

Research on the Supply-Demand Matching Path for Personalized Smart Healthy Aging Services in Dalian under the Context of Integrated Medical and Elderly Care

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Abstract: Background: The aging process of China's population continues to intensify. Changes in family structures have rendered traditional elderly care models unsustainable, posing severe challenges to the national social governance system and public service capabilities. Against this backdrop, the national strategy has successively promoted "Integrated Medical and Elderly Care" and "Smart Eldercare," aiming to address the aging crisis through technological innovation and resource integration. Dalian, a coastal city in Northeast China characterized by a high degree of aging and relatively well-developed smart city infrastructure, represents a typical yet urgent case for exploring smart healthy aging solutions. Objective: This study aims to systematically analyze the supply structure of smart healthy aging services in Dalian and the current situation of the diversified, multi-level actual demands of the elderly population. It seeks to precisely identify the core issues of the current supply-demand mismatch and, based on this, construct a systematic implementation path and countermeasure framework to achieve precise supply-demand matching. Methods: This research comprehensively utilizes literature review and policy text analysis to analyze the macro background and local practices. Through theoretical deduction and typical case analysis, it defines the demand characteristics of the elderly population and the supply bottlenecks of services. Finally, it employs systems thinking methods for logical reasoning and theoretical model construction. Conclusion: This study is expected to conclude that the supply-demand mismatch in Dalian's smart healthy aging services is mainly manifested across three dimensions: content, technology, and information. The key to achieving precise matching lies in shifting from a "technology-driven" to a "demand-driven" approach, constructing a multi-level, multi-stakeholder collaborative path model centered on "Precise Identification - Precise Linking - Precise Provision - Precise Governance." This model can provide theoretical reference and practical action guidelines for Dalian and similar cities to optimize their smart eldercare service systems and enhance service efficacy.

Keywords: Dalian City; Integrated Medical and Elderly Care; Personalized Services; Smart Healthy Aging; Supply-Demand Matching

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1. Introduction

China's elderly population continues to grow, with trends towards advanced age and functional disability becoming increasingly pronounced, placing higher demands on the quality and structure of elderly care services. "Integrated Medical and Elderly Care," an innovative model integrating medical and elderly care resources, has become a crucial national strategy for addressing population aging. Concurrently, smart eldercare, leveraging information technologies such as the

Internet of Things (IoT), big data, and artificial intelligence (AI), provides technical support for intelligent and personalized elderly care services.

However, in practical implementation, a widespread mismatch persists between the supply of smart healthy aging services and the actual needs of the elderly. Dalian, as one of the cities entering population aging earlier, possesses a certain foundation in smart city construction. Nevertheless, its development of smart healthy aging faces challenges such as fragmented services, data silos, and insufficient age-friendly design. Therefore, systematically analyzing the supply and demand status of smart healthy aging services in Dalian and exploring its precise matching path holds significant theoretical value and can provide a replicable practical paradigm for similar cities.

2. Core concepts and theoretical foundation

2.1. Conceptual definitions

Integrated medical and elderly care refers to the provision of continuous, seamlessly integrated care services for the elderly by breaking down resource barriers between medical treatment and elderly care through institutional mechanism innovation and service integration ^[1].

Smart healthy aging involves the application of new-generation information technologies, such as the IoT, big data, and AI, to achieve the intelligent allocation of elderly care resources, precise management of service delivery processes, and efficient response to the needs of the elderly ^[2-3].

Personalized services emphasizes a shift from standardized, large-scale service provision towards individualized and customized service models. Its core lies in the precise identification of needs, accurate provision of services, and targeted allocation of resources.

2.2. Theoretical foundation

Precision governance theory emphasizes the use of informatization means to achieve fine-grained identification of governance objectives, precise allocation of resources, and accurate assessment of performance. It provides the core analytical framework for this study ^[4].

Collaborative governance theory posits that collaboration among multiple stakeholders—including the government, market entities, social organizations, communities, and families—is necessary to jointly enhance the suitability and effectiveness of public services. This theory is particularly applicable to cross-sectoral, multi-stakeholder service systems like smart healthy aging ^[5].

3. Current status and mismatch of supply and demand for smart healthy aging services in Dalian

3.1. Supply status

Currently, the supply of smart healthy aging services in Dalian presents a pattern of “diversified yet fragmented.” For instance:

- (1) Supply entities are diverse but lack coordination. The government is the leading promoter, driving development through policy guidance and project procurement; some technology companies provide products and technical solutions; elderly care institutions attempt to apply smart tools to improve efficiency. However, these parties fail to form an effective synergy, operating in a state of “working in silos” with low resource integration;
- (2) Products and services are nascent but often “supply does not meet demand.” Market supply predominantly consists of basic safety alert devices like smart bracelets and one-button callers, suffering from severe product homogenization and widespread issues such as complex user interfaces and lack of age-friendly design. Integrated

“smart medical-elderly care” service products that deeply combine daily elderly care with medical health (e.g., chronic disease management, rehabilitation training, remote diagnosis and treatment) are particularly scarce;

- (3) Platforms are initially established but plagued by “data silos.” Although a municipal-level elderly service information platform has been established, it lacks interoperability and operational synergy with the resident health records of the health department, settlement data from the medical insurance system, and household registration information. Stringent data barriers prevent the platform from achieving comprehensive perception and intelligent analysis of elderly needs, thus failing to support truly “personalized” services.

3.2. Demand status

The demand for smart healthy aging among the elderly population is not monolithic but exhibits significant multi-level and differentiated characteristics^[6]. According to Maslow’s hierarchy of needs, the core demands of the elderly vary considerably based on health status, economic income, educational background, and family structure. For instance, disabled and semi-disabled elderly have urgent demands for medical nursing and long-term care, while healthy and active seniors pay more attention to spiritual and cultural life, social participation, and convenient daily services.

Generally, the demand for “medical” aspects is a core concern, encompassing chronic disease management, emergency rescue, rehabilitation guidance, medication reminders, remote consultations, etc. Simultaneously, significant divergence and a digital divide exist in the elderly population’s attitude towards “smart” technology. Most older adults do not reject technology but require solutions that are “usable, easy-to-use, and useful,” disliking cumbersome, flashy products focused on “tech for tech’s sake.” The ease of use and practicality of technology are key determinants of its acceptance.

3.3. Specific manifestations of supply-demand mismatch

Based on the above supply-demand analysis, the current mismatch manifests specifically as:

- (1) Content mismatch, where supply focuses on basic daily care and safety monitoring (“care”), relatively neglecting the elderly’s most pressing medical and health needs (“medical”); emphasis is placed on hardware deployment over soft service support and humanistic care;
- (2) Technology mismatch, where the complexity of smart product technology does not match the generally low technological acceptance and operational proficiency of the elderly, leading to the abandonment of many devices;
- (3) Information mismatch as the elderly and their families are unaware of available, reliable services; service providers cannot accurately and dynamically grasp the real, personalized needs of each elderly individual. A significant information asymmetry exists between supply and demand, lacking an efficient and trustworthy linking and matching mechanism^[7].

4. Path construction for precise supply-demand matching

4.1. Matching objective

The ultimate goal of precise supply-demand matching is to remove the blockages between the “demand side” and the “supply side,” optimize the allocation of service resources, and ultimately enhance the accessibility of elderly care services, the sense of fulfillment and satisfaction of the elderly, and the efficiency of overall social resource utilization.

4.2. Core pathways

The core pathways are as listed below:

- (1) Demand-oriented precise identification path by establishing a unified municipal comprehensive assessment standard system for elderly functional ability and needs, serving as the scientific basis for service allocation and subsidy distribution, and utilizing and strengthening existing community grid management resources, combined

with feedback channels such as online APPs and hotlines, to form a dynamic demand assessment and updating mechanism integrating “online + offline,” constructing a detailed and dynamic database of elderly needs;

- (2) Data-centric precise linking path, where the key lies in breaking down data silos and constructing a city-level big data center for smart healthy aging. Under the premise of ensuring data security and privacy protection, promote data sharing and operational synergy among government departments such as Civil Affairs, Health, Medical Insurance, and Public Security. Based on this, build a comprehensive service platform integrating demand declaration, intelligent matching, service delivery, and quality evaluation, achieving a “one-click” and “intelligent” link between demand and supply;
- (3) Integrated medical-elderly care characterized precise provision path by guiding and incentivizing the market towards product and service innovation, focusing on developing integrated smart medical-elderly care products and service packages that combine prevention, monitoring, alerting, and intervention, while cultivating and promoting demonstration projects for “Smart Medical-Elderly Care Consortiums,” supporting elderly care institutions in establishing close cooperation with medical institutions and community health service centers. Moreover, technologies like 5G and IoT could also be leveraged to provide closed-loop services from online health consultations and chronic disease management to offline home nursing and referral medical care, achieving seamless connection between “medical,” “care,” and “nursing”;
- (4) Multi-stakeholder collaboration guaranteed precise governance path by clarifying the roles and responsibilities of the four main stakeholders: government, market, community, and family. The government needs to fulfill the roles of standard-setter, market regulator, service purchaser, and ultimate guarantor, creating a fair and standardized policy environment. The market (enterprises) should provide professional, diversified, and high-quality products and services, with continuous iteration and optimization. The community, as the last-mile implementation hub, needs to undertake responsibilities such as promotion, technical training, assisted operation, and feedback collection, effectively bridging the digital divide. Family members should actively participate in the service selection and supervision process and maintain interaction with the service system.

5. Conclusion and outlook

5.1. Research conclusions

This study conducted a systematic analysis of the supply-demand matching issues concerning smart healthy aging services in Dalian within the context of integrated medical and elderly care. It aimed to identify the main types of mismatches and their underlying causes within the current service system and, based on this, propose a pathway model for achieving precise matching. The findings indicate that while Dalian has made certain achievements in constructing smart eldercare, practical challenges persist, including a disconnect between the supplied content and genuine demand, a misalignment between technology application and the acceptance capabilities of the elderly, and data silos hindering resource integration. The root cause lies in the current service supply still being predominantly characterized by a “technology-driven” approach, failing to adequately embody a “demand-led” development philosophy^[8].

The key to transitioning from “extensive supply” to “personalized services” is the construction of a multi-level, multi-stakeholder, whole-process collaborative matching mechanism. This mechanism should encompass four core components:

- (1) Establishing a scientific and unified needs assessment system to achieve precise identification of the elderly’s functional status and service requirements;
- (2) Leveraging the municipal smart eldercare platform to break down data barriers between departments such as Civil Affairs, Health, and Medical Insurance, achieving cross-system, cross-level information interconnection and resource sharing;
- (3) Promoting service innovation characterized by the integration of medical and elderly care, focusing on developing smart eldercare products and service packages that combine medical treatment, rehabilitation, nursing, and daily

care functions;

- (4) Improving the multi-stakeholder collaborative governance mechanism by clarifying the roles and responsibilities of the government, enterprises, communities, and families, thereby forming an effective synergy of policy, market, technology, and social support.

In summary, the high-quality development of smart healthy aging relies not only on technological iteration and equipment upgrades but, more importantly, on achieving a dynamic balance between service supply and the real needs of the elderly through institutional innovation, process optimization, and stakeholder collaboration. The four-dimensional pathway model of “Identification - Linking - Provision - Governance” constructed in this study provides theoretical reference and practical guidance for Dalian and similar cities to optimize their smart eldercare service systems.

5.2. Policy recommendations

Based on the above conclusions, this paper proposes the following countermeasures and suggestions to promote the personalized development of smart healthy aging services in Dalian and enhance the level of supply-demand matching.

Top-level design and institutional guarantees should be strengthened to break down data barriers and systemic obstacles. It is recommended that the municipal government establish a special task force for smart healthy aging development, coordinating resources and policies from departments including Civil Affairs, Health, Medical Insurance, and Industry and Information Technology. Formulate the “Dalian Municipal Measures for the Management of Smart Healthy Aging Data Sharing,” clarifying standards and permissions for data collection, updating, exchange, and use, and establish an inter-departmental information sharing mechanism to provide a data foundation for precise services. Other than that, a comprehensive needs assessment system should be established and improved for the elderly. Based on national standards and incorporating local realities such as the income structure, health status, and family support of Dalian’s elderly, develop an assessment tool with local applicability. Promote its linkage with systems like long-term care insurance payments, government procurement service catalogs, and nursing home ratings to guide service resources to be precisely targeted towards those most in need.

The development of integrated “medical-care-rehabilitation-nursing” service models should be encouraged by supporting deep cooperation between medical institutions and elderly care facilities through technical collaboration, talent sharing, and information exchange, focusing on promoting the development of integrated services such as chronic disease management, rehabilitation training, remote diagnosis and treatment, and emergency rescue. This can be achieved by establishing special support funds and creating regional demonstration projects to stimulate innovation among market entities. Smart eldercare accessibility adaptation and digital literacy enhancement programs should be implemented as well through providing training on smart technology applications for the elderly and family caregivers to improve their awareness and ability to use smart eldercare products and services. Simultaneously, encourage enterprises to enhance age-friendly product design, developing intelligent devices and systems with simple interfaces, easy operation, and practical functions to genuinely reduce the technical usage barrier.

A multi-dimensional service supervision and performance evaluation mechanism should be constructed by establishing a comprehensive service quality monitoring system encompassing government evaluation, third-party assessment, and satisfaction surveys of the elderly and their families and regularly assessing the implementation effectiveness of smart eldercare services and use the results as a critical basis for policy adjustment and financial investment, forming a management closed loop for continuous service quality optimization.

5.3. Research limitations and future prospects

This study, primarily based on literature analysis, policy interpretation, and theoretical deduction, preliminarily constructs a pathway model for supply-demand matching in smart healthy aging. However, it possesses certain limitations. The research methodology is predominantly qualitative. While striving for comprehensiveness, it still lacks support from large-scale questionnaire surveys and empirical data; the proposed pathway model has not been fully tested in practice.

Moreover, the discussion on the multi-stakeholder collaboration mechanism remains somewhat theoretical, lacking in-depth exploration of the underlying mechanisms such as interest coordination, responsibility distribution, and collaborative motivation among different stakeholders.

Future research could be deepened in the following aspects:

- (1) Validating and refining the proposed matching pathways through broader field investigations and quantitative analysis, particularly employing empirical methods like Structural Equation Modeling (SEM) and Social Network Analysis (SNA) to examine the action mechanisms and path relationships of various influencing factors;
- (2) Conducting case tracking and action research in selected typical communities or elderly care institutions in Dalian to summarize the implementation models and operational experiences of smart eldercare services from a practical perspective;
- (3) Combining comparative studies with experiences from advanced domestic and international cities to further explore potential pathways and development trends in institutional design, technological integration, and governance innovation for smart healthy aging, thereby enhancing the scientific rigor and generalizability of the research.

In conclusion, as China's population aging continues to deepen and digital technology constantly innovates, research in the field of smart healthy aging still holds broad development prospects. It is hoped that the preliminary exploration of this study can provide a useful reference for subsequent academic discussion and policy practice.

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Disclosure statement

The authors declare no conflict of interest.

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