Perceptions and satisfaction with the use of digital medical services in urban older adults of China: a mixed-methods study

Ning Wang, Siyu Zhou, Zhuo Liu, Ying Han

Submitted to: Journal of Medical Internet Research
on: May 02, 2023

Table of Contents

Perceptions and satisfaction with the use of digital medical services in urban older adults of China: a mixed-methods study

Ning Wang[1*] BA, MA; Siyu Zhou[2*] BA, MA, PhD; Zhuo Liu[1] BE, MA; Ying Han[1] BA, MA, PhD

[1]School of Management Shanxi Medical University Jinzhong CN
[2]School of Public Health Hangzhou Normal University Hangzhou CN
[*]these authors contributed equally

Corresponding Author:
Ying Han BA, MA, PhD
School of Management
Shanxi Medical University
No.98, University Street
Jinzhong
CN

Abstract

Background: In an aging and information-based society, older adults have unique perceptions of and demands for digital medical services. The government, healthcare providers, and other sectors of society must comprehend the unique needs of older adults in order to work together to develop a more sensible digital healthcare pattern. This work focused on the adaptation of digitalization for older adults in the process of medical treatment in hospitals.

Objective: This study aimed to evaluate the behavioral intention and satisfaction of digital medical services among older adults, identify the perceived factors and influence paths related to them.

Methods: Based on Technology Acceptance Model, perceived risk was incorporated into this study. This study combined qualitative and quantitative analysis. 30 older adults in Hangzhou were invited to participate in the focus group interview, and we transcribed the interviews verbatim and coded them using a grounded-theory approach with open, axial, and selective coding of interview transcripts. We devised our questionnaire and selected four community healthcare centers in Hangzhou by stratified sampling to conduct a face-to-face survey among older adults aged 60 or above who have independent digital medical experience. All the data in the 926 returned questionnaires was valid. The collected data were subjected to descriptive analysis, difference analysis, correlation analysis, mediating effect tests, and a structural equation model.

Results: The qualitative study condensed the core category of ‘medical service relief and transformation paths for older adults in the context of digital reform’. According to the quantitative analysis, we found the path and degree of influence between the variables. With age, education, residence status, and frequency of medical visits in the last six months as control variables, the pathways of influence in the model held. The mediating effect was also verified: perceived usefulness (a1b1=0.154) and perceived ease of use (a2b2=0.210) mediated between the external variables and behavioral intention, and the external variables would also influence behavioral intention first through perceived ease of use and then through perceived usefulness (a2c1b1=0.107).

Conclusions: Based on the results of the study and oriented to the needs of older adults, the program aims to assist older adults overcome the dilemma of ‘digital divide’ and improve their willingness and satisfaction with digital medical services. The digital medical products should be modified, strategies should be proposed, and older adults themselves and the community need to put in the effort. Clinical Trial: This study was approved by the Hangzhou Normal University Ethics Committee (REC number 2021-1147).

(JMIR Preprints 02/05/2023:48654)
DOI: https://doi.org/10.2196/preprints.48654

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

Original Paper

Ning Wang1*, MA; Siyu Zhou2*, PhD; Zhuo Liu1, MA; Ying Han1, PhD
[1]School of Management, Shanxi Medical University, Jinzhong, China
[2]School of Public Health, Hangzhou Normal University, Hangzhou, China
* These authors contributed equally

Corresponding Author:
Ying Han, PhD
School of Management
Shanxi Medical University
No.98, University Street
Jinzhong, 030600
China
Phone: 86 13603513812
Email: hanying0520@sxmu.edu.cn

ORCiD:
Ning Wang: 0009-0006-3487-6889
Zhuo Liu: 0009-0008-6858-6331
Siyu Zhou: 0000-0001-7946-8172
Ying Han: 0009-0000-2426-6418

Perceptions and satisfaction with the use of digital medical services in urban older adults of China: a mixed-methods study

Abstract

Background: In an aging and information-based society, older adults have unique perceptions of and demands for digital medical services. The society must comprehend them and develop a more sensible digital healthcare pattern.

Objective: To evaluate the behavioral intention and satisfaction of digital medical services among older adults, identify the perceived factors and influence paths related to them.

Methods: This study combined qualitative and quantitative analysis. 30 older adults were randomly selected to participate in the focus group interview, and we transcribed the interviews verbatim and coded them based on grounded-theory. We collected 876 valid questionnaires to describe the perceptions and satisfaction of older adults on digital medical care, and used t-test and ANOVA to explore differences among different groups. Hierarchical multiple regression was conducted to clarify the factors closely related to satisfaction. Structural equation modeling was used to identify the multiple mediating effects.

Results: The qualitative study condensed the core category of '*medical service relief and transformation paths for older adults in the context of digital reform*'. Quantitative analysis showed that more than 60% of older adults were satisfied with digital medical services and that behavioral intentions were higher for those with higher incomes and higher education. Structural equation modeling verified that external variables such as digital skills training positively influenced perceived ease of use (β=0.594, P<0.001), perceived usefulness (β=0.544, P<0.001), promoted digital medical behavioral intentions (β=0.256, P<0.001), and reduced perceived risk (β=-0.295, P<0.001), H1 holds; perceived ease of use (β=0.168, P<0.001) and perceived usefulness (β=0.508, P<0.001) positively affect behavioral intention, and perceived risk (β=-0.05, P=0.037) exerts a negative influence, H2 holds; and behavioral intention (β=0.641, P<0.001) positively affects older adults' satisfaction with digital medical care, H5 was established. The mediation test verified that H3 partially holds (the mediating effect played by perceived riskiness is not significant) and H4 holds, specifying four significant paths: (1) external variables→ perceived ease of use→ behavioral intention (effect size of 13.9%), (2) external variables→ perceived usefulness→ behavioral intention (effect size of 38.4%), (3) external variables→ perceived ease of use→ perceived usefulness→ behavioral intention (effect size of 10.1%), and (4) a direct effect (35.5%) from external variables to behavioral intention.

Conclusions: Relying on the results of the study, orienting to the needs of the older adults and improving perceived usefulness is the most effective way to promote the use of digital healthcare devices. The community helps and facilitates the integration of the older adults into digital healthcare and adapts the design of the services and products for them, which leads to improved perceptions of digital healthcare and promotes the use behavior and satisfaction, with the negative impact of the perceived risk being negligible.

Keywords: Digital medical services; Older adults; Technology Acceptance Model; Perception; Behavioral intention; Satisfaction

Introduction

Background

According to data from the seventh national census, China has 260 million people who are 60 or older, making up 18.7% of the country's entire population, which is significantly greater than the global average of 12.8%. Aging was a key concern of society, and the continuing transmutation of this issue has posed great pressure and challenge to China. Along with the swift advancement of internet technology, ‘Internet Plus Service’ was applied to various fields and formed a group effect to serve the public. Integrated with traditional healthcare models, the digital model of ‘Internet Plus Healthcare’ combined with resident services obtained significant achievements in the application of various fields of society. However, older adults becoming an ‘information island’ was marginalized from the digital society [1].

In the current era of rapidly advancing information and communications technology, older adults are digitally excluded [2]. China's non-Internet users over 60 years of age account for 41.9% of the total number of non-Internet users [3], and the older adults is a marginal audience with a low willingness to use digital medical services [4], because they were fearful of the new features of digital mobile products. The synergistic effect of many factors, such as personal, family, social and technological factors [5], has led to the inability of the older adults to efficiently access health information and health services, leading to the birth of the ‘health digital divide’ [6]. Compared to younger age groups, older adults need to spend more effort and time to overcome more difficulties when familiarizing themselves with Internet technologies such as digital medical services [7]. A study found that the digital medical utilization in Jordan is significantly influenced by demographic variables of age (physiological changes) and gender [8]. Previous research has also proposed that healthy older adults prefer to use the Internet than those who have a medical condition [7]. Older adults’ body functions deteriorate with age, they often experience physical impairments such as hearing and sight limitations [9, 10], memory loss [11], reduction of fine motor control [12] and cognitive decline [13], which influence their willingness to try digital medical services [14]. Doubts about the security of Internet information further weaken their willingness to use it. Older adults encounter numerous barriers to using digital medical services [15], resulting in technology anxiety [16]. Summarized by Heart and Kalderon, determinants of health information technology utilization in aging users include six dimensions: usefulness, ease of use, technology-related issues, characteristics, social issues, and convenience measures [17].

Currently, the digital medical healthcare and service system for older adults in China is not yet well established. Older adults lacking digital literacy rights is unable to get the convenience of digital, which then reduces the efficiency of medical treatment for this group. Age diminishes the physical functions such as vision, hearing loss, and mobility problems and show weak adaptability and low sensitivity to digital health care, as well as behavioral disorientation and decreased perception of health services during medical visits. Declining healthcare satisfaction among older adults also inevitably leads to digital healthcare inequities [18]. Growing injustice in digital health among older adults, the ‘health digital divide’ has seriously affected the underutilization of services for older adults in the daily healthcare process. To change this situation and turn the tide, the State Council of the People's Republic of China has recognized the significance of ‘accelerating the construction of a digital society’, requesting to promote the use of digital services in medical, healthcare and pension services, to continuously improve the public's sense of access. A series of policies has been introduced, focusing on high frequency matters in healthcare services for older adults in the digital environment and making the facilitation of daily medical care a breakthrough in serving people's livelihood.

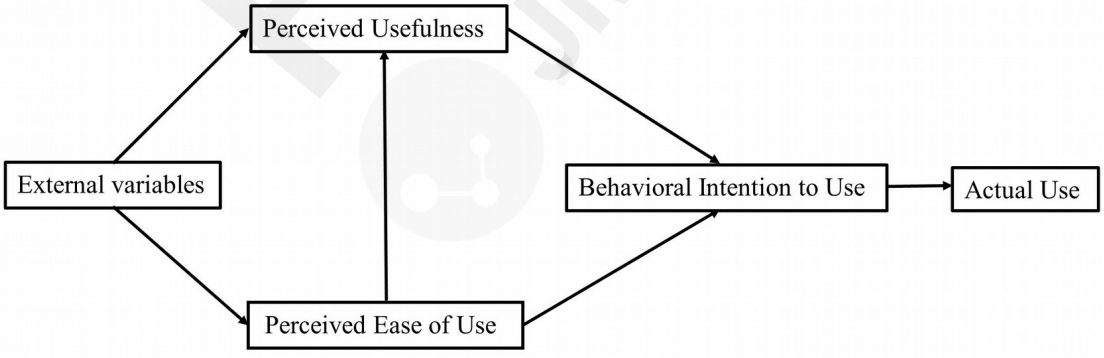
This study took Hangzhou City in Zhejiang Province, the ‘first city of digital governance in China’, as an example. As an increasingly mature megacity, Hangzhou has a high level of Internet development [19]. A large number of Internet technology enterprises, led by Alibaba, have provided support for the digital development of Hangzhou, and Hangzhou has a superb radiation-driven ability, and the level of digital governance in the Yangtze River Delta region is significantly higher than that of the whole country [20]. Many studies on digital healthcare and digital infrastructure development have used Hangzhou as an example for national and global urban digital governance [21, 22].

Hangzhou City, as a national role model for elderly care services, is actively implementing the national strategy to cope with population aging by making smart products more intelligent, practical, popular, and suitable for older adults. Hangzhou has achieved fruitful achievements in exploring medical innovations, but the system of digitally accessing medical services for the old adults has yet to be perfected. Therefore, the purpose of this study is to investigate the current situation of digital medical service perception and satisfaction among older adults in Hangzhou through a survey, and explore the major perceptual reasons why older adults cannot adapt to digital medical service under the current ‘health digital divide’ and put forward some strategies to help them escape from the dilemma. It is of great practical significance to strengthen the digital healthcare ageing transformation, provide experience for the digital reform in other aspects, and give full play to its radiating ability to drive the digital construction in China and even the neighboring countries. At the same time, this study incorporates perceived risk and satisfaction into the Technology Acceptance Model, exploring the possibility of a relationship between the variables, which is potentially theoretically relevant for the further refinement of the theory.

Theories and Hypotheses

Technology Acceptance Model (TAM), the most mature and robust theoretical model in the current information system application area, as shown in Figure 1. The model, based on the Theory of Reasoned Action, which was first proposed by Davis in 1989, after two revisions in1993 and 1996, has become the most generalized and commonly used model [23]. The modified TAM contains three core concepts: perceived usefulness, perceived ease of use, and behavioral intention to use.

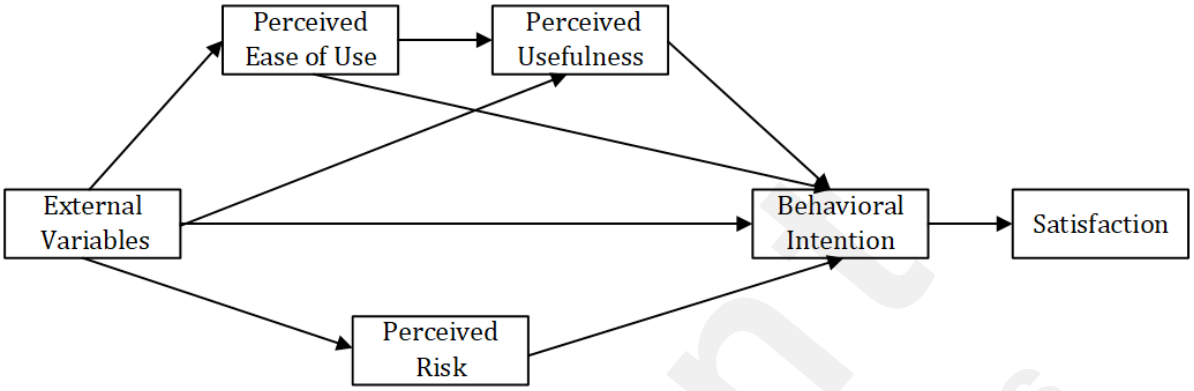
Figure 1. TAM revised by Davis in 1996



TAM has a powerful predictive and explanatory effect on users' accepting behavior. This study focused on behavioral intention to use and satisfaction factors affecting utilization of digital medical services for the aging population, involving new technologies such as online booking and e-payment. This population has varying degrees of distrust of digital technology, so it is necessary to consider the perceived risks of using new technologies when constructing new models [24]. Therefore, based on the TAM, this paper incorporates the perceived risk of older adults while receiving digital medical services into the

model, taking the satisfaction of older adults with digital medical services as the outcome variable. It focuses on the interactive correlation between the perceptual elements, analyzes the influence of each perceptual element on satisfaction to explain the influence logic of perceived health care utilization among urban older adults from the demand side, and constructs the final model (Figure 2).

Figure 2. Satisfaction model of digital medical service utilization for older adults



External variables include system characteristics, interface features, individual differences and so on [25]. The systematic assistance provided by digital devices can help users to access useful information more easily, and the simpler the access to this information, the more convenient it is for the user [26], and good design of the interface features of electronic devices can help to reduce the user's burden, affecting perceived ease of use, which affects behavioral intentions. If older adults perceive that digital devices are extremely convenient for their lives during this process, the desire to access digital healthcare is further facilitated [27]. If older adults are popularized with knowledge about digital medical services and receive guidance and assistance from volunteers, families, and friends in the process of digital medical services, it will greatly improve their perceived usefulness, and increase their behavioral intention of using digital medical services. The external variables in this study are social environment factors such as training older adults on the use of digital equipment and the distribution of promotional materials. Using online applications or self-service machines for registration and bill payment can save queuing time and gain other conveniences. Using individual differences as a control variable. Davis [23] argued that external variables determine users' perceived ease of use of new technologies and that external variables and perceived ease of use jointly determine perceived usefulness.

In this study, perceived usefulness refers to older adults believing that using digital health services will improve their access to health care or facilitate access to health-related information. Perceived ease of use refers to how easy older adults find it to use digital medical services, such as how easy it is to get instructions on how to operate digital access devices. Perceived ease of use significantly and positively affects perceived usefulness [23, 28], Martin[29] performed a study on the adoption of behavioral intention of mHealth applications among patients in community health service centers and found that perceived ease of use and perceived usefulness positively influenced the behavioral intention to be adopted. Lee’s [30] study confirmed this mediating effect: perceived ease of use influences attitude toward using by affecting perceived usefulness.

Bauer [31] defined perceived risk as ‘a combination of uncertainty plus seriousness of outcome involved’. In this study, perceived risk refers to the fact that older adults typically consider safety when using new technologies in digital medical services, which is one of the factors that directly affect its wide diffusion. Older adults may find risks such as personal information leakage and insecure payment in the process of using digital medical services [24, 32]. If government and organizations fail to provide appropriate digital health care training and publicity, mistrust of digital medical services among older adults will further increase. When they in the plight of the digital

divide perceive many risks, it may affect their motivation to participate in digital healthcare behavioral intentions.

Behavioral intention refers to the willingness of using digital medical services among older adults, which is also a subjective expression of intention. Satisfaction means the level of satisfaction with services before, during, and after the digital medical visit. This study argues that external variables such as social environment and convenience affect the behavioral intention of older adults by influencing their perception of digital healthcare, which in turn affects their digital healthcare satisfaction. Based on this conjecture, the hypotheses below are proposed in the light of theory and existing research.
H1: External variables positively influence perceived ease of use, perceived usefulness, behavioral intention and negatively influence perceived risk.
H2: Perceived ease of use and perceived usefulness positively affect behavioral intention, and perceived risk negatively affect behavioral intention.
H3: There are parallel multiple mediating effects of perceived ease of use, perceived usefulness, and perceived risk on external variables and behavioral intention.
H4: There is a chain mediation of behavioral intention through perceived ease of use through perceived usefulness and then through perceived risks to influence behavioral intention.
H5: Behavioral intention positively influences satisfaction with digital healthcare in the older adults.

Methods

Participants

In this paper, a multi-stage sampling method was used to randomly select four administrative districts from the eight main urban areas of Hangzhou, and then randomly select a community health service center from each of these districts, and number the older adults over the age of 60 in the e-health medical record database of that community health service center. Five to eight numbers were randomly selected by the computer, and the selected older adults were contacted by a team of family physicians, with at least five 60-year-olds with experience in digital healthcare use participating in focus group interviews in each community. Each community health service center by the computer program each randomly selected 250 older adults with self-directed health care behaviors for the questionnaire survey. A pre-survey was conducted with 50 older adults before the official questionnaire survey was conducted. Based on the feedback and responses from the respondents, the content of the questionnaire was optimized to be easy to read and understand, and the questionnaire questions and page settings were optimized to be suitable for older adults.

All survey members were trained in advance to familiarize themselves with the interview outline and questionnaire contents and fully understand their connotations, they explained the purpose and significance of this study to the participants, and carried out the questioning and survey after obtaining the informed consent of the participants. The questionnaires were preferably filled out by the elders themselves, and for those who had difficulty in filling out the questionnaires, the distributors read the questions aloud item by item and recorded the elders' responses so that the questionnaires could be filled out accurately and completely.

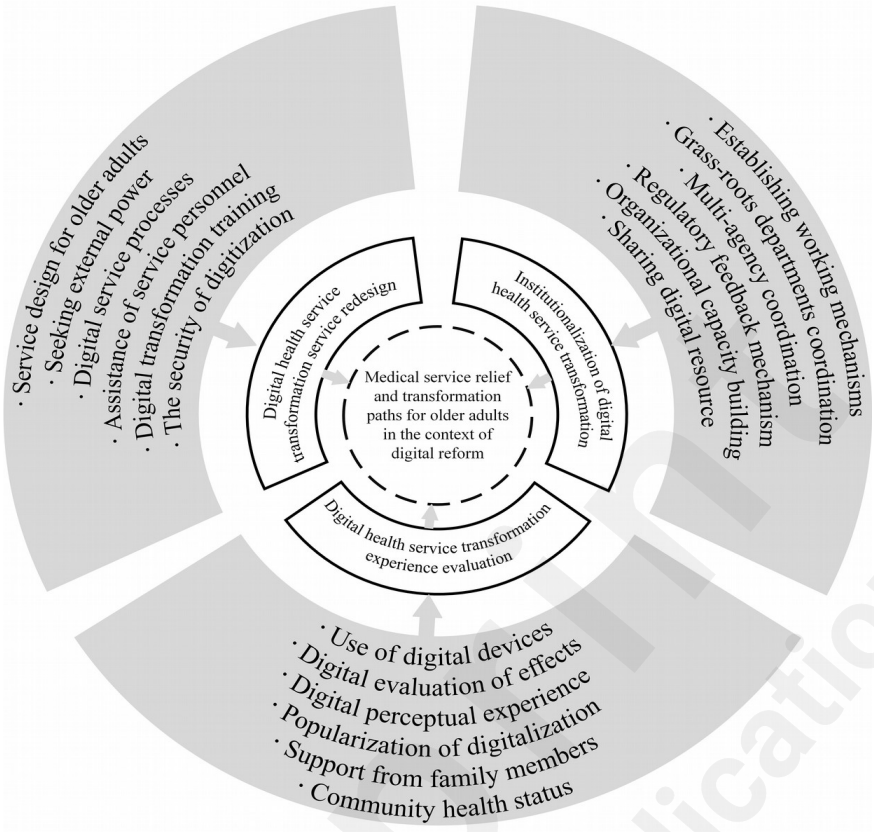
Semi-structured Interviews

In this study, the interview outline was initially formulated based on literature research, and the outline was revised through expert consultation to confirm the final outline. Based on the grounded theory, NVivo11.0 was applied to the open coding, axial coding, and selective coding of raw data, and memos and interview outlines were written:

(1) Basic digital health perception: *What are your health needs? Is it possible to solve this through digital methods?*
(2) Digital medical use experience: *Which functions of digital devices have you used, and can you tell us about your experience with and feelings about using them? What are the advantages and disadvantages of digital medical services compared to manual services?*
(3) Digital medical use dilemma: *Do you have any difficulties using it? Do you have any concerns or worries about using digital equipment for registration, billing, etc.? Have you received help from family, friends, the community, volunteers, or medical personnel?*
(4) Recommendations for digital medical services: *What can be improved in digital medical services?*

We conducted semi-structured interviews with 30 older adults over the age of 60, a sample size that met the sample size requirements demanded by the Rooted Theory study, and data saturation was judged to be reached when the interviewer kept hearing repeated narratives. The interview recordings and textual materials were collated to form 110,000 words of raw data; the study randomly selected 2/3 of the raw data used for analysis, and the remaining 1/3 was taken to test the theoretical saturation. Following the grounded theory [33], the study performed open coding and conceptualization of the collected original text word by word and further analysis, comparison, categorization, and conceptualization of the initial concepts. In this study, 668 conceptualized labels were obtained by word-by-word open coding of the original data. This study yielded 125 valid concepts as well as 18 categories after eliminating invalid and repetitive concepts. To further clarify the figurative relationship between the categories, the main categories and sub-categories were grouped and re-categorized by axial coding based on logical relationships between categories. Summarized the core categories from the main categories and then developed storylines that encapsulated most findings in a broader theoretical context, verifying these relationships with all the information. After repeatedly comparing and analyzing the links among the major categories, it was the core category that was extracted and purified to summarize a complete picture of the case, ‘Medical service relief and transformation for older adults in the context of digital reform’. Analyzing the barriers to the access and use of digital healthcare by older adults from a perceptual point of view, in order to facilitate the bridging of the ‘health digital divide’ and promote health equity. Figure 3 showed the story line, main and secondary categories. Theoretical saturation means that new concepts and categories were no longer generated during the data analysis process [34], and by continuing to code the remaining 1/3 of the interview texts, no new concepts and relationships were generated, and it can be assumed that the coding of this study has been basically perfected, and that the data saturation of the qualitative study has been reached theoretically, with a certain degree of realistic explanatory power. The qualitative research is able to inspect the influencing factors, satisfaction and suggestions, expectations and prospects for the future development of digital medical service utilization among older adults in Hangzhou, as well as provide a reference for questionnaire design.

Figure 3. The results of three-level coding



Quantitative analysis

A questionnaire was constructed after the qualitative research, and it was conducted by trained investigators who followed uniform protocols. The study's purpose and significance were explained to senior citizens who met the eligibility criteria, and their consent was obtained prior to the commencement of the inquiry. To prevent omissions, each respondent's records were examined individually. We examined the collected data, removed invalid questionnaires, dummy variables for categorical variables, and performed reliability and validity tests. The Cronbach' α coefficient for the overall scale in this study was 0.914, and the Cronbach' α values for all dimensions were greater than 0.8, proving that the reliability of the questionnaire was good.

First, the scale designed in this study has good content validity based on references to many studies and modifications to the questionnaire content after expert consultation. Second, after Bartlett's test and KMO test, the KMO value was 0.933 ($P < 0.001$), which is very suitable for factor analysis. Third, Confirmatory Factor Analysis was conducted using AMOS 26.0, and the overall fit coefficient of the model was acceptable, and the model was considered to have good structural validity ($\chi 2/df$=4.957□*RMSEA*=0.067□*NFI*=0.926>0.9□*RFI*=0.914>0.9□*IFI*=0.940>0.9□*TLI*=0.930>0.9□*CFI*=0.940>0.9). Fourth, the AVE for each latent variable was greater than 0.5 and the CR was greater than 0.8, indicating ideal convergent validity (shown in Table 2). Fifth, from the Table 1, it can be seen that the vast majority of correlation coefficients were less than the square root of the AVE, which indicates that there is a certain degree of differentiation between the latent variables, which means that the discriminant validity of data of the scale is acceptable. In summary, the questionnaire has good validity.

Table 1. Discriminant Validity

Dimensions	External variables	Perceived ease of use	Perceived risk	Perceived usefulness	Behavioral intention	Satisfaction

External variables	0.503					
Perceived ease of use	0.594	0.787				
Perceived risk	-0.295	-0.175	0.549			
Perceived usefulness	0.688	0.565	-0.203	0.742		
Behavioral intention	0.721	0.617	-0.258	0.79	0.844	
Satisfaction	0.462	0.395	-0.165	0.506	0.641	0.662
Square root of AVE	0.709	0.887	0.741	0.861	0.919	0.814

The diagonal cell value is AVE

The questionnaire adopts the Likert 5 scale model, where 1 means ‘totally disagree’, 2 means ‘comparatively disagree’, 3 means ‘generally’, 4 means ‘comparatively agree’ and 5 means ‘totally agree’, to measure the specific feedback of older adults on digital medical services, as shown in Table 1. Scoring core formula for each dimension is Score = $\frac{\sum_{n=1}^{i}(a+b+\ldots n)}{n}$. The questionnaire includes: ①basic demographic characteristics, including information on gender, age, education level, marriage status, residency, former occupation, and frequency of medical treatment to provide descriptive statistical analysis of the sample for the empirical study; ②Digital healthcare service utilization survey scale for the urban older adults, including questions on external variables, perceived ease of use, perceived usefulness, perceived risk, and behavioral intentions; ③satisfaction evaluation of digital medical service, including satisfaction ratings for each process of digital access to care. The items are shown in the table below.

We selected the issues that worry older adults the most and synthesized the results of previous studies and qualitative research to design entries corresponding to each dimension. The ‘external variables’ were designed to reflect the influence of external factors on the willingness to use and satisfaction with digital medical devices among the older adults in terms of age-adapted equipment (T1), community guidance on use (T2.T3), and convenience conditions (T4.T5.T6); ‘perceived ease of use’ to understand the areas of difficulty in the use of devices (smartphones T8, kiosks T9) and links (registration and payment T4) in the process of medical care for older adults, which reduces willingness to use and satisfaction; ‘perceived usefulness’ analyzes the current role and value of digital healthcare services for older adults from three perspectives: time saving (T10), knowledge acquisition (T11), and social adaptation (T12), which is conducive to service upgrading and improvement; ‘perceived riskiness’ investigates what current risks older people are most worried about from four perspectives: privacy protection (T13), payment security (T14), cost settlement (T15), and report accuracy (T16), and more attention should be paid to this aspect of risk avoidance in the design of the software to enhance older adults' trust in digital healthcare; ‘behavioral intentions’ analyzes the different processes of acceptance (T15), learning (T16), and use (T17) to determine which part of the process of digital healthcare service utilization by older adults is a barrier, leading to impeded behaviors and reduced satisfaction, and provides guidance for the development of future interventions.

Table 2. Questionnaire items and results of reliability and validity tests

Dimensions	Scale items	References	Cronbach’α	AVE	CR
External variables	T1: If digital devices improve friendliness (e.g., longer operation time, simplified interaction interface and flow, enlarged fonts, etc.), it will increase my using willingness. T2: The community offers training on the use of digital medical devices, and I	Fishbein M, et al. [35] Thompson R, et al. [36] Sung Youl P. [37]	0.856	0.503	0.847

	would like to attend. T3: I would like to read and study the digital medical information provided by the community. T4: I think self-service registration (self-service machines or cell phone) is more convenient than manual registration. T5: I think it is more convenient to make an appointment than to wait for a consultation on site. T6: I think self-service payment (self-service machines or cell phone) is more convenient than tollbooth.				
Perceived ease of use	T7: I can use my smartphone proficiently. T8: I can make online appointments and payments. T9: I can operate the self-service machines in the hospital.	Davis F, et al [38] Venkatesh V, et al [28] Paluri R, et al. [39] Jimenez J, et al. [40]	0.889	0.787	0.917
Perceived usefulness	T10: Digital access can save time. T11: Digital access helps me get more information about medical care in advance. T12: It is easier to adapt to society if you have digital medical skills.	Davis F, et al. [38] Venkatesh V, et al. [28] Paluri R, et al. [39] Jimenez J, et al. [40]	0.896	0.742	0.896
Perceived risk	T13: I am concerned that third-party platforms used in the digital medical process (e.g., WeChat, various apps, etc.) may disclose personal information. T14: I am concerned about the security of online and self-service machines payment. T15: I am concerned that there is a haphazard fee for doctor's office billing. T16: I am concerned about the accuracy of the self-service report retrieval.	Featherman MS, et al. [24] Grewal D, et al. [41] Mitchell VW. [42]	0.841	0.549	0.827
Behavioral intention	T17: I am willing to accept digital access to medicine. T18: I would like to learn about the use of digital medical equipment. T19: I would like to use digital medical equipment.	Davis F, et al. [38] Venkatesh V, et al. [28] Paluri R, et al. [39]	0.943	0.884	0.942
Satisfaction	T20: Various ways of digital appointment registration T21: Guidance on the use of digital medical equipment T22: Online doctor appointment T23: Call information indicator screen	Jimenez J, et al. [40] Hider S, et al. [43] Suggala S, et al. [44]	0.946	0.662	0.940

	in the waiting room T24: Pay for medical treatment in the doctor's office without paying at the tollbooth. T25: Self-service payment (mobile phone/self-service machine) T26: Self-service report retrieval (mobile phone/self-service machine) T27: The whole process of digital medical treatment	

According to Kandell sample estimation method, based on the number of questionnaire entries 10-20 times set [45], and taking into account the recovery rate of the questionnaire and the efficiency of the recovered questionnaires, on the basis of which it is necessary to increase the sample size by 20%, according to the formula: 27 questions items × 20 × (1 + 20%) = 648, which results in the need for this study at least 648 samples. Because of the complex advanced analysis of the data using multivariate statistical methods, the sample size was further expanded to 1000 in order to make the statistical parameters more robust. Data entry was done by two-person and two-machine input. 1,000 questionnaires were distributed and 876 valid questionnaires were recovered, with an effective recovery rate of 87.6%.

In this study, descriptive analyses were conducted to understand the basic demographic information and perception of digital access of the older adults interviewed; and difference analyses were conducted to clarify whether there were differences in each of the core explanatory variables among older adults of different genders, ages, educational status, and other demographic characteristics; hierarchical regression analysis was used to verify whether the inclusion of core explanatory variables such as external variables, perceived ease of use, perceived usefulness, perceived riskiness, and behavioral intention were meaningful for the refinement of the model; finally, structural equation modeling was constructed to test the multiple mediating effects played by perceived usefulness, perceived ease of use, and perceived risk in the influence of external variables on behavioral intention and the chain mediating effects played by perceived ease of use and perceived usefulness.

Ethics Approval

This study was approved by the Hangzhou Normal University Ethics Committee (REC number 2021-1147). Participants were informed of the use of this data prior to the start of both the interview and questionnaire, and they had the right to be informed and to withdraw at any time. All data were anonymized to protect participant privacy. As this survey would not potentially harm the respondents, we gave facial tissue, towels, and other household items to thank them for their participation and cooperation.

Results

Participant Characteristics

Descriptive analyses were conducted to know the demographic characteristics, perceptions of digital medical care, and the current status of satisfaction of the surveyed older adults. Table 3 describes the demographic information of the respondents. Education was concentrated in junior high schools, accounting for 41.8%. More than 50% of older adults believed that declining physical function

affected the use of digital devices. Their preference for registration methods was in the order of manual window registration, self-service machine registration, and online registration. The results of the feedback from older adults showed that the digital medical equipment has problems such as an interface and process that are too complicated, the time limit that is too short, the font that is too small, the system that is inconsistently updated at each hospital, and equipment that is prone to failure. These issues increase the difficulty of using digital health-care devices and may be a major barrier to access and use for older adults, exacerbating gaps in access to health information and widening the 'health digital divide'.

Table 3. Participant demographic data (N=876).

Characteristic		Participants
Gender, n (%)	Male	358(40.9)
	Female	518(59.1)
Age(years), n (%)	60-69	433(49.3)
	70-79	282(32.2)
	80-89	151(17.2)
	≥90	10(1.1)
Education, n (%)	Primary and below	125(14.3)
	Junior high school	366(41.8)
	Technical secondary school/ Senior high school	243(27.7)
	Junior college/ Bachelor and above	142(16.2)
Marriage, n (%)	Married	724(82.6)
	Unmarried	19(2.2)
	Bereaved spouse	133(15.2)
Living conditions, n (%)	Living with spouse	400(45.7)
	Living with spouse and children	288(32.9)
	Living alone	141(16.1)
	Others	47(5.4)
Monthly disposable income (CNY), n (%)	<1000	19(2.2)
	1001-3000	124(14.2)
	3001-5000	483(55.1)
	5001-7000	179(20.4)
	>7000	71(8.1)
Previous Occupations, n (%)	Government Offices	64(7.3)
	Enterprises and Businesses	575(65.6)
	Private enterprise	127(14.5)
	Individuals	62(7.1)
	Others	48(5.5)
Frequency of medical treatment in the past six months, n (%)	0	166(18.9)
	1-2	306(53.9)
	3-4	135(69.3)
	>5	269(30.7)
Health Insurance, n (%)	Urban employee medical insurance	431(49.2)
	Urban residents' medical insurance	357(40.8)
	New Rural Cooperative Medical Care	35(4.0)
	Commercial Health Insurance	10(1.1)
	None	41(4.7)
	Others	2(0.2)
Deterioration of physical function (e.g., vision loss, hearing loss) that	Totally disagree	69(7.9)
	Comparatively disagree	95(10.8)

affects your ability to use digital medical devices, n (%)	Generally	234(26.7)
	Comparatively agree	395(45.1)
	Totally agree	83(9.5)
Preferred appointment method, n (%)	Online	157(17.9)
	Self-service machines	323(36.9)
	Manual window	334(38.1)
	Doctor makes the next clinic appointment	19(2.2)
	Make a call	28(3.2)
	Others	15(1.7)
The problems of digital medical equipment	Time limit is too short	106(12.1)
	Too complicated interface and process	469(53.5)
	Font size too small	92(10.5)
	Others	209(23.9)

Participants' Perceptions and Behavioral Intentions of Digital Medical Care

Table 4 showed the descriptive analysis of the scores of each influencing factor of digital medical service utilization among the urban older adults. The standard deviation of all variables was above 0.5, indicating that the survey respondents showed differences in the selection of question items. After compiling the statistical data, the scores of the dimensions influencing the perception of digital medical service utilization among older adults, from highest to lowest, were: perceived usefulness (3.78±0.86), external variables (3.68±0.74), behavioral intention (3.61±0.97), perceived ease of use (2.94±1.01), and perceived risk (2.80±0.87). It can be seen that most of the older adults believe that digital access to healthcare is useful for their lives, but factors such as the difficulty and risk of operation prevent them from efficiently utilizing digital access devices.

Table 4. Descriptive statistical analysis of influencing factors

	Minimum	Maximum	Average	SD
External variables	1.00	5.00	3.68	0.74
Perceived usefulness	1.00	5.00	3.78	0.86
Perceived ease of use	1.00	5.00	2.94	1.01
Perceived risk	1.00	5.00	2.80	.87
Behavioral intention	1.00	5.00	3.61	.97
Number of valid cases	876			

Participant Satisfaction with each aspect of Digital Medical Care

Table 5 showed the satisfaction evaluation of digital medical services and equipment before, during and after diagnosis. Among the respondents, more than 60% were satisfied with the digital medical process, such as the registration methods, digital medical guidance, online doctor appointment, call information indicator screen in the waiting room, paying in the doctor's office, self-service payment, and self-service report retrieval.

Table 5. The constituent ratio of digital medical satisfaction (N=876)

	Highly Dissatisfied	Dissatisfied	Common	Satisfied	Highly Satisfied
Various ways of digital appointment registration, n (%)	10(1.1)	47(5.4)	249(28.4)	443(85.5)	127(14.5)
Guidance on the use of digital medical equipment, n (%)	8(0.9)	62(7.1)	256(29.2)	412(47.0)	138(15.8)
Online doctor appointment, n (%)	11(1.3)	51(5.8)	287(32.8)	396(45.2)	131(15.0)
Call information indicator screen in the waiting room, n (%)	7(0.8)	38(4.3)	247(28.2)	444(50.7)	140(16.0)

Pay for medical treatment in the doctor's office without paying at the tollbooth, n (%)	9(1.0)	44(5.0)	278(31.7)	401(45.8)	144(16.4)
Self-service payment (mobile phone/self-service machine), n (%)	12(1.4)	61(7.0)	258(29.5)	415(47.4)	130(14.8)
Self-service report retrieval (mobile phone/self-service machine), n (%)	13(1.5)	63(7.2)	242(27.6)	429(49.0)	129(14.7)
The whole process of digital medical treatment, n (%)	9(1.0)	45(5.1)	238(27.2)	464(53.0)	120(13.7)

Differences in Perceptions, Behavioral Intentions and Satisfaction between Groups

The t-test and ANOVA were used to explore whether there were differences between external variables, perceived ease of use, perceived usefulness, perceived risk, behavioral intention, and satisfaction among people with different characteristics (shown in table 6). Gender differences were not statistically significant in any of the dimensions. The older the age and the lower the level of education, the lower the scores on external variables, perceived ease of use, perceived usefulness, behavioral intention, and satisfaction, and the difference in perceived risk was not statistically significant. Married older adults scored significantly higher on external variables, satisfaction, older adults living with their children scored high on perceived ease of use and perceived risk of digital medical devices, probably because older adults can get easier access to guidance from their children, which reduces the difficulty of using digital devices, and their children's fraud prevention reminders make older adults more alert, and older adults living alone with their spouses scored high on the rest of the dimensions. Older adults with higher incomes have lower perceived risk and higher scores on the other dimensions. Because higher incomes are likely to have higher levels of education, the results are similar. Older adults who had worked in government units scored high on perceived usefulness and behavioral intention, perhaps because former work experience gave older adults more courage to try new things. Older adults with high frequency of access to healthcare have high scores on external variables, perceived usefulness, behavioral intention, and satisfaction, and low scores on perceived risk, perhaps because their higher frequency of access to and use of digital access devices makes them more proficient and less prone to errors, and therefore better able to feel the convenience of digital access to healthcare.

Table 6. Difference analysis of characteristics of older adults

riables			External variables	Perceived ease of use	Perceived usefulness	Perceived risk	Behavioral intention	Satisfactio
	X±	male	3.68±0.69	3.00±1.08	3.72±0.89	2.80±0.90	3.57±0.98	3.71±1.08
ender	*S*	female	3.69±0.77	2.97±1.08	3.82±0.83	2.80±0.85	3.64±0.96	3.70±0.71
		t	-0.031	-0.802	-1.597	0.018	-1.112	0.216
		P	0.975	0.423	0.111	0.985	0.267	0.829
		60-69	3.81±0.76	3.35±1.04	3.90±0.44	2.75±0.86	3.79±0.97	3.82±0.74
	X±	70-79	3.64±0.63	2.68±0.95	0.72±0.43	2.78±0.88	3.58±0.84	3.67±0.65
ge	*S*	80-89	3.47±0.75	2.33±0.95	0.88±0.72	2.94±0.90	3.22±1.07	3.49±0.67
		>90	2.63±0.94	2.27±1.15	0.80±0.25	3.05±0.82	2.53±0.65	3.41±0.78
		F	12.611	51.127	7.809	2.087	20.613	9.298
		P	<0.001	<0.001	<0.001	0.100	<0.001	<0.001
		Primary and below	3.41±0.87	2.37±1.07	3.64±0.82	2.92±0.89	3.20±1.15	3.55±0.78
	X±	Junior high school	3.66±0.69	2.85±0.99	3.72±0.84	2.83±0.85	3.55±0.90	3.68±0.70
ucation	*S*	Technical secondary school/	3.78±0.71	3.19±0.99	3.86±0.86	2.75±0.85	3.75±0.93	3.78±0.65

		Senior high school						
		Junior college/ Bachelor and above	3.81±0.74	3.28±1.20	3.93±0.89	2.70±0.94	3.91±0.91	3.78±0.74
		F	7.348	21.357	4.156	1.845	12.516	3.787
		P	<0.001	<0.001	0.006	0.137	<0.001	0.010
		Married	3.73±0.71	3.02±1.06	3.81±0.84	2.80±0.87	3.67±0.92	3.74±0.70
	X± *S*	Unmarried	3.54±0.91	3.04±1.28	3.65±1.13	2.74±1.04	3.68±1.12	3.49±1.15
arriage		Bereaved spouse	3.44±0.81	2.53±1.07	3.64±0.86	2.80±0.88	3.28±1.14	3.57±0.69
		F	9.647	11.827	2.270	0.049	7.007	3.837
		P	<0.001	<0.001	0.104	0.952	0.002	0.029
		Living only with spouse	3.81±0.66	2.98±1.09	3.90±0.83	2.72±0.87	3.77±0.90	3.78±0.68
	X± *S*	Living with spouse and children	3.65±0.70	3.05±0.99	3.67±0.82	2.90±0.84	3.56±0.90	3.74±0.66
ving nditions		Living alone	3.52±0.90	2.66±1.16	3.75±0.91	2.74±0.96	3.45±1.12	3.59±0.84
		Others	3.32±0.82	2.82±1.13	3.48±0.99	3.05±0.70	3.09±1.20	3.27±0.74
		F	9.383	4.584	6.526	4.475	7.895	7.716
		P	<0.001	0.003	<0.001	0.005	<0.001	<0.001
		<1000	3.07±1.28	2.56±1.14	3.28±1.21	3.01±1.12	2.72±1.10	3.02±1.15
		1001-3000	3.54±0.73	2.74±1.06	3.56±0.80	2.98±0.86	3.37±0.94	3.62±0.77
onthly	*X*± *S*	3001-5000	3.69±0.69	2.87±1.03	3.76±0.82	2.81±0.83	3.63±0.92	3.71±0.63
posable		5001-7000	3.75±0.74	3.20±1.04	3.97±0.82	2.70±0.92	3.74±0.98	3.73±0.74
come		>7000	3.92±0.74	3.26±1.32	3.97±1.02	2.62±0.95	3.84±1.09	3.96±0.75
		F	4.389	5.984	6.316	2.737	8.000	4.078
		P	0.003	<0.001	<0.001	0.033	<0.001	0.004
		Government Offices	3.75±0.77	3.01±1.11	3.88±0.85	2.62±0.90	3.88±0.78	3.65±0.74
	X± *S*	Enterprises and Businesses	3.73±0.71	2.98±1.09	3.86±0.82	2.77±0.86	3.68±0.96	3.77±0.68
evious		Private enterprise	3.61±0.66	2.74±1.03	3.63±0.84	2.83±0.86	3.43±0.97	3.70±0.65
ccupations		Individuals	3.65±0.77	3.06±1.04	3.61±0.92	3.07±0.85	3.52±1.02	3.58±0.74
		Others	3.25±0.98	2.89±1.07	3.33±1.02	2.97±0.92	2.98±0.98	3.21±0.91
		F	3.508	1.570	6.512	2.946	8.666	7.882
		P	0.009	0.180	<0.001	0.02	<0.001	<0.001
		0 times	3.60±0.85	3.01±1.17	3.67±0.94	2.83±0.87	3.50±1.05	3.62±0.79
	X± *S*	1-2 times	3.67±0.70	2.87±0.99	3.69±0.82	2.92±0.87	3.65±0.88	3.66±0.68
equency medical		3-4 times	3.61±0.72	2.87±1.10	3.80±0.84	2.82±0.85	3.59±0.94	3.63±0.70
atment		5 times and more	3.79±0.69	3.02±1.10	3.94±0.83	2.63±0.86	3.64±1.03	3.85±0.68
		F	3.216	1.406	5.119	5.636	0.865	5.606
		P	0.022	0.240	0.002	0.001	0.459	0.001
		Urban employee medical insurance	3.74±0.68	3.04±1.06	3.89±0.80	2.76±0.86	3.74±0.95	3.78±0.66
		Urban residents' medical insurance	3.64±0.69	2.80±1.05	3.64±0.83	2.80±0.85	3.49±0.91	3.67±0.69
alth urance	*X*± *S*	New Rural Cooperative Medical Care	3.34±1.09	2.59±1.13	3.63±1.15	2.89±1.15	3.10±1.24	3.28±0.97
		Commercial Health Insurance	3.00±1.14	3.03±1.13	3.07±1.40	3.75±0.87	3.10±1.35	3.26±1.16

None	3.89±1.04	3.41±1.23	4.09±0.87	2.80±0.82	3.86±1.08	3.74±0.90
Others	3.67±0.47	3.83±0.24	3.50±0.71	2.88±0.53	3.50±0.71	3.94±0.09
F	2.042	4.705	4.350	2.637	3.708	4.182
P	0.157	<0.001	0.023	0.022	0.036	0.023

Factors Associated with Satisfaction of Digital Medical Care

Hierarchical multiple regression was used to assess the influence of each dimension of perception factors on the satisfaction of digital healthcare for older adults and also to determine whether the influence of each control variable on the explanatory variables was significant or not, so as to provide a reference for the construction of the subsequent structural equation model. With demographic variables such as gender, age, and education as control variables, the model significance level was less than 0.001 and each *VIF* was less than 5, indicating that there was no multicollinearity among the variables and the findings were statistically significant. There was a significant effect of all dimensions on satisfaction with digital access to healthcare, hypothesis H5 holds true, “behavioral intention positively influences satisfaction”, and a non-significant effect of demographic variables, which were excluded from the construction of the structural equation model. Regression analysis was used to confirm the reliability of the results after the control variables were removed from the model (Model 3). The analysis's findings indicated that the core independent variables' significance and direction of coefficients did not significantly change, indicating that the model had passed the robustness test and that there was a generally reliable relationship between them and the dependent variable.

Table 7. Hierarchical multiple regression results

Variables	Satisfaction		
	Model 1	Model 2	Model 3
(Constant)	3.931***	1.808***	1.570***
Gender	.012	-.041	
Age	-.181***	.008	
Education	.032	-.042	
Marriage	.036	.033	
Living conditions	-.110***	-.035	
Monthly disposable income	.080*	-.003	
Previous Occupations	-.094***	-.029	
Frequency of medical treatment	.055*	.021	
health insurance	-.021	-.027	
External variables		.346***	.354***
Perceived usefulness		.110***	.124***
Perceived ease of use		.136***	.114***
Perceived risk		-.069***	-.076***
Behavioral intention		.069*	.066*
F	10.893***	130.349***	159.84***
R^2	0.102	0.489	0.479
ΔR^2	0.102	0.387	

*P<0.05, **P<0.01, ***P<0.001

Structural Equation Modeling of Perceptions and Satisfaction of Digital Medical Care for Older Adults

In order to determine the path coefficient relationships between the latent variables involved in this study as well as the multiple mediation effects, the structural equation modeling was performed using

the Amos 26.0 software (shown in Figure 4) and the significance of the paths was analyzed through the t-test results (shown in Table 8). As can be seen from the test results:

(1) The significant effects of external variables on the dimensions in descending order were perceived ease of use (0.594), perceived usefulness (0.544), perceived risk (-0.295), and behavioral intention (0.256), and Hypothesis H1 holds.

(2) Perceived usefulness (0.508), perceived ease of use (0.168), and external variables (0.256) have a significant positive effect on behavioral intention, while perceived risk (-0.050) has a weak negative effect on behavioral intention, and the effect of perceived usefulness is much greater than that of the other dimensions, so hypothesis H2 holds.

(3) Behavioral intention significantly and positively affects the satisfaction of digital healthcare access among the older adults with a path coefficient of 0.641 and hypothesis H5 is also valid.

Figure 4. The Structural Equation Model

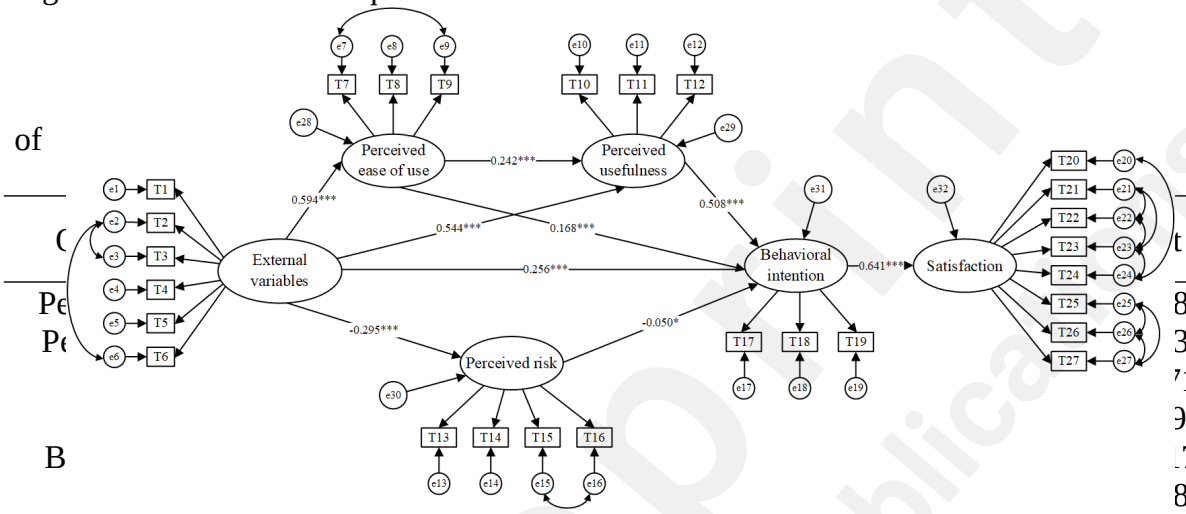


Table 8. Scalar Estimates of Research Model

C					t	P
Pe					801	<0.001
Pe					352	<0.001
					714	<0.001
					945	<0.001
B					.79	<0.001
					87	<0.001
	Perceived usefulness		0.508	0.041	14.281	<0.001
	Perceived risk		-0.05	0.025	-2.087	0.037
Satisfaction	Behavioral intention	0.41	0.641	0.023	20.703	<0.001

Mediating Role Played by Perceived Ease of Use, Perceived Usefulness, and Perceived Risk

To verify the multiple mediating roles of perceived ease of use, perceived usefulness, and perceived risk between external variables and behavioral intention (H3) and the chained mediating roles of perceived ease of use and perceived usefulness (H4), the bias-corrected percentile Bootstrap procedure test for the significance of each path of the multi-mediation model was performed using Amos 26.0, with 5000 repeated extractions to obtain 95%*CI* [46]. As can be seen from Table 9, the Bootstrap (95% *CI*) of ind3 is [0,0.033], which contains 0, indicating that the mediation effect of this path is not significant, and the Bootstrap (95% *CI*) of ind1, ind2, and ind4 do not contain 0, which has a significant mediation effect, and the value of the mediation effect is ind2>ind1>ind4. Hypothesis H3 partially holds, the mediating effects of perceived ease of use and perceived usefulness are significant, the mediation hypothesis of perceived risk does not hold, and the hypothesis H4 of chained mediation effects is valid.

Table 9. Results of Distal Mediation Test

Effect types	Effect	Boot SE	Boot LLCI	Boot ULCI	Ratio of indirect to total effect	Ratio of indirect to direct effect
Total effect	0.721	0.027	0.662	0.771		
Direct effect	0.256	0.045	0.169	0.345	35.5%	
Total indirect effect	0.465	0.033	0.403	0.537	64.5%	

ind1: External variables→ Perceived ease of use→ Behavioral intention	0.1	0.019	0.066	0.142	13.9%	39.1%
ind2: External variables→ Perceived usefulness→ Behavioral intention	0.277	0.034	0.213	0.348	38.4%	108.2%
ind3: External variables→ Perceived risk→ Behavioral intention	0.015	0.008	0	0.033	2.1%	5.9%
ind4: External variables→ Perceived ease of use→ Perceived usefulness→ Behavioral intention	0.073	0.016	0.044	0.11	10.1%	28.5%
C1: ind1-ind2	-0.176	0.044	-0.266	-0.092		
C2: ind1-ind3	0.086	0.021	0.047	0.129		
C3: ind1-ind4	0.027	0.028	-0.027	0.081		
C4: ind2-ind3	0.262	0.036	0.197	0.336		
C5: ind2-ind4	0.203	0.041	0.124	0.286		
C6: ind3-ind4	-0.058	0.019	-0.098	-0.023		

Discussion

This study used a mixed qualitative and quantitative methodology, both of which found that older adults could perceive the convenience of digital access but were less willing to use digital devices due to numerous personal and external factors, such as low literacy, loss of vision and hearing, a lack of assistance and guidance, and fear and anxiety about new technologies. They also expected digital devices to be adapted to the characteristics of older adults, thus improving satisfaction. The qualitative research learned from the interviews about the reasons for the digital dilemmas encountered by older adults and raised expectations for future digital development based on their own needs, providing a scientific reference for the design of the questionnaire. While the quantitative study used the questionnaire data to further verify whether these causes influenced the older adults' willingness to use digitalization and the path and extent of the impact, validating hypotheses.

Principal Findings

The recent situation and trend of digital medical care among older adults were low awareness, low utilization, and high demand [47]. This study based on TAM, investigated the current situation of digital medical services for older adults, and explored the factors affecting the behavioral intention and satisfaction. The following conclusions were drawn, which were consistent with the previous studies:

Each dimension has a significant effect on behavioral intention, Jiao L [48] believes that perceived ease of use has the greatest influence on the attitude of continued use of online appointment platforms, and Shang S [49] believe that perceived usefulness positively influences behavioral intention of digital healthcare services in the older adults. In this study, perceived usefulness plays the most important role in the study of behavioral intention towards digital healthcare platforms and devices for the older adults, and we can even think that as long as this service can adequately serve and facilitate the older adults, all other difficulties can be overcome, so we should focus on the transformation and upgrading of digital healthcare platforms and devices to improve the capability of convenient services. In order to promote the willingness of older persons to use digital healthcare

devices, it is certainly necessary to balance the enhancement of external variables such as the social environment's help, perceived ease of use, perceived usefulness, and the reduction of perceived risk in the process of institutionalizing, service redesigning, and experience of digital healthcare's ageing transition.

Pavlou (36) argued for the negative effect of perceived risk on willingness to use, and this study similarly validates this finding. However, older adults perceive digital access to healthcare as low-risk and having little effect on behavioral intentions. Older adults perceive digital access to healthcare to be low-risk and to have little effect on behavioral intentions. This study suggests the following reasons for this phenomenon: First, the lack of awareness of digitalization among old adults, which leads to a lack of awareness of the risks that may arise in the process of digitalization of health care; Second, most of those providing digital access to healthcare are public hospitals, and old adults' trust in government-run healthcare organizations extends to their online platforms and self-service devices; Third, digital access platforms and devices have relatively uniform and strict regulatory standards, less negative press, and less distrust among older adults; Fourth, the convenience of digitization is sufficient to compensate for its potential risks, and older adults are still willing to experiment with use and integrate into the digital healthcare environment.

Numerous studies verified the positive effect of satisfaction on behavioral intention [50, 51] and this finding is consistent with the common sense that older adults' satisfaction with each process of digital healthcare access influences their behavioral intentions. However, this study explored whether older adults' internal acceptance of digital healthcare largely determines their satisfaction with digital healthcare. This study argues that fundamentally improving the ability of digital healthcare to serve the older adults has to start with the willingness of them to accept and use digital healthcare platforms and devices for the purpose of realizing the positive facilitation effect of behavioral intention and satisfaction in a cyclic cumulative manner.

According to the study's results, we propose ways to improve the willingness to use and satisfaction with medical services of urban older adults in the background of digital healthcare and provide references and ideas for the optimization of digital medical services in Hangzhou and the development of healthcare in other cities.

Improve accessibility of digital medical information and assistance.

As the results of the study showed, external variables such as social environment factors and convenience had a remarkable positive correlation with perceived usefulness and perceived ease of use of digital medical services among older adults. Convenience and other factors had a remarkable effect on older adults' healthcare behavior choices [52]. Therefore, all departments should collaborate to promote and increase the reach of channels to enhance the convenience and accessibility of digital healthcare knowledge and guidance for older adults. Government departments should disseminate digital healthcare through various channels, including traditional media and new media, to promote publicity, build public trust in government-provided service products [53], reduce the perceived risk of digital access to healthcare among older adults, and enhance perceived usefulness, harnessing the powerful contribution of perceived usefulness to behavioral intentions. The community, where older adults live, should assist the government as an auxiliary force to promote the community digital access platform. Older adults who have received services on the intelligent platform terminal for senior care services attend the session to promote their experiences and feelings of using it, and communities should offer digital access training sessions to increase the opportunities for older adults to learn about and pick up digital access platforms in their daily lives. Teaching older adults to identify information that is beneficial to them and basic cyber security skills will increase their confidence in using digital medical devices and enhance perceived ease of use [54]. Health care

institutions should recruit more trained volunteers to provide digital access support to protect older adults from being less willing to use self-service machines due to a lack of timely assistance and guidance when using them. While encouraging digital access to patients, it is also extremely important to consider the particular needs of the older adults. by opening green channels to provide manual services or one-on-one assistance from volunteers. In addition, we should continue to ‘interact with relatives’ and ‘interact with friends’, so that friends and relatives may hold an irreplaceable role in assisting older adults to overcome the ‘health digital divide’ [55]. These measures are aimed at improving the perception of digital healthcare by the older adults themselves through external help and support, and thus promoting the use of behaviors, sharing the dividends of digital healthcare, and bridging the ‘digital divide in health’.

Promote digital access platform more suitable for older adults

The most intuitive display of digital medical treatment to users is the interactive interface, operation process, and server response speed of APPs and self-service machines. The quality of hardware and software will affect one’s capacity to employ digital technologies [56]. Older adults may give up using it because they do not receive timely help when problems arise, which leads to deepening the health digital divide. Departments should pay more attention to distributing resources for digital medical services more equitably and adapt mobile platforms and self-service machines to make them more suitable for older adults. Therefore, the government should unify hospitals to share an official platform for registration, payment, and other medical activities, which greatly improves perceived ease of use and reduces perceived risk. At the same time, the authority of the official platform will also enhance older adults' willingness to employ digital medical services. Smart terminal developers need to optimize product design depending on the characteristics of older adults, and develop more suitable electronic products, applications, websites, etc. According to the characteristics of older adults, various programs should reduce unnecessary upgrades, be more accessible to low-educated and elderly users[48], enhance their perceived ease of use, and improve their behavioral intention and Satisfaction.

Increasing the acceptance of digital health services

Based on the findings of the questionnaire and interviews, the study found that the barriers of older adults in the digital medical process are not only technical, social, and literacy barriers, but also their personal and cognitive factors [1]. This is the most fundamental measure for this population to bridge the health digital divide. Due to financial, physical, and ideological factors, older adults are resistant to digital medical care [48]. Therefore, older adults should try to accept the product of the development of the times, take the initiative to change their mindset, abandon the mentality of ‘afraid to ask’ and ‘afraid of being ridiculed’, dare to learn and master digital knowledge, and promote a positive change in their capacity towards using it. Older adults should actively participate in digital training activities to improve their abilities to screen information, resist risk, reduce perceived risk, improve behavioral intention, and increase Satisfaction with digital medical care.

Limitations

This study has some limitations. First, due to time and human resource constraints, this study only surveyed older adults aged 60 and above in urban areas of Hangzhou. In future studies, the sample size should be increased and the survey scope should be expanded to cover the whole country to make the sample more representative. The age limit of the survey population can also be relaxed to study the differences and similarities of users' willingness to use digital medical treatment and their influencing factors in each age group. Second, there are many other factors that affect the willingness and satisfaction of using digital medical services, but the influencing factors for satisfaction chosen in this study were only five variables: external variables, perceived usefulness, perceived ease of use,

perceived risk and behavioral intention. Future studies may take into account more hypotheses and contributing factors.

The ongoing advancements in Internet technology optimization and aging transformation will lead to a shift in older adults' digital medical behavior toward online health management, online chronic disease management, online hospitals, and a host of other health services. This research provides some of the foundations for us and others to conduct future research on a wider range of digital health topics to help older people close the digital health gap. For example, we can focus on helping mobility-impaired, disabled, and incapacitated older people access online medical consultations, purchase medication, book home appointments, and improve their ability to participate in society and benefit from the digital society. These efforts are critical to advancing the concept of active aging for older people globally.

Conclusion

In summary, this study constructed a structural equation model to illustrate the influence and mechanism of the effects of external variables, perceived usefulness, perceived ease of use, and perceived risk on behavioral intention and satisfaction with digital medical among older adults. To improve the behavioral intention to use digital healthcare and satisfaction of the older adults, it is necessary to improve the behavioral intention to use digital healthcare by optimizing the external influencing factors, enhancing the perceived usefulness and perceived ease of use of digital healthcare, and reducing the perceived risk through the efforts of the government, all sectors of the society, and the older adults themselves, and help digitalization serve the older adults better, so as to fundamentally improve the satisfaction of the older adults, achieve the fairness in the access to healthcare services and bridge the health digital divide.

Acknowledgments

We thanks to Dr. Le Yang for her linguistic assistance during the preparation of this manuscript. This study would not have been possible without the support of the Hangzhou Normal University and Shanxi Medical University.

Data Availability

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

Conflicts of Interest

None declared.

Author Contributions

NW conceived and designed this research, designed the questionnaire, collected the questionnaire, entered the data, and wrote the manuscript. SZ wrote semi-structured interview outlines, provided assistance during the distribution of questionnaires and interviews and helped revise questionnaires and manuscript. ZL proofread and analyzed the data, checked and revised the manuscript. YH provided guidance, reviewed and edited the manuscript throughout the research process. All authors contributed to manuscript revision, read, and approved the submitted version.

Declaration

This study did not use ChatGPT in any process of conceptualization or writing, etc.

Multimedia Appendix

Questionnaire and collected data.

References

1. Mubarak F, Suomi R. Elderly Forgotten? Digital Exclusion in the Information Age and the Rising Grey Digital Divide. INQUIRY: The Journal of Health Care Organization, Provision, and Financing. 2022/01/01;59:00469580221096272. PMID: 35471138. doi: 10.1177/00469580221096272.
2. Neves BB, Waycott J, Malta S. Old and afraid of new communication technologies? Reconceptualising and contesting the 'age-based digital divide'. Journal of Sociology. 2018 2018/06/01;54(2):236-48. doi: 10.1177/1440783318766119.
3. CNNIC. The 52nd Statistical Report on China's Internet Development. Beijing: CHINA INTERNET NETWORK INFORMATION CENTER, 2023.
4. Wang L, He L, Dai K, Zhao L, Xu R, Liu X, et al. In the "Internet +" environment, the needs and countermeasures of the information community of urban and rural elderly in Tianjin are home-based. Chinese Journal of Gerontology. 2018;38(11):2778-80. doi: 10. 3969 /j. issn. 1005-9202. 2018. 11. 083.
5. Lythreatis S, El-Kassar A-N, Singh S. The digital divide: A review and future research agenda. Technological Forecasting and Social Change. 2021 11/01;175:121359. doi: 10.1016/j.techfore.2021.121359.
6. Yanbin Y, Chengyu M. A Review on Health Digital Divide Across the Word. Documentation, Information & Knowledge. 2023:1-13.
7. Choi N. Relationship between health service use and health information technology use among older adults: analysis of the US National Health Interview Survey. Journal of medical Internet research. 2011 Apr 20;13(2):e33. PMID: 21752784. doi: 10.2196/jmir.1753.
8. Faqih K, Jaradat M. Assessing the moderating effect of gender differences and individualism-collectivism at individual-level on the adoption of mobile commerce technology: TAM3 perspective. Journal of Retailing. 2015;22(jan.):37-52. doi: 10.1016/j.jretconser.2014.09.006.
9. Cajita MI, Hodgson NA, Lam KW, Yoo S, Han HR. Facilitators of and Barriers to mHealth Adoption in Older Adults With Heart Failure. Computers, informatics, nursing : CIN. 2018 Aug;36(8):376-82. PMID: 29742549. doi: 10.1097/cin.0000000000000442.
10. Nymberg VM, Bolmsjö BB, Wolff M, Calling S, Gerward S, Sandberg M. 'Having to learn this so late in our lives…' Swedish elderly patients' beliefs, experiences, attitudes and expectations of e-health in primary health care. Scandinavian journal of primary health care. 2019 Mar;37(1):41-52. PMID: 30732519. doi: 10.1080/02813432.2019.1570612.
11. Zibrik L, Khan S, Bangar N, Stacy E, Novak Lauscher H, Ho K. Patient and community centered eHealth: Exploring eHealth barriers and facilitators for chronic disease self-management within British Columbia's immigrant Chinese and Punjabi seniors. Health Policy and Technology. 2015 2015/12/01/;4(4):348-56. doi: 10.1016/j.hlpt.2015.08.002.
12. Mishuris RG, Stewart M, Fix GM, Marcello T, McInnes DK, Hogan TP, et al. Barriers to patient portal access among veterans receiving home-based primary care: a qualitative study. Health expectations : an international journal of public participation in health care and health policy. 2015 Dec;18(6):2296-305. PMID: 24816246. doi: 10.1111/hex.12199.
13. Rasche P, Wille M, Bröhl C, Theis S, Schäfer K, Knobe M, et al. Prevalence of Health App Use Among Older Adults in Germany: National Survey. JMIR mHealth and uHealth. 2018 Jan 23;6(1):e26. PMID: 29362211. doi: 10.2196/mhealth.8619.

14. Han R, Fu J, Liu S, Luo Y. Research progress on the application of "Internet+" medical services in the elderly. Chinese Nursing Research. 2021;35(20):3657-60. doi: 10. 12102/j. issn. 1009-6493. 2021. 20. 016.
15. Deng Z, Hong Z, Ren C, Zhang W, Xiang F. What Predicts Patients' Adoption Intention Toward mHealth Services in China: Empirical Study. JMIR mHealth. 2018;6(8). PMID: 30158101. doi: 10.2196/mhealth.9316.
16. Pywell J, Vijaykumar S, Dodd A, Coventry L. Barriers to older adults' uptake of mobile-based mental health interventions. Digital health. 2020 Jan-Dec;6:2055207620905422. PMID: 32110429. doi: 10.1177/2055207620905422.
17. Heart T, Kalderon E. Older adults: Are they ready to adopt health-related ICT? International Journal of Medical Informatics. 2011;82(11):E209-E31. PMID: 21481631. doi: 10.1016/j.ijmedinf.2011.03.002.
18. Liew HP. Healthcare Satisfaction among Older Adults. American journal of health behavior. 2018 Jan 1;42(1):99-108. PMID: 29320343. doi: 10.5993/ajhb.42.1.10.
19. Yang K, Li Y, Qi H. Determinants of and Willingness to Use and Pay for Digital Health Technologies Among the Urban Elderly in Hangzhou, China. Risk management and healthcare policy. 2023;16:463-78. PMID: 37007299. doi: 10.2147/rmhp.S393767.
20. Hangzhou's digital governance index ranks first in China. Hangzhou Daily News; 2020 [updated 20200818; cited 2023 20231019]; Available from: https://www.hangzhou.gov.cn/art/2020/8/19/art_812262_54590710.html.
21. Yan X, Li T. Construction and application of urban digital infrastructure—practice of “Urban Brain” in facing COVID-19 in Hangzhou, China. Engineering, Construction and Architectural Management. 2022 08/29;30. doi: 10.1108/ECAM-10-2021-0935.
22. Guanghui Z, Jingchao H. Following the "Smart Governance" to Solve the Predicaments of Grassroots Social Public Opinion Work ——Reflecting the Values and Future of China's Digital Reform from the case of Hangzhou. 2023 (01):46-50. doi: 10.14167/j.zjss.2023.01.019.
23. Davis FD. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. Mis Quarterly. 1989;13(3):319-40. doi: 10.2307/249008.
24. Featherman MS, Pavlou PA. Predicting e-services adoption: a perceived risk facets perspective. International Journal of Human-Computer Studies. 2003 2003/10/01/;59(4):451-74. doi: 10.1016/S1071-5819(03)00111-3.
25. Kai Z, Kai G, Zhao L. Review on Factors Affecting of the Adoption Behavior of Mobile Library Users Based on the TAM. 2018 (06):93-100.
26. Park N, Roman R, Lee S, Chung JE. User acceptance of a digital library system in developing countries: An application of the Technology Acceptance Model. International Journal of Information Management. 2009 06/01;29:196-209. doi: 10.1016/j.ijinfomgt.2008.07.001.
27. Jeong H. An investigation of user perceptions and behavioral intentions towards the e-library. Library Collections, Acquisitions, & Technical Services. 2011 04/01;35:45-60. doi: 10.1080/14649055.2011.10766298.
28. Venkatesh V, Morris MG, Davis GB, Davis FD. User Acceptance of Information Technology: Toward a Unified View. MIS Quarterly. 2003;27(3):425-78. doi: 10.2307/30036540.
29. Martin J, Mortimer G, Andrews LJJoR, Services C. Re-examining online customer experience to include purchase frequency and perceived risk. Journal of Retailing and Consumer Services. 2015;25(jul.):81-95. doi: 10.1016/j.jretconser.2015.03.008.
30. Lee JK. The roles of individual differences in time perspective, promotion focus, and innovativeness: Testing technology acceptance model. Current Psychology. 2022. PMID: 36415452. doi: 10.1007/s12144-022-04016-8.
31. Bauer RA. Consumer Behavior as Risk Taking. In: Cox, D.F., Ed., Risk Taking & Information

Handling in Consumer Behavior: Graduate School of Business Administration, Harvard University; 1967.
32. Gatto SL, Tak SH. Computer, Internet, and E-mail Use Among Older Adults: Benefits and Barriers. Educational Gerontology. 2008 2008/08/22;34(9):800-11. doi: 10.1080/03601270802243697.
33. Glaser B, Strauss A. Discovery of grounded theory: Strategies for qualitative research2017. 1-271 p. ISBN: 9780203793206.
34. Bowen G. Naturalistic Inquiry and the Saturation Concept: A Research Note. Qualitative Research - QUAL RES. 2008 02/01;8:137-52. doi: 10.1177/1468794107085301.
35. Fishbein M, Ajzen I. Belief, attitude, intention and behaviour: An introduction to theory and research1975.
36. Thompson R, Compeau D, Higgins C. Intentions to Use Information Technologies: An Integrative Model. JOEUC. 2006 01/01;18:25-46. doi: 10.4018/978-1-59904-295-4.ch006.
37. Sung Youl P. An Analysis of the Technology Acceptance Model in Understanding University Students' Behavioral Intention to Use e-Learning. Journal of Educational Technology & Society. 2009;12(3):150-62.
38. Davis F, Bagozzi R, Warshaw P. User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. Management Science. 1989 08/01;35:982-1003. doi: 10.1287/mnsc.35.8.982.
39. Paluri R, Mehra S. Exploring the acceptance for e-learning using technology acceptance model among university students in India. International Journal of Process Management and Benchmarking. 2015 01/30;5:194-210. doi: 10.1504/IJPMB.2015.068667.
40. Jimenez J, Del Rio A, Berman AN, Grande M. Personalizing Digital Health: Adapting Health Technology Systems to Meet the Needs of Different Older Populations. Healthcare (Basel, Switzerland). 2023 Jul 26;11(15). PMID: 37570380. doi: 10.3390/healthcare11152140.
41. Grewal D, Gotlieb J, Marmorstein H. The Moderating Effects of Message Framing and Source Credibility on the Price-perceived Risk Relationship. Journal of Consumer Research. 1994;21(1):145-53. doi: 10.1086/209388 %J Journal of Consumer Research.
42. Mitchell VW. Understanding Consumers' Behaviour: Can Perceived Risk Theory Help? Management Decision. 1992;30(3). doi: 10.1108/00251749210013050.
43. Hider S, Muller S, Gray L, Manning F, Brooks M, Heining D, et al. Digital exclusion as a potential cause of inequalities in access to care: a survey in people with inflammatory rheumatic diseases. Rheumatology advances in practice. 2023;7(1):rkac109. PMID: 36632437. doi: 10.1093/rap/rkac109.
44. Suggala S, Pathak B, Thomas S. Determinants of customer relationship building on digital healthcare networks: an extension of social media engagement theory from emerging market context. International Journal of Electronic Marketing and Retailing. 2023 02/06;14:123-38. doi: 10.1504/IJEMR.2023.10053415.
45. Wu M. SPSS Statistical Applications: Questionnaire Analysis and Applied Statistics. Chongqing: Chongqing University Press; 2005. 62-78 p.
46. Lau RS, Cheung GW. Estimating and Comparing Specific Mediation Effects in Complex Latent Variable Models. Organizational Research Methods. 2010 2012/01/01;15(1):3-16. doi: 10.1177/1094428110391673.
47. Sun X, Yu Z, Xue Z, Zhang X. Research on present situation and service demand of Internet combination with home-based treatment-care service among the elderly. Chinese Nursing Research. 2020;34(2):318-422. doi: 10. 12102/j. issn. 1009-6493. 2020. 02. 029.
48. Jiao L. Study of Influencing Factors of Sustained Use Behavior of Network Medical Reservation Platform Users. Medicine and Society. 2017;30(10):81-3. doi: 10.13723/j.yxysh.2017.10.025.

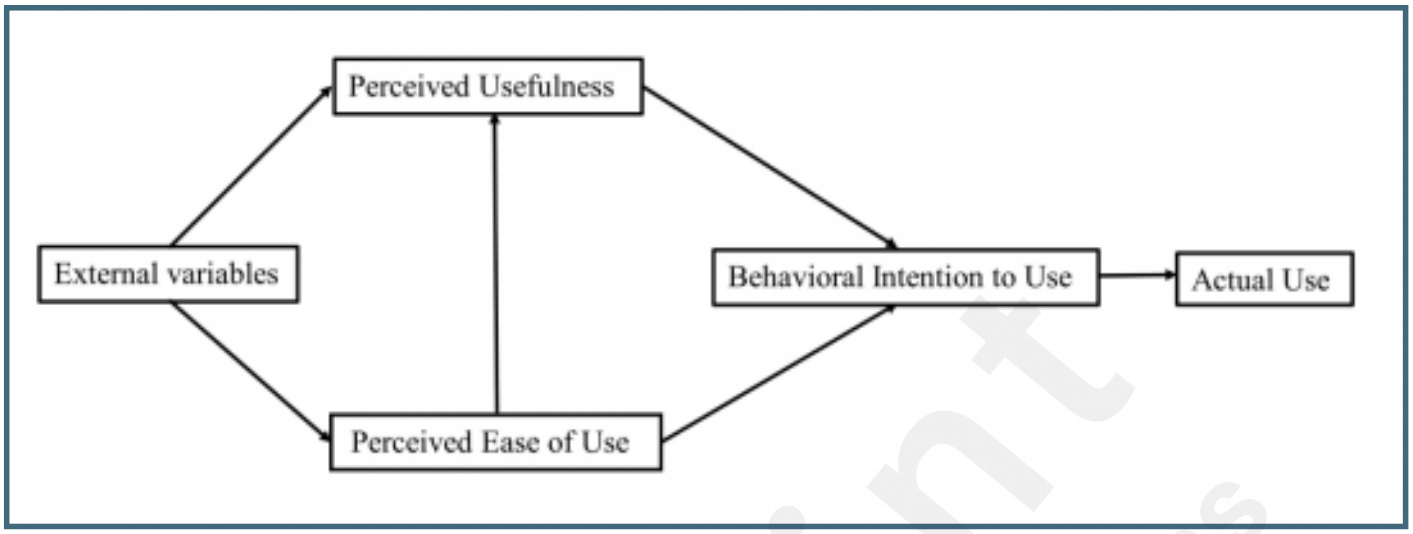
49. Shang S, Wang Y. Continuous Use of information Behavior by Weibo Users Based on TAM Model. Shanxi Library Journal. 2021 (4):23-31.
50. Zhang Y, Lian N. Research on the influencing factors of institutional intelligent old-age service satisfaction—— Based on the empirical evidence of Baotou City. China Academic Journal Publishing House. 2019;191(02):114-27+30.
51. Wang F, Ding H. Research on the Public's Willingness to Continue to Use Mobile Government Affairs: Taking the Government Service APP as an Example. E-Government. 2019 (12):65-74. doi: 10.16582/j.cnki.dzzw.2019.12.007.
52. Zhou M, Zhao L, Kong N, Campy KS, Qu S, Wang S. Factors influencing behavior intentions to telehealth by Chinese elderly: An extended TAM model. International Journal of Medical Informatics. 2019 2019/06/01/;126:118-27. doi: 10.1016/j.ijmedinf.2019.04.001.
53. Shi Y, Ma D, Zhang J, Chen B. In the digital age: a systematic literature review of the e-health literacy and influencing factors among Chinese older adults. Zeitschrift fur Gesundheitswissenschaften = Journal of public health. 2021 Jun 4:1-9. PMID: 34104627. doi: 10.1007/s10389-021-01604-z.
54. Chen Y, Cao M. Discussion on mobile Health Education for the Elderly Based on Roy Adaptation Model Health Research. 2018;38(2):148-51. doi: 10□3969 /j□issn□1674-6449□2018□02□008.
55. Schreurs K, Quan-Haase A, Martin K, Schreurs K, Martin. Problematizing the Digital Literacy Paradox in the Context of Older Adults' ICT Use: Aging, Media Discourse, and Self-Determination. Canadian Journal of Communication. 2017 03/01;42. doi: 10.22230/cjc.2017v42n2a3130.
56. Carney F, Kandt J. Health, out-of-home activities and digital inclusion in later life: Implications for emerging mobility services. Journal of Transport & Health. 2022 2022/03/01/;24:101311. doi: 10.1016/j.jth.2021.101311.

Supplementary Files

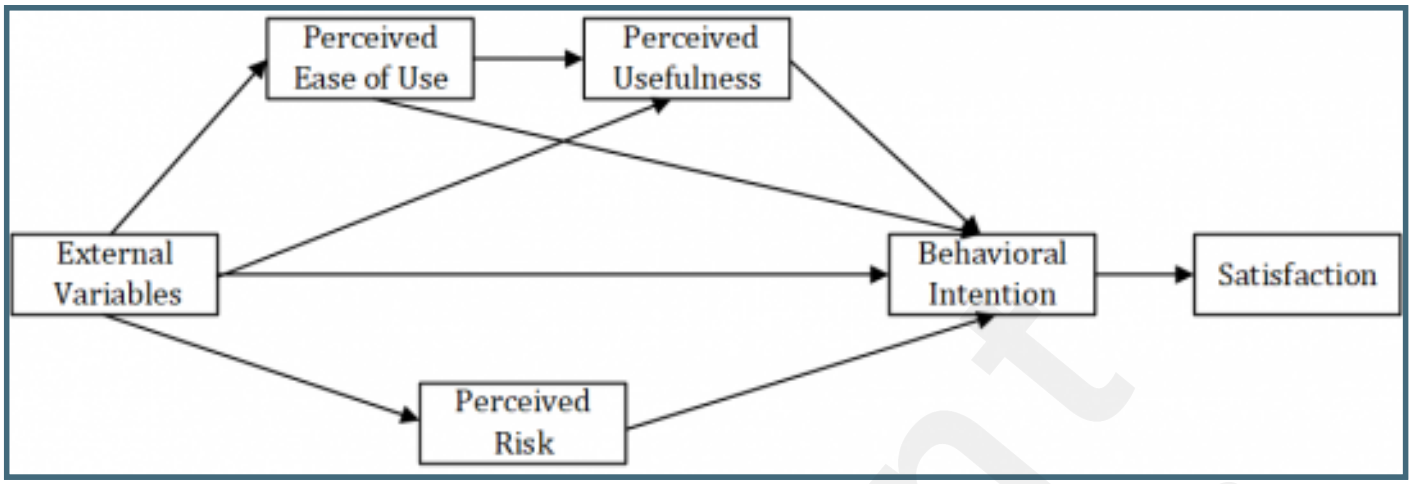
Questionnaire data.
URL: http://asset.jmir.pub/assets/7e0356d3a87d4eaace7ca3348de2e2c8.xlsx

Figures

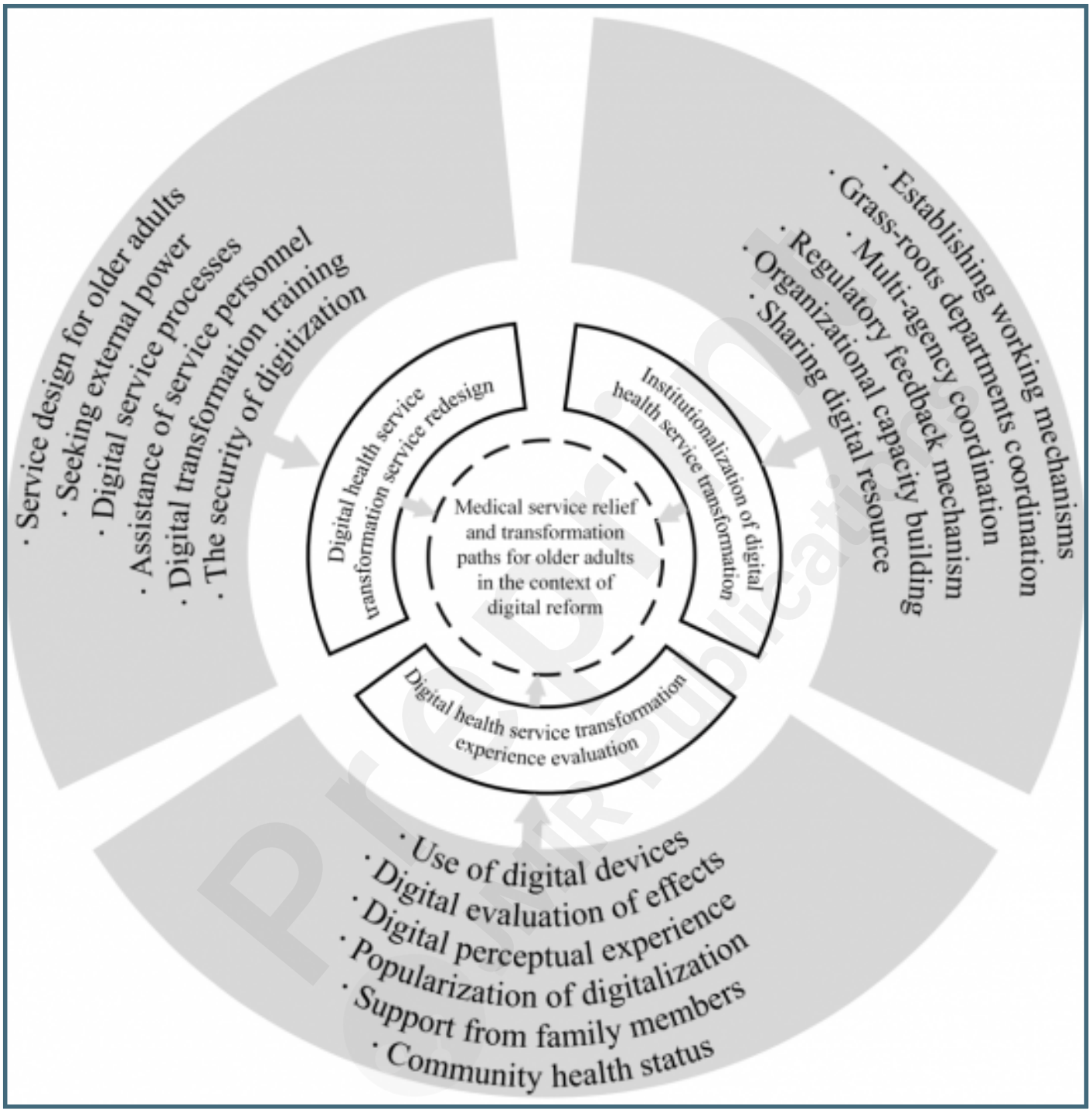
TAM revised by Davis in 1996.



Satisfaction model of digital medical service utilization for older adults.



The results of three-level coding.



The Structural Equation Model.