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Internet-Based Healthcare Services Use Patterns and Barriers Among Middle-Aged and Older Adults in China: A Cross-Sectional Study

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Abstract

Background

The rapid aging of the global population has intensified chronic disease burdens, widened healthcare access disparities, and increased unmet care needs. Internet-based healthcare services (IHS) offer a potential solution to these challenges. This study assessed the prevalence of IHS use, its key determinants, and the main motivations and barriers among adults aged ≥ 50 years in mainland China.

Methods

An online survey of adults aged ≥ 50 years in mainland China was conducted in March 2021. Participants (N = 500) were recruited via an automated random-sampling procedure on an online platform. Logistic regression models were used to examine predisposing, need, and enabling factors associated with IHS use.

Results

Only 17.14% of respondents reported using IHS, with online medical consultation being the most common (38.5%). Respondents aged between 50 and 59 years (AOR = 4,975 [95% CI 1.224–19.608]), urban residents (AOR = 6.056 [95% CI 1.689–21.713]), higher income (AOR = 3.862 [95% CI 1.822–8.186]), chronic conditions (AOR = 5.323 [95% CI 2.866–9.888]), delays in seeking healthcare (AOR = 5.323 [95% CI 2.866–9.888]), mobility difficulties (AOR = 9.802 [95% CI 4.005–23.993]), positive attitude (AOR = 3.038 [95% CI 1.039–8.884]) were more likely to use IHS, after adjusting for variations in other variables. The primary barriers were distrust and ambiguity in self-described symptoms.

Conclusion

Low levels of IHS use were observed among middle-aged and elderly populations in mainland China. Although IHS can benefit individuals with high healthcare needs or mobility challenges, income-related and urban-rural inequalities in IHS use persist. Addressing trust issues and enhancing digital literacy among the elderly are essential for the widespread and effective development of IHS.

1. Background

The global aging surge is fundamentally reshaping healthcare demand patterns. By 2030, 25% of the EU population will be over 65 [1], while China anticipates 334 million seniors by 2050 [2]. This demographic shift multiplies healthcare demands for chronic disease management, rehabilitation services, and preventive care [3].

Globally, many healthcare institutions struggle to deliver comprehensive, elderly-centered care. Complex administrative procedures, prolonged waiting times [4], inadequate rural infrastructure [5], and poor

chronic-care coordination [6]. The resulting mismatch between primary-care resources and older adults' needs exacerbates access disparities [7]. Studies have shown that unmet healthcare needs in older populations are associated with higher mortality [8].

Internet-based healthcare services (IHS) have emerged as a complement to traditional care [9]. Originating from China's 2015 "Internet Plus" initiative, IHS provide remote medical consultations, health information and consultation remotely [9, 10]. By removing spatial and temporal constraints, they extend quality care to rural areas [11] improve systemic efficiency [12, 13], enhance health literacy [14], and support chronic-disease management [15].

Despite being a national strategic priority, IHS uptake remains low among Chinese adults aged ≥ 50 years. This study therefore (1) identifies predisposing, enabling, and need factors predicting IHS use in this demographic, and (2) diagnoses key implementation barriers to inform targeted improvement strategies. Focusing on middle-aged and older adults—a group under-represented in existing research—our findings will guide optimization of current IHS platforms and the expansion of digital health services to broader, diverse populations.

2. Methods

2.1. Study setting and participants

A cross-sectional online survey was conducted in mainland China. The survey was conducted administered anonymously, and participants were presented with an informed consent form detailing the study's purpose, procedures, and potential risks. Proceeding to the questionnaire was considered as implied consent.

Individuals aged 50 years and above were defined as the target population. Based on previous research [16], the estimated prevalence of IHS use among middle-aged and older adults in China is 14%. The required sample size was calculated using the standard formula for cross-sectional studies: $N = Z^2 \times P (1-P)/E^2$ [17], where Z = 1.96 (for a 95% confidence level), P = 14% (expected proportion) and E = 5% [18] (margin of error). This yielded a minimum required sample size of 185. Allowing for an anticipated 20% rate of invalid or incomplete responses, the final target sample size was set at 222 to ensure adequate statistical power.

2.2. Instrument Validation

The questionnaire was developed based on an extensive literature review to identify key constructs and generate relevant items. Four experts were consulted to seek their feedback on the clarity, logic, relevance, and completeness of items. A pilot test was then conducted on a convenient sample of 15 participants. Several changes were made as a result, including adding some choices relating to the two items measuring functions and challenges of IHS use and refining wording of the questionnaire. We also found that completing the questionnaire required at least 10 minutes.

2.3. Data Collection and Retention

Data were collected in March, 2021 over nearly one month. Participants were recruited from the online survey platform Wenjuanxing (www.wjx.cn), a widely used online survey platform with over one million daily responses across mainland China. Random sampling was conducted through Wenjuanxing's automated services, and recruitment continued until the predetermined sample size was reached. To prevent duplicate responses, only one submission per IP address was allowed, and the survey was closed once 571 responses were obtained. To ensure data quality, responses with logical inconsistencies or those completed in under 10 minutes were excluded. This process resulted in 560 valid responses, representing 98.75% of the returned questionnaires.

2.4. Variable measurement

Outcome Measurements (Dependent Variable)

The primary focus of this study was participants' experiences with IHS in the past year. Participants answered a series of questions in both close-ended and open-ended formats. They could select from a list of predefined options, with an opportunity to specify additional IHS experiences not covered by the list. The predefined options included online consultations, online medical appointments, online medication purchases, medical information searches, remote treatment or rehabilitation, electronic prescriptions, recording personal consultation information on mobile devices (e.g., appointment history, departments visited, diagnoses, prescribed medications or tests, and payment details), and use of wearable medical devices for health data collection (e.g., heart rate or blood glucose monitoring). An "Other" option allowed participants to describe additional IHS experiences, such as virtual health education sessions or telemonitoring of disease conditions.

Participants were also asked to identify challenges encountered while using IHS, selecting from a list [19, 20] that included distrust of IHS, ambiguity in self-described symptoms, lack of standardized online billing, long wait times for online responses, navigation difficulties, privacy concerns, and lack of continuity in online diagnoses or consultations. An "Other" option allowed respondents to specify additional challenges.

Predictors of Outcomes (Independent Variables)

The selection of independent variables was guided by Andersen's service utilization model [21], which categorizes health service utilization predictors into predisposing, enabling, and needs factors.

In this study, *predisposing factors* included gender (male vs. female), age (50–59 years, 60–69 years, ≥ 70 years), and marital status (married vs. others).

Enabling factors included residency (urban vs. rural), educational attainment (with or without a high school degree), income level (≥ 5000 vs. <5000 Yuan per month [22]), family support (high vs. low), and social support (high vs. low). Respondents rated the overall emotional, material, and informational support received from family on a five-point Likert scale, as well as support from friends, colleagues, neighbors, community organizations, and professional service agencies. A score below 3 indicated low support; otherwise, it was classified as high. Respondents were also asked if they experienced any delay in seeking health care (yes vs. no) in the past year when it was needed.

Needs factors included self-reported overall health on a five-point Likert scale (1–2 indicating poor, 3–5 indicating good) and chronic conditions diagnosed by a medical doctor, such as cardiovascular diseases, metabolic disorders, bone diseases, digestive system diseases, tumors, and others. Respondents also rated their current sleep quality (1–2 indicating poor, 3–4 indicating good), slowness in physical activities (yes vs. no), and their overall optimism regarding their health (1–2 indicating low, 3–4 indicating high).

2.5. Statistical Analysis

Participant characteristics were described using percentage distributions, with Chi-square tests used to compare across different age groups. A multivariate logistic regression model was established to identify the predisposing, enabling, and needs factors associated with IHS use, adjusting for variations in other variables. The reasons for using IHS and the barriers to its use were described using frequency distributions and ranked in order. All statistical analyses were conducted using SPSS 23.0, with a two-sided p-value of < 0.05 considered statistically significant.

3. Results

3.1. Characteristics of respondents

Among the 560 study participants, 71% were aged 50 to 59 years, 21% were 60 to 69 years, and 8% were older than 70 years. Slightly more than half (53.6%) were female, and 51.1% had obtained a high school qualification. Most participants were married (85.5%), resided in an urban area (75.7%), earned a low income (5000 Yuan per month) (61.1%), and self-reported good health (92%). Although 67.7% reported living with chronic conditions, only 12.5% had multiple chronic conditions. The vast majority experienced no delays in seeking health care (68.6%), had good sleep quality (79.5%), reported no slowness in movement (84.8%), and maintained an optimistic attitude toward health (86.8%). High levels of family support (95.4%) and social support (82.3%) were also reported (Table 1).

Those aged 70 years or older were less likely to be married ($p < 0.001$), report poorer self-rated health ($p < 0.001$), showed a higher prevalence of slowness in movement ($p < 0.001$), and received less family support compared with those aged 50–59 ($p = 0.003$). Participants aged 60 to 69 years were more likely to reside in urban areas ($p = 0.007$) and had a higher prevalence of chronic conditions ($p = 0.027$) compared with those aged 50 to 59, and were more likely to hold an optimistic attitude than those aged 70 or older ($p = 0.005$). In contrast, respondents aged 50 to 59 years had the highest proportion earning a high income ($p = 0.001$), and were more likely to have completed high school compared with those aged 60–69 years ($p = 0.003$) (Table 1).

Table 1
Characteristics of study participants and Post-hoc Comparisons Across Age Groups (n = 560)

Characteristics	Total		Group A: 50–59 years		Group B: 60–69 years		Group C: ≥70 years		*p*	*Post-hoc comparisons*
	N = 560		N = 399 (71%)		N = 115 (21%)		N = 46 (8%)			
	N	%	N	%	N	%	N	%		
Gender									0.349	A vs. B: p = 0.209, A vs. C: p = 0.364, B vs. C: p = 0.960
Male	260	46.4	193	48.4	48	41.7	19	41.3		
Female	300	53.6	206	51.6	67	58.3	27	58.7		
Marital status									< 0.001***	A vs. B: p = 0.884, A vs. C: p < 0.001***, B vs. C: p = 0.002**
Married	479	85.5	349	87.5	100	87	30	65.2		
Others	81	14.5	50	12.5	15	13	16	34.8		
Residency									0.026*	A vs. B: p = 0.007**, A vs. C: p = 0.647, B vs. C: p = 0.167
Urban	424	75.7	291	72.9	98	85.2	35	76.1		
Rural	136	24.3	108	27.1	17	14.8	11	23.9		
Educational attainment									0.012*	A vs. B: p = 0.003**, A vs. C: p = 0.996, B vs. C: p = 0.068
With high school qualification	274	48.9	208	52.1	42	36.5	24	52.2		
Without high school qualification	286	51.1	191	47.9	73	63.5	22	47.8		
Level of Income (Yuan)									0.001**	A vs. B: p < 0.001***, A vs. C: p =

*Note. *p < 0.05; **p < 0.01; ***p < 0.001*

Characteristics	Total		Group A: 50–59 years		Group B: 60–69 years		Group C: ≥70 years		*p*	*Post-hoc comparisons*
	N = 560		N = 399 (71%)		N = 115 (21%)		N = 46 (8%)			
	N	%	N	%	N	%	N	%		
										0.252, B vs. C: p = 0.180
High (≥ 5000)	218	38.9	174	43.6	28	24.3	16	34.8		
Low (< 5000)	342	61.1	225	56.4	87	75.7	30	65.2		
Self-rated health									< 0.001***	A vs. B: p = 0.053, A vs. C: p < 0.001***, B vs. C: p < 0.001***
Good	515	92	380	95.2	104	90.4	31	67.4		
Poor	45	8	19	4.8	11	9.6	15	32.6		
Chronic condition									0.054	A vs. B: p = 0.027*, A vs. C: p = 0.211, B vs. C: p = 0.818
Yes	379	67.7	258	64.7	87	75.7	34	73.9		
No	181	32.3	141	35.3	28	24.3	12	26.1		
Multiple chronic conditions									0.016*	A vs. B: p = 0.111, A vs. C: p = 0.006**, B vs. C: p = 0.218
Yes	70	12.5	41	10.3	18	15.7	11	23.9		
No	490	87.5	358	89.7	97	84.3	35	76.1		
Delay of seeking health care									0.500	A vs. B: p = 0.936, A vs. C: p = 0.252, B vs. C: p = 0.289
Yes	176	31.4	123	30.8	35	30.4	18	39.1		
No	384	68.6	276	69.2	80	69.6	28	60.9		

*Note. *p < 0.05; **p < 0.01; ***p < 0.001*

Characteristics	Total		Group A: 50–59 years		Group B: 60–69 years		Group C: ≥70 years		*p*	*Post-hoc comparisons*
	N = 560		N = 399 (71%)		N = 115 (21%)		N = 46 (8%)			
	N	%	N	%	N	%	N	%		
Sleep quality									0.449	A vs. B: p = 0.261, A vs. C p = 0.684, B vs. C: p = 0.277
Good	445	79.5	314	78.7	96	83.5	35	76.1		
Poor	115	20.5	85	21.3	19	16.5	11	23.9		
Slowness in movement									< 0.001***	A vs. B: p < 0.001***, A vs. C:p < 0.001***, B vs. C: p = 0.033*
Yes	85	15.2	38	9.5	28	24.3	27	58.7		
No	475	84.8	361	90.5	87	75.7	19	41.3		
Optimistic attitudes toward health									0.023*	A vs. B: p = 0.100, A vs. C: p = 0.059, B vs. C: p = 0.005**
High	486	86.8	345	86.5	106	92.2	35	76.1		
Low	74	13.2	54	13.5	9	7.8	11	23.9		
Family support									0.014*	A vs. B: p = 0.404, A vs. C: p = 0.003**, B vs. C: p = 0.088
High	534	95.4	385	96.5	109	94.8	40	87		
Low	26	4.6	14	3.5	6	5.2	6	13		
Social support									0.644	A vs. B: p = 0.382, A vs. C: p = 0.833, B vs. C: p = 0.456
High	461	82.3	326	81.7	98	85.2	37	80.4		

*Note. *p < 0.05; **p < 0.01; ***p < 0.001*

Characteristics	Total		Group A: 50–59 years		Group B: 60–69 years		Group C: ≥70 years		*p*	*Post-hoc comparisons*
	N = 560		N = 399 (71%)		N = 115 (21%)		N = 46 (8%)			
	N	%	N	%	N	%	N	%		
Low	99	17.7	73	18.3	17	14.8	9	19.6		

*Note. *p < 0.05; **p < 0.01; ***p < 0.001*

3.2 Use of Internet-based healthcare services

Overall, 17.14% of respondents used IHS, with 71% of these users aged 50–59 years, 21% aged 60–69 years, and 8% aged 70 years or older. Respondents aged 50–59 years (AOR = 4.975 [95% CI 1.224–19.608]), and those who resided in urban areas (AOR = 6.056 [95% CI 1.689–21.713]), had higher income (AOR = 3.862 [95% CI 1.822–8.186]), lived with chronic conditions (AOR = 5.323 [95% CI 2.866–9.888]), experienced delays in seeking healthcare (AOR = 5.323 [95% CI 2.866–9.888]), reported slowness in movement (AOR = 9.802 [95% CI 4.005–23.993]), and held an optimistic attitude toward health (AOR = 3.038 [95% CI 1.039–8.884]) were more likely to use IHS. Although a high school qualification was initially a significant predictor of IHS use, its effect became statistically insignificant after adjusting for other variables in the multivariate model (Table 2). The multivariate model explained 30.9% of the total variance (R^2).

Table 2
Predictors of IHS use: Results of the multivariate logistic model (n = 560)

Predictor	Total	IHS use							
	(N = 560)	N	%	Unadj. OR	*p*	Adjusted OR	95% Confidence Interval		*p*
Predisposing factor									
Gender									
Female (Reference)	300	49	16.3						
Male	260	47	18.1	1.130	0.585	0.994	0.543	1.819	0.984
Age (Years)									
≥70 (Reference)	46	6	13.0						
(60–69)	115	13	11.3	1.177	0.758	0.746	0.174	3.205	0.694
(50–59)	399	77	19.3	1.595	0.306	4.975	1.224	19.608	0.025*
Marital status									
Others (Reference)	81	12	14.8						
Married	479	84	17.5	1.223	0.548	1.247	0.479	3.246	0.651
Enabling factor									
Residency									
Rural (Reference)	136	3	2.2						
Urban	424	93	21.9	12.456	< 0.001***	6.056	1.689	21.713	0.006**
Educational attainment									
Without high school qualification (Reference)	286	20	7						
With high school qualification	274	76	27.7	5.105	< 0.001***	1.431	0.676	3.027	0.349
Level of income (Yuan)									

*Note. *p < 0.05; **p < 0.01; ***p < 0.001*

Predictor	Total	IHS use							
	(N = 560)	N	%	Unadj. OR	*p*	Adjusted OR	95% Confidence Interval		*p*
Low (5000) (Reference)	342	21	6.1						
High (≥ 5000)	218	75	34.4	8.017	< 0.001***	3.862	1.822	8.186	< 0.001***
Family support									
Low (Reference)	86	9	10.5						
High	474	100	21.1	5.410	0.100	8.260	0.855	79.771	0.068
Social support									
Low (Reference)	100	18	18						
High	460	91	19.8	0.780	0.374	1.394	0.618	3.144	0.424
Enabling factor									
Self-rated health									
Poor (Reference)	45	7	15.6						
Good	515	89	17.3	1.134	0.768	1.179	0.331	4.201	0.799
Chronic condition									
No (Reference)	181	6	3.3						
Yes	379	90	23.7	9.083	< 0.001***	5.323	2.866	9.888	< 0.001***
Multiple chronic conditions									
No (Reference)	490	83	16.9						
Yes	70	13	18.6	1.118	0.735	0.410	0.156	1.080	0.071
Delay in seeking health care									
No (Reference)	384	32	8.3						

*Note. *p < 0.05; **p < 0.01; ***p < 0.001*

Predictor	Total	IHS use							
	(N = 560)	N	%	Unadj. OR	*p*	Adjusted OR	95% Confidence Interval		*p*
Yes	176	64	36.4	6.286	< 0.001***	5.323	2.866	9.888	< 0.001***
Sleep quality									
Poor (Reference)	115	20	17.4						
Good	445	76	17.1	0.978	0.937	1.574	0.698	3.549	0.274
Slowness in movement									
No (Reference)	475	61	12.8						
Yes	85	35	41.2	4.751	< 0.001***	9.802	4.005	23.993	< 0.001***
Optimistic attitudes toward health									
Low (Reference)	74	7	9.5						
High	486	89	18.3	2.146	0.065	3.038	1.039	8.884	0.042*

*Note. *p < 0.05; **p < 0.01; ***p < 0.001*

3.3 Reasons and barriers in using IHS

Among the 96 respondents who used IHS, 38.54% sought online consultations, 30.21% purchased medications online, 29.17% booked medical appointments online, and 28.13% used IHS for querying medical information (Table 3)

Table 3
Reasons for Using IHS by Respondents (n = 96)

Reasons for Using IHS	N	%
Online consultations	37	38.54
Purchasing medicines online	29	30.21
Online medical appointments	28	29.17
Querying medical information	27	28.13
Engaging in remote treatment	10	10.42
Receiving electronic prescriptions	7	7.29
Utilizing wearable medical devices	6	6.25
Establishing electronic medical records	4	4.17
Other	1	1.04
Note. Multiple responses were allowed.		

Respondents also reported several barriers that limited their effective use of IHS, including distrust of IHS (37.5%), ambiguity in symptom self-descriptions (27.08%), long waiting times for online responses (16.67%), navigation difficulties (16.67%), and lack of continuity in online care (13.54%) (Table 4).

Table 4
Barriers to IHS Use by Respondents (n = 96)

Barriers in using IHS	N	%
Distrust of IHS	36	37.50
Ambiguity in symptom self-descriptions	26	27.08
Long waiting times for online responses	16	16.67
Navigation difficulties	16	16.67
Lack of continuity in online care	13	13.54
Concerns about privacy breaches	12	12.50
Lack of standardized online billing	12	12.50
Other	5	5.21
Note. Multiple responses were allowed.		

4. Discussion

This study explored the prevalence and predictors of IHS use among middle-aged and older adults in China, as well as the reasons for and barriers to its adoption. Our findings address the research questions posed in

the study objectives, and the following discussion interprets these results and explores their implications for improving digital healthcare delivery among aging populations.

4.1. Utilization of Internet-Based Healthcare Services

The study showed among the 560 responses, only 17.14% reported using IHS within the past year. This rate is lower than that reported in the United States (23.9%) [23], but higher than in Germany (5.7%) [24]. These differences may reflect varying levels of digital infrastructure, health policy implementation, and population readiness for digital health across countries.

Increasingly, IHS is recognized as a valuable complement to conventional healthcare, particularly in regions with limited medical resources. For instance, Afghanistan has effectively leveraged IHS to reduce unnecessary hospital visits and alleviate pressure on overburdened facilities [25].

4.2. Predictors of Internet-Based Healthcare Service Usage

Our study identified several predictors of IHS use, categorized into predisposing (age), enabling (residency, income), and needs (chronic conditions, delay in seeking healthcare, slowness in movement, optimistic attitudes toward health) factors. The decision to adopt IHS is not only driven by the urgency of healthcare needs, individual health risk assessments, but is also deeply influenced by structural inequities, such as urban-rural disparities and income-related barriers within the broader social and healthcare environment.

Age-Related Disparities

Participants aged 50–59 years were more likely to use IHS compared to those aged 70 and older. This age gradient may reflect a persistent generational digital divide, in which older adults face greater challenges in adopting new technologies. Age-related cognitive declines, such as slower processing speed and memory limitations, may hinder digital literacy development [26]. In addition, older adults may favor traditional face-to-face consultations due to ingrained cultural preferences and established healthcare-seeking behaviors [27]. In contrast, middle-aged adults are more likely to be employed and have higher educational attainment, which increases exposure to and acceptance of digital services.

To address this disparity, tailored interventions are necessary. Community-based digital literacy programs, co-designed with older adults, can help build confidence and competence in using IHS. Moreover, hybrid models —combining online services with in-person support—may accommodate user preferences while promoting gradual digital integration.

Urban-Rural and Socioeconomic Disparities

Urban residents and individuals with higher incomes were more likely to use IHS, echoing findings from previous studies [28]. Urban populations tend to have greater access to health information and services, as well as higher levels of health literacy and engagement in preventive care behaviors [29]. Conversely, rural residents may have limited awareness of IHS or may not perceive its added value, particularly when local clinics adequately meet basic healthcare needs. In addition, lower-income individuals may also be deterred by concerns about out-of-pocket costs associated with IHS.

To mitigate these barriers, targeted health promotion campaigns in rural areas could raise awareness about the benefits of IHS. Expanding health insurance coverage to include a wider range of IHS services could also reduce financial burdens and incentivize use among low-income populations.

Chronic Conditions and Need-Based Predictors

Participants with chronic illnesses such as cardiovascular or metabolic diseases were more likely to use IHS, consistent with prior research indicating that IHS facilitates chronic disease management [30]. Its convenience and remote accessibility make it especially suitable for individuals facing mobility challenges or living far from healthcare facilities. Furthermore, respondents with more optimistic views about their health were also more likely to engage with IHS, echoing findings that proactive attitudes contribute to digital health adoption [31]. To encourage broader IHS use, educational initiatives should emphasize its specific advantages —such as continuity of care, time-saving features, and suitability for managing long-term conditions.

4.3. Reasons and barriers in using Internet-Based Healthcare Service

Our findings align partially with prior research. For example, Pan et al. [32] explored the shift from offline to online health consultations in a Chinese sample during the post-pandemic period, reporting that online consultations and medicine purchases were the dominant functions driving digital healthcare adoption. Similarly, He et al. [33] analyzed a nationally representative sample of older US adults with multimorbidity, demonstrating that the use of digital health information and services was primarily focused on accessing online consultations. In addition, Bpharm et al. [34] based on a national survey of older adults in the United States, also emphasized the growing willingness to use video-based telehealth for clinical consultations.

Despite these promising trends, middle-aged and older adults still face several challenges when engaging with IHS. Our analysis categorizes these barriers into four major domains:

- **Trust and Privacy Concerns**: Persistent distrust in IHS and concerns over privacy breaches remain substantial deterrents. These concerns underscore the need for robust encryption systems, transparent data privacy policies, and mandatory industry certifications to foster user trust and ensure compliance with legal and ethical standards.
- **Communication Barriers in Online Consultations**: Participants reported ambiguity in symptom self-descriptions and experienced long wait times for online responses. Enhancing the structure of online consultations through the use of standardized symptom checklists and guided prompts may improve communication efficiency. Moreover, increasing the number of digitally trained healthcare professionals could boost the overall responsiveness and quality of virtual care.
- **System Functionality Issues**: Navigation difficulties and discontinuity of care suggest that current IHS platforms may not be sufficiently user-friendly for older adults. Enhancements such as simplified interfaces, larger fonts, intuitive navigation, and consistent care pathways are essential. In addition, system infrastructure should be upgraded to ensure stable connections and seamless user experiences.
- **Non-Standardized Billing Mechanisms**: A lack of unified billing protocols creates confusion and reduces system transparency. National-level guidelines that standardize billing formats and procedures could

help users better understand payment processes and reinforce confidence in online service systems.

4.4. Conclusion

This study explores the prevalence of IHS among the middle-aged and elderly in mainland China and identifies factors associated with its use. Only 17.14% of the participants reported using IHS. Factors such as age, geographic location, income, chronic health conditions, healthcare delays, mobility challenges, and positive attitudes toward health were key predictors of IHS use. Furthermore, users reported using IHS primarily for online consultations, medication purchases, and online medical appointments.

While IHS shows great potential for improving health management among middle-aged and older adults, addressing barriers such as distrust, lack of standardization, and user-unfriendliness must be addressed to enhance accessibility and effectiveness. As the healthcare landscape continues to evolve, future research should focus on creating a more equitable healthcare system, ensuring that everyone, regardless of age, income or geographic location, can benefit from healthcare technology in the digital age.

4.5. Limitations

This study has several limitations. First, the sample was recruited via an online survey platform, which may introduce self-selection bias and limit the representation of older adults, particularly those with limited internet access, thus potentially overestimating the utilization rate of internet healthcare among older adults. Second, the cross-sectional design captures data at a single time point, preventing the tracking of changes in IHS usage or the establishment of causal relationships. Finally, the questionnaire used in this study was developed by our own research team. Although we tested the reliability and validity of the questionnaire, further validation of the questionnaire is needed. Future studies employing longitudinal designs and diverse sampling methods are recommended to address these limitations.

Abbreviations

IHS Internet-based healthcare services

AOR Adjusted odds ratio

CI Confidence interval

Declarations

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Authors' contributions

YH and CL took overall responsibility for the study design, coordination of the survey, provided guidance on data collection, data analyses and manuscript preparation. ZW, PY, and ZY contributed to manuscript

drafting. QR, ZY, and YM were involved in data collection, data analysis and literature review. CC participated participated in data collection and manuscript revisions.

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Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available due to participant confidentiality and data protection regulations but are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This work was approved by the Research Ethics Committee of Harbin Medical University (IRB code HMUIRB20200004), ensuring strict adherence to ethical standards throughout the study. Informed consent was obtained from all participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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