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Research on the Improvement Paths of Rural Public Health Service Supply in the Context of Digital Village

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Abstract: In the context of digital villages, the digital transformation of rural public health is subject to multiple constraints. Based on the literature and cases, three dilemmas are identified: the urban-rural digital divide coexists with farmers' weak legal awareness, low digital literacy, and a supply-demand mismatch; fiscal investment emphasizes construction over operation and maintenance, with insufficient funding, making it prone to "zombie platforms"; and data silos coexist with talent shortages, as the public health workforce is insufficient and urban-rural allocation is imbalanced. Accordingly, it proposes an improvement approach of "legal safeguards, offline-first, digital as a supplement, equal emphasis on construction and operation, and bridging the divide."

Keywords: Digital village; Rural public health services; Digital divide

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1. Introduction

1.1. Research background

The Fourth Plenary Session of the 20th Central Committee of the Communist Party of China proposed the strategic requirement of "accelerating the construction of a Healthy China and steadily promoting the equalization of basic public services," further highlighting the important role of healthy village construction in safeguarding the health and well-being of rural residents, promoting fair and inclusive urban-rural basic medical and health services, and filling the shortcomings of rural livelihoods [1]. In 2024, the National Health Commission and 14 other departments jointly issued the Guiding Opinions on Promoting Healthy Village Construction, stating that a healthy village will be built by 2035. This reflects China's current emphasis on the supply of rural public health services.

The Digital Village Development Action Plan clearly proposes to promote "Internet + healthcare" extension to rural areas, taking digitalization as an important lever to improve rural basic public service capacity. The Law of the People's Republic of China on Basic Medical Care and Health Promotion legalizes

citizens' right to basic public health services, giving the system stable legal protection. Under the mutual promotion of institutional construction and grassroots practice, national basic public health services have gradually realized a transition from basic supply-oriented services to a combination of quality-oriented and health-outcome-oriented services, and the service model has gradually moved from traditional management to digital and smart governance [2].

1.2. Research significance

This paper distinguishes public health services from ordinary medical diagnosis and treatment services. Taking a micro-individual perspective, it incorporates public health service supply, self-rated health, and health well-being into a unified analytical framework. In the context of overlapping policies of Digital Village and Healthy Village, it focuses on clarifying the logical chain through which digital technology affects the supply of rural public health services, identifying its bottlenecks and root causes, and exploring feasible improvement pathways.

As Healthy Village construction continues to advance, the empirical results of this paper can provide a practical basis for optimizing the allocation of rural public health resources. It guides farmers to develop a scientific and healthy lifestyle, addresses rural health service problems, and builds a solid health foundation for high-quality agricultural development and rural harmony and stability, thereby embodying the people-centered development philosophy and advancing public health undertakings toward more balanced, higher-quality, and more inclusive development [3].

2. Research cases and problem discovery

2.1. Practical cases of rural public health service supply

(1) Case 1: In July 2024, a stratified random sampling method was used to select villagers aged 15–74 in 41 counties (districts) of 9 cities in Shaanxi Province as survey subjects, and their awareness of public health emergencies was scored and evaluated. The risk awareness score of rural residents in Shaanxi Province regarding public health emergencies was 31 points, and there were differences among different regions and age groups [4]. The survey showed that villagers had a better understanding of the dimension of infection possibility, but a poorer understanding of the dimensions of disease severity and disease controllability. This indicates that villagers only have a certain understanding of particularly obvious infectious diseases, while their legal awareness and risk management awareness are not strong.

(2) Case 2: Jiangsu Province shows typical differentiation in China's national economic development pattern, with significant differences in economic structure, governance capacity, and resource endowments within the province. Due to long-term constraints of industrial structure rigidity and weak fiscal autonomy, the overall economic development level of northern Jiangsu is relatively lagging, and public health digital infrastructure construction therefore faces the dual practical dilemmas of insufficient fiscal support and limited medical resource supply. Due to insufficient adaptability in policy design and formulation, digital transformation policy support is mainly manifested as infrastructure construction challenges under fiscal input constraints, namely how to achieve the construction and upgrading of grassroots medical digital facilities through optimizing fiscal support mechanisms under limited funding guarantees [5]. As far as the digital dilemma is concerned, its core problem is insufficient fiscal input.

(3) Case 3: The current number of public health personnel in the disease prevention and control system of the Xinjiang Uygur Autonomous Region is 5,066, including 1,955 males (38.59%) and 3,111 females (61.41%), with females significantly higher than males [6]. According to the standards stipulated in the Guiding Opinions on Job Setting Management of Disease Prevention and Control Centers issued by the National Health and Family Planning Commission, the required number of personnel for the disease prevention and control system of Xinjiang Uygur Autonomous Region in 2025 should be 6,463. However, the current number is 5,066, which is somewhat different from the national standard. The total gap is significant, and this situation is basically consistent with the total personnel gaps in disease control institutions in some other regions, such as Wenzhou in Zhejiang, Xuzhou in Jiangsu, and Fujian.

2.2. Current practical problems in rural public health service supply

2.2.1. Problem 1: The urban-rural digital divide in rural areas is prominent, and farmers' legal awareness of public health is weak

The key targets of public health services are rural elderly and chronic disease groups, but this group generally has low digital literacy and cannot operate smartphones. Compared with cities, rural areas' emergency response systems for public health emergencies are relatively weak, and rural residents' ability to respond to public health emergencies is relatively insufficient [4]. Many digital service designs are oriented toward young and middle-aged people, resulting in the problem that "those who can use them do not need them, and those who need them cannot use them." Digital tools cannot replace offline services.

Most rural areas in China have not yet fully formed a legal environment of "handling affairs according to law, seeking law when encountering problems, using law to solve problems, and relying on law to resolve contradictions," and there is much narrow-mindedness and many drawbacks in rural grassroots social governance. In the process of epidemic prevention and control, illegal and irregular phenomena often occur in rural areas. For example, some grassroots township governments independently decide to block normal provincial roads, which clearly exceeds the scope of legal authorization [7]. Farmers' weak legal awareness of public health is not simply a matter of individual quality, but a tension between institutional supply and traditional grassroots governance habits. The government-led administrative promotion model easily ignores farmers' subject status.

2.2.2. Problem 2: Emphasis on platform construction, neglect of operation and maintenance, and fiscal problems lead to inadequate software and hardware adaptation

In the practice of digital village construction, a common but long-neglected structural contradiction is that a large amount of resources are invested in the early construction of digital platforms, while operation and maintenance after completion lack sustained institutional guarantees and resource supply. This problem is particularly prominent in the field of rural public health services. Local digital village governance platforms have fallen into the "zombie platform" dilemma due to "emphasizing early construction and neglecting later maintenance." Some townships simply equate digitalization with purchasing equipment and building platforms, investing large amounts of funds in system construction, but later operation and maintenance funds are insufficient; some remote rural areas have poor network signals, and after equipment is damaged, there is a lack of repair funds.

2.2.3. Problem 3: Data silos among departments still exist, and public health talent capacity is weak

In the current initial stage of digital villages, data from health, medical insurance, and rural revitalization systems are still not interconnected. Village doctors need to repeatedly enter health records and follow-up information in multiple different systems, and data collection once and multi-party reuse has not been realized. The task of promoting Healthy China construction proposed at the 20th National Congress of the Communist Party of China pointed out the need to develop and strengthen the medical and health team, focusing on rural areas and communities. The 2023 National Statistical Bulletin shows that the total number of medical and health talents has increased, and urban data has decreased while rural data has increased, but the urban-rural gap in the allocation of health talents remains large. There are still some deficiencies in the connection and coherence between different levels of public health education. Supply-side institutional reform of health education will become the key to solving the shortage of public health talents [8].

3. Improvement paths for rural public health service supply

Based on the two analytical dimensions of empowerment mechanisms and practical bottlenecks, this paper examines the problem of rural public health service supply. This paper advocates adhering to the overall approach of "legal guarantee, offline first, digital as a supplement, equal emphasis on construction and operation, and bridging the divide." Accordingly, it proposes corresponding improvement paths from five dimensions.

(1) Path 1: Narrow the urban-rural digital divide and build and improve the rural public health legal guarantee system. For rural residents: for the elderly and low-education groups, it is not possible to rely entirely on online services. Timely offline assistance should be provided, volunteer service points should be established, and digitalization should be concretized for "people."

To achieve coordinated urban-rural public health development in China, in view of the difficulties and problems faced by rural public health development and combining the current status and deficiencies of rural public health legal guarantees, it is necessary to make efforts in all links of legislation, law enforcement, justice, and law observance to build and improve China's rural public health legal guarantee system [7]. The publicity and education of relevant laws and regulations such as the Emergency Response Law and the Regulations on Emergency Response to Public Health Emergencies should be incorporated into the normalized work of the rural emergency management system. A rural public health supervision mechanism should also be established to ensure the reasonable operation and expenditure of rural public health finances, and to establish a public health service supervision mechanism led by the government, jointly participated in by health administrative departments and the whole society, with multiple measures.

(2) Path 2: Improve grassroots software and hardware facilities and establish an integrated "construction + operation" guarantee mechanism. Change the model of emphasizing procurement and neglecting operation and maintenance. A demand-front identification and full-cycle operation mechanism can be established. The experience of Tianjin's grassroots digital health community can be drawn on. This model established a municipal-level special budget for grassroots medical digitalization. Expenses such as cloud platform development, batch procurement of smart devices, and annual system upgrades are uniformly coordinated and allocated by the municipal government. In the project budget, later network maintenance, equipment repair, and platform operation funds are included in the fiscal budget, avoiding

the situation where a platform is built, but no one maintains it.

The strength of fiscal policy support capacity directly affects the sustainable advancement of the digital transformation of rural public health services and the robust operation of the governance system. The resilience and allocation structure of fiscal policy support have a major impact on digital investment [5]. To avoid the "rigid ossification" of fiscal funds, classified and layered fund allocation can be implemented, changing the "one-size-fits-all" appropriation method, and allocating funds according to the development stage of grassroots medical institutions. Given the weak payment ability of rural residents, in addition to continuing to increase fiscal input, it is also necessary to change the equal fixed-amount payment system implemented in most areas. Referring to the urban-rural residents' pension insurance system, a classified fixed-amount system can be implemented, dividing medical insurance premiums into 25 grades, reflecting income gaps and economic affordability between grades. Different grades of payment adapt to different reimbursement ratios, realizing the linkage between individual payment and economic income level, with more payment for more benefits [9].

(3) Path 3: Break down data silos and promote county-township-village three-level public health data interconnection. Taking the promotion of digital health records as an example, the government provides fiscal input and implementation standards and norms; enterprises are mainly responsible for developing highly compatible and user-friendly system platforms; communities improve residents' awareness and ability to use the digital health record system through organizing publicity and training activities. The three parties work together to more effectively implement data sharing. The policy execution coordination mechanism forms a policy chain with complementary functions and linked responsibilities. Its operational model particularly emphasizes institutional interaction and governance dynamics, and is committed to integrating the institutional resources, technical capabilities, and organizational momentum held by various actors into a unified sharing platform by building cross-departmental and cross-regional coordination mechanisms, thereby achieving the systematic release of digital governance effectiveness [5]. It is necessary to accelerate the coordination of health, medical insurance, and medical community platform data at the county level, and help realize the shared reuse of health records, physical examinations, and multiple systems.

(4) Path 4: Adhere to the effective integration of online services and offline implementation, and clarify the functional positioning of digital tools. It should be clear that digitalization is only a supplementary means and cannot completely replace traditional offline public health services. In China, information conveyed by rural village cadres has authority and can effectively guide villagers to correctly understand and implement epidemic prevention measures. As "opinion leaders," village cadres should assume responsibility. Through accurate policy communication, personalized care, and emotional support, they ensure unity and stability of rural communities in crises [10]. Online and offline should cooperate with each other, avoiding blind "all-online" approaches, thereby protecting the service rights and interests of elderly and vulnerable groups.

(5) Path 5: Build a multi-party collaborative pattern and place the construction of public health talent teams in a more prominent position. The government plays a coordinating role in this process and should do a good job in fund guarantees, institutional supply, and supervision implementation. Talent cultivation must also keep up so that the rural public health team can stay and work well. Township governments can jointly carry out "order-based" training with county-level health departments, and can also establish

long-term cooperation with local medical colleges to send graduates majoring in rural public health to the grassroots in a targeted manner.

Implement a structural supplementary strategy combining talent introduction and staffing optimization. For work in medical and health institutions, provide salary subsidies and preferential support in professional title evaluation. Ensure that talent can stay and play their role [3]. Accelerate innovation in talent introduction models, and introduce outstanding public health talents through preferential policies such as increasing salary and treatment, providing scientific research start-up funds, and implementing housing guarantees.

4. Discussion

This paper mainly discusses that technology itself cannot automatically solve the supply problem. Digital empowerment is not simply purchasing equipment and building systems; the release of its effectiveness is highly dependent on the coordinated adaptation of the institutional environment, fiscal guarantees, talent support, and grassroots governance capacity.

The essence of the digital divide problem is the structural imbalance of service accessibility. Case 1 in this paper shows that the key targets of public health services are rural elderly and chronic disease groups, but they generally have low digital literacy and cannot independently use digital services such as online follow-up and online health classes. Digital public health services may face the dilemma that "those who can use them do not need them, and those who need them cannot use them." The deep logic of this problem lies in the systematic mismatch between the design logic of digital services and actual rural needs. Financial support for remote and economically underdeveloped areas should be increased, the gap in health resources between different regions should be narrowed, and the accessibility and equalization level of rural health services should be improved. Adhere to the supply logic of "offline first, digital as supplement," and position digital tools as auxiliary means rather than alternatives [11].

Fiscal sustainability is the core constraint on insufficient supply of digital public health services. Case 2 reflects that some townships simply equate digitalization with purchasing equipment and building platforms. They only need to invest funds to build systems, but due to insufficient later operation and maintenance funds, after the platform is completed, there is a lack of continuous operation and maintenance, and the system gradually becomes a "zombie platform." The essence of this problem is that fiscal sustainability has not been effectively implemented. The government should, in addition to funding input, attach importance to service quality improvement and performance evaluation mechanism improvement, and establish a long-term use awareness that finance is not only for construction but also for maintenance. Through health education, disease prevention, regular physical examinations, and other methods, improve farmers' health awareness and self-care ability, and enhance health capital from the source [11]. "Emphasizing construction and neglecting operation and maintenance" is not simply a technical problem or management negligence, but a structural contradiction between the logic of fiscal resource allocation and the operational laws of digital services.

Data silos and talent shortages constitute a systematic bottleneck in digital service supply. At present, data from health, medical insurance, and rural revitalization systems are not yet interconnected. Village doctors need to repeatedly enter health records and follow-up information in multiple different systems, and there is no data-sharing platform for multi-party use. The root of this problem lies in poor communication in the management system. County-level health institutions find it difficult to provide effective business guidance to lower-level institutions, while township health centers, due to resource and management

limitations, find it difficult to play their bridging role in public health services [12]. The imbalance in resource allocation brought by the urban-rural dual structure, combined with factors such as population mobility and lifestyle changes, makes rural public health services face multiple challenges. Existing management models show insufficient adaptability in responding to complex health needs [12].

The dual shortcomings of technology and talent overlap, greatly reducing the effectiveness of digital public health services at the grassroots level. The government should continue to improve the family doctor system and raise the level of rural public health. Give play to the family doctor's role as a "gatekeeper" in residents' health and medical expenses, publicize health concepts, adhere to prevention first, and enable people not to get sick or to get fewer serious illnesses, thereby saving medical expenses and resources to the greatest extent [9].

5. Conclusion and outlook

5.1. Conclusion

In the context of digital villages, this paper studies the problem of rural public health service supply and proposes systematic optimization paths. The research conclusions are as follows:

First, the advancement of digital village construction has indeed created favorable conditions for improving rural public health service supply, but digitalization is not equal to simply adding equipment and building systems, and technology cannot automatically solve the supply problem. Constrained by residents' digital literacy, operation and maintenance funds, data silos, and excessive shift to online services, digital tools easily become "zombie platforms" and even increase the fiscal burden at the grassroots level.

Rural public health service supply faces three structural dilemmas: first, the digital divide and weak legal awareness. Some elderly and low-educated groups cannot effectively obtain digital services, and farmers lack knowledge and compliance with public health management measures. Second, fiscal emphasis on construction over operation and maintenance. Fixed and project-based funds lead to a lack of sustained guarantees for later operation and maintenance. Third, data silos and talent shortages result in systems not being interconnected and personnel not knowing how to use them. The three are intertwined, constituting a systematic obstacle to the digital supply of rural public health services.

Third, improving the rural public health service supply is currently mainly advanced through coordinated efforts in five dimensions. First, narrow the urban-rural digital divide, build and improve the rural public health legal guarantee system, combine digital health popularization with traditional methods, and clarify farmers' legal obligations and boundaries of rights. Second, improve grassroots software and hardware facilities, establish an integrated "construction + operation" guarantee mechanism, and include later operation and maintenance funds in the fiscal budget. Third, break down data silos, promote county-township-village three-level public health data interconnection, and realize multi-system shared reuse. Fourth, adhere to deep online-offline integration and clarify the functional positioning of digital tools. Fifth, multi-party collaboration, strengthen public health talent training, and stabilize the rural public health team through policies such as "order-based" training, salary subsidies, and preferential professional titles.

5.2. Future outlook

Existing research mostly focuses on the interpretation of policy texts and analysis of typical cases. Future research can consider setting different policy scenarios, simulating the performance of different options in

actual implementation, and then seeking feasible directions for strategy optimization. Big data analysis and policy simulation methods can also be introduced to establish a policy evaluation model that can reflect the situation in real time and is systematic, dynamically capturing key variables and performance feedback in policy implementation, thereby identifying the internal mechanisms affecting implementation effects.

Fiscal sustainability is the core constraint on the supply of digital public health services. China's rural areas differ considerably in economic development level, population structure, and digital infrastructure. Future research can consider further incorporating variables such as regional economic structure, public resource allocation, and institutional elasticity to build an analytical framework with stronger explanatory power, used to examine policy adaptation issues under regional differences. For example, coastal developed areas have relatively mature foundations in digital technology embedding, platform construction, and fiscal guarantees, while central and western regions and remote villages face multiple constraints such as weak infrastructure, tight fiscal supply, and insufficient institutional execution capacity. This development imbalance will directly affect whether policy effects can be sustained and whether experience can truly be scaled up.

Disclosure statement

The authors declare no conflict of interest.

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