Postprint: Factors Influencing Accessibility of Health Information Services for Older Adults in Digital-Intelligence Environments

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Abstract

[Purpose/Significance] Exploring the accessibility of health information services for the elderly in the digital-intelligence environment can provide effective support for the construction of an age-friendly society, and investigating its influencing factors and relationships is of significant importance. [Method/Process] Based on information ecology theory, influencing factors were extracted from four dimensions: information, information user, information environment, and information technology. The Decision-Making Trial and Evaluation Laboratory (DEMATEL) method was employed to identify key influencing factors, and the Interpretive Structural Modeling (ISM) method was used to determine the hierarchical structure and relational pathways of these key factors. [Results/Conclusion] The results indicate that four root factors—data storage technology, information coordination and sharing, policies and regulations, and communication infrastructure—and two surface-level factors—demand compatibility and service stability—have significant impacts on accessibility improvement. Consequently, recommendations are proposed for optimizing health information resource allocation, guiding the development of age-appropriate services, and improving infrastructure construction.

Full Text

Preamble

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Research on Factors Influencing the Accessibility of Health Information Services for the Elderly in a Digital Intelligence Environment
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Abstract

[**Purpose/Significance**] Exploring the accessibility of health information services for the elderly in the digital intelligence environment can provide effective support for building an age-friendly society, and investigating its influencing factors and relationships holds significant importance. [**Method/Process**] Based on information ecology theory, influencing factors were extracted from four dimensions: information, information actors, information environment, and information technology. The Decision-Making Trial and Evaluation Laboratory (DEMATEL) method was employed to identify key influencing factors, while the Interpretive Structural Modeling (ISM) method was used to determine the hierarchical structure and association paths of these critical factors. [**Result/Conclusion**] The results indicate that four root factors—data storage technology, information coordination and sharing, policies and regulations, and communication infrastructure—and two surface factors—demand fit and service stability—have important impacts on enhancing accessibility. Accordingly, recommendations are proposed to optimize health information resource allocation, guide the development of age-appropriate services, and improve infrastructure construction.

Keywords: digital intelligence environment; health information services for the elderly; accessibility; influencing factor research; DEMATEL-ISM
Classification Number: G252

Introduction

In recent years, new-generation technological thinking and applications, represented by big data and artificial intelligence, have driven the integration of digital governance and smart governance [1], endowing services with networked, digital, and intelligent characteristics. While these developments have brought health benefits to the elderly, they have also introduced new challenges, such as health information leakage, neglect of elderly-specific needs, and difficulties in obtaining, accepting, and adapting to digital intelligence-based health information services.

The transformation and upgrading of health information services for the elderly have created new opportunities. The "14th Five-Year Plan for National Healthy Aging" explicitly proposes strengthening the support of science, technology, and digital information for elderly health services, while the "Healthy China 2030" Planning Outline encourages and promotes the development of "Internet + Health and Medical Care." Social service entities such as medical institutions, communities, and public libraries have actively explored smart health information services for the elderly under technological and policy support, achieving certain results. However, based on these practical challenges, there is an urgent need for deep integration of technology and services to ensure that services can be accessed and enjoyed fairly by the elderly, improve the alignment between services and elderly health needs, and effectively enhance the accessibility of health

information services for the elderly in the digital intelligence environment.

Therefore, this study aims to comprehensively identify the factors influencing the accessibility of health information services in the digital intelligence environment, identify key factors among these complex influences, and reveal their mechanisms of action, thereby providing theoretical insights for addressing accessibility issues for the elderly.

Literature Review

Health Information Services Research

Health information services refer to activities that utilize various technical means to process, integrate, and use health information resources to meet health information needs, thereby changing residents' health behaviors and improving health awareness levels [2]. In the digital intelligence environment, technical means such as big data, artificial intelligence, the Internet of Things, and mass media are applied to health information services, making them digital, networked, and intelligent. The social environment in which health information services operate has changed, with intelligent services becoming a new development direction [3].

Current research on health information services in the digital intelligence environment mainly focuses on user information behavior and supply methods. First, studies on health information behavior include health information needs, usage intentions, and utilization patterns. For instance, Qian Xingyu et al. used data mining methods to identify that elderly online health community users' information needs mainly fall into four categories: traditional Chinese medicine health principles and methods, lifestyle adjustments, disease prevention and aging response, and food nutritional value and efficacy [4]; Wu Jiang et al. explored influencing factors of online health community users' information service usage intentions based on perceived value theory [5]; and Gao Bingjie et al. divided elderly online health information behavior processes into need, adoption, search, use, and sharing stages, summarizing influencing factors for each type of behavior from personal, environmental, content, and technological perspectives [6].

Second, research on supply methods includes service model construction and service system studies. Zhai Xing proposed a theoretical framework for a smart health information service system encompassing service subjects, operation modes, service processes, and service resources based on the basic characteristics of smart health information services [3]; Xu Xiaoting used semi-structured interviews to explore elderly groups' health information needs, constructing a smart community collaborative health information service model [2]; and Tang Huilan et al. built a network health information precision service model including personalized customization, information push, and personalized interaction services based on summarizing mainstream network health information service models [7].

Accessibility Research

Currently, there are two main perspectives on the conceptual connotation of "accessibility": "service utilization" and "fitness." The former was first proposed by R. Anderson when studying citizens' access to medical services, defining accessibility as the possibility of using health services [8]. The latter was proposed by R. Penchansky and J. W. Thomas, arguing that the essential connotation of accessibility is the degree of fit between customers and the system [9]. Given that strengthening health information services is an important way to improve national health levels and concerns people' s right to life and health, there exists a "fitness" problem within services between supply and public demand and characteristics [10]. Therefore, this study defines the accessibility of health information services for the elderly from a fitness perspective: whether health information services can be fully, conveniently, and fairly obtained by the elderly, and whether they can meet the health needs of the elderly.

Current accessibility research from the fitness perspective mainly focuses on medical and health services, public cultural services, and educational services, with limited research in the health information service field. Related studies primarily examine satisfaction and equity of health information services from a service utilization perspective. Yan Zejin [11] explored information, information actor, and information environment factors affecting the effective supply of health information services from the supply side, providing insights for improving effectiveness and precision; Zhao Dongxiang et al. [12] found that personal and social support factors hinder the elderly from obtaining health information, leading to inequitable use of health information services. Additionally, some studies seek reasons for differential health information behaviors during service use, such as factors influencing users' health information disclosure, acquisition, adoption, and sharing.

In summary, although existing research has extensively studied health information services from multiple perspectives, several issues remain: (1) In the current digital intelligence environment, the means and methods of health information services have undergone new changes. The application of data mining and intelligent sensing technologies has made proactive service models a new trend, yet most research remains focused on passive service models, with insufficient attention to service acquisition, use, and adaptation in the digital intelligence environment and to elderly user groups. (2) Existing accessibility research primarily focuses on service utilization, emphasizing satisfaction and equalization issues, equating accessibility with concepts like satisfaction and equalization, and paying insufficient attention to the basic theoretical research on accessibility. To ensure equal supply of health information services and improve public satisfaction and sense of gain, basic issues should receive greater attention.

Theoretical Framework

Characteristics of Health Information Services for the Elderly in the Digital Intelligence Environment

With the advent of the digital intelligence era, health information services for the elderly are developing toward intelligence, digitalization, and networking. Based on smart concepts and intelligent technologies, building health information service models for the elderly group to meet their diverse and heterogeneous needs has new characteristics distinct from traditional service models:

(1) Age-Appropriate Service Content. Research shows that due to physiological aging and functional decline, the elderly have stronger health information needs than other groups, requiring richer quantities and types of health information. They have significant information needs in medical care, physical activity, psychology, nutrition, safety, and health education, requiring a "big health" model to achieve demand satisfaction [13]. Digital intelligence technology provides realistic conditions for this requirement, changing the content of original health information services through efficient integration of health information resources. Services have transformed from simply providing health consultation and education to smart services guided by smart service concepts and supported by big data and artificial intelligence, such as automatic user need perception, disease risk early warning, intelligent health diagnosis, and precise health information recommendation [3]. Through technology empowerment, humanistic care for the elderly group is achieved.

(2) Diversified Service Subjects. Health information services for the elderly are highly targeted and professionally demanding, making it impossible for a single subject to provide high-quality services [14]. From a service quality perspective, the supply of health information service content is often jointly achieved by multiple service subjects. Common elderly health information service subjects include social organizations, communities, medical institutions, libraries, commercial institutions, and public health departments. Collaboration among subjects is key to achieving high-quality health information services, and digital intelligence technology provides a foundation for multi-subject cooperation. Big data and artificial intelligence technologies promote information resource flow among multiple subjects, enhancing information synergy efficiency and gradually forming a "joint response, collaborative supply" service mechanism [2].

(3) Intelligent Service Methods. In the digital intelligence technology-driven elderly health information service model, the elderly are no longer "passive recipients" of services but "active builders." Through service and information technologies, service providers can quickly and accurately grasp demand information, ultimately achieving precise and timely service matching and transforming service content from "homogeneous and fixed" to "context-adaptive" [15]. Digital intelligence environment health information services aim for real-time, precise, perceptive, personalized, and diversified services. During service processes, multiple terminals and demand mining technologies dynamically col-

lect user demand information, organize and aggregate massive, scattered supply and demand information, and process it through unified, convenient service platforms to provide elderly users with information services meeting diverse needs. Throughout the service process, achieving service goals requires reliance on health information service technologies such as user profiling, knowledge graphs, and machine learning [3].

Ecosystem Model of Accessibility for Elderly Health Information Services in the Digital Intelligence Environment

From a fitness perspective, accessibility elements include four dimensions: availability, approachability, acceptability, and adaptability. When these elements are orderly arranged and organically integrated, they significantly promote the realization of accessibility goals for elderly health information services [16]. The integration and sequencing of elements require support from external environments such as policies, regulations, management mechanisms, infrastructure, and usage environments, relying on intelligent service platforms embedded with information technology to organize, coordinate various information resources, and achieve dynamic cycles of demand identification, resource allocation, supply-demand matching, and effect feedback to ensure precise fitness among service participants. In this dynamic cycle system for accessibility realization, information resources, information actors, information environment, and information technology have interdependent, symbiotic relationships, and the absence of any element may cause system imbalance, which aligns with the core ideas of information ecology theory. Therefore, based on information ecology theory, this study constructs an accessibility ecosystem for elderly health information services in the digital intelligence environment from four dimensions: information, information actors, information environment, and information technology, as shown in Figure 1 [Figure 1: see original paper].

Influencing Factor System for Accessibility of Elderly Health Information Services

The accessibility ecosystem comprehensively and scientifically summarizes the accessibility realization process, reveals the symbiotic mechanism among various elements in the accessibility realization system, and provides an important theoretical foundation for constructing the influencing factor system. Based on this ecosystem and through literature review, this study constructs an initial influencing factor system for accessibility of elderly health information services.

Information Resources Health information resources specifically refer to personal health information and literature information stored in digital form [3]. Personal health information includes various health behavior information and health record information carrying personal health needs. Literature information mainly includes service information stored in medical databases and websites, such as health care knowledge, medical literature, and clinical cases.

Due to significant differences in education level, economic status, and age within the elderly group, health information needs present diverse characteristics [17], placing high demands on the quantity and types of information resources. In the digital intelligence environment, literature information sources are complex and voluminous, while elderly users, constrained by professional literacy and knowledge acquisition skills, cannot distinguish the authenticity of health information or reasonably use online health resources to meet their needs [18]. Therefore, only by meeting accuracy requirements and automatically filtering false information can precise and convenient services be provided to elderly users. For sustainable development, health information services must continuously adjust their service information according to changing user needs, maintaining good timeliness [3]. Issues such as information overload and uneven information quality hinder elderly users' utilization of health information services, requiring information organization and provision methods to be designed according to elderly digital habits for simple and convenient access [2]. With low digital health literacy, the elderly struggle to select appropriate information from large amounts of health data, necessitating that health service providers accurately identify and match user demand information to achieve the goal of health information serving needs. Related indicators under the information dimension are shown in Table 1 .

Information Actors Health information actors refer to people with participation attributes in health information services, divided into health information service personnel and service objects according to different degrees of service demand and utilization. Health information service personnel mainly refer to staff providing health information service products [3]. During service provision, platform staff' s attitude, ability, and personal characteristics may affect user cognition and decision-making [7]. With generally low digital health literacy among the elderly, technical support from service personnel can increase elderly users' opportunities to access and use digital intelligence devices, enhance their cognition of health information services, and reduce anxiety and rejection [22]. Affected by cognitive decline and insufficient digital experience, the elderly have low perceived credibility of health information services, seriously impacting their enthusiasm for using services to improve health levels. This requires service providers to ensure service reliability and authority [23], guaranteeing that elderly users can obtain high-quality services regardless of personal factors. Service reliability is the foundation of usefulness. To enhance service adaptability and better meet personalized health needs, service platforms must fully integrate supply and demand information resources, build health information databases and user demand databases, and help elderly users obtain useful information promptly [7].

Health information service objects refer to users with health information needs [3]. Due to physical and psychological aging, the elderly have more urgent health information needs than younger people. However, difficulties in adopting, using, and accepting services in real life mean that elderly health information needs

cannot be met, which is closely related to elderly users' own factors. At the personal willingness level, when elderly individuals recognize the importance of health management and discover their necessary health needs, they become more willing to express their health information needs and seek health information services to improve their health levels [4]. Regarding personal capability, individual health information literacy—the ability to obtain and utilize health information to meet health needs—affects perceptions of service usefulness and ease of use, determining the degree to which health information needs are satisfied [24]. Self-efficacy has a direct impact on elderly users' health information usage behaviors; successful experience in using health information services builds confidence in their usage abilities, fostering recognition and positive attitudes toward services that positively influence adoption and use [25]. Related indicators under the information actor dimension are shown in Table 2 .

Information Environment The information environment can be divided into internal and external environments. The internal environment mainly refers to the service usage environment based on the service platform. The service system should fully integrate multi-source heterogeneous health information resources to build a comprehensive and stable service platform that meets users' personalized and diversified health information needs [3]. Simultaneously, a strong information security guarantee mechanism should be established within the system to reduce privacy leakage and online fraud risks in elderly digital life, protecting users' vital interests and alleviating anxiety about digital security [22].

The external environment refers to the environment faced by health information services. Due to historical reasons, health and medical data have long been in a state of non-unified and non-standardized data standards, with severe data silo phenomena. The government urgently needs to take the lead in unified organization and management of data, storing personal health information in a unified form and achieving information openness and sharing among different service subjects to enhance the intrinsic value of personal health information and improve personal health levels [30]. Additionally, the absence of systems and regulations has led to a lack of unified standards for health information service development, with uneven service quality and quantity struggling to keep pace with China' s aging development speed. Therefore, the government urgently needs to introduce relevant policies and regulations to guide high-speed, high-quality development of health information services. In the precise supply process of health information services, large amounts of image, video, and audio data need to be transmitted and processed, making communication infrastructure construction levels, represented by 5G signal coverage and network transmission quality, important factors affecting health information service quality. Related indicators under the information environment dimension are shown in Table 3 .

Information Technology Information technology is the foundation and means for achieving precise, intelligent, and real-time health information

services. From the service realization process, the following technical supports are needed: First, through automatic perception technology to automatically collect user demand information. Then, combined with data mining technology, deeply excavate user characteristics and behavior patterns to provide targeted service content. Finally, users provide feedback on services, and the service side begins a new round of collection, mining, and analysis. These technologies need to be implemented through specific information service platforms, where users express needs and obtain services through interactive interfaces. For the elderly, developing interactive platforms that match their group characteristics—such as simplifying service processes, setting up necessary offline service channels, and designing clear interfaces—can effectively avoid excessive cognitive burden and reduce self-efficacy issues [22]. Furthermore, in the big data environment, health data resources are widely distributed and diverse. Structuring, systematizing, and standardizing scattered, massive, and disordered health data and converting them into uniformly formatted data stored in data center cloud platforms are prerequisites and foundations for achieving health information services [18]. Related indicators under the information technology dimension are shown in Table 4 .

Determination of Influencing Factors

Based on the preliminary influencing factors identified above, expert surveys were used for final determination. Through email invitations, social media communication, and face-to-face meetings, 12 experts were invited to rate the impact degree of each factor on the accessibility of elderly health information services in the digital intelligence environment using a five-level scale (1-5 points representing "no impact" to "very large impact"). The 12 experts came from health medical services, information services, and smart city fields, possessing relevant knowledge reserves or practical experience for this research problem. The rating results showed that the average score of each factor was above 3.0. Therefore, the above 20 influencing factors were finally determined as the influencing factor system for accessibility of elderly health information services in the digital intelligence environment.

Research Methodology

DEMATEL-ISM Method

Interpretive Structural Modeling (ISM) is one of the qualitative and quantitative methods commonly used for complex system structure analysis, while Decision-Making Trial and Evaluation Laboratory (DEMATEL) is also an important method for complex system analysis and decision-making [34]. Due to their commonalities—both can express the transitivity of influence relationships through models and reflect expert opinions through matrices—the combined use of these two methods has been widely applied in various studies. Therefore, this study uses the DEMATEL method to analyze the relationships among influencing factors of accessibility of elderly health information services in the

digital intelligence environment, identify key influencing factors, and employs the ISM method to obtain a multi-level hierarchical structure model of accessibility influencing factors, laying a theoretical foundation for in-depth research on accessibility of elderly health information services.

Direct Influence Matrix Based on the above 20 accessibility influencing factors, a matrix scale was developed and distributed to 15 experts and scholars with work or research experience in health medical services, information services, and smart city fields. The experts scored the relationships between accessibility influencing factors using a five-level scale (strong relationship = 4, relatively strong = 3, medium = 2, weak = 1, none = 0) to reflect direct influence relationships. The scores from the 15 experts were arithmetically averaged to construct the direct influence matrix A(aij)n×n, where aij represents the influence of factor Fi on factor Fj.

Comprehensive Influence Matrix (1) Calculation of Standardized Influence Matrix B. Based on formula (1), matrix A was transformed into standardized influence matrix B:

$$B = \frac{1}{\max_{1 \le i \le n} \sum_{j=1}^{n} a_{ij}} \cdot A$$

(2) Calculation of Comprehensive Influence Relationship Matrix T. Based on formula (2), matrix calculations were performed using MATLAB software to obtain comprehensive influence matrix T, with results shown in Table 5 . Where I is the identity matrix (value 1 on the diagonal, 0 elsewhere).

$$T = B(I - B)^{-1}$$

Cause-Result Diagram The influence degree (D) and influenced degree (C) of each element were obtained by summing rows and columns of comprehensive influence matrix T, respectively. The centrality (D+C) and causality (D-C) were then calculated by summing and differencing these values. The ranking results are shown in Table 6 , and the cause-result diagram was drawn accordingly (see Figure 2 [Figure 2: see original paper]).

Figure 2 shows that factors in the first quadrant—C15 Information Coordination and Sharing, C7 Technical Support Degree, and C8 Service Usefulness—have high centrality and causality, playing important driving roles in accessibility of elderly health information services. Factors in the second quadrant—C17 Communication Infrastructure, C16 Policies and Regulations, C20 Data Storage Technology, C18 Health Information Service Technology, C14 Service Security, C9 Health Information Literacy, and C6 Service Reliability—have relatively low centrality but high causality, strongly influencing other factors and representing key factors for achieving accessibility. Factors in the third quadrant—C1

Information Richness, C2 Information Accuracy, C10 Health Needs, and C11 Self-Efficacy—rank low in both centrality and causality, having relatively minor impacts on accessibility realization and belonging to relatively independent factors. Factors in the fourth quadrant—C3 Information Timeliness, C4 Demand Fit, C5 Information Accessibility, C13 Service Stability, C19 Age-Appropriate Platform Construction, and C12 Service Perfection—have high centrality but are easily influenced by other factors, representing key factors for achieving accessibility.

Inspired by Yuan Hong et al. [35], this study further analyzed the 16 key influencing factors located in the first, second, and fourth quadrants of the cause-result diagram to clarify relationships among these factors.

Reachability Matrix (1) Calculation of Overall Influence Matrix H. The 16 key influencing factors were retained from comprehensive influence matrix T to establish matrix T . Based on formula (3), overall influence matrix H was calculated:

$$H = T' + I$$

(2) Calculation of Reachability Matrix K. Based on formula (4), reachability matrix K was obtained (see Table 7). Where hij is the element in row i and column j of overall influence matrix H; kij = 1 indicates hi has direct influence on hj; kij = 0 indicates no direct influence; λ is the threshold for removing redundant information from the overall influence matrix. After multiple rounds of expert discussion, the threshold λ was set at 0.14, which can filter weaker influence relationships, simplify system structure, and make the multi-level hierarchical structure clearer.

$$k_{ij} = \begin{cases} 1, & \text{if } h_{ij} \geq \lambda \\ 0, & \text{if } h_{ij} < \lambda \end{cases}$$

Multi-Level Hierarchical Interpretive Structural Model Through layer-by-layer processing of the reachability matrix, the reachable set, antecedent set, and common set were obtained. The reachable set includes elements with value 1 in row i of the reachability matrix; the antecedent set includes elements with value 1 in column i. If the condition is satisfied, the element is identified as the highest-level factor. After extraction, the corresponding row and column are deleted, and the operation is repeated for remaining factors to hierarchically classify all elements. The final hierarchical classification is as follows: Level 1: C4, C13; Level 2: C3, C5, C14; Level 3: C9, C12, C19; Level 4: C6, C7, C8, C18; Level 5: C15, C16, C17, C20. This yields the multi-level hierarchical interpretive structural model for accessibility of elderly health information services in the digital intelligence environment, comprising five layers: surface factors (L1), middle factors (L2, L3), deep

factors (L4), and root causes (L5), as shown in Figure 3 [Figure 3: see original paper].

Conclusion and Recommendations

Surface factors are the most direct influences on accessibility, including demand fit and service stability. In the digital intelligence environment, massive information resources are stored digitally in different information management systems. Only when services actively pay attention to and respond to changes in elderly health information needs, providing precise and personalized health information services that meet deep health needs, can elderly users' value perception of services be enhanced. Additionally, stable platform operation is an important manifestation of health information service levels. If internal functions are missing and operational guarantees are insufficient, service utilization effectiveness and efficiency may be reduced, affecting user acceptance.

Middle factors are influenced by deep factors and influence surface factors, playing an indirect but non-negligible role in accessibility. These roughly include elements related to information quality, platform construction, and personal literacy. Research shows that elderly health information behavior is affected by perceived ease of use, perceived usefulness, and perceived cost [6]. By building mature service platforms embedded with artificial intelligence and big data technology to dynamically collect elderly demand information and provide timely services in ways acceptable to the elderly, and by establishing relevant security guarantee mechanisms during service processes to eliminate usage concerns, positive cognition of health information services can be formed. Furthermore, user health information literacy—the ability to search for, use, and evaluate health information—when insufficient, can cause information overload, preventing users from obtaining needed information and negatively affecting health decision-making.

Deep factors mainly include service reliability, service usefulness, technical support degree, and health information service technology. These are key factors for achieving accessibility in the digital intelligence environment. Using health information service technology to fully integrate large amounts of heterogeneous and scattered information resources is the prerequisite for providing precise health information services that meet personalized needs [7]. Semantic recognition technology should be used to collect demand data to form user profiles, aggregating health knowledge scattered across medical databases, literature databases, and media service platforms to achieve semantic matching between user needs and knowledge services based on supply and demand data resources [18]. Additionally, service provider characteristics affect user experience and feelings. Due to the professional nature of health information services and the elderly group' s insufficient health information literacy and limited ability to distinguish conflicting or false information, patient guidance and professional support from relevant staff are needed to enable convenient and fair access to health information services.

Root factors are the deepest influences on accessibility of elderly health information services, playing a dominant role. These include information coordination and sharing, policies and regulations, communication infrastructure, and data storage technology. The four root factors correspond to three major drivers for accessibility realization: policy support, technological innovation, and infrastructure improvement. In recent years, society has attached great importance to the development of health information services in the digital intelligence environment, achieving certain results. However, overall development remains in its infancy, with unbalanced and insufficient development, insufficient concern for the elderly group in a disadvantaged position in digital application, and development speed and quality still struggling to meet the diverse health needs of the elderly. As the backbone of national health service construction, the government plays an irreplaceable role in improving health information service quality. On one hand, policies and regulations need to play a "top-down" role, encouraging and guiding high-quality, high-speed service development and promoting fair social resource supply while considering elderly needs. On the other hand, network communication infrastructure construction needs strengthening to guarantee network transmission speed and coverage, ensuring unrestricted service access by time and location and providing a stable and reliable external environment for remote medical service supply. Additionally, health data characteristics of being massive, heterogeneous, and multi-source make acquisition, organization, processing, and matching of health information challenging [30]. To maximize health information value, heterogeneous, multi-source, and scattered health information must be stored in unified formats through unified standards and norms to ensure effective acquisition and utilization, thereby achieving the goal of meeting user needs.

Recommendations

Middle factors only play a "transitional role" with poor control effects. Surface factors, as direct influencing factors, have immediate effects on accessibility improvement, while root factors exert important and fundamental influences on other factors, enabling fundamental accessibility improvement [35]. Therefore, combining hierarchical division results, recommendations are proposed from three aspects:

(1) Optimize Health Information Resource Allocation to Achieve Effective Supply-Demand Matching. Research results show that demand fit has the strongest promoting effect on accessibility. Information coordination and sharing and data storage technology are foundational factors affecting accessibility, indicating that integrating, opening, and sharing health information resources are key to improving service accessibility. Top-level design should be strengthened to build a unified standard system for dynamic health data collection. Personal health data' s intrinsic value should be emphasized, with strengthened security governance and precise assessment and identification of user needs based on personal health data to provide targeted health products

or services, forming a service system meeting elderly lifecycle needs.

(2) Guide Age-Appropriate Service Construction to Promote Service Equalization. Social technical support significantly influences accessibility by affecting service platform characteristics. Policies and regulations have the largest absolute causality value, exerting a critical influence on accessibility formation. Therefore, the unique role of policies should be leveraged to encourage and guide market entities to participate in the research, development, and production of smart health information services for the elderly, strengthening the integration of advanced information technology with age-appropriate health information services to provide comprehensive and humanized smart health information services for the elderly.

(3) Improve Infrastructure Construction to Enhance Service Stability. Infrastructure construction strongly influences accessibility, while service stability directly affects accessibility. Therefore, infrastructure construction should be improved to ensure rapid information transmission among people, people and things, and things and things, achieving anytime-anywhere access and full-demand coverage of elderly health information services.

Limitations and Future Research

This study constructs an influencing factor system for accessibility of elderly health information services based on information ecology theory, uses the DEMATEL method to determine factor importance, screens 16 key influencing factors, and further explores hierarchical structures and transmission paths among factors using the ISM method, systematically revealing the formation mechanism of key factors and providing a scientific basis for empirical research and practical exploration. However, limitations exist: current research results on accessibility of elderly health information services in the digital intelligence environment are limited, resulting in a restricted number of referenceable literature during research. Some important influencing factors may have been omitted during factor selection. Future research can obtain more valuable original data through qualitative research methods such as semi-structured interviews to improve the accessibility indicator system for elderly health information services in the digital intelligence environment.

References

[1] Sun Jianjun, Li Yang, Pei Lei. Reflections on the transformation of library and information science in the "digital intelligence"empowerment era[J]. Library and Information Science Knowledge, 2020(3): 22-27.

[2] Xu Xiaoting, Yang Mengqing, Zhu Qinghua. Construction of a smart community collaborative health information service model for the elderly group[J]. Library Forum, 2020, 40(12): 107-116.

[3] Zhai Xing, Xiao Yuan, Wang Ruojia, et al. Research on the construction of smart health information service system in the digital intelligence environment[J]. Information Science, 2022, 40(10): 43-50.

[4] Qian Yuxing, Zhou Huayang, Zhou Liqin, et al. Research on mining health information needs of elderly online community users[J]. Modern Information, 2019, 39(6): 59-69.

[5] Wu Jiang, Li Shanshan. Research on user information service usage intention in online health communities[J]. Information Science, 2017, 35(4): 119-125.

[6] Gao Bingjie, Zhang Ning. Research status and frontier prospects of elderly online health information behavior[J]. Library Science Research, 2020(6): 9-16, 77.

[7] Tang Huilan, Wen Tingxiao, Luo Aijing, et al. Research on network health information precision service model[J]. Modern Information, 2019, 39(7): 109-114, 127.

[8] ADAY L A, ANDERSEN R. A framework for the study of access to medical care[J]. Health services research, 1974, 9(3): 208-220.

[9] PENCHANSKY R, THOMAS J W. The concept of access: definition and relationship to consumer satisfaction[J]. Medical care, 1981, 19(2): 127-140.

[10] Wang Qian, Wu Licai. Research on accessibility evaluation of public cultural services: experience reference and framework construction[J]. Journal of Shanghai Administration Institute, 2015, 16(3): 53-59.

[11] Yan Zejin, Pan Yuting, Pang Chunmei. Influencing factors of public library health information service supply: application of interpretive structural modeling[J/OL]. Library Forum: 1-11[2023-02-24]. http://kns.cnki.net/kcms/detail/44.1306.G2.20221222.1009.005.html.

[12] Zhao Dongxiang, Ma Feicheng, Zhang Qiping. Phenomenological study on elderly health information seeking behavior[J]. Journal of Information Science, 2019, 38(12): 1320-1328.

[13] Sun Xinran, Sun Jinhai, Chen Lifu, et al. Characteristics of elderly health needs and health management countermeasures[J]. Chinese Journal of Gerontology, 2018, 38(21): 5275-5277.

[14] Liu Yiming, Yang Jinxian. Feasibility study on blockchain technology supporting precise health information services for the elderly[J]. Digital Library Forum, 2022(10): 56-61.

[15] Liu Yi, Li Xiaona. Comparative study and optimization path of community smart elderly care models in China's digital era[J]. E-Government, 2022(5): 112-124.

[16] Luo Juan. Process logic: realization mechanism of rural public cultural service accessibility under digital rural construction background[J]. Rural Econ-

omy, 2022(10): 82-90.

[17] Liu Yiming, Li Lu. Review of library health information services for the elderly[J]. Library and Information Service, 2021, 65(24): 123-134.

[18] Ma Haiyun, Cao Siyuan, Xue Xiang. Research on user demand-oriented health domain knowledge organization and service framework[J]. Information and Documentation Services, 2022, 43(2): 71-78.

[19] Li Jiao. Research on triple helix model and key influencing factors of public library health information services in new media environment[J]. Information Science, 2022, 40(9): 31-40.

[20] Liu Bing, Zhang Wenjue. Research on constructing network health information service quality evaluation system from user perspective[J]. Information Science, 2019, 37(12): 40-46.

[21] Zhang Min, Luo Meifen, Zhang Yan. Systematic review of mobile health user adoption behavior at home and abroad: knowledge base, influencing factors, and frontier prospects[J]. Modern Information, 2018, 38(8): 154-162.

[22] Dai Xinquan, Xiong Huixiang, Shen Shuyue, et al. Construction of digital immigrant health management service model facing "Healthy China 2030"[J/OL]. Library Forum: 1-11[2023-02-24]. http://kns.cnki.net/kcms/detail/44.1306.G2.20230112.1516.008.html.

[23] Li Huafeng, Sun Xiaoning, Yuan Qinjian. Review of elderly online information seeking behavior research[J]. Library and Information Science Knowledge, 2021(2): 79-87.

[24] Zhang Min, Liu Xuerui, Zhang Yan. Conceptual model of online health community users' diagnosis and treatment information help-seeking behavior formation mechanism: exploratory research based on grounded theory[J]. Information Science, 2019, 37(4): 22-28.

[25] Liu Yan, Zhang Haitao, Li Jiawei, et al. Research on influencing factors of elderly users' online health information seeking behavior from mobile terminal perspective[J]. Library and Information Service, 2021, 65(11): 46-54.

[26] Deng Chaohua, Hong Ziying. Empirical research on influencing factors of doctor-patient trust in online medical health services[J]. Management Science, 2017, 30(1): 43-52.

[27] Du Peng, Han Wenting. Internet and elderly life: challenges and opportunities[J]. Population Research, 2021, 45(3): 3-16.

[28] BEAUNOYER E, DUPÉRÉ S, GUITTON M J. COVID-19 and digital inequalities: reciprocal impacts and mitigation strategies[J]. Computers in human behavior, 2020, 111: 106424.

[29] Huang Huanhuan, Cao Songmei, Xiao Mingzhao, et al. Descriptive qualitative study on community-dwelling elderly' s acceptance of gerontechnology and

influencing factors[J]. Journal of Nursing of Chinese People' s Liberation Army, 2021, 38(10): 4-7.

[30] Ma Feicheng, Zhou Liqin. Knowledge management and services for smart health[J]. Journal of Library Science in China, 2018, 44(5): 4-19.

[31] Zhao Yijun, Deng Dasong. Research on constructing smart elderly care service model driven by artificial intelligence[J]. Jianghuai Forum, 2021(2): 146-152.

[32] Wang Xiaohui, Xiang Yunhua. Research on smart elderly care service system[J]. Study and Practice, 2019(5): 88-97.

[33] Jiang Mingnan, Xue Xingqun, Yang Yi. Research on key influencing factors of online medical information service quality based on SVM[J]. Information Science, 2020, 38(3): 99-105.

[34] Xie Gang, Li Guoping. Research on gradient interpretation structural model in generalized gradient theory[J]. Systems Engineering, 2004(5): 1-6.

[35] Yuan Hong, Wang Tao. Identification and mechanism analysis of key influencing factors for sustainable development of government data opening[J]. Library and Information Service, 2022, 66(9): 4-15.

Note: Figure translations are in progress. See original paper for figures.