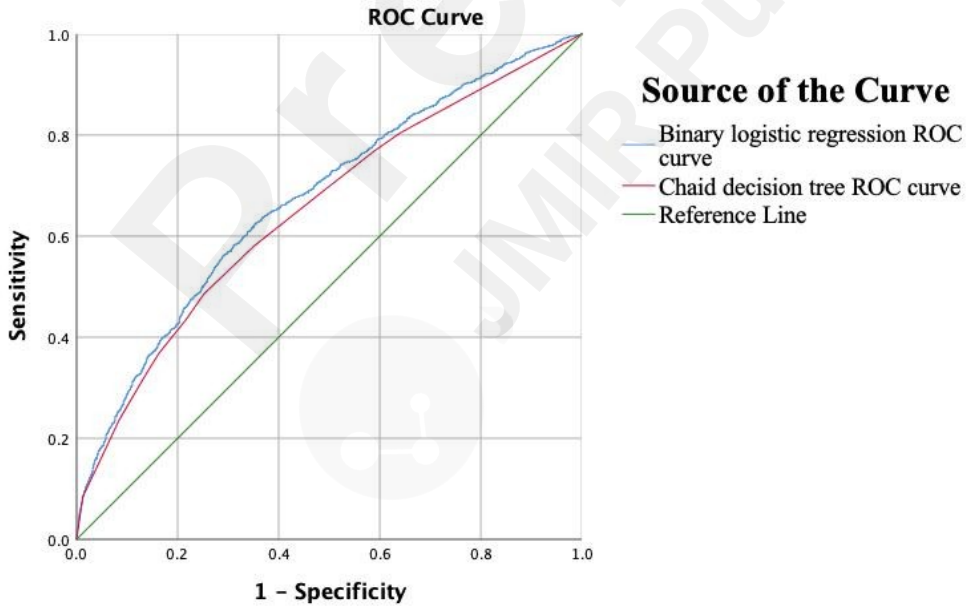



Figure 5. ROC curve results

## Discussion

## Principal Results

The study finds that the gap in willingness to use mobile health devices between older and non-older adults is relatively small. The average willingness score for older adults is 63.70, compared to 69.18 for non-older respondents. This may be partly due to the fact that older adults have greater health needs（Győrffy, （2023）. Meanwhile, it may also be attributed to the fact that today's digital technologies have increasingly prioritized age-friendly design, making elder-friendly devices more accessible and ensuring that older adults are no longer left on the periphery of digitalization（Brunzini（2023）.

In terms of research methodology, this study employs a combined model of logistic regression and decision tree analysis to comprehensively and rigorously examine the factors influencing older adults' willingness to use mobile health devices. Both methods identify key determinants such as quality of life, identity bubble, perceived social support, self-efficacy, family communication, per capita monthly household income, and health literacy. The logistic regression model further highlights additional demographic factors, including region of residence, education level, and chronic disease status. In contrast, the decision tree model emphasizes the stronger impact of subjective psychological factors.

## Factors Influencing Older Adults' Willingness to Use Health Devices

This study focuses extensively on the adaptability of the elderly population in the context of digital health and smart healthcare. Using elderly individuals' usage of mobile health devices as a starting point, it explores their willingness to use such devices and the influencing factors. Employing a comprehensive systematic framework of predisposing characteristics, enabling resources, and needs, this study conducts a thorough analysis of variables and fits the data using binary logistic regression. The findings indicate that educational level, perceived family social status, perceived social support, self-efficacy, quality of life, health literacy, identity bubble, and intra-family communication significantly influence the elderly's willingness to use mobile health devices. This not only validates the Behavioral Model of Health Services Use (BMHSU) in explaining the utilization of healthcare services among the elderly but also demonstrates its applicability in the digital age.

In terms of predisposing factors, this study reveals that perceived family social status, educational level, and health literacy are positively correlated with elderly individuals' willingness to use mobile health devices. This finding can be elucidated through the lens of the digital divide. Concerning perceived family social status, on one hand, the formation of the digital divide often relates to the objective social strata within families, encompassing dimensions such as income(Ilie,2020)and sociocultural factors. Individuals with higher incomes are more likely to have greater access to the internet and information technology(Martin,2007). Moreover, formal and informal rules regarding inequality within social cultures also influence the digital divide experienced by different groups(Beneito-Montagut,2022). On the other hand, as a subjective variable, perceived social class is influenced by objective social strata and often correlates more closely with individuals' life and psychological states(Choi,2015). Therefore, individuals who perceive themselves as belonging to a higher social class often possess the capability to access digital devices, utilize digital technologies effectively and reasonably, and fulfill their personal needs through these technologies. They also exhibit higher levels of acceptance and inclusiveness towards digital technologies, resulting in a greater willingness to use mobile health devices. It is important to note that existing research typically describes the phenomenon of the digital divide among the elderly from the perspective of objective social strata or social capital, without extensively exploring the impact of subjective social class perceptions on elderly preferences for using mobile health devices. Thus, this study contributes by supplementing existing research from a subjective psychological perspective.

Research on the digital divide and digital engagement among older adults often presents two perspectives concerning the variables of education level and health literacy. One perspective considers the integration or participation of older adults in digital life as a consequence of the three-level digital divide. It suggests that individuals with higher education levels and greater technological understanding are generally more active in using digital devices. Accordingly, older adults benefit from mastering digital technologies and actively engaging in digital life(Cresci,2010). The second perspective views "digital disengagement" among older adults as a fourth type of digital divide(Olphert,2013). It contends that even as older adults enhance their digital literacy and acquire basic knowledge and skills in information technology while integrating into the digital society, they may become unwilling to use digital technologies due to discriminatory content and other factors present in digital applications aimed at older demographics(Wu,2015). The results of this study support the first perspective, indicating that overall, individuals on the periphery of the digital society within the elderly population exhibit relatively lower willingness to use digital devices. This finding aligns with some existing research in this field. A survey of the Polish population reveals that the educational level of older adults and their motivation to use digital devices are significant variables influencing their level of digital participation(Malgorzata Orłowska,2021). There is also evidence suggesting that through professional training or digital literacy education, older adults' digital skills and literacy can significantly improve（Martínez-Alcalá CI，2021). These digital skills form the foundation for older adults to use digital devices（Wang，2022）. Therefore, reducing the digital

divide and increasing familiarity with digital devices among older adults may be a way to enhance their willingness to use such devices.

Furthermore, this study found that self-efficacy significantly influences older adults' use of mobile health devices, consistent with previous research findings. The research indicates a correlation between willingness to use digital technology and self-efficacy among retired elderly populations(Lozoya,2022). On one hand, learning to use digital technology can enhance self-efficacy among older adults(Gatti,2017); on the other hand, lower self-efficacy can diminish their ability to use smart devices(Alvseike,2012). These findings provide a basis for the conclusions drawn in this study.

In terms of facilitating resources, this study found, firstly, a significant positive correlation between perceived social support, identity bubbles, and the willingness of elderly individuals to use mobile health devices. This aligns with previous research findings. Scholars argue that perceived social support is among the crucial factors influencing tablet device usage among older adults(Tsai,2017). This can be explained using social identity theory. Research indicates that there are often stereotypes about older adults within society, and younger individuals who have more contact with older adults tend to possess greater knowledge about aging-related issues. They also show more understanding and fewer biases toward older adults(Hale,1998). Due to their greater proficiency and flexibility in using mobile health devices, younger individuals often serve as exemplary models for older adults when they experience higher levels of social acceptance and reduced stereotyping. Consequently, older adults are more likely to learn from younger generations in

using mobile health devices and receive greater encouragement in digital device utilization. Therefore, increased social support and a sense of belonging on social media platforms among older adults enhance their willingness to engage with mobile health devices. Furthermore, the findings of this study validate hypotheses derived from social capital theory, which posits that objective resources and subjective identities and trust within social relationships positively influence internet usage(Barbosa Neves,2018). Therefore, older adults' identification with internet communities and their level of digital identity bubbles also positively influence their willingness to use digital devices.

Secondly, this study found that family communication significantly negatively impacts the willingness of older adults to use mobile health devices, indicating that greater family communication correlates with a reduced inclination among older adults to use such devices. This finding contrasts with existing research conclusions. Existing studies suggest that intergenerational family networks are crucial in enhancing older adults' digital literacy and can increase their willingness to use relevant digital devices(Vercruyssen,2023). This could be due to several factors. On one hand, there are distinctions between health devices and typical digital social devices. On the other hand, older adults experience significant social isolation, particularly those living alone and lacking care from their children, thereby increasing their willingness to use digital devices(Rodríguez,2009). The application of digital devices by older adults often serves as a substitute or supplement to real-world social and health needs. When these needs are adequately met in reality, there is a decrease in both the willingness and usage rates of relevant digital devices among older

adults(Hope,2014), which could serve as an explanatory mechanism for the conclusions drawn in this study.

In terms of demand, this study found that quality of life has a significantly positive impact on older adults' willingness to use mobile health devices. Existing research has laid the groundwork for this conclusion. Studies, such as those involving telephone interviews with elderly individuals in Hungary during COVID-19, have identified substantial demand for digital health solutions among older populations, highlighting its importance as a critical application area(Győrffy,2023). This suggests that older adults' subjective perception of health and their objective life circumstances both influence their demand for and willingness to use digital health devices. This supports the conclusions drawn in this study.

It is noteworthy that explanations of these three dimensions are not entirely distinct; in fact, these variables collectively exert a systematic and comprehensive influence on older adults' willingness to use mobile health devices.

## Future Prospects

This study has the following strengths: Regarding the research topic, it explores the psychological foundation of the digital divide among older adults from the perspective of subjective willingness, enriching the structural discussion as corroborated by existing research. In terms of data, the study employs scientifically sampled large-scale samples of older adults, encompassing rich variables and comprehensive discussions, thereby

supplementing existing research with empirical analysis from China. Theoretically, the study systematically categorizes variables and discusses the theoretical relationship between subjective class perception and the digital divide, while validating social identity and social capital theories, contributing to theoretical significance.

However, this study's limitations are primarily evident in its cross-sectional design, preliminary exploration of influencing factors without delving into potential mechanisms and causal effects, and the absence of comprehensive external databases for triangulation in decision tree analysis. Furthermore, the study lacks subgroup explanations. In reality, elderly individuals with different characteristics may not score similarly on various influencing factors, and their motivations for using mobile health devices can vary in terms of initiative, passivity, and purpose.

To further delve into this topic in the future, we propose the following questions for in-depth discussion:

Firstly, This study found that there was no significant difference in the willingness of older adults to use health devices compared to the general population, which contrasts with previous researches. Existing studies indicate that younger age groups prefer generative AI that enhances productivity compared to generative AI primarily used in health settings. Additionally, research suggests that the internet has a greater impact on younger individuals than on older adults. However, individuals aged 60 and above tend to approach the use of information technology devices with caution, shyness, and deliberation(Görgün Baran,2020). It suggests a need for further exploration into

the underlying reasons for this distinction.

Secondly, do the influencing factors on older adults' willingness to use health devices similarly apply to different age groups? Research indicates that for children and adolescents, family factors and parent-child relationships often have a significant positive impact on their use of digital devices(Terras,2016), yet there remains a lack of research on their use of health devices. Therefore, this could serve as a direction for further exploration in the future.

## Conclusion

The results of this study showed that Chinese older adults' willingness to use mHealth devices was positive overall, with an average score of 63.70 out of 100. The positive state of family communication, on the contrary, reduced their willingness to use. This suggests that particular attention should be paid to the singleton and widowed elderly groups, where the lack of family communication may translate into higher acceptance and dependence on mHealth devices. Therefore, policy development should focus on providing free or subsidized health devices for these groups, and in addition, when designing promotional strategies, attention should be paid to balancing the relationship between family communication and technology acceptance, and at the same time, strengthening family digital health education to promote the incorporation of technology in ways that can Enhance rather than weaken family health management and emotional connection, help fill the gaps in elderly care services and improve health management, and realize the harmonious coexistence of technology and humanistic care.

## Abbreviations

| | |
|---|---|
| EQ VAS | EuroQol Visual Analogue Scale |
| FCS-10 | Family Communication Scale-10 |
| HLS-SF | Health Literacy Scale–Short Form |
| mHealth | mobile health |
| NGSES-SF | New General Self-efficacy Scale–Short Form |
| PSSS | Perceived Social Support Scale |
| IBRS | Identity Bubble Reinforcement Scale |

## Funding sources

This work was supported by the Chinese Academy of Medical Sciences (CAMS) Innovation Fund for Medical Sciences—A Strategic Study on Healthy China Development and Health system Reform (2021-I2M-1-046).

## Ethics Approval and Informed Consent

This study was approved by the Ethics Research Committee of the Health Culture Research Center of Shaanxi (number JKWH-2022-02). Informed consent was obtained from all participants. All data were collected anonymously and kept confidential.

## Acknowledgements

We are very grateful to the staff and participants of the the Psychology and Behavior Investigation of Chinese Residents. Additionally, we would like to extend our appreciation to the anonymous reviewers for their constructive comments, which significantly contributed to the improvement of our manuscript.

## References

National Bureau of Statistics,2024. The total population has declined, and the quality of population development has been effective. https://www.stats.gov.cn/

xxgk/jd/sjjd2020/202401/t20240118_1946711.html.(accessed 11 June 2024).
Peng, W., Chen, S., Chen, X., Ma, Y., Wang, T., Sun, X., Wang, Y., Ding, G., & Wang, Y. (2023). Trends in major non-communicable diseases and related risk factors in China 2002-2019: an analysis of nationally representative survey data. The Lancet regional health. Western Pacific, 43, 100809. https://doi.org/10.1016/j.lanwpc.2023.100809
Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2016 (GBD 2016) Burden by Risk 1990-2016. Seattle, United States of America: Institute for Health Metrics and Evaluation (IHME), 2017.
Bay alarm medical,2024.https://www.bayalarmmedical.com/(accessed 15 May 2024).
Morawski, K., Ghazinouri, R., Krumme, A., et al. (2018). Association of a Smartphone Application With Medication Adherence and Blood Pressure Control: The MedISAFE-BP Randomized Clinical Trial. JAMA internal medicine, 178(6), 802–809. https://doi.org/10.1001/jamainternmed.2018.0447
Ma C, Xu H, Li D, Zhang Z. [Research progress on wearable physiological parameter monitoring and its clinical applications]. Sheng Wu Yi Xue Gong Cheng Xue Za Zhi. 2021 Jun 25;38(3):583-593. Chinese. doi: 10.7507/1001-5515.202009031.
Sun, L., & Buijsen, M. (2022). Mobile Health in China: Does it meet availability, accessibility, acceptability and quality standards? Health Policy and Technology.
Zhang, X., Lai, K., & Guo, X. (2017). Promoting China's mHealth market: A policy perspective. Health policy and technology, 6, 383-388.
Ministry of Civil Affairs.2023.2022 Annual Report on the Development of National Undertakings for the Aged□https://www.gov.cn/lianbo/bumen/202312/P020231214405906944856.pdf/(accessed 15 May 2024)
IDC.2023.Quarterly Tracking Report on China's Wearable Devices Market.https://www.idc.com/getdoc.jsp?containerId=prCHC51569823(accessed 15 May 2024)
GUO Zijing, LUO Yuchuan, CAI Zhiping,et al.(2021) .Overview of Privacy Protection Technology of Big Data in Healthcare. Journal of Frontiers of Computer Science and Technology, 15(3): 389-402.https://doi.org/10.3778/j.issn.1673-9418.2009071
Sim, I. (2019). Mobile Devices and Health. The New England journal of medicine, 381 10, 956-968 .
Wang, Y., Lu, L., Zhang, R., Ma, Y., Zhao, S., & Liang, C. (2023). The willingness to continue using wearable devices among the elderly: SEM and FsQCA analysis. BMC Medical Informatics and Decision Making, 23.
Wang, Y., Kaierdebieke, A., Fan, S., et al. (2022). Study protocol: A cross-sectional study on psychology and behavior investigation of Chinese residents, PBICR. Psychosomatic Medicine Research.
Andersen, R.M., & Davidson, P.L. (2007). Improving Access to Care in America: Individual and Contextual Indicators.
Bass, D. M., & Noelker, L. S. (1987). The influence of family caregivers on elder's use of in-home services: an expanded conceptual framework. Journal of health and social behavior, 28(2), 184–196.
Lederle, M., Tempes, J., & Bitzer,et al. (2021). Application of Andersen's behavioural model of health services use: a scoping review with a focus on qualitative health services research. BMJ open, 11(5), e045018.

https://doi.org/10.1136/bmjopen-2020-045018
LI Yue-e, LU Shan. The development, application and implications of the Anderson Model in the field of healthcare[J]. Chinese Journal of Health Policy, 2017, 10(11): 77-82.

Sun, X., Lv, K., Wang, F., et al. (2023). Validity and reliability of the Chinese version of the Health Literacy Scale Short-Form in the Chinese population. BMC public health, 23(1), 385. https://doi.org/10.1186/s12889-023-15237-2
SUN Xiaonan, CHEN Ke, WU Yunchou, TANG Jingqi, WANG Fei, SUN Xinying, HE Miao, WU Yibo. Development of a Short Version of the Health Literacy Scale Based on Classical Test Theory and Item Response Theory[J]. Chinese General Practice, DOI: 10.12114/j.issn.1007-9572.2023.0072.
Chen, G., Gully, S. M., & Eden, D. (2001). Validation of a New General Self-Efficacy Scale. Organizational Research Methods, 4(1), 62-83.https://doi.org/10.1177/109442810141004
Wu, Yunchou, Jingqi Tang, et al. 2022. “Development of a Short Version of the Perceived Social Support Scale: Based on Classical Test Theory and Item Response Theory.” PsyArXiv. November 3. doi:10.31234/osf.io/d95zg.
Li, L., Peng, T., Liu, R., et al. (2020). Development of the psychosomatic symptom scale (PSSS) and assessment of its reliability and validity in general hospital patients in China. General hospital psychiatry, 64, 1–8. https://doi.org/10.1016/j.genhosppsych.2020.01.008
Kwon, H. J., Ahn, T. K.,et al. (2015). The Relationship between a Spouse's Alcohol Use Disorder and Family Communication. Korean journal of family medicine, 36(2), 92–102. https://doi.org/10.4082/kjfm.2015.36.2.92
Guo, N., Ho, et al. (2021). Factor Structure and Psychometric Properties of the Family Communication Scale in the Chinese Population. Frontiers in psychology, 12, 736514. https://doi.org/10.3389/fpsyg.2021.736514
Kaakinen, M., Sirola, A.,et al. (2020). Shared identity and shared information in social media: Development and validation of the identity bubble reinforcement scale. Media Psychology, 23(1), 25–51. https://doi.org/10.1080/15213269.2018.1544910
Ilie, D., Neghină, et al. (2020). NEW MEDIA, OLD PROBLEMS: SOCIAL STRATIFICATION, SOCIAL MOBILITY AND TECHNOLOGY USAGE.
Martin, S.P., & Robinson, et al. (2007). The Income Digital Divide: Trends and Predictions for Levels of Internet Use. Social Problems, 54, 1-22.
Beneito-Montagut, R., Rosales, et al. (2022). Emerging digital inequalities: A comparative study of older adults’ smartphone use. Social Media+ Society, 8(4), 20563051221138756.
Choi, Y., Kim, et al. (2015). The effect of subjective and objective social class on health-related quality of life: new paradigm using longitudinal analysis. Health and quality of life outcomes, 13, 1-11.
Cresci, M. K., Yarandi, et al. (2010). The digital divide and urban older adults. CIN: Computers, Informatics, Nursing, 28(2), 88-94.
Olphert, W., & Damodaran, L. (2013). Older people and digital disengagement: a fourth digital divide?. Gerontology, 59(6), 564-570.
Wu, Y. H., Damnée,et al. (2015). Bridging the digital divide in older adults: a study from an initiative to inform older adults about new technologies. Clinical interventions in aging, 193-201.

Malgorzata Orłowska, Krystyna M. Błeszynska (2021). Education as the Factor of Digital Inclusion of Elder Persons: A Study Case in Poland, European Research Studies Journal Volume XXIV Special Issue 4, 490-500.

Martínez-Alcalá CI, Rosales-Lagarde A, Pérez-Pérez YM, et al. (2021) The Effects of Covid-19 on the Digital Literacy of the Elderly: Norms for Digital Inclusion. Front. Educ. 6:716025. doi: 10.3389/feduc.2021.716025

Wang, C. H., & Wu, C. L. (2022). Bridging the digital divide: the smart TV as a platform for digital literacy among the elderly. Behaviour & Information Technology, 41(12), 2546-2559.

Lozoya, S. V. M., Guirado,et al. (2022). Use of technologies and Self-Efficacy in older adults. IEEE Revista Iberoamericana de Tecnologias Del Aprendizaje, 17(2), 125-130.

Gatti, F. M., Brivio, et al. (2017). “The future is ours too”: a training process to enable the learning perception and increase self-efficacy in the use of tablets in the elderly. Educational Gerontology, 43(4), 209-224.

Alvseike, H., & Brønnick, K. (2012). Feasibility of the iPad as a hub for smart house technology in the elderly; effects of cognition, self-efficacy, and technology experience. Journal of multidisciplinary healthcare, 299-306.

Tsai, H. Y. S., Shillair, et al. (2017). Social support and “playing around” an examination of how older adults acquire digital literacy with tablet computers. Journal of Applied Gerontology, 36(1), 29-55.

Hale, N. M. (1998). Effects of age and interpersonal contact on stereotyping of the elderly. Current Psychology, 17, 28-38.

Barbosa Neves, B., Fonseca, et al. (2018). Social capital and Internet use in an age-comparative perspective with a focus on later life. PloS one, 13(2), e0192119.

Vercruyssen, A., Schirmer,et al. (2023). How" basic" is basic digital literacy for older adults? Insights from digital skills instructors. In Frontiers in Education (Vol. 8, pp. 1-11).

Rodríguez, M. D., Gonzalez, et al. (2009). Home-based communication system for older adults and their remote family. Computers in Human Behavior, 25(3), 609-618.

Hope, A., Schwaba, et al. (2014, April). Understanding digital and material social communications for older adults. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 3903-3912).

Győrffy, Z., Boros, et al. (2023). Older adults in the digital health era: insights on the digital health related knowledge, habits and attitudes of the 65 year and older population. BMC geriatrics, 23(1), 779.

Görgün Baran, A., & Öztekin Alpaydın, M. (2020). A qualitative study on skills of elders to use digital technology products from digital divide perspective. Yaşlı Sorunları Araştırma Dergisi, 13(2), 107-122. https://doi.org/10.46414/yasad.788412

Terras, M. M., & Ramsay, J. (2016). Family digital literacy practices and children’s mobile phone use. Frontiers in psychology, 7, 213065.

Győrffy, Z., Boros, J., Döbrössy, B., & Girasek, E. (2023). Older adults in the digital health era: insights on the digital health related knowledge, habits and attitudes of the 65 year and older population. BMC geriatrics, 23(1), 779.

Brunzini, A., Caragiuli, M., Atzori, F., Bronzini, M., & Germani, M. (2023, July). Digital technology for elders better living: a usability and user-experience

assessment. In Proceedings of the 16th International Conference on PErvasive Technologies Related to Assistive Environments (pp. 123-130).