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Comparison of the middle-aged and older users' adoption of mobile health services in China

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ABSTRACT

Objective: Given the increasing number of older people, China has become an aging society. A mobile health service is a type of health informatics that provides personalized healthcare advice to those who require it, especially the older people and the middle-aged. However, few studies consider the adoption of mobile health services with regard to older and middle-aged users. This paper explored a research model based on the value attitude behavior model, theory of planned behavior, and four aging characteristic constructs to investigate how older and middle-aged citizens adopted mobile health services.

Method: The hypothesized model was empirically tested using data collected from a survey of 424 residents older than 40 years in China. Structural equation modeling was used to estimate the significance of the path coefficients.

Results: The findings revealed that (1) perceived value, attitude, perceived behavior control, and resistance to change can be used to predict intention to use mobile health services for the middle-aged group; (2) perceived value, attitude, perceived behavior control, technology anxiety, and self-actualization need positively affected the behavior intention of older users; and (3) subjective norm and perceived physical condition showed no significant effects on the behavior intention to use mobile health services for the two groups. The theoretical and practical implications and contributions of this study are then discussed.

1. Introduction

With the rapid development of mobile communications and wireless technologies, the penetration of both mobile phones and various emerging mobile applications is very high [1]. Applications used in computers are now also designed for mobile phones. Mobile health services are a typical example of such applications, which aim to provide medical and healthcare service to both professionals, so that their work may be better supported, and for consumers, so that they may obtain useful information and guidance to manage their health better [2]. Compared to health services in the Internet delivered from desktops and laptops, mobile health services have the capacity to interact with the individual with much greater frequency and flexibility without being limited by time and place [3,4]. In addition, the initial Internet digital divide has limited the reach of computerized health services for lower socioeconomic groups; thus, obtaining healthcare service via mobile phone appears more significant for populations most in need of healthcare, especially elderly people [5,6].

China, which has the largest population of older citizens in the world, has become an aging society. Statistics from the China National Committee on Aging (CNCA) show that the proportion of people older than 60 years has reached 14.8% [7]. An earlier report by CNCA [8] predicted that the

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proportion of elderly people in China would increase to 30% from 2025 to 2050. Older people have noticeably limited regenerative abilities and are more prone to chronic disease [9]. A study on healthcare for elderly Chinese shows that roughly 79.5% of people over 60 years old have at least one chronic disease, almost 50% have at least two, and more than 25% have three or more [10]. As the cost of medical care dramatically increases, the issue of increased medical expenses for an aging population is a difficult problem awaiting a solution [11]. Hence, finding an effective solution to relieve the heavy burden of providing healthcare for the elderly people is an urgent concern.

The number of mobile phone users is also rapidly increasing. According to the statistics issued by the Ministry of Industry and Information Technology of the People's Republic of China (MIIT), the number of Chinese mobile phone users has reached 1.15 billion, and mobile Internet users have accounted for 96.4% of all mobile phone users [12]. Mobile phones have become the most convenient and ubiquitous technological device due to the advancements in their capabilities and functionalities; moreover, they have proved to be an indispensable part of the daily lives of elderly people because mobile phones can help them communicate with their children and relatives [13]. Studies indicate that older people adopt mobile phones at a much higher rate than the Internet [14]. Given that elderly people rely heavily on mobile phones and the high penetration rate among them, a golden opportunity to develop mobile health services for the elderly has presented itself so that they could better manage their health. For example, through mobile health services, elderly people can seek medical advice, register for or check appointments, access medical test results, and seek post-diagnostic treatment for active prevention at their convenience.

Despite the potential benefits of mobile healthcare services, they have inevitably encountered numerous difficulties and challenges as a newly emerging phenomenon, especially with regard to elderly people who typically lag behind in technology-based innovation [15]. In China, this service is still in the infancy stage and requires a user adoption process, especially considering older users who have unique physical and psychophysical characteristics. Therefore, factors that influence the adoption of mobile health services by elderly people must be investigated.

Previous studies have focused mainly on the professionals' or organizations' view of mobile or electronic health [16–21]. Several studies have focused on the older people's or women's adoption of mobile health [22–24]. However, little attention has been paid to the view of middle-aged users. A gradually increasing number of middle-aged people are acquiring chronic diseases due to intensive social pressure and exacerbating environment pollution. In addition, middle age is the closest pre-age group to elderly people. Specifically, the middle-aged will soon experience health problems encountered by the elderly. Thus, investigating middle-aged acceptance is of importance. Therefore, focusing on middle-aged acceptance is necessary as well. However, previous studies on the behaviors of elderly people have generally examined only one specific population, that is, the elderly. We argue that developing a model to compare the adoption behavior of the elderly and middle-aged people is necessary, as well discussing their different influential factors.

The value attitude behavior model (VAB) is a useful framework for examining the behavior of users [25,26]. According to the VAB, the perceived values of individuals influence their attitude, and their attitude, in turn, influences their behavior. We assume that the value perceived by middle-aged and older users in adopting a mobile health service will predict their adoption behavior. The theory of planned behavior (TPB) and its extensions are widely used in adoption research [20,27,28]. TPB is mainly used for predicting technology adoption by considering the individual role (attitude, behavior control) and environmental role (subjective norm) of the user. We hypothesize that TPB can also predict the adoption of mobile health services by middle-aged and elderly Chinese users. Moreover, given that aging is an obvious characteristic of middle-aged and older users, the adoption behavior of aging people may differ from that of younger users. Research models that consider aging-specific constructs proved to be more powerful in explaining the adoption behavior of older users [29]. Therefore, to better understand the factors that influence the adoption behavior of middle-aged and elderly persons toward mobile health services, our paper developed an integrative model that applies VAB, TPB, and aging characteristic constructs.

2. Literature review and hypotheses development

In this research, we conduct empirical studies on the factors that affect the adoption of mobile health services by middle-aged and older users. Mobile health services are relatively new and are still tentative in most parts of China; hence, we use behavioral intention instead of actual usage as the dependent variable in this study.

2.1. *Mobile health service*

Mobile health is an important subset of e-health applications for a growing number of e-health functionalities have been made available on mobile platforms [30]. Mobile health is an umbrella term that covers areas of networking, mobile computing, medical sensors, and other communication technologies within healthcare. According to Istepanian and Pattichis [31], m-health refers to the health care-based mobile computing, medical sensors, and communications technologies. The three key components in mobile health are mobile devices, software platform (providing basic services such as networking and database), and m-health applications [32]. In this study, we define mobile health service as the services or applications regarding the provision of health care, prevention, diagnosis, treatment, and monitoring services via mobile devices. Mobile devices typically include personal digital assistants (PDAs), smart mobile phones, and tablet computers such as the iPad. Mobile phones are the prototype device within this space. Most healthcare services use mobile phone platforms. Additionally, standalone PDAs have become obsolete because of the incorporation of PDA features into smart phones [33]. Thus, we will discuss mobile health services that are mainly based on mobile phones.

Mobile health services enable users to access personalized and interactive health services due to their mobility, portability, and ubiquity [34]. Generally, mobile health services have several functions. (1) Mobile health services improve the diagnosis, investigation, treatment, monitoring, and management of diseases. (2) They offer preventive services in health promotion and treatment compliance. (3) They enhance health care processes, such as appointment attendance [3]. Considering their target users, mobile health services can be classified into four types, namely, (1) mobile health services for the healthcare researchers, such as data collection; (2) mobile health services for healthcare professionals, such medical education and medical records; (3) mobile health services for patients, such as appointment reminders and treatment programs; and (4) mobile health services for the general population, such as health behavior change and first aid and emergency care [23]. A number of popular mobile health services are available in China. Chunyu handheld doctor, developed by Beijing Spring Rain Software Co. Ltd., enables general users (often health consumers) to look up symptoms or consult with professional doctors free of charge, as well as allows professionals to communicate with health consumers [35]. A special mobile health service for people with diabetes, recently explored by Shidaiyinuo, combines the five stages of diabetes control in the mobile terminal, including diabetes self-tests, diabetes education, diet therapy, exercise therapy for diabetes, and diabetes medication. Patients can upload their data to a platform through which doctors can access data in real time, thus providing a reliable basis for diagnoses [36]. The mobile version of Yimaitong, developed by King Yee Co. Ltd., is specifically designed to assist clinicians in making clinical decisions [37]. In this study, we focus on preventive services used by the general population.

2.2. *Adoption of health information technology by the elderly*

Studies on adoption behaviors of technologies include the adoption of traditional technologies and the adoption of online-based information systems (ISs) or innovative information and communication technologies (ICTs). In the information system (IS) field, the adoption behavior of users is one of the most popular topics among scholars, and the most influential variables include information technology factors, psychological factors, and sociological factors [38]. Undoubtedly, ISs have a significant impact on managing healthcare costs and improving the quality of care [39]. Researchers have empirically studied user adoption in the context of health information systems. Or and Karsh [40] listed 94 determinants that affect patient acceptance of consumer health information technology, including 67 patient-related factors associated with patient health, socio-demographic variables, and the prior experience of an individual with computers, along with 27 variables related to human–computer interaction and organizational or environmental factors.

Age is often considered in the healthcare context. Compared to younger adults, older adults felt less comfort, had lower efficacy, and had less control over ICT [41,42]. Older adults also had perceptions that were likely to negatively affect acceptance [43]. Heart and Kalderon summarized the determinants that affect ICT use by elderly people in the healthcare context, including, (1) factors reflecting the degree of usefulness; (2) factors reflecting the degree of ease of use; (3) technological issues; (4) personal traits; (5) social issues; and (6) facilitating issues [44].

A number of previous studies regarding the technology adoption behaviors of the elderly population developed elderly-specific characteristic constructs to better understand the unique features of elderly people. Ryu et al. [45] introduced new constructs that are used in gerontology and marketing research, which consists of perceived user resource, previous similar experiences, computer anxiety, and physical and psychosocial age (perceived physical condition, life course events) to reflect the participation of elderly users in video UCC (User Created Content), which refers to the video content created by users themselves. Their study demonstrated that perceived user resource, perceived physical condition, and life course events significantly influenced the intention to participate. Xue et al. [46] adopted aging-specific constructs, including perceived user resource, technology anxiety, and bio-physical age (perceived physical condition), and revealed that perceived user resource and technology anxiety were the antecedents for perceived usefulness, whereas perceived physical condition significantly affected perceived ease of use. Guo et al. [23] studied the negative aspect of elderly acceptance of mobile health services in China. They highlighted that resistance to change and technology anxiety influenced the perception of users regarding enablers and inhibitors, which in turn, affected the intention of users to adopt mobile health services.

2.3. *Value-attitude-behavior model*

The Value-attitude-behavior (VAB) model is proved to be a useful framework for investigating consumer behavior, which includes three main constructs, namely, perceived value, attitude, and behavior. Since behavioral intention is measured contemporaneously with beliefs, it is suitable for survey-based research [47]. Other studies also stated that behavioral intention significantly related to, and can be used to predict, actual usage. Thus, we use behavior intention to replace behavior in the VAB model. Perceived value involves the ratio of the outcome/input of consumers to the outcome/input of service providers. Customer-perceived value is derived from an evaluation of the relative rewards and sacrifices associated with the offering. Customers are inclined to feel equitably treated if they perceive that the outcome-to-inputs ratio is comparable to the outcome-to-inputs ratio experienced by the company [48]. The concept of perceived value is a highly popular approach among business managers and marketing researchers. Although most studies present different conceptualizations, perceived value is undoubtedly important and relevant in examining customer behavior [49]. Consumers are “value-driven” [50], and high value is a primary motivation for customer patronage. Attitude is related to, but differs from, perceived value. Perceived value, which refers to the worth or utility of performing the target behavior, focuses on a cognitive assessment; meanwhile, attitude, defined as “an individual’s positive or negative feelings (evaluative effect) about performing the target behavior,” includes cognitive and affective evaluation [51–53]. Behavior intention is defined as

"a measure of the strength of one's intention to perform a specified behavior."

The relationships among these three constructs are very close. According to Sirdeshmukh et al., the perceived value of consumers is likely to regulate their behavior intentions (or customer loyalty) [54]. Prior empirical studies have identified perceived value as a major determinant of behavior intention [55,56]. Given its cognitive and affective features, attitude is often determined by the cognitive factor of perceived value and other affective factors [57]. In addition, attitude often has a strong predicting effect on the behavioral intention of consumers.

In this study, we used perceived value to describe the perceptions of elders regarding mobile-health services, and evaluate relative rewards (e.g., better health management and efficient healthcare services) and the associated sacrifices (e.g., related costs, time consumption, and inconvenience to their daily life). Mobile health services are innovative technology-based services; thus, the behavior intention of consumers should also be influenced by the attitude of users. In light of the preceding discussion and findings, we propose that if users have a high perceived value regarding mobile-health services, they would have a positive attitude toward acceptance of m-health services and would thus be more likely to adopt them. Hence, we hypothesize:

H1. Perceived value positively affects behavior intention.

H2. Perceived value positively affects attitude toward mobile health services.

H3. Attitude positively affects behavior intention.

2.4. *Theory of planned behavior*

Theory of planned behavior (TPB), an extension of theory of reasoned action, assumes that target behavior can be predicted by intentions, which in turn, are affected by three main components, namely, attitudes, subjective norms, and perceived behavioral control (PBC) [58]. PBC refers to "the perceptions of internal and external constraints on behavior and encompasses self-efficacy, resource facilitating conditions, and technology facilitating conditions." Subjective norm is defined as "the person's perception that most people who are important to him think he should or should not perform the behavior in question" [38]. TPB considers subjective norms as the sum of the individual perceptions and motivation assessments for all significant referents; TPB also expresses behavioral controls as the individual's perception of the difficulty of performing a behavior, which is on a continuum of easy to demanding [59]. Attitude, subjective norm, and PBC are the main independent constructs, whereas behavior intention is the dependent construct. IS research generally refers to the PBC construct as "self-efficacy" or the judgment of an individual's ability to use a computer technology [60]. TPB is a popular theory used in investigating the adoption of IS. Lee [27] employed an integrated TPB model to explain customer intention to use online banking. Rozario et al. [61] examined factors that influence the willingness of drivers to use handheld mobile phones based on TPB. In the context of health IS, Wu [20] combined TPB and technology acceptance model to examine mobile healthcare services from the perspective of professionals. Heart and Kalderon [44] empirically used the TPB model to explain the behavioral intentions of older people toward health-related ICT.

According to the discussion above, attitude, perceived behavioral control, and subjective norm are three direct antecedents for determining behavioral intention to use. The relationship between attitude and behavior intention has been discussed in the VAB model. We argue that, in the context of mobile health services for Chinese senior citizens, there are two other potential linkages between perceived behavior control and behavioral intention, and subjective norm and behavior intention to use. Thus, we posit the following hypotheses:

H4. Perceived behavior control positively affects behavioral intention.

H5. Subjective norm positively affects behavioral intention.

2.5. *Aging characteristic factors*

In the healthcare context, numerous determinants have been assumed to affect ICT use. To better understand the adoption of mobile health services by elderly and middle-aged people, we must initially determine the changes that occur when a person ages. In this subsection, we assume the following constructs would reflect the perception of mobile health service adoption among middle-aged and elderly users.

2.5.1. *Perceived physical condition*

Aging is a continuous and highly complex process [62], which consists of bio-physical and psychosocial changes [63,64]. In the aging process, individuals undergo gradual changes that affect the way they interact with and respond to their environment. The aging process causes gradual losses to the sensory and motor systems and a decline in physical and cognitive capabilities, which may cause the elderly to experience greater difficulties in adopting innovative technologies. Moreover, the influence of physical conditions on adoption behavior was empirically investigated in previous studies on the adoption behavior of elderly people. Ryu et al. [45] reported that perceived physical condition had a significant negative influence on the intention to participate in video UCC services. In addition, Xue et al. [46] argued that physical condition was significantly related to perceived ease of use, which in turn, affected behavior intention.

Thus, in this paper, we use perceived physical condition as internal controls or inhibiting conditions that increase the expectancy of middle-aged and older users to use mobile health services. Therefore, we posit the following hypothesis:

H6. Perceived physical condition is positively related to mobile health service behavioral intention.

2.6. *Resistance to change*

According to continuity theory of normal aging, older people will typically maintain the same activities and behaviors they

previously had [65]. They attempt to maintain this lifestyle continuity by adopting strategies that are connected to their past experiences. Being born at least 60 years ago when mobile phones were not yet commonplace in China, elderly people received professional healthcare services that were mainly delivered in a face-to-face manner instead of through information technology channels. Despite the emergence of mobile health services, the elderly choose to continue their previous behaviors and resist changing their medical habits. Moreover, elderly people have been found to have a high propensity for resisting change [66,67]. Given that changes in lifestyle result from the usage of new technologies, elderly people's reaction to change will also influence their intention to adopt a new technology. Several previous studies, such as Phang et al., used a "preference to human contact" structure, "which is relative to resistance to change, to examine senior citizens' acceptance of e-government services [68]." Bhattacherjee and Hikmet [69] confirmed the significant negative effect of physicians who resist change with regard to their behavior intention on health information technology. Considering that the adoption of mobile health services will change their health-relevant behaviors, people have to change their past habits to reshape how they handle their health. Hence, their resistance to change diminishes their behavior intention to adopt mobile health services.

Therefore, we put forward the following hypothesis:

H7. Resistance to change is negatively related to mobile health service behavioral intention.

2.7. *Technology anxiety*

Technology anxiety is another aging-specific factor associated with behavioral intention [46,70]. Technology anxiety is a negative emotional response, and pertains to the fear or discomfort people experience when they think of using or actually use technology [71]. It also refers to the apprehension of an individual when he or she is faced with the possibility of using technology. Technology anxiety is derived from social cognitive theory [72]. Individuals who perceive themselves as inefficacious create stress and impair performance by obsessing over their personal deficiencies, and unduly overwhelm themselves with thoughts of failure and mishaps [73]. Older adults generally have fewer new technology skills and have less technological self-efficiency than younger adults [41]. Moreover, their declining physical and cognitive capabilities possibly cause them to suffer a higher level of anxiety, which reduces their intention to use innovative technology.

Researchers stated that elderly users have higher technology anxiety than young users [70,74]. Tung et al. [75] identified technology anxiety as the most important variable in their study that negatively affects behavior intention. Guo et al. [23] asserted that technology anxiety can reduce the adoption intention of elderly people by reducing the perceived ease of use and increasing resistance to change. Other studies about the elderly have also argued that technology anxiety creates major barriers in adopting innovations [76,77].

In this study, we propose:

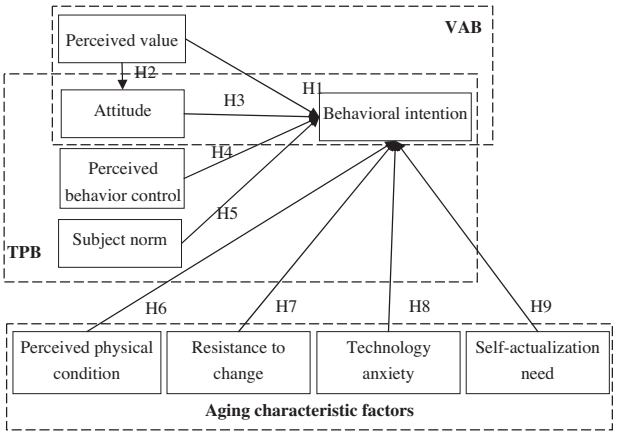

Fig. 1 – Research model.

H8. Technology anxiety is negatively related to mobile health service behavioral intention.

2.8. *Self-actualization needs*

Erikson's Eight Stages of Life model [78] explains the eight stages through which a normally developing human should pass from infancy to late adulthood. The last stage (late adulthood) is the wisdom stage, which centers on the development of ego integrity. Ego integrity represents the development of a reliable sense of self, a reliable sense of other, and an understanding of how those constructs interact to form a person's experience of reality, which implies that a sense of fulfillment becomes a crucial element for the successful adjustment of senior citizens to later life [79]. Maslow's Hierarchy of Needs also emphasizes the attainment fulfillment in old age. The last level of need is self-actualization need, which refers to the full potential of a person and the realization of that potential. Maslow describes this level as the desire to accomplish everything that one can and to become the most that one can be [80]. Individuals may perceive or focus on this need very specifically. The motivation for higher self-actualization enables people to be open to new experiences and learn new ideas and skills [81].

In the context of the current study, learning to use new IS applications, such as mobile health services, could mean embarking on activities that senior citizens have not previously attempted. Learning to use IS applications may thus present opportunities for them to actualize their personal capacity. Phang et al. [68] reported that self-actualization significantly influenced elderly people's adoption behavior of e-government services. Therefore, we propose:

H9. Self-actualization need is positively related to behavior intention of mobile health services.

In accordance with the foregoing hypotheses, we provide the research model in Fig. 1.

Table 1 – Research constructs and measurements.

Construct	Operational definition	Number of measurement items
Behavior intention (BI)	An individual's intention to use mobile health services	4
Perceived value (PV)	An individual's perception of his or her expected utility of mobile health services	4
Attitude (ATT)	An individual's attitude toward mobile health services	3
Perceived behavior control (PBC)	Perceptions of internal and external constraints on mobile health usage	4
Subject norm (SN)	An individual's perception that most people who are important to him think he should or should not use mobile health services	4
Perceived physical condition (PPC)	The beliefs of one's physical difficulties of vision, hearing, and motion that may be faced in everyday life using mobile health services	3
Resistant to change (RTC)	An individual's unwillingness to change the way of health management and life style.	4
Technology anxiety (TA)	An individual's apprehension when faced with the possibility of using mobile health services	4
Self-actualization need (SAN)	Intrinsic motivation to become everything that one is capable of becoming	4

3. Methodology

3.1. *Instrument development and pretest*

This study used a questionnaire survey to collect data. We adapted commonly-used measures from previous studies to detect content validities. Specifically, the items measuring behavioral intention, subjective norm, perceived physical condition, and technology anxiety were adapted from Xue et al. [46]. The items measuring perceived behavior control and attitude were from Wu et al. [20]. Self-actualization need was measured by four items adapted from Phang et al. [68]. Items measuring perceived value were created based on Zeithaml [82]. Resistance to change was measured by items adapted from Guo et al. [23].

After we developed the preliminary questionnaire, we conducted two pretests. In the first pilot, we asked 10 elderly people for their feedback on the questionnaire, and revised the questions they identified as ambiguous and repetitive. We deleted items with similar phrasing on the condition that such deletions would not affect the content validity of the scales. Next, we interviewed two academic mobile health researchers for feedback on our survey, and revised the questions based on their suggestions. Table 1 shows the constructs and their operational definitions. The detailed questions of each construct are listed in the appendix. All items corresponding to the constructs were measured using five-point Likert scales, with answer choices ranging from "strongly disagree" (1) to "strongly agree" (5).

3.2. *Data collection procedure*

The data were collected in Wuhan, a central Chinese city. Our target participants were at least middle-aged and older. The definition of "middle-aged" varies, being identified on different occasions as 40–59, 45–59, or 40–65 years of age. Chronically ill patients have been getting younger; thus, this study adopts the broader definition of middle age as "beginning after age 40" [83]. Our sample included two groups, namely, the middle-aged group comprising those between 40 and 59 years old, and the older group comprising those 60 years old and above. Given the specific population of subjects that we targeted, we chose six communities where large numbers of elderly people were accessible. We contacted the managers of each community service center to obtain their support for our study. At each center, we had organized a briefing introduction about mobile health services for the senior citizens, and afterwards asked them to answer a questionnaire survey. All of the six communities we contacted agreed to participate.

For one week, data collection sessions were conducted by six investigators at each of the six communities. Given that the concept of m-health services is in its infancy and might have been difficult for our participants to understand, we presented the services via a series of posters and brochures; the features and functionalities offered by the service were also explained. Afterwards, a question-and-answer period was provided so that the attendees could better understand the services. The questionnaires were distributed next and detailed instructions on how to fill up the questionnaire were provided. If the participants had difficulties (e.g., vision problems, dyslexia) in finishing the questionnaires, we conducted face-to-face interviews with them instead. Although participation was voluntary, we provided articles for daily use, such as socks, towels, and soap, as gifts to the respondents as incentives. We are committed that every respondent who participate the survey can choose a gift.

We sent out 500 questionnaires and received 485 questionnaires. We excluded 61 responses because 25 of them had conflicting answers or incomplete responses and 36 of them did not come from our target participants (i.e., they were younger than 40 years of age). The remaining 424 responses were used in the data analysis. Among these respondents, 218 (51.4%) were in the middle-aged group, whereas 206 (48.6%) were in the older group.

The sample descriptive statistics of the respondents for the middle-aged group and the older group are listed in Table 2. Among these respondents, both groups were found to have more female participants than male participants. This

Table 2 – Sample descriptive statistics.

Variable		Middle-aged (N = 218)		The older (N = 206)	
		Count	(%)	Count	(%)
Gender	Male	80	36.7	90	43.7
	Female	138	63.3	116	56.3
Education level	None, primary	27	12.4	50	24.3
	Secondary	58	26.6	68	33.0
	Pre-university	107	49.1	59	28.6
	University	25	11.5	27	13.1
	Postgraduate	1	0.5	2	1.0
Monthly income (RMB)	0–1000	25	11.5	32	15.5
	1000–2000	114	52.3	100	48.5
	2000–3000	48	22.0	41	19.9
	3000–4000	23	10.6	28	13.6
	4000–5000	6	2.8	4	1.9
	5000–	2	0.9	1	0.5
Chronic disease	Yes	61	28.0	131	63.6
	No	157	72.0	75	36.4
Have you heard about m-health	Yes	84	38.5	54	26.2
	No	134	61.5	152	73.8
Mobile phones usage frequency	Many times a day	124	56.9	81	39.3
	Once a day	40	18.3	40	19.4
	A few times a week	26	11.9	22	10.7
	A few times a month or less	28	12.8	63	30.6

finding further confirmed that females were more active and interested in better care for their health [84]. The data indicated that compared to the older group, the middle-aged group had higher levels of education, fewer chronic illnesses, and higher frequencies of using mobile phones. However, the monthly income levels of both groups were similar (about half of the respondents' monthly income was from 1000 RMB to 2000 RMB). According to NBSC (the National Bureau of Statistics of China), the median value of urban residents' monthly income in 2011 is about 1600 RMB [85], which demonstrates that most of our participants are the middle-income earners. And then, the income gap is not big. So it is not likely to influence the response. Among 206 older people, 131 (63.6%) had chronic diseases. Conversely, 61 (28.0%) of the middle-aged people had chronic diseases. There are more older respondents had chronic diseases. However, as we discussed earlier, older people have noticeably limited regenerative abilities and are more prone to disease. In addition, middle age is the closest pre-age group to elderly people. And the middle-aged will soon experience health problems encountered by the elderly. Thus, all of our respondents may face health problems. In addition, during the question-and-answer session, most of them asked many health related questions, they are very concern about health, and hope mobile health service can help to prevent or alleviate disease. Accordingly, we think that all of our respondents are potential consumers of mobile health services, so the question of whether they had chronic disease will not influence the response. Regarding whether they had thought about mobile health services, the middle-aged group had more positive responses than the older group (38.5% vs. 26.2%), although those who responded positively were the minority in both groups. We have asked each respondent whether they have experienced the mobile health service. Almost each older age and middle aged person did not use mobile health service. Only a few young people experienced the services. But because they are not within our study scope, we have deleted the data from them. Moreover, middle-aged users had higher frequencies of mobile phone usage than older users.

4. Results

We first compared the means of each factor in the two groups, and then used the two-step approach to test the hypothesis.

4.1. *t-Test of the means of the factors*

We initially conducted an independent samples *t*-test to compare the means of each factor for the middle-aged group and the older group. The results are summarized in Table 3.

The results revealed significant differences between the mean scores of behavior intention, perceived behavior control, perceived physical condition, resistance to change, and technology anxiety of the middle-aged group and the older group. Compared to the middle-aged group, the older group had significantly lower behavior intention of mobile health services, lower perceived behavior control, lower perceived physical condition, lower resistance to change, more technology anxiety, and more self-actualization needs. No significant differences were found between the two groups in terms of attitude, perceived value, and subjective norm.

We next presented our measurement and structural model testing results. Our independent samples *t*-tests revealed significant differences between the middle-aged group and the older group; thus, we also separately tested our structural models for the two groups and reported the results.

4.2. *Measurement model testing results*

In order to test the hypothesis model, we tested the measurement model and structural model based on Anderson and Gerbing [86]. We conducted a confirmatory factors

Table 3 – Results of the independent samples t-tests.

Construct	The middle-aged		The older		T value for difference in means
	Means	Std. dev.	Means	Std. dev.	
BI	3.93	0.81	3.67	0.93	3.061**
PV	4.02	0.63	4.05	0.56	−0.466
ATT	4.16	0.70	4.24	0.61	−1.375
PBC	3.97	0.67	3.69	0.84	3.532***
SN	3.68	0.74	3.70	0.61	−0.370
PPC	2.91	1.01	2.68	0.95	2.366**
RTC	3.74	0.98	3.49	0.99	1.754*
TA	2.48	1.05	2.89	1.04	2.862**
SAN	3.76	0.74	3.89	0.68	−1.931*

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

Table 4 – Convergent validity and internal consistency reliability.

Factor	Item	The middle-aged				The older			
		Standard loadings	CR	AVE	Cronbah's alpha	Standard loadings	CR	AVE	Cronbach's alpha
BI	BI1	0.83	0.88	0.66	0.89	0.79	0.90	0.69	0.90
	BI2	0.83				0.82			
	BI3	0.82				0.88			
	BI4	0.76				0.82			
PV	PV1	0.65	0.85	0.59	0.85	0.66	0.89	0.66	0.88
	PV2	0.77				0.83			
	PV3	0.80				0.90			
	PV4	0.83				0.85			
ATT	ATT1	0.60	0.81	0.60	0.81	0.67	0.83	0.63	0.83
	ATT2	0.86				0.84			
	ATT3	0.83				0.85			
PBC	PBC1	0.74	0.86	0.60	0.88	0.82	0.86	0.61	0.86
	PBC2	0.83				0.80			
	PBC3	0.82				0.82			
	PBC4	0.69				0.68			
SN	SN1	0.74	0.85	0.58	0.84	0.68	0.81	0.51	0.75
	SN2	0.84				0.71			
	SN3	0.82				0.83			
	SN4	0.64				0.63			
PPC	PPC1	0.79	0.89	0.72	0.88	0.90	0.95	0.866	0.95
	PPC2	0.91				0.97			
	PPC3	0.84				0.92			
RTC	RTC1	0.89	0.89	0.68	0.88	0.81	0.9	0.69	0.91
	RTC2	0.76				0.83			
	RTC3	0.79				0.91			
	RTC4	0.85				0.78			
TA	TA1	0.91	0.94	0.80	0.94	0.91	0.96	0.85	0.96
	TA2	0.95				0.96			
	TA3	0.90				0.95			
	TA4	0.80				0.87			
SAN	SAN1	0.79	0.91	0.71	0.91	0.85	0.86	0.61	0.86
	SAN2	0.91				0.91			
	SAN3	0.91				0.70			
	SAN4	0.75				0.63			

analysis to verify the reliability and validity of the measurement models, including item loadings, construct reliability, and average variance extracted (AVE). The results are shown in Table 4.

The composite reliabilities and Cronbach's alpha coefficients of all factors were higher than 0.80, indicating that they were reliable for their respective constructs [87]. The standard loadings of most of the latent factors were above

Table 5 – Correlation coefficient matrix and square roots of the AVEs for the middle-aged group (shown as diagonal elements).

	BI	PV	ATT	PBC	SN	PPC	RTC	TA	SAN
BI	**0.81**								
PV	0.71	**0.77**							
ATT	0.58	0.54	**0.77**						
PBC	0.42	0.35	0.25	**0.77**					
SN	0.26	0.71	0.20	0.11	**0.76**				
PPC	0.11	0.13	0.10	0.10	0.27	**0.85**			
RTC	−0.06	0.03	0.02	0.06	0.25	0.18	**0.82**		
TA	0.06	0.09	0.08	0.05	0.22	0.41	0.17	**0.89**	
SAN	0.28	0.62	0.46	0.28	0.21	0.13	0.04	0.10	**0.84**

Table 6 – Correlation coefficient matrix and square roots of the AVEs for the older group (shown as diagonal elements).

	BI	PV	ATT	PBC	SN	PPC	RTC	TA	SAN
BI	**0.83**								
PV	0.45	**0.82**							
ATT	0.67	0.51	**0.79**						
PBC	0.31	0.29	0.15	**0.78**					
SN	0.24	0.35	0.18	0.14	**0.72**				
PPC	0.05	−0.04	−0.02	−0.08	0.08	**0.93**			
RTC	0.07	0.04	0.02	−0.03	0.04	0.20	**0.83**		
TA	−0.05	−0.06	−0.13	−0.23	0.09	0.30	0.21	**0.92**	
SAN	0.38	0.48	0.24	0.24	0.35	−0.11	0.11	0.02	**0.78**

0.70 and significant at the 0.001 level. In addition, the AVE of each factor was higher than the threshold of 0.5, indicating reasonable convergent validities [88].

Another method to assess discriminate validity is comparing the level of square root of AVE and the correlation between any two constructs. In this way, the former should be greater than the latter. We calculated the square root of the AVE of each factor (shown as diagonal elements in bold) and its correlation coefficient with each of the other factors for the two groups. The results are summarized in Tables 5 and 6.

The square roots of the AVEs of each factor were larger than their corresponding correlation coefficients with other factors, indicating that our data had good discriminant validity.

4.3. *Structural model testing results*

We used Lisrel version 8.70 to test our structural model for middle-aged and older users. Including 34 items describing 9 latent constructs, the model was used to test the significance of each hypothesis estimate for all specified paths, as well as standard errors and test statistics for each path.

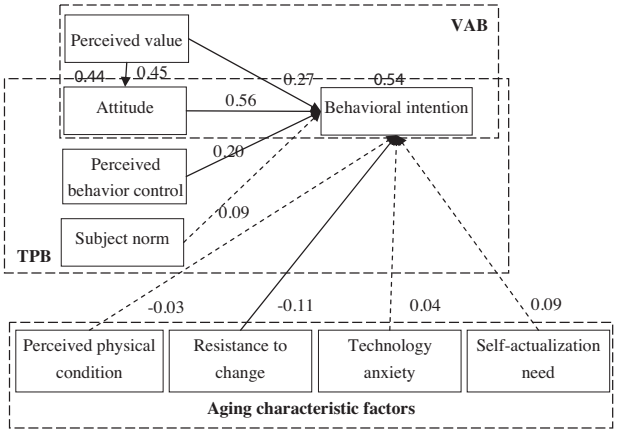

Fig. 2 – Results of the research model testing for the middle-aged. *Note*: Numbers in bold are the explained variances.

4.3.1. *Results of the structural model testing for the middle-aged group*

The structure equation model results are shown in Fig. 2, and the results of the hypotheses tests are presented in Table 7.

The results indicated that five out of the 9 hypothesized paths were significant at the 0.05 level. Perceived value, attitude, perceived behavior control, and resistance to change positively predicted behavioral intention, and the variance was 0.54. Among these four factors, the most important determinant of behavior intention was attitude, as its path coefficient was 0.56 ($p < 0.001$). The influence of perceived value was less, with a path coefficient of 0.27 ($p < 0.001$). The impact of perceived behavior control was 0.20 ($p < 0.001$), and resistance to change had the smallest significant impact. In addition, perceived value was positively related to user attitude, with a large path coefficient of 0.45 ($p < 0.001$), accounting

Table 7 – Results of the hypotheses tests for the middle-aged group.

Hypothesis	Path	Coeffecients	*T* value[a]	Results[b]
H1	PV-BI	0.27	5.67***	Y
H2	PV-ATT	0.45	7.71***	Y
H3	ATT-BI	0.56	8.03***	Y
H4	PBC-BI	0.20	4.00***	Y
H5	SN-BI	0.09	1.80	N
H6	PPC-BI	−0.03	−0.50	N
H7	RTC-BI	−0.11	−2.48*	Y
H8	TA-BI	0.04	0.91	N
H9	SAN-BI	0.09	1.67	N

[a] *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
[b] Y: supported; N: not supported.

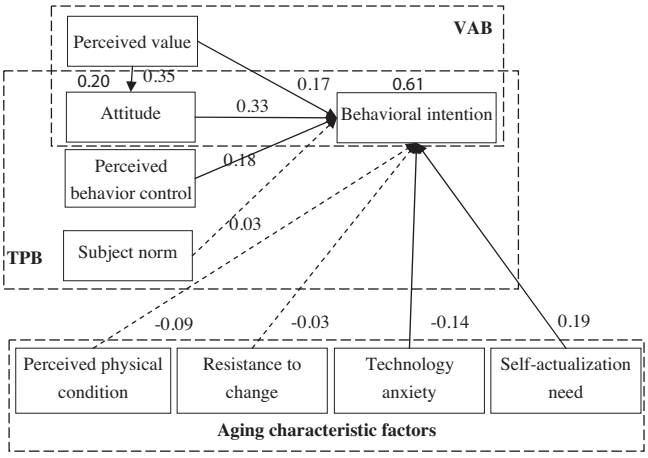

Fig. 3 – Results of the research model testing for the older group. *Note*: Numbers in bold are the explained variances.

for 44% of the variance in attitude. However, the path from subjective norm to behavior intention was not significant. Moreover, among the four aging characteristic constructs, only the effect of resistance to change was significant.

4.3.2. *Results of the structural model testing for the older group*

We also tested the structural equation model using the data from older users. The results are depicted in Fig. 3 and Table 8.

For the older group, the results indicated that perceived value, attitude, perceived behavior control, technology anxiety, and self-actualization need significantly affected behavior intention with paths coefficients of 0.17, 0.33, 0.18, −0.14, and 0.19, respectively. The variance explained was 0.61. Perceived value was positively related to attitude, and the path coefficient was 0.35 and accounted for 20% of the variance in attitude. Among the four constructs of aging characteristic factors, different from the middle-aged group, resistance to change was found to have no significant effect on behavior intention, whereas technology anxiety and self-actualization need did have a significant effect.

Table 8 – Results of the hypotheses tests for the older group.

Hypothesis	Path	Coefficients	*T* value[a]	Results[b]
H1	PV-BI	0.17	3.19***	Y
H2	PV-ATT	0.35	4.13***	Y
H3	ATT-BI	0.33	7.04***	Y
H4	PBC-BI	0.18	2.77**	Y
H5	SN-BI	0.03	0.48	N
H6	PPC-BI	−0.09	1.59	N
H7	RTC-BI	−0.03	−0.53	N
H8	TA-UI	−0.14	−2.73**	Y
H9	SAN-UI	0.19	2.69**	Y

[a] $^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$.
[b] Y: supported; N: not supported.

5. Discussion

Separately analyzing the perceptions of the middle-aged group and the older group enabled us to examine the factors that affected both groups' adoption of mobile health services in China, which allowed us to expand our understanding of the difference in adoption between the middle-aged and older users of mobile health services. Several key findings emerge from this study.

First, as hypothesized, significant support for perceived value, attitude, and perceived behavior control was found as determinants of behavior intention in both groups. Attitude was the most important factor in determining the behavior intention of mobile health services in both groups; for middle-aged and older adults, the more positive their attitude toward the services, the more intensive their behavior intention was.

In both groups, perceived value had significant effects on both attitude and behavior intention, which demonstrated that the more value middle-aged and older users perceived from the adoption of mobile health services, the more likely that they would have a more positive attitude toward mobile health services; they would thus be more likely to use these services. Given that the effect of attitude on behavior intention was proven to be significant, perceived value also indirectly influenced behavior intention by encouraging the establishment of a positive attitude. Perceived value in the middle-aged group had a higher path coefficient to behavior intention than it had in the older group, which indicates that the extent of the elderly persons' attitudes being influenced by perceived value was relatively weaker than that of the middle-aged group. We suggested that elderly people put less value on the utility of mobile health services based on the perceptions relating to their attitude toward mobile health services.

Second, after an analysis of the 424 valid questionnaires in both samples, we found a strange but interesting point that resistance to change was an antecedent for behavior intention in the middle-aged group, whereas for the older group, it was not. According to continuity theory, we proposed that the elderly people would prefer the traditional health services based on their previous experiences. However, the results contradicted our hypothesis. The reason for this might be, on the one hand, the inequalities and inconvenience of access to healthcare services in China, especially for elderly people. Waiting to meet the doctors always requires a few hours or even an entire day. Additionally, senior citizens generally have declining physical conditions, suggesting that more effort is needed and more difficulties are experienced when they attempt to obtain health care services. On the other hand, a number of middle-aged users of about 45 years old can seek health-related information using the Internet. They probably do not want to change to a small screen mobile device to obtain health services. Thus, the perception of resistance to change will negatively affect their adoption of mobile health services.

Moreover, from the perspective of modernization theory [89], today's modernized and science-oriented society can trigger a loss of social status for senior citizens because knowledge from the book is now valued more than knowledge acquired through personal experience [90]. Therefore, senior citizens no longer put too much importance on their previous

habits, and they are ready to change their styles of receiving health services if necessary. These results are consistent with Phang et al. [68].

Third, technology anxiety was found to have a significant impact on the behavior intention for the older group, but was insignificant for the middle-aged group. The probable reason is that most middle-aged users still work; thus, they have more chances to access new technology to support their job tasks. However, most elderly people have retired; they are less familiar with technology, and thus their perceptions of technology anxiety are stronger. They would hence be more likely not to use mobile health services.

In order to further clarify the relationship between resistant to change and technology anxiety, we have the fowling statements. On the one hand, resistance to change refers to users' unwillingness to change their way of health management and life style, and technology anxiety refers to individual's apprehension when faced with the possibility of using the new technology based services, mobile health services. That is, resistance to change is about the way of health management and life style, while technology anxiety is about technology operation. From this aspect, resistance to change covers much broader. Although the questions of technology anxiety seems not emphasize the technology operation aspect, when we interview with our respondents, we have explained that clearly. Thus, the result can imply that the two constructs indicate two different factors. On the other hand, "Technology anxiety plays an important role in shaping elderly users' perception of ease of use" [23]. Perceived ease of use may negatively related to their resistance to change, but conversely, is not so. That is, technology anxiety may significantly affect users' behavior intention, while resistance to change has no significant effect. For example, a user would like to change traditional style, consulting health problems with professionals, to a new one, consulting health problems via mobile health service. However, because of the fear of complexity of using it, he or she would not use it.

Another personal characteristic construct, self-actualization need, had different levels of influence on behavioral intention in the middle-aged group and the older group. Self-actualization need was positively related to intention for the older people, but not for the middle-aged people. This result is consistent with the results from another study about elderly persons' adoption of e-government. According to Erikson et al. [78] and Maslow [80], the ego integrity or self-actualization need is salient in later adulthood (the older people). Middle-aged adults care more about generativity and self-esteem than self-actualization. Therefore, in the middle-aged group, self-actualization need did not significantly affect behavioral intention.

Lastly, two hypotheses have not been confirmed for either the middle-aged or the older group. Contrary to suggestions from previous literature, subjective norm and perceived physical condition showed no significant relationships with either group's intention to use mobile health services. The pressure from close relatives and friends in the context of using mobile health services was not salient. Based on our question-and-answer period, part of the reason might be explained by most people's view that mobile health services seemed too distant from the reality of the existing medical environment. Even if these services are available, they would be too expensive to afford. In this case, people would prioritize their own economic condition over the influence of others. In our research, the beliefs about one's physical difficulties of vision, hearing, and movement that may be faced in everyday life (perceived physical condition) and the response capability when faced with the possibility of using m-health services (technology anxiety) did not significantly affect the behavioral intention of either of the two groups. Our questionnaire investigation was conducted outdoors; hence, only those with relatively better physical conditions and sufficient leisure time participated in our survey, whereas those with acute physiological problems were excluded. This aspect might explain the preceding finding about behavioral intention. For participants from both the middle-aged and the older groups, adoption of mobile health services would slightly affect their daily life as their physical conditions improve. Therefore, in terms of mobile health, a new technology, most of them expressed their willingness to learn to use the services, and they believed they could learn the services quickly only if someone would teach them how to use them.

6. Implications and limitations

6.1. *Implications*

Our study has several implications for both researchers and practitioners.

For researchers, this study examined user adoption by comparing two different age groups (middle-aged and older people). Extant research has mainly drawn on general users regardless of their age, or only on elderly users, and has seldom considered the views of both middle-aged and older users. This research attempts to fill the gap and compares the differences in a general model. The results of this study also highlight the significant effects of perceived value, attitude, perceived behavior control, and the aging characteristics on middle-aged and older users' adoption of mobile health services, which is overlooked in the existing literature. Furthermore, we demonstrate that VAB and TPB are also practical in Chinese middle-aged and older users' adoption behavior of mobile health services. In the four aging specific constructs, technology anxiety and self-actualization need are the major antecedents of older users' behavior intention to use mobile health services. Meanwhile, middle-aged users' resistance to change significantly influences their behavior intention, implying that the different aging characteristics between middle-aged and older users determine their different influences on their behavior, thus shedding light on future research on mobile health service adoption.

Our research also has important implications for practitioners. One of the challenging tasks of mobile health service practitioners is to develop a valuable service that users are willing to use. Thus, understanding the factors that influence the target users' adoption can allow practitioners to pay more attention to the factors that significantly affect user adoption behavior. As suggested by our model, both middle-aged and older users will be more likely to adopt mobile health services if the formation of positive attitudes, value perception,

and behavior control is well managed. Therefore, to attract new users who are more than 40 years old, mobile health service providers should focus on these psychological processes. Attitude has the greatest impact among these factors. Thus, demonstrating a positive image to users, caring more about user needs, and improving the user value of their services are important for mobile health service providers.

More specifically, the older group had a higher need for self-actualization than the middle-aged group; this need can be fulfilled through the process of learning and using new technology. Therefore, service providers should design a user-friendly interface and provide a sophisticated help menu or design a special mode with additional functions (i.e., voice prompt) for elderly people. Thus, elderly people would better enjoy the process of using mobile health services. Furthermore, technology anxiety has more negative effects on the adoption behavior of older users. Therefore, providers should undertake measures, such as providing good illustrations and training, to ease the use of the service and eliminate older users' anxiety about the technology.

Middle-aged people are more influenced by their usage habits. Therefore, marketers should design the functions and operations of mobile health services that are similar to those used in computers; this approach would persuade middle-aged users to gradually realize the convenience of the services and subsequently accept them. Although the influence of resistance to change on older users is insignificant, providers should also persuade the elderly that mobile health services will simplify their lives, and demonstrate how the service will work to ease the management of their health.

6.2. *Limitations*

This study develops a research model for exploring middle-aged and older users' adoption of mobile health services in China. Despite the rigorous validation procedure, the study still has some limitations. First, our model was tested through data collected in central China. As the uptake of mobile health services will be different among different regions within China, and China's mobile health services may further differ from those of other cultures; hence, researchers should be cautious when interpreting our results. Second, our subjects were mainly participants of our briefing sessions in the six communities. The senior citizens who attended were relatively healthier and more sociable and active than those who did not attend. Future research may strive to obtain responses from senior citizens who have disabilities and are less socially active. Finally, our study tested the impact of several factors on the middle-aged and older users' adoption of mobile health, and the variance explained by the model was 54% and 61%. Moreover, other important factors were not considered in our model. Thus, market practitioners should focus on facets other than those mentioned in this study.

7. Conclusions

This work compared the adoption of mobile health services among middle-aged and older users in China. Our research has the following contributions.

First, we explore the mobile health service perceptions of middle-aged and older users in China, which is seldom covered in other studies. Thus, our research fills the gap in gaining an academic understanding of these aging groups. Second, by integrating VAB, TPB, and aging characteristic constructs, we develop and validate a more comprehensive adoption model in the context of China's mobile health services than those presented in previous research. The current study also sheds light on the nomological relationships among the factors of VAB, TPB, and aging characteristic constructs.

Authors' contributions

Deng designed and conceptualized the study, assisted with data analysis, and wrote the paper. Mo gathered and analyzed the data. Liu checked the conceptual model and revised the paper. All co-authors revised the paper critically.

Conflicts of interest

There are no known conflicts of interest.

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Appendix. Construct measurements

A.1. *Behavior intention*

BI1. I have a high intention to use mobile health services.

BI2. I intend to learn about using mobile health services.

BI3. I plan to use mobile health services to manage my health.

BI4. Comparing to other healthcare management, I prefer mobile health services.

A.2. *Attitude*

ATT1. Using mobile health services is a good idea.

ATT2. Using mobile health services will promote me to manage health more actively.

ATT3. I like the idea of using mobile health services.

A.3. *Subject norm*

SN1. If I use mobile health service, I can depend less on others for finding health information for me.

SN2. If I use mobile health service, the people I care about will worry less about my health.

SN3. If I use mobile health service, I can provide better health information to my friends and family.

SN4. If I use mobile health service, I can do a better job of guarding the health of people who are important to me.

A.4. *Perceived behavior control*

PBC1. I believe I can learn to use mobile health services

PBC2. I believe I can use mobile health services by myself.

PBC3. I believe I can use mobile health services to manage my health.

PBC4. I have relative necessary knowledge to use mobile health services.

A.5. *Perceived value*

PV1. Using mobile health service is worth the money.

PV2. It is a good deal to use mobile health services as compared to other services.

PV3. I can get the best value form using mobile health services.

PV4. The overall value of using mobile health services is high.

A.6. *Perceived physical condition*

PPC1. Using mobile health services would require me to exert more effort to perform usual daily activities.

PPC2. Using mobile health services would limit the kind of activities I can perform.

PPC3. Using mobile health services would cause me to have difficulty in performing daily activities.

A.7. *Resistant to change*

RTC1. I don't want the mobile health services to change the way I deal with health-relevant problems.

RTC2. I don't want the mobile health services to change the way I keep myself healthy.

RTC3. I don't want the mobile health services to change the way I interact with other people.

RTC4. Overall, I don't want the mobile health services to change the way I currently live.

A.8. *Technology anxiety*

TA1. Using mobile health services would make me very nervous.

TA2. Using mobile health services make me worried.

TA3. Using mobile health services may make you feel uncomfortable.

TA4. Using mobile health services may make me feel uneasy unconfused.

A.9. *Self-actualization need*

SAN1. Learning to use mobile health services gives me opportunity for personal progress.

SAN2. Learning to use mobile health services gives me opportunity for personal development.

SAN3. Learning to use mobile health services increases my feeling of self-fulfillment.

SAN4. Learning to use mobile health services gives me a feeling of accomplishment.

Summary points

What was already known on the topic?

- Obtaining healthcare service via mobile phone appears significant for older people.
- Older people's adoptions of mobile health are highly related to their perceived usefulness and ease of use, and some other aging specific characteristics factors.

What this study has added to the body of knowledge?

- By integrating Value-Attitude-Behavior, the Theory of Planned Behavior, and aging characteristic constructs, we develop and validate a more comprehensive adoption model in the context of China's mobile health services than those presented in previous research.
- The current study sheds light on the nomological relationships among the factors of VAB, TPB, and aging characteristic constructs.

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