A Study of Willingness to Adopt Smart Aging Services: Evidence from Anhui Province, China

Exploring the adoption intention of smart senior care services can help improve the actual adoption rate. Taking a questionnaire survey of 1600 households in Anhui Province as an example, structural equation modeling was used to study the adoption intention and influencing factors of smart senior care services. The results show that subjective norms, perceived usefulness and perceived ease of use are the key factors influencing the adoption intention of smart senior care services. Further, age has an impact on perceived usefulness and adoption intention, education has an impact on perceived ease of use and adoption intention, and monthly household income has an impact on perceived usefulness and adoption intention. This paper broadens the existing technology acceptance model (TAM) theory and provides some basis for the development of economics. The findings will be beneficial to the government in formulating more precise policies on elderly services to properly address the challenges of aging.

Keywords: *smart aging services, willingness to adopt, structural equation modeling, China, elderly*

Declaration of competing interest

The authors declare that they have no known competing financial or other interests that could have compromised the work reported in this paper.

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1. Introduction

With the rapid development and continuous progress of society, population aging has gradually become an important problem that needs to be solved for all human beings. By 2020, China's elderly population aged 60 and above will reach 255 million, accounting for 17.8% of the total population, and this proportion is still increasing; the degree of aging will exceed that of most developed countries by the middle of the 21st century (National Health Commission 2017). In the new era, promoting the comprehensive and healthy development of home care services is an important measure to solve the problem of constructing the current urban and rural elderly service system in China (Yi 2021).

The rapid development of information science and technology in recent years has led to the flourishing of "Internet+" home care services. The traditional community home care service has defects such as dysfunction of supply and demand, low efficiency of the service, etc. Smart senior care service can solve not only these problems but the aging problem, too. In 2017, the Ministry of Industry and Information Technology and the Ministry of Civil Affairs issued the "Action Plan for the Development of Intelligent Healthy Aging Industry (2017–2020)," proposing to build out 500 intelligent healthy aging demonstration communities in five years, greatly increasing the speed of intelligent aging development. The introduction of Internet technology into traditional home care services has enabled the integration of information technology, artificial intelligence, and other high technologies with home care services to provide personalized and efficient intelligent elderly care services (Xu and Zhang 2021). The Life Trust of the United Kingdom first introduced the concept of smart aging, which is a new intelligent aging model that can help the elderly enjoy a high-quality and efficient home aging life without the constraints of time and space. Since then, different scholars have improved the definition of the concept; based on the existing research, this study considers that intelligent senior care service is a kind of senior care service that takes the home life of the elderly as the basic starting point, and provides an efficient, fast, low-cost and intelligent senior care service with the help of an external sensor information system and an internet data structure platform. It is also divided into seven types of service: meal assistance, cleaning assistance, walking assistance, bathing assistance, medical assistance, shopping assistance, and remote care (Liao and Chen 2019; Van der Kloet 2019; Goundrey-Smith 2019).

By the end of 2020, the number of elderly people aged 60 and above in the province exceeded 11.7 million, accounting for 18.41% of the total population of the province, and the degree of aging is at the forefront of the country (Anhui Provincial Bureau of Statistics 2021). However, the overall economic development level of the province is not high, the intelligent senior care service industry is still in the period of development and exploration, the stable market demand has not yet formed, the operation regulation and development structure is still not perfect, and the gap between supply of and demand for home senior care service is prominent. Exploring the adoption behavior of smart senior care services and promoting the adoption rate will help solve not only the aging problem but also the imbalance between sup-

ply and demand. However, so far, the adoption rate of the elderly is still not high; so how can the service penetration and adoption rate be improved? The factors influencing adoption intention can help to improve the adoption rate, so early clarification of the adoption intention and influencing factors has become an important challenge to be solved. The findings of this paper can help strengthen the policy relevance and effectiveness of government subsidy policies for the promotion of smart senior care services and achieve the development goal of smart living.

2. Literature review

Many scholars have studied the willingness and constraints of the elderly to use intelligent products on different levels, which can be roughly divided into the following three categories: First, the influence of technology itself is a factor. Older people's concern about healthcare services that use wireless sensors depends on the level of system independence (Steele et al. 2009). Seniors are more satisfied with medical consultations of a service nature than with physical disease treatment alone (Chae et al. 2001). Evaluation of the robot's aging and acceptance by the elderly can clarify its ease of use, and satisfaction with use is directly related to ease of use (Körtner et al. 2014). Second is the influence of psychological and physical factors. It has been found that weaker health levels and higher awareness of novelty among the elderly increase their acceptance of and satisfaction with high-tech elderly products (Lu, Zhou and Wang 2009). Some scholars have also used empirical research to further verify the important role of social-psychological characteristics in determining elderly use of information technology social network systems (Godfrey and Johnson 2009). Third is the influence of economic- and education-level factors. Older adults have different attitudes toward using the Internet, and individual income levels directly determine the degree of willingness to shop online (Eastman and Iyer 2004). Older adults' age and education level affects their adoption of information systems, but continued use depends on differences in user beliefs and perceptions before and after use (Chakraborty, Vishik and Rao 2013). Besides, other scholars have explored issues such as the elderly's post-use perceptions of the new technologies. For instance, Internet of Things (IoT)-based elderly care services have advantages such as multidirectional sensing and powerful transmission (Xi, Ren and Zhai 2014); smart elderly services have advantages such as efficiency, speed, and convenience compared to traditional elderly services (Gu, Wu and Cao 2017); using smart elderly technology can eliminate the problem of spatial and temporal barriers to senior care services and improve service continuity (Zhu 2016); and the higher the health level, the lower the willingness to demand smart senior care, while the stronger the cognitive ability, the higher the willingness to demand it (Yu and Sun 2017; Davis, Bagozzi and Warshaw 1989).

There have been quite a lot of studies, but they mostly focus on the external level such as policy system and resource endowment, and there are limited studies that examine the problem from the internal level in relation to the elderly psychological cognitive perspective, and the research methods are still focused on traditional

models such as Logistic and Probit, which have obvious shortcomings in clarifying the internal relationship between factors and elements and specific influence paths (Jian, Dai and Dai 2016). In contrast, structural equation models not only depict the influence relationships among latent variables but also sort out the path relationships among latent variables (Dufhues et al. 2021). Besides, previous studies have not tested the robustness of the model, which cannot further improve the scientific and accuracy of the conclusions (Huang and Liu 2020).

3. Theoretical foundation and research hypothesis

3.1. Theoretical foundation

Davis first proposed the technology acceptance model in the 1990s, which is a model to explain and predict the degree and behavior of users' acceptance of information technology (Davis, Bagozzi and Warshaw 1989). This model clarifies that behavioral intention determines end-user behavior, while perceived usefulness (PU) and perceived ease of use (PEU) jointly influence behavioral intention. Subsequently, many scholars refined this model and proposed TAM2 and TAM3 models (Venkatesh and Davis 2000; Venkatesh and Bala 2008), in which TAM3 further demonstrates that behavioral intention is influenced by PU, PEU, and community influence, and directly affects subject behavior. PU and PEU are influenced by individual differences, convenience, system characteristics, and community influence. This model has been widely used in the field of information intelligence technology at the level of technology behavior acceptance, which better shows what factors influence the adoption behavior of information intelligence technology, but there is limited research related to its application to the adoption intention in the field of smart elderly services (Figure 1).

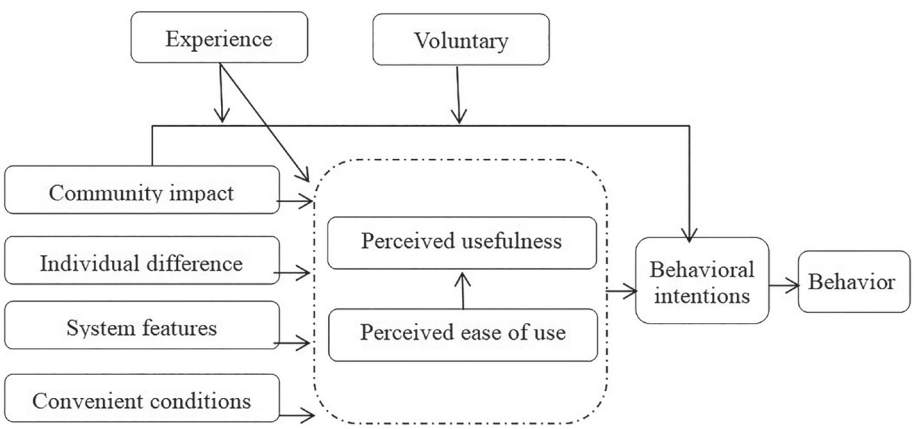

Figure 1. Technology acceptance model (TAM3) (Venkatesh and Bala 2008)

3.2. Research hypothesis

The external validity associated with the adoption of smart senior care services is called PU. Using adoption technology theory to explore the issue of factors influencing social networking sites, it has been shown that PU and PEU influence the elderly's willingness to adopt (Ji et al. 2010). The following hypotheses are proposed because the actual adoption effect is of greater concern when accepting smart senior care services, and seniors will choose to use them only if they perceive that the adoption brings higher effects than before.

H1: Perceived usefulness has a significant positive effect on the willingness to adopt smart senior care services.

The degree of mastery needed to operate smart senior care services easily is called PEU. Older adults' sense of self-enablement indirectly influences adoption intentions by affecting PU and PEU of social networking sites (Braun 2013). Older people are less able to accept new technologies, and the less effort it takes to use smart devices, the more willing they are to adopt them. The following hypothesis is made.

H2: Perceived ease of use positively influences both adoption intention and perceived usefulness.

The external environmental factors that constrain the adoption of smart senior care services are called subjective norms. Because of the risk of uncertainty in the use of smart senior care services, most elderly people do not have a clear opinion before deciding to adopt them and seek to consult their children, friends, and neighbors. If people around them have a positive attitude toward using the services, it will significantly increase the elderly people's willingness to adopt. The following hypothesis is made.

H3: Subjective norms not only positively influence adoption intentions but also positively contribute to perceived usefulness and perceived ease of use.

The help of smart senior care service promoters in adopting the service is called external facilitation. Studies have shown that external social support forces and internal technical capabilities have an indirect effect on PU and PEU (Sintonen and Immonen 2013). Identifying good external conditions can drive up the level of willingness to adopt. The following hypothesis is made.

H4: Convenience not only affects perceived usefulness but also affects perceived ease of use.

The degree of improvement in life achieved by adopting smart senior care services is called results display. The use of smart senior care services can promote the ability of senior care services (Yu and Sun 2017; Tian 2015). Results display includes direct results display, which indicates a direct improvement in the physical and mental health of the elderly, and indirect results display, which indicates an indirect improvement in physical and mental health by changing the life satisfaction of the elderly. The following hypothesis is made.

H5: Results display positively promotes both perceived usefulness and perceived ease of use, as well as adoption intentions.

The expectation theory is expressed by the formula: Expectation × Valence = Excitement power, which indicates that the product of expectation and valence deter-

mines the magnitude of human motivation, and the greater the degree of grasping the goal, the greater the original power motivation will be stimulated and the motivation will be significantly increased. That is, the greater the benefits of adopting smart senior care services for the elderly, and the closer it is to the user's expectation, the more it will increase the adopter's willingness to use. The following hypothesis is proposed.

H6: Performance expectations significantly affect perceived usefulness, perceived ease of use, and willingness to adopt.

Based on the above research hypotheses and the specific TAM, the following theoretical analysis framework (Figure 2) is proposed concerning the actual problem.

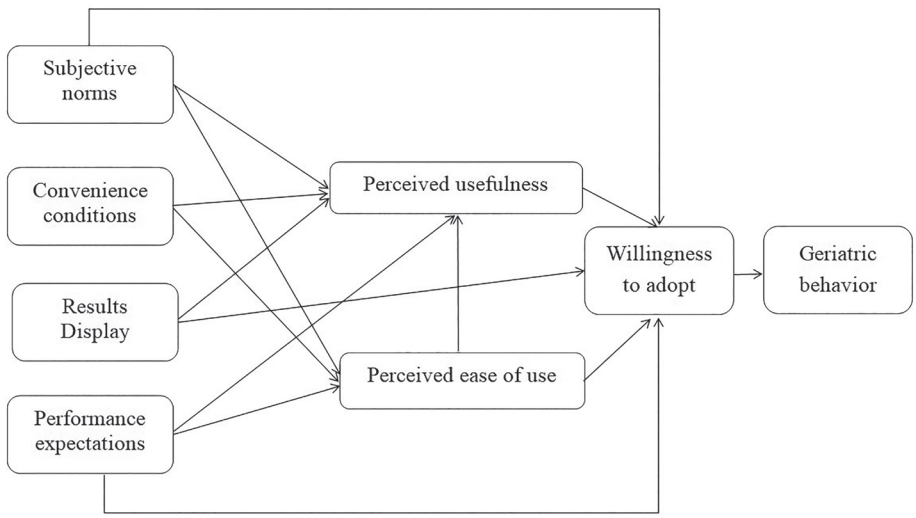

Figure 2. Model of factors influencing the willingness to adopt smart senior care services (own editing)

4. Materials and research methods

4.1. Questionnaire design and data sources

Combining the technology acceptance model and existing studies, seven latent variables were set: willingness to adopt, PEU, PU, presentation of results, performance expectations, convenience, and subjective norms. The indicator structures of willingness to adopt, PU, and PEU were set by drawing on the research scales of Ji and Braun (Ji et al. 2010; Braun 2013); the indicator structure of subjective norms was set by drawing on the research of Qunlin Zhang (Zhang and Atani 2019); the indicator structures of convenience and outcome were set by drawing on the research of Sintonen and Jie Tian et al.'s demonstration indicator structure (Sintonen and Immone 2013; Tian 2015); and the indicator structure of performance expectations was set with the help of Lei Wang et al.'s study (Wang et al. 2020).

The data in this paper were obtained from a survey conducted by three universities, including Shanghai University and Nanjing Agricultural University, on the precise supply of smart senior care services, and the research team conducted household surveys from February to October 2019 among elderly people aged 60 years and above in the target communities in three waves. Using the typical sampling and random sampling survey methods, the province was divided into six cities from north to south, including Huaibei and Suzhou, according to the socioeconomic development and taking into account the geographical and spatial distribution characteristics. Each city correspondingly selected 2~3 districts (counties), and each district (county) selected 3~4 representative communities with a wide coverage of traditional elderly services, and randomly selected elderly aged 60 and above in the community with medium distance sampling for the survey. A total of 1600 questionnaires were distributed. After excluding the questionnaires that were not successfully collected, a total of 1556 valid questionnaires were obtained, with an effective rate of 97%. There were 829 males and 727 females in the sample group, and the proportions of the two were 53.3% and 46.7%, respectively, which were roughly equal. The majority of the elderly were aged 65–80 years old, accounting for 70.6% of the total number, and the majority of the elderly were educated in primary and junior high school, while the proportion of the elderly in high school and above was only 9.3%. Only 685 elderly people adopted the smart elderly service; the adoption rate was thus only 44%.

4.2. Variable description

As shown in Table 1, this paper establishes a structural equation model (SEM) for the adoption of smart elderly services by the elderly, in which willingness to adopt, PU, and PEU are endogenous latent variables, and performance expectations, subjective norms, outcome presentation, and convenience are exogenous latent variables. The observed latent variables were measured using a 5-point Likert scale, with levels 1~5 indicating "totally disagree," "disagree," "generally agree," "agree," and "strongly agree." The specific index settings and variables are shown in Table 1, because the smart elderly service includes seven types of service: walking aid, bathing aid, medical aid, meal aid, etc. If any one or more of these services are used, it is considered as using this service.

4.3. Research methodology

SEM, as a multivariate statistical analysis method, is often used to deal with complex relationships between individual latent variables that cannot be directly observed (Zhang, Zhang and Wang 2018; He, Bai and Zhu 2019). It is widely used in questionnaire data processing, and the biggest advantage is that it provides observable treatment of latent variables that are difficult to observe clearly (Bentler and Chou 1987).

Specifically, it includes two models, structural equation and measurement equation, and the specific model equation is as follows:

$$\eta = B\eta + \Gamma\xi + \varsigma \quad (1)$$

$$X = \Lambda_X \xi + \delta \quad Y = \Lambda_Y \eta + \varepsilon \quad (2)$$

Equation (1) is the structural equation model describing the relationship between latent variables; η is the endogenous latent variable, ξ is the exogenous latent variable, ς is the residual term, and B and Γ are the path coefficient. Equation (2) is a measurement equation model describing the relationship between latent and observed variables; X is the observed variable of the exogenous latent variable ξ, Y is the observed variable of the endogenous latent variable η, Λ_X and Λ_Y denote the matrix of observed variables to latent variables ξ and η with factor loadings,and δ and ε denote the error terms of the exogenous and endogenous variables, respectively.

Variable		Variable description	Mean	Standard deviation
Willingness to adopt (WA)	WA_1	I would consider using smart senior care services when conditions permit.	3.72	0.891
	WA_2	I will keep an eye on the development of smart senior care services.	3.43	0.664
	WA_3	I would recommend the use of smart senior care services to my friends and family.	3.60	1.032
Perceived usefulness (PU)	PU_1	Smart senior care service can reduce the cost of senior care service.	2.47	0.455
	PU_2	Smart senior care service can improve the efficiency of senior care service.	3.11	0.504
	PU_3	Smart senior care service can promote further improvement of the social security system.	3.66	1.242
	PU_4	Smart senior care service can improve the quality of life.	3.75	0.900
Perceived ease of use (PEU)	PEU_1	I think smart senior care technology is easy to master.	3.20	0.451
	PEU_2	I can easily master the use of smart devices through simple training.	3.63	1.106

	PEU_3	Through instruction, I can clearly understand the principles of using smart devices.	2.77	1.290
Subjective norms (SN)	SN_1	Whether or not to use smart senior care services is influenced by children.	2.88	0.479
	SN_2	Whether to use smart senior care service will be influenced by friends and relatives.	3.06	0.874
	SN_3	Whether to use smart senior care service will be influenced by government staff.	3.41	0.635
Convenience conditions (CC)	CC_1	The government has corresponding subsidies for using smart senior care services.	2.70	1.344
	CC_2	The government and community have specialized personnel to provide door-to-door guidance services.	3.22	0.772
	CC_3	I have the financial conditions to adopt smart senior care services.	2.83	1.046
Results display (RD)	RD_1	I can visually find the benefits of smart senior care services.	3.31	0.765
	RD_2	I have heard from friends and relatives that smart senior care services work well.	3.45	1.309
	RD_3	Through media reports, I know that smart senior care service is a very scientific way of providing senior care service.	2.94	0.608
Performance expectations (PE)	PE_1	I hope the cost required for smart senior care service can be reduced appropriately.	3.07	1.299
	PE_2	I hope it can improve my physical health.	3.16	1.057
	PE_3	I hope to improve my mental health.	2.67	0.452

Table 1. Descriptive statistics of measurement indicators and question items (own editing)

5. Results

5.1. Reliability and validity tests

To ensure the reliability and validity of the questionnaire information, the latent variables and the validity of the questionnaire need to be tested. In this study, Cronbach's alpha value was used to test the internal consistency of the measurement factors, and a Cronbach's alpha value greater than 0.7 indicates good validity of the measurement factors; greater than 0.8 indicates very good reliability (Lu and Guo 2019). The seven latent variables were analyzed using SPSS22.0 software, and the results are shown in Table 2. From the results, it can be seen that Cronbach's α values are all above 0.7, which indicates that the questionnaire has high reliability. Meanwhile, the overall validity of the questionnaire was analyzed, generally using the Kaiser-Meyer-Olkin (KMO) test and Bartlett's spherical test. The results showed that the KMO test values for each latent variable ranged from 0.610 to 0.715 and Bartlett's spherical test values were placed at the 1% level of significance, making them suitable for factor analysis.

5.2. Overall model fitness test

The overall model was evaluated using AMOS 22.0 software and the model parameters were estimated using the great likelihood method to identify the goodness-of-fit of the model through the absolute fitness index, the value-added fitness index, and the parsimonious fitness index. Table 3 shows that the original model fit index is good, and the new path trajectory is obtained after the original model is revised several times and the least significant three paths are removed. Also, the new revised results were obtained by adding the new path of RD → PEU (Table 3). The modified model fitness index has improved significantly compared with the previous one, and the model itself has improved significantly in terms of fit. Although the Adjusted Goodness of Fit Index (AGFI) and Normed Fit Index (NFI) values are not too high, they are significantly greater than 0.8, and most of the fit index values are within the normal range. Thus, the overall model fit is good (Zhang and Lian 2019).

Variables	Measurement question items	Cronbach's alpha coefficient	Commonality	KMO	Bartlett's sphericity test (significance)
Willingness to adopt (WA)	WA1	0.782	0.765	0.711	289.311 (P=0.000)
	WA2		0.749		
	WA3		0.800		
Perceived usefulness (PU)	PU1	0.725	0.717	0.607	246.780 (P=0.000)
	PU2		0.705		
	PU3		0.736		
	PU4		0.683		

Perceived ease of use (PEU)	PEU1	0.805	0.746	0.746	312.078 (P=0.000)
	PEU2		0.772		
	PEU3		0.813		
Subjective norms (SN)	SN1	0.763	0.745	0.648	270.655 (P=0.000)
	SN2		0.759		
	SN3		0.782		
Convenience conditions (CC)	CC1	0.824	0.819	0.627	304.560 (P=0.000)
	CC2		0.746		
	CC3		0.755		
Results display (RD)	RD1	0.720	0.688	0.702	312.568 (P=0.000)
	RD2		0.705		
	RD3		0.719		
Performance expectations (PE)	PE1	0.716	0.730	0.653	268.041 (P=0.000)
	PE2		0.722		
	PE3		0.654		

Table 2. Reliability and validity tests (own editing)

Fitting index	Specific index	Reference value	Initial model fitted values	Modified model fit values	Test results
Value-added suitability index	CMIN/DF	1~3	1.667	1.258	Ideal
	GFI	>0.90	0.945	0.927	Ideal
	AGFI	>0.90	0.856	0.871	Acceptable
	RMSEA	<0.08	0.058	0.046	Ideal
	NFI	>0.90	0.865	0.893	Acceptable
	IFI	>0.90	0.912	0.955	Ideal
	TLI	>0.90	0.923	0.947	Ideal
Minimalist suitability index	CFI	>0.90	0.906	0.940	Ideal
	PNFI	>0.50	0.610	0.711	Ideal
	PCFI	>0.50	0.540	0.607	Ideal
	PGFI	>0.50	0.537	0.558	Ideal

Table 3. SEM model fitness index results (own editing)

5.3. Analysis of SEM results

The new test results were obtained after the revised model was evaluated again (Figure 3 and Table 4), and it is clear from the standardized coefficients that PU, PEU, and SN can produce a 1% significance test on adoption intention. In addition, the

ranking of each influence is: PEU (0.512)>PU (0.406)>SN (0.278), and we also find that the effects of RD, SN, and CC on PEU are significant at the 1% level, PE and PEU are significant at the 5% level, PE, RD, etc. PU is significant at the 1% level, and SN and PU are significant at the 5% level. As many as 10 of the 13 different path trajectories set up above have been validated and are explained as follows.

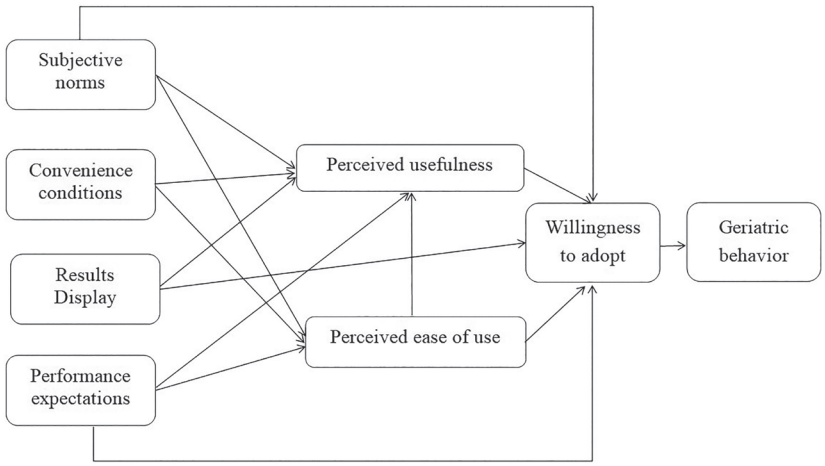

Figure 3. Adopting the Smart Aging Service Willingness Model Pathway Map (own editing)

Paths	Standardized path coefficient	Standard error	Is it significant ?
WA ← PU	0.336***	0.229	Significant
WA ← PEU	0.430***	0.288	Significant
WA ← SN	0.511***	0.188	Significant
PEU ← SN	0.279***	0.167	Significant
PEU ← PE	0.472**	0.230	Significant
PEU ← RD	0.340***	0.156	Significant
PU ← CC	0.110***	0.086	Significant
PU ← RD	0.455***	0.182	Significant
PU ← PEU	0.564**	0.285	Significant
PU ← PE	0.104***	0.054	Significant
PU ← SN	0.436**	0.146	Significant

Note: *, **, *** denote p<0.1, p<0.05, and p<0.01, respectively.

Table 4. Estimation results of the modified SEM (own editing)

(1) PU has a positive effect on the elderly's willingness to adopt smart senior care services, which is significant at the 1% level. The standardized coefficient is 0.336, and hypothesis H1 is verified. In recent years, smart elderly care has been continuously paid attention to by the government, and the documents "Guidance on Actively Promoting 'Internet+' Action" and "Action Plan for the Development of Smart Health Elderly Industry (2017–2020)" pointed out the direction for the future of smart elderly care and improved its development standardization and feasibility. More elderly users perceive the great advantages of smart senior care services in improving their quality of life, promoting the efficiency of senior care services, and reducing the burden of senior care on family members, which enhances the sense of identity of smart senior care services. Thus, the level of PU is improved and the willingness to adopt the services is increased.

(2) PEU has a significant positive effect on both PU and the willingness of the elderly to adopt smart senior care services, with standardized coefficients of 0.564 and 0.430, respectively, and hypothesis H2 is verified. The recognition of smart senior care services is high and maintains high coverage ratios of adoption (0.610), understanding (0.563), and mastery (0.745). Emerging smart senior care is highly professional and technical, which limits the degree of PEU improvement and plays a restraining role in further promotion in the later stage. Increasing the guidance of community senior care service personnel in households and simplifying the operation steps are the key measures to solve this dilemma.

(3) Subjective norms play a facilitating role in both the willingness of elderly people to adopt smart elderly services and PEU, which are significant at a 1% level. And it played a 5% positive effect on PU with standardized coefficients of 0.511, 0.279, and 0.436, respectively, and hypothesis H3 is verified. Meanwhile, the coefficients of each sub-option of subjective norms are SN1 (0. 66), SN2 (0. 68), and SN3 (0. 63), indicating that subjective norms have a stronger influence on the willingness of the elderly, and the degree of influence of each sub-variable is the same. The supportive behaviors of community elderly service organization personnel and government department cadres for smart elderly service can significantly increase the willingness to adopt smart elderly service.

(4) Convenience plays a positive contribution related to the PU of smart senior care services and is significant at the 1% level with a standardized coefficient of 0.110, and hypothesis H4 partially holds. The availability of good adoption conditions, the availability of sufficient government subsidies, and the ability to ensure that technical personnel enter the home to provide guidance are key factors limiting the adoption of smart senior care services and are also important factors affecting the PU.

(5) Both PEU and PU were positively promoted by the results display, which remained significant at the 1% level with standardized coefficients of 0.340 and 0.455, respectively, and hypothesis H5 partially holds. For the elderly, the demonstration of expected usage effects can significantly affect PEU and PU, but at the same time, the study verifies that the demonstration of results does not directly affect the willingness to adopt smart elderly services, which is inconsistent with the above hypothesis.

(6) Performance expectation positively affects PEU at the 5% level and PU at the 1% level. The standardized coefficients of the former and the latter are 0.472 and 0.104, respectively, according to which hypothesis H6 is partially valid. Combined with the validation results, it appears that the elderly have higher expectations, have a positive attitude toward this service, and psychologically perceive that the use will bring beneficial effects, although there is no way to know exactly how valuable the service is, due to the strong endogenous forces that motivate the elderly to have high expectations that the smart elderly service will be a great help in their lives, and, in terms of behavioral perception, to firmly believe that the complex operational technology becomes easier to use.

5.4. Robustness testing

In this paper, the robustness test is conducted by adding new variables to the original structural equation model by introducing a new covariate "individual characteristics of the elderly"(ICE) and treating it as a control variable. The new covariate includes three observable variables: age, education level, and monthly household income. After the introduction of the control variables, the significance and regression coefficients of the before and after models were compared to test whether the latter model reached the level of robustness (Table 5).

From the regression results of the structural model in Table 5, the effects of PU and PEU on the willingness to adopt are still significant at the 1% level when the new ICE covariate is added. This indicates that the direction and the significance level of the regression coefficients of the structural equation model are consistent with the original equation model after adding the ICE covariate. The addition of the ICE covariate has a strong and significant effect on adoption intention, and the coefficient increases by 1.3 percentage points compared with the original model. Thus, the model fits better overall.

Paths	Standardized path coefficient	Standard error	Is it significant ?
WA ← PU	0.339***	0.227	Significant
WA ← PEU	0.437***	0.290	Significant
WA ← SN	0.520***	0.188	Significant
PEU ← SN	0.283***	0.171	Significant
PEU ← PE	0.494**	0.254	Significant
PEU ← RD	0.340***	0.156	Significant
PU ← CC	0.113***	0.092	Significant
PU ← RD	0.472***	0.198	Significant
PU ← PEU	0.600**	0.331	Significant
PU ← PE	0.108***	0.058	Significant

PU ← SN	0.447**	0.152	Significant
WA ← ICE	0.117**	0.005	Significant
PU ← ICE	0.287*	0.203	Significant
PEU ← ICE	0.459**	0.256	Significant
Measurement models			
ICE ← Age	-0.176	0.124	——
ICE ← Education level	0.303	0.083	——
ICE ← Monthly household income	0.410	0.277	——

Note: *, **, *** denote p<0.1, p<0.05, and p<0.01, respectively

Table 5. Robustness test results after adding control variables (own editing)

To investigate more clearly the effect of the ICE control variables on various perceptual factors and willingness, this paper conducted one-way ANOVAs on three demographic characteristics: age, education level, and monthly household income, and the comparison of ANOVAs and cross-sectional results between groups showed the following: (1) Age has a significant effect on PU F=3.156, P=0.008) and WA (F=3.457, P=0.061). PU is reduced by the limited innovation awareness of older seniors, their low awareness and limited understanding of products with high technological content. Such elderly people are limited by the idea of insufficient usefulness and thus reluctant to actively adopt smart elderly services. However, the effect of age on PEU is not significant. (2) Education level has a significant effect on PEU (F=3.340, P=0.013) and WA (F=3.531, P=0.022). Older adults with higher education levels are more receptive to new technologies and more skilled in using and operating smart senior care services, thus increasing PEU. Moreover, educational experiences broaden the horizons of older adults, making them more likely to improve their quality of life through new technologies, and thus increasing their willingness to adopt services. However, there was no significant effect of education level on PU. (3) Monthly household income has a significant effect on PU (F=2.780, P=0.045) and WA (F=2.158, P=0.033). PU is enhanced by the fact that households with high income levels have fewer binding financial budgets and a greater demand for healthy elderly care services, and believe that smart elderly care services can better serve the elderly. At the same time, with the increase of income, elderly people's needs show diversified and complex characteristics, and the willingness to adopt services to better meet their demand level is increased. However, monthly household income does not significantly affect PEU.

6. Discussion

This study explored the adoption intention and influencing factors of smart elderly services in Anhui Province, and found that PU can significantly increase the adoption intention, which is consistent with the results of Liu Wei's study (Liu 2015).

However, the adoption intention degree is higher in this paper, indicating that the degree of demand for smart elderly services exceeds that of social network services, and PU is the primary prerequisite for measuring the adoption of new technologies (Xia and Zhang 2020). PEU has an impact on both adoption intention and PU, and PEU may not directly affect usefulness but is mediated by psychological effects to increase PU (Wang 2020), so increasing product ease of use will have multiple beneficial effects. SN significantly affect adoption intentions and PEU, and the neighborhood effect helps to dispel older adults' internal concerns and significantly increase PEU. The latter part of hypothesis 4 does not hold because convenience does not have a positive effect on PEU, probably because the first consideration of elderly users in adopting a smart senior care service is not how easy it is to use but how useful it is. Even if a service is easy to learn and master, if it does not have the desired effect, it will not ultimately increase adoption intentions. The reason why the results showed no increase in adoption may be that most of the elderly are unfamiliar with smart senior care services and direct adoption in a short period implies an increased risk of uncertainty. From a rational point of view, seniors are not likely to adopt the service directly; only when the PU and PEU of the smart senior care service are perceived to increase will it be possible to further increase the adoption intention. While Li et al. (2019) found an increase in farmers' willingness to adopt formula fertilizer application technology, the reason for the inconsistency with the findings of this paper may be because smart pension services, as a novelty, still need time to test their effectiveness and therefore reduce the willingness to adopt. In addition, an important implication of the results for us is that, when promoting and advertising the smart senior care service, we should pay much attention to whether the seniors are sure that they have felt the actual effects of the service, This is because only after the seniors' actual psychological feelings are improved can the adoption intention be finally increased. However, other studies (Bai and Zhu 2018; Zhang, Yuan and Zhou 2019) lacked measurement of service effectiveness in terms of demand-side psychological perceptions. Similarly, PE do not contribute effectively to adoption intentions. We believe that this may be because, despite the existence of hope values, the elderly are risk-averse and mostly hold a wait-and-see attitude. Fear hinders their use of the service, i.e., the increase in PU and PEU does not necessarily lead to adoption of the service, so it is more important to increase the actual adoption rate. However, another study (Niu, Zhang and Huang 2020) showed that PE can positively influence academic social network adoption intentions, which differs from this paper's study, probably due to the bias of the results caused by the different ages of the study group.

The robustness results show that age does not have a significant effect on PEU, and we argue that no matter how old, the elderly make usefulness their preferred goal, so there is a strong need to design products and services that are useful. The effect of education level on the PU of traditional Internet technologies has been studied previously (Chen 2020), but this paper shows that there is no significant effect of education level on PU, suggesting that the designers of new smart senior care services have taken into account the needs of people with different educational backgrounds. Monthly household income fails to affect PEU, so we can exclude the

interference of income factor when designing humanized services, and invest our efforts into other factor dimensions.

Although age, education level, and monthly household income have significant effects on adoption intentions, it is still not known what the adoption intentions and paths are for different types of elderly people, so group heterogeneity analysis of each of these three factors is a future research direction. Based on the TAM3 theory, this paper constructs a model of factors influencing the adoption intention of smart elderly services, which we believe not only expands the classical TAM theory to a certain extent but also deepens the research space for similar problems. For example, we can use the same framework to explore the technology adoption behavior of farmers by analogizing them to the elderly. This study not only deepens the social security research results but also extends the management theory and has some reference value for economics, especially agricultural economics.

Although this paper examines the relevant issues and makes some meaningful findings, there are some limitations. First, the research area of this paper is concentrated in Anhui Province, which is limited by the scope and number of studies, and more time is needed to test the generalizability of the findings. In the next step, the scope of the study can be broadened and more questionnaires can be used to further improve the persuasiveness. Second, many factors influence the elderly's willingness to adopt smart senior care services, so are there any important influencing factors missing? Are there any internal interactions among these factors? These can be expanded in depth in future studies. Despite the limitations, this study provides a strong basis for the government to conduct policy promotion and improve subsidy policies and early establishment of a demand-driven service system.

7. Conclusions

In this paper, after model validation, we found that the willingness of elderly people to adopt smart senior care services is influenced by various factors, and the study showed that SN, PU, and PEU are the key factors that directly affect the willingness of elderly people to adopt smart senior care services. That said, the magnitude of the influence of different factors is not consistent; in order of influence, they are PEU >PU > SN. Further, SN and PEU not only directly influence the willingness of elderly people to adopt smart senior care services but also act as mediators to positively promote WA by influencing PU. PE and RD have different degrees of positive effect on PU and PEU, and CC also increases the degree of PU. Age has a significant effect on PU and WA, while education level has a significant effect on PEU and WA, and monthly household income has a significant effect on PU and WA. The findings of the study are beneficial to the future development of more suitable policies for the promotion of smart elderly services, and the expanded TAM theory can be applied to agricultural economic research. Exploring the adoption intentions of different types of older adult based on a heterogeneity perspective is our next research direction.

Based on the findings of the study, we were able to draw several policy insights: First, improve the role of government policy orientation and enhance the cognitive

level of older adults. The role of smart elderly services in improving the overall quality and efficiency of elderly services is conveyed to enhance the PU of the elderly. Second, pay attention to the radiation effect of the demonstration group and play the leading role of cadres. Give full play to the exemplary leading role of cadres of government agencies and full-time senior care service personnel in the community to help the elderly solve technical problems and enhance the enthusiasm of elderly users to adopt the service. Third, improve the cost-effectiveness of smart senior care services and simplify the operation procedures. Establish a responsibility mechanism shared by individuals, government, and society to gradually eliminate the "digital divide" in the use of intelligent products by the elderly. Fourth, improve the standardization of intelligent senior care organizations and build a reasonable evaluation system. Establish a systematic evaluation model to effectively evaluate the implementation effect of intelligent senior care services in a precise and quantitative manner.

References

Anhui Provincial Bureau of Statistics data. "Anhui's 'aging' degree ranks 9th in the country." *Anhui Business Daily* (February 24, 2021). http://ah.sina.com.cn/news/2021-02-24/detail-ikftpnny9369558.shtml

Bai, Mei, and QingHua Zhu. "Impact Factors of Smart Care Needs and Volunteer Service Willingness for the Aged——A Case of Jianghan District in Wuhan." *Journal of Modern Information* 38, no. 12 (2018): 3–8. https://doi.org/CNKI:SUN:XDQB.0.2018-12-00

Bentler, P., and Chih-Ping Chou. "Practical issues in structural modeling." *Sociological Methods & Research* 16, no. 1 (1987): 78–117. https://doi.org/10.1177/0049124187016001004

Braun, Michael. "Obstacles to social networking website use among older adults." *Computers in Human Behavior* 29, no. 3 (2013): 673–680. https://doi.org/10.1016/j.chb.2012.12.004

Central People's Government of the People's Republic of China. "Notice of three ministries on the issuance of the Action Plan for the Development of the Intelligent Health and Aging Industry (2017–2020)." (2017). https://www.gov.cn/gongbao/content/2017/content_5222955.htm

Chae, Moon, Joo Heon Lee, Seung Hee Ho, Hee Ja Kim, Ki Hong Jun, and Jong Uk Won. "Patient satisfaction with telemedicine in home health services for the elderly." *International Journal of Medical Informatics* 61, no. 2–3 (2001): 167–173. https://doi.org/10.1016/s1386-5056(01)00139-3

Chakraborty, Rajarshi, Claire Vishik, and Raghav Rao. "Privacy preserving actions of older adults on social media: Exploring the behavior of opting out of information sharing." *Decision Support Systems* 55, no. 4 (2013): 948–956. https://doi.org/10.1016/j.dss.2013.01.004

Chen, Xin. "A study of the impact and differences of Internet use on social isolation of older adults." *Contemporary Economic Management* 42, no. 9 (2020): 53–59. https://doi.org/10.13253/j.cnki.ddjjgl.2020.09.008

Davis, Fred, Richard Bagozzi, and Paul Warshaw. "User acceptance of computer technology: A comparison of two theoretical models." *Management Science* 35, no. 8 (1989): 982–1003. https://doi.org/10.1287/mnsc.35.8.982

Dufhues, Thomas, Judith Möllers, Diana Traikova, Gertrud Buchenrieder, and David Runschke. "Why villagers stay put—A structural equation model on staying intentions." *Journal of Rural Studies* 81, no. 6 (2021): 345–357. https://doi.org/10.1016/j.jrurstud.2020.10.054

Eastman, Jacqueline, and Rajesh Iyer. "The elderly's uses and attitudes towards the internet." *Journal of Consumer Marketing* 21, no. 3 (2004): 208–220. https://doi.org/10.1108/07363760410534759

Godfrey, Mary, and Owen Johnson. "Digital circles of support: Meeting the information needs of older people." *Computers in Human Behavior* 25, no. 3 (2009): 633–642. https://doi.org/10.1016/j.chb.2008.08.016

Goundrey-Smith, Stephen. "Technologies that transform: Digital solutions for optimising medicines use in the NHS." *BMJ Health & Care Informatics* 26, no. 1 (2019): 1–4. https://doi.org/10.1136/bmjhci-2019-100016

Gu, ShengZu, HuaJun Wu, and DongMei Cao. "Strategic Thinking on Rationalizing Aged Care Service System in China." *Population Research* 41, no. 1, (2017): 3–14. https://doi.CNKI:SUN:RKYZ.0.2017-01-001

He, ZhengYu, Mei Bai, and QingHua Zhu. "A quantitative study of China's pension policies from 2013–2017." *Journal of Information Resource Management* 9, no. 1 (2019): 21–29.

Huang, JingRu, and YongMo Liu. "Effect of Media Attention on the Cost of Corporate Debt Financing——Based on the Mediator of Accounting Conservatism." *Review of Investment Studies* 39, no. 2 (2020): 113–133. https://doi.CNKI:SUN:TZYJ.0.2020-02-008

Ji, Yong, Junho Choi, Jee Lee, Kwang Han, Jinwoo Kim, and In-Kwon Lee. "Older adults in an aging society and social computing: A research agenda." *International Journal of Human-Computer Interaction* 26, no. 11–12 (2010): 1122–1146. https://doi.org/10.1080/10447318.2010.516728

Jian, XiaoZhu, BuYun Dai, and HaiQi Dai. "Theoretical construction and simulation analysis of logistic weighting model." *Journal of Psychology* 48, no. 12 (2016): 1625–1630. https://doi.10.3724/SP.J.1041.2016.01625

Körtner, Tobias, Alexandra Schmid, Daliah Batko-Klein, and Christoph Gisinger. "Meeting requirements of older users? Robot prototype trials in a home-like environment." In *Universal Access in Human-Computer Interaction: Aging and Assistive Environments*, 660–671. Heraklion, Crete, Greece: 8th International Conference, UAHCI 2014, held as part of HCI International, 2014. https://doi.org/10.1007/978-3-319-07446-7_63

Li, ZiLin, Yi Han, Xi Guo, YeFeng Jiang, and WenLu Lin. "Analysis of Influencing Factors on Farmer's Willingness to Adopt Soil Testing and Formula Fertilization Technology Based on SEM." *Resources and Environment in the Yangtze Basin* 28, no. 9 (2019): 2119–2129. https://doi:CNKI:SUN:CJLY.0.2019-09-011

Liao, Chuhui, and Juan Chen. "Factors influencing smart aged care services acceptance of elderly in nursing homes: A perspective of perceived quality." In *Proceedings of the 5th Annual International Conference on Social Science and Contemporary Humanity Development (SSCHD 2019)*. Wuhan, Hubei, China: SSCHD 2019, 2019. https://doi.org/10.2991/sschd-19.2019.114

Liu, Wei. "SNS Acceptance of Older Adults Based the Extended TTF and UTAUT Model." *Soft Science* 29, no. 3 (2015): 120–124. https://doi:10.13956/j.ss.1001-8409.2015.03.26

Lu, JieHua, and Ran Guo. "Compression or expansion of morbidity? A study on the long-term change trends of health among the elderly: 1998–2014." *Population and Development* 25, no. 6 (2019): 76–86.

Lu, Yaobin, Tao Zhou, and Bin Wang. "Exploring Chinese users' acceptance of instant messaging using the theory of planned behavior, the technology acceptance model, and the flow theory." *Computers in Human Behavior* 25, no. 1 (2009): 29–39. https://doi.org/10.1016/j.chb.2008.06.002

National Health Commission data (China). "China's elderly population aged 60 and above to reach 255 million by 2020." *Thirteenth Five-Year Plan for Healthy Ageing* (2017). https://www.gov.cn/xinwen/2017-03/23/content_5180093.htm

Niu, YanXia, YaoKun Zhang, and Lei Huang. "The Factors Influencing the Use of Academic Social Network Services: An Empirical Study Using UTAUT Model." *Library* no. 4 (2020): 91–97.

Sintonen, Sanna, and Mika Immonen. "Telecare services for aging people: Assessment of critical factors influencing the adoption intention." *Computers in Human Behavior* 29, no. 4 (2013): 1307–1317. https://doi.org/10.1016/j.chb.2013.01.037

Steele, Robert, Amanda Lo, Chris Secombe, and Yuk Wong. "Elderly persons' perception and acceptance of using wireless sensor networks to assist health-care." *International Journal of Medical Informatics* 78, no. 12 (2009): 788–801. https://doi.org/10.1016/j.ijmedinf.2009.08.001

Tian, Jie. "Feasibility Analysis and Policy Suggestions to Carry out Science and Technology Endowment." *Studies in Dialectics of Nature* 31, no. 2 (2015): 56–60. https://doi:CNKI:SUN: ZRBZ.0.2015-02-014

Van der Kloet, Hieke. "Aging and smart independent living in Dutch rural areas." In *26th Annual European Real Estate Society Conference*. Cergy-Pontoise, France: ERES Conference, 2019. https://doi.org/10.15396/eres2019_197

Venkatesh, Viswanath, and Hillol Bala. "Technology acceptance model 3 and a research agenda on interventions." *Decision Sciences* 39, no. 2 (2008): 273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

Venkatesh, Viswanath, and Fred Davis. "A theoretical extension of the technology acceptance model: Four longitudinal field studies." *Management Science* 46, no. 2 (2000): 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926

Wang, Lei, Jing Qu, ZhongChao Zhao, and LiLi Ding. "Organizational performance expectation gap and behavioral choices of heterogeneous institutional investors: A dual principal–agent perspective." *Management World* 36, no. 7 (2020): 132–153. https://doi.10.19744/j.cnki.11-1235/f.2020.0107

Wang, XiaoFei. "Influencing factors and paths of farmers' willingness to adopt soil testing and formulated fertilization technology." *Journal of Hunan Agricultural University (Social Science)* 21, no. 1 (2020): 1–7. https://doi.10.13331/j.cnki.jhau(ss).2020.01.001

Xi, Heng, Xing Ren, and ShaoGuo Zhai. "Smart pension: The elderly care service innovation with information technology." *Scientific Research on Aging* no. 7 (2014): 14–22. https://doi.10.3969/j.issn.2095-5898.2014.07.002

Xia, EnJun, and ZhenMing Zhang. "A Meta-analysis of Adoption of Preventive Innovation Technology and Its Implications for Crossing the Chasm: Taking Wearable Healthcare Devices as an Example." *Journal of Technology Economics* 39, no. 2 (2020): 134–143.

Xia, EnJun, and ZhenMing Zhang. "A Meta-analysis of Adoption of Preventive Innovation Technology and Its Implications for Crossing the Chasm: Taking Wearable Healthcare Devices as an Example." *Journal of Technology Economics* 39, no. 2 (2020): 163. https://doi:CNKI:SUN:JSJI.0.2020-02-017

Xu, Lan, and Yu Zhang. "Quality improvement of smart senior care service platform in China based on Grey Relational Analysis and Fuzzy-QFD." *Grey Systems: Theory and Application* [preprint] (2021). https://doi.org/10.1108/gs-05-2020-0068

Yi, Yu. "Healthy aging in urban China: Governing the aging population." *Geographical Journal* 187, no. 1 (2021): 28–38. https://doi.org/10.1111/geoj.12372

Yu, Xiao, and Yue Sun. "The Model of"Internet + Old-age Service": The Innovative Development of Old-age Service in New Era." *Population Journal* 39, no. 1 (2017): 58–66. https://doi:10.16405/j.cnki.1004-129X.2017.01.006

Zhang, HuaiYing, DanQi Yuan, and ZhongLi Zhou. "Entrepreneurship, members' own capacity, and cooperative performance." *Guizhou Social Science* no. 5 (2019): 123–129. https://doi.10.13713/j.cnki.cssci.2019.05.018

Zhang, Jiang Guang, Teng Zhang, and Fang Wang. "A study of key information ecology factors that influence smart-government development." *Modern Information* 38, no. 3 (2018): 3–9. https://doi.10.3969/j.issn.1008-0821.2018.03.001

Zhang, QunLin, and Isabel Atani. "Rural older males' marriage concepts and marriage strategies under the marriage squeeze." *Population and Development* 25, no. 4 (2019): 106–116.

Zhang, QunLin, and Isabel Atani. "Rural older males' marriage concepts and marriage strategies under the marriage squeeze." *Population and Development* 25, no. 4 (2019): 93.

Zhang, Yuan, and NanNan Lian. "Institutional Intelligent Care Service and the Satisfaction of the Elderly: Empirical Evidence from Baotou City." *Chinese Journal of Population Science* no. 2 (2019): 112–125.

Zhang, Yuan, and NanNan Lian. "Institutional Intelligent Care Service and the Satisfaction of the Elderly: Empirical Evidence from Baotou City." *Chinese Journal of Population Science* no. 2 (2019):128. https://doi:CNKI:SUN:ZKRK.0.2019-02-011

Zhu, HaiLong. "Smart Care: Innovation and thinking of Chinese elderly care paradigm." *Journal of Social Science of Hunan Normal University* 45, no. 3 (2016): 68–73.