frontiers | Research Topics

Maximizing local government impact on community health initiatives

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Published in
Frontiers in Public Health

ISSN 1664-8714
ISBN 978-2-8325-6707-4
DOI 10.3389/978-2-8325-6707-4

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Maximizing local government impact on community health initiatives

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Citation
Sobczyk, K., Robakowska, M., eds. (2025). *Maximizing local government impact on community health initiatives*. Lausanne: Frontiers Media SA.
doi: 10.3389/978-2-8325-6707-4

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frontiers | Frontiers in Public Health

TYPE Editorial
PUBLISHED 04 August 2025
DOI 10.3389/fpubh.2025.1660969

OPEN ACCESS

EDITED AND REVIEWED BY
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RECEIVED 07 July 2025
ACCEPTED 15 July 2025
PUBLISHED 04 August 2025

CITATION
Sobczyk K and Robakowska M (2025) Editorial: Maximizing local government impact on community health initiatives. *Front. Public Health* 13:1660969. doi: 10.3389/fpubh.2025.1660969

Editorial: Maximizing local government impact on community health initiatives

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KEYWORDS

local governments unit, public health, health program, health promotion, health economics

Editorial on the Research Topic
Maximizing local government impact on community health initiatives

Background

Local governments occupy a critical position in public health governance due to their influence over key social determinants of health, such as housing, transportation, education, land use, and environmental regulation. According to the theory of social determinants of health, these non-medical factors are among the most powerful influences on population health outcomes (1, 2). To address the complex and interrelated nature of health challenges, the "Health in All Policies" (HiAP) approach has gained prominence. HiAP is a governance strategy that integrates health considerations into policymaking across all sectors, not just the health sector. It rests on three main pillars: intersectoral collaboration, systems thinking, and a commitment to health equity (2, 3).

Intersectoral collaboration emphasizes the need for coordinated efforts among various municipal departments and external partners, recognizing that no single sector can address public health challenges alone. Systems thinking provides a framework for understanding how different policy areas interact and influence health over time. The focus on health equity underscores the moral and practical imperative to address avoidable disparities, particularly among marginalized or disadvantaged groups (1, 3). Theoretical models of local health governance—including HiAP, the theory of health equity, and community health frameworks—stress the importance of participatory governance. Community engagement in decision-making processes enhances the relevance, effectiveness, and sustainability of public health interventions, while also fostering trust and civic empowerment (1, 2).

Effective public health policy at the municipal level therefore involves more than delivering healthcare services. It requires strategic management of the social and environmental contexts in which people live. Data-informed policymaking is essential, enabling local authorities to target interventions where they are most needed, evaluate outcomes, and adjust strategies accordingly. Ultimately, the theoretical foundation of local public health governance points toward integrated, equity-driven, and participatory approaches. By embedding health into all aspects of local policy and planning, municipalities can act as powerful agents in creating conditions that support healthier, more resilient communities (1, 4).

This collection of 13 articles explores how local authorities can effectively address social determinants of health, reduce disparities, and implement sustainable, community-focused strategies. The contributions offer a wide range of perspectives, including empirical

case studies, policy analyses, and conceptual frameworks. Across this diversity, common threads emerge: the importance of cross-sector collaboration, meaningful community engagement, and the use of data to inform action.

Key contributions

- Khadka et al. examine barriers to implementing Nepal's national health policy at the local level. Lack of infrastructure, staff, and funding were major obstacles. Younger, tech-savvy workers were more effective implementers. The study advocates for training and better coordination.
- Li X. et al. study investment models in senior health in Japan and South Korea. Successful models combined fiscal investment, tech innovation, social capital, and institutional support. The authors highlight the need for flexible, context-specific public–private partnerships.
- Zhang et al. analyze how Wuhan's local government managed COVID-19 by allocating administrative attention across routine and emergency tasks. Their model helps explain decision-making under resource constraints but warns of attention fatigue.
- Jiang et al. assess how participatory budgeting in Chinese hospitals affects performance. While objective self-efficacy links were weak, perceived participation improved planning and communication, ultimately enhancing non-healthcare outcomes.
- Wang et al. review China's fragmented Health Impact Assessment (HIA) legislation. Despite pilot programs in 32 provinces, comprehensive regulation is lacking. The authors call for a unified HIA statute and capacity-building to integrate health into policy.
- Wei, Xu et al. compare three Chinese counties' responses to COVID-19. Counties with better insight, coordination, and learning capacities managed outbreaks more effectively. The study underscores the value of adaptive, responsive local governance.
- Zhu and Du explore public sports expenditure across China's provinces. Effective investment models integrated tech, cultural promotion, and housing support. Findings support cross-sector strategies to enhance physical activity participation.
- Stöllman et al. identify factors behind low sickness absence in Swedish municipalities: accessible leadership, continuous staff development, inclusive work environment management, and open communication. These practices promote organizational resilience.
- Lontano et al. present the CareVax protocol, integrating hospital and regional systems to improve vaccination among frail adults in Italy. Using secure data matching, the system identifies candidates for recommended vaccines and invites them to participate. The model could serve broader preventive care efforts.
- Wei, Wang et al. examine "pairing assistance" during China's COVID-19 crisis, where strong central coordination met local cooperation. A three-phase model—launch, decision, and implementation—illustrates how national and local governments worked together effectively.
- Peters et al. review tobacco control in the U.S., identifying uneven policy effects due to variations in design, overlapping regulations, and subgroup differences. They recommend more nuanced evaluations that account for equity and context.
- Xue et al. assess Traditional Chinese Medicine (TCM) in reducing antibiotic use among children. Herbal therapies and non-pharmaceutical methods showed promise, though challenges in standardization and policy integration remain.
- Li T. et al. explore consumer understanding of food recall notices in China. Despite concern for food safety, many struggled to interpret notices. Personalized, clear messaging increased trust and effectiveness.

Summary

Several recurring challenges are identified—insufficient funding, limited staff capacity, political turnover, and fragmented authority structures. However, the articles also point to tangible opportunities: building skills and capacity within local governments; leveraging partnerships with community organizations to co-design and implement initiatives; using local data and evaluation to adapt strategies and build public and political support; and embedding health into all municipal policy areas, not only those traditionally linked to healthcare.

The message is clear: local governments are not peripheral actors in public health—they are essential to driving sustainable, equitable improvements in population wellbeing. When equipped with the right tools, partnerships, and leadership, municipalities can lead meaningful change.

As attention continues to shift upstream toward the social and environmental determinants of health, the role of local actors becomes increasingly central. Change does not always require national legislation or large-scale reform; it can begin with a city council decision, a school-based initiative, or a neighborhood-led program. Together, the articles in this collection provide a practical blueprint for how municipalities—regardless of size or resource level—can become true champions of health. Their insights offer valuable guidance for policymakers, researchers, and practitioners working to strengthen the health of communities from the ground up.

Author contributions

KS: Writing – original draft, Project administration, Resources, Conceptualization, Writing – review & editing. MR: Resources, Conceptualization, Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

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Publisher's note

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 09 December 2024
DOI 10.3389/fpubh.2024.1467518

OPEN ACCESS

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RECEIVED 09 August 2024
ACCEPTED 25 November 2024
PUBLISHED 09 December 2024

CITATION
Li T, Jin X and Zhu D (2024) Cognitive and preference disparities of Chinese consumers regarding the disclosure of unsafe food recall information.
Front. Public Health 12:1467518.
doi: 10.3389/fpubh.2024.1467518

Cognitive and preference disparities of Chinese consumers regarding the disclosure of unsafe food recall information

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Introduction: Information disclosure is important in promoting unsafe food recalls and reducing potential food safety risks. However, the governance of unsafe food recall information in China is distorted, leading to cognitive dissonance in Chinese consumers' perceptions of unsafe food recall information. Focusing on consumers' search and cognitive costs, this study suggests that market regulators should proactively and fully disclose unsafe food recall information to satisfy consumers' needs and preferences for recall information, thereby optimizing consumer perceptions and facilitating the improvement of the information governance system for unsafe food recalls.

Methods: This study administered a survey via a discrete choice experiment to obtain data from 1,010 consumers in China and employed multiple linear regression (MLR) to analyze the overall cognition and preferences of consumers regarding food recall information and identify differences in cognition and preferences regarding unsafe food recall information.

Results: Chinese consumers experience cognitive dissonance regarding food recall information, and their utility can be improved through disclosure. They expressed preferences for recall information about food shops and distribution markets, more visualized hazard content, and new media presentations. Those who had purchased unsafe food, families with pregnant women or children, and those with more education were more concerned about recall information. Consumers' information preferences also show a bystander mentality; however, consumers with higher educational levels are more altruistic.

Discussion: The results suggest that personalized, intuitive, and cognitively matched recall information can reduce consumers' search and cognitive costs and increase their utility. This finding provides a reference and practical basis for establishing a food safety information governance system in China.

KEYWORDS

unsafe food recall, information disclosure, cognitive dissonance, altruism, bystander effect

1 Introduction

China's food safety governance faces challenges (1). Information asymmetry in the food industry and the resulting cognitive dissonance among consumers have been a longstanding significant concern in the public health field (2–4). Between 2008 and 2019, more than 430,000 food safety incidents occurred in China (5), impacting the health and safety of the Chinese

people. However, the current situation indicates that China's recalls of unsafe foods remain relatively low. Based on data on unsafe food incidents at the provincial level in mainland China from 2017 to 2022, the average recall rate was estimated to be approximately 7–12%[1] (Figure 1). As unrecalled food poses potential food safety risks, since 2015, the Chinese government has revised food recall regulations to address unsafe food, the primary goal of which is to retrieve unsafe food, for which food enterprises are responsible. The new regulations emphasize information disclosure to allow recall disclosure to play an important role in the information governance of unsafe food. The regulations require the State Administration for Market Regulation (SAMR) and local market regulators to order food companies to carry out recalls at three levels based on the degree of impact and require food companies to inform sellers and consumers of the production batch, the reason for the recall, and the scope of the region, and to stop consuming unsafe food. Regulatory authorities publish risk warnings, verifications, and disposal information on their official websites. However, the results in Figure 1 show that information governance policies are dysfunctional. In 2023, the survey team's findings indicated that consumers rarely had access to unsafe food recall information (see Figure 2). What prevents consumers from receiving and understanding the recall information?

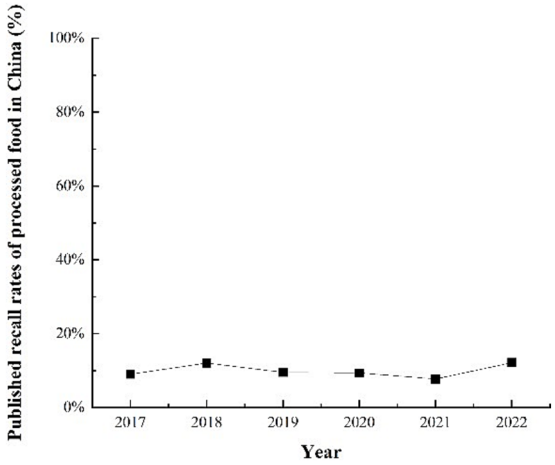

FIGURE 1
The average rate of food recalls publicized by Chinese province, 2017–2022.

Food companies, the bearers of unsafe food recalls, have little incentive to disclose such information. Many studies of food information disclosure suggest that food products have strong "trustworthy" characteristics (6), making it difficult to verify the quality of agricultural products (7). For consumers, food safety is often an afterthought, creating a significant information asymmetry among consumers, food producers, and distributors throughout the production, processing, distribution, and consumption processes (8), which facilitates opportunistic behavior by food producers (9–11). To address information asymmetry, consumers can rely only on nutritional information provided by food companies (12), food labels (13), or quality safety certifications provided by third-party certification bodies (14). However, this entails the risk of adverse selection, because consumer behavior and attitudes toward food and labels encourage food companies to convey positive information voluntarily (15). Contrariwise, food companies are unwilling to disclose negative food safety information such as food recalls, which have a "contagious effect" (16). Such behavior can cause widespread consumer behavior changes in the market (17). For example, the recall of beef with *E. coli* has reduced consumer demand for ground beef (18, 19), and the recall of packaged spinach caused by *E. coli* has led to a significant decline in spinach sales (20). Corporate recalls can affect consumers' willingness to buy and their perceptions of food safety (21). It is not appropriate to place too much responsibility on companies for disclosure. This implies that consumers must pay higher search costs to obtain information on corporate recalls.

Moreover, news media coverage of food incidents is selective. The news media tend to prioritize major events and are biased because of underlying political and socioeconomic views (22). Owing to the clustering behavior of social information dissemination (23), exposure by the news media makes consumers prone to overreaction in the food industry (24–26). Many studies have shown that consumers in developing countries have a lower level of awareness of the relationship between production methods and food safety than those in developed countries (27, 28), making them more susceptible to food safety panics (29). In China, food safety panics occur frequently because of consumers' low awareness of food safety issues. For example, during the 2003 SARS outbreak in China, distorted information transmission caused a food panic in Guangzhou Province (30). The recall of dairy products in China triggered a food safety panic, significantly changing consumer purchasing behavior (31). Consequently, news media coverage of food recalls fails to meet consumers' daily information needs and can cause cognitive distortions.

The critical role of digital platforms and social media in disseminating food safety information is increasingly evident. Early research by Thackeray et al. (32), who conducted a cross-sectional study of state public health departments, indicated that social media has gradually emerged as an essential tool for public health agencies to communicate health information. However, this study also highlighted the need to enhance public interaction to strengthen public health communication. With the widespread adoption of new media technologies, social media platforms—characterized by rapid dissemination, accessibility, and interactivity—have played a pivotal role in communicating food risks and benefits (33). Increasing consumer trust in social media has heightened risk perception regarding food safety (34), with more consumers relying on online platforms for food risk information (35–37). Furthermore, Avelino et al. (38) highlighted the effectiveness of platforms like Facebook and Instagram in promoting healthy eating and nutrition education, particularly among low-income groups, through their broad user coverage and engagement levels.

1 Data were collected from the "Risk Control" section of the official website of the Market Supervision and Administration of the 31 provinces of mainland China. The author excluded catering food and edible produce, calculating each province's processed food recall rate as the arithmetic average of the province's recall rate for each batch of problem food in that year. The national recall rate for processed foods is the arithmetic mean of the recall rates for all provinces for the year, with missing values for some provinces, and the resulting data are approximate ranges. Notes: Recall rate per batch = actual recalls/quantity sold.

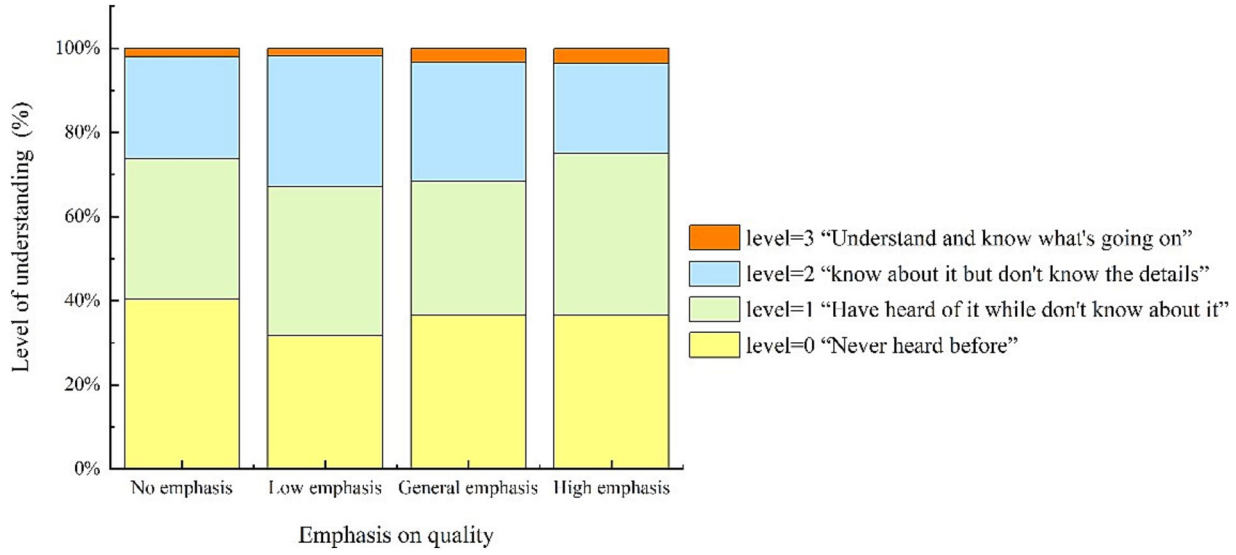

FIGURE 2
Proportion emphasizing quality by level of knowledge of food recall information.

It is also important to combine information disclosure in the food industry with government regulations to maximize its impact (39). Regulatory authorities can leverage information disclosure as a low-cost regulatory tool (40–42), particularly in food safety (43). For instance, the United States has established a comprehensive food recall information exchange system. Through FDA and FSIS websites, the public receives detailed information on risk levels, product specifics, potential contamination, and recall volumes. Additionally, the National Outbreak Reporting System (NORS) records and monitors foodborne illnesses and disseminates health risk information to the public (44, 45). Similarly, the European Union's food safety risk communication system excels in information dissemination, data collection, and public communication (46). Supported by transparent and standardized traceability mechanisms, these systems facilitate effective food recall and risk management (47). In contrast, China faces significant challenges due to the lack of transparency in its current food safety governance framework (2). The SARS epidemic made Chinese residents aware of the importance of citizens' right to know and of government information disclosure (48). In particular, the greatest demand for food safety among Chinese consumers is for the disclosure of food safety information (49), which is a prerequisite for narrowing the gap between Chinese food safety information and consumer cognition (50). Figure 1 shows that China's food recall program has not achieved its desired results. This finding suggests that information governance has not played a significant role in recall systems. Tang et al. (51) found that Chinese food information disclosure was not well combined with the recall system. The inefficiency of the regulator in information governance is demonstrated by the insufficient transmission of information, as well as the failure to reverse the bias in consumer perceptions of risk. A survey of Chinese residents found that less than one-tenth of the population could access such food safety-related information (3). There is also a divergence between consumers' subjective risk perceptions and objective food safety conditions (4). Researchers believe that the Chinese government should correctly guide consumers through the timely and objective publication of food quality test results and strengthening food safety publicity (52). Faced with food safety risks, China's food regulatory authorities should prioritize consumer rights and explain and convey risk information such as harmful foods and foods unsuitable for specific populations (53).

Extensive research has examined the actors responsible for disclosing food recall information and the effectiveness of such disclosures, particularly in addressing the challenges of information governance faced by the Chinese government. These studies have made significant contributions to these fields. However, several questions remain unanswered: How can the Chinese government achieve complete disclosure of food recall information asymmetry? How can consumer demand for recall information be satisfied to prevent cognitive dissonance? What heterogeneous factors influence consumer information needs? These critical issues require further in-depth exploration.

In China, the government is the most trusted institution among consumers. Consequently, in situations where food companies are reluctant to disclose information or news media coverage is selective, government disclosure becomes a critical channel for consumers to access food recall information. However, does the information disclosed by the Chinese government regarding unsafe food truly meet consumer needs? If not, what are consumer's preferences for such information? Furthermore, how do individual characteristics, household factors, and, particularly, the level of education shape consumers' perceptions of unsafe food recall information? The study seeks to address these key questions and research objectives. This study explores the following issues: First, it analyzes consumer perceptions of current unsafe food recall information based on field research data. Second, information that meets consumers' needs and perceptions is analyzed from the perspectives of search cost and cognitive cost, and it is shown that consumers can gain utility growth through unsafe food recall information, which is verified by the results of the choice experiment method. Third, the existence of heterogeneity

in consumers' preferences for unsafe food recall information across different characteristic groups and the reasons behind this are analyzed. Finally, the role of education in information cognition and demand is discussed, providing a basis for guiding food regulators to scientifically disclose information and communicate food safety risks.

2 Conceptual framework and hypotheses development

2.1 Unsafe food recall disclosure and cognitive dissonance

Festinger (54) demonstrated that cognitive dissonance arises from inconsistencies between attitudes and behaviors. Consumers' cognition is typically influenced by the information they encounter (55). In China, food safety panics occur frequently because of consumers' low awareness of food safety issues (30, 31). And only a small percentage of the population could access this food safety information (3). Research on the impact of African swine fever on Chinese pork consumption also suggests that Chinese consumers have a low perception of food safety risks (56). Accordingly, we propose the following hypothesis:

> *Hypothesis* 1: Consumers have cognitive dissonance about unsafe food recall information.

2.2 Search, cognition, and unsafe food recall information preferences

Consumers are limited by their cognitive ability and limited information in their ability to understand all information accurately and display limited rationality in their decision-making processes (57). Stigler (58) argued that with information asymmetry, people need to pay costs, such as fees, time, and effort, to obtain and process information. Zenon et al. (59) examined the cognitive cost of information, and proposed that the complexity of information and the need to process it affect people's subjective perceptions of information. Therefore, we incorporate search and cognitive costs into consumer utility functions.

Assuming that the consumer's utility function is U, consumers gain safety benefits by avoiding food safety risks when they are informed of an unsafe food recall V, and consumers have search costs C_S and cognitive costs C_C for unsafe food recall information. θ dictates the extent of the impact of negative news, $\theta \in [0, 1]$. ν and μ are coefficients, where ν indicates the level of consumer effort in searching for unsafe food recall information; larger ν means more C_S, so C_S is a is a monotonically increasing function of ν. μ denotes the level of cognitive ability of the unsafe food recall information, where larger μ means that the C_C paid to understand the information is lower; thus, μ and C_C are inversely related functions. Consumers are more likely to give up the search for unsafe food recall information as ν increases, and the θ they obtain decreases, so ν is inversely related to θ. When μ is higher, consumers better understand what the recall message conveys and the higher the degree of negative impact they receive, so μ and θ are positively related. For analysis, we construct θ as a one-time linear function, where the implicit condition is that the search behavior precedes the cognitive behavior; if a consumer has a low cognitive ability but requires a high level of effort to produce utility, then that consumer will not engage in the search behavior and θ will be meaningless. Based on the above discussion, this paper constructs Equations 1 and 2 to represent $U_{\max}$ and constraints.

$$U_{\max} = \theta \cdot V - C_S - C_C \tag{1}$$

$$s.t. \theta(\nu, \mu) = -\nu + \mu, 0 \le \nu \le 1; 0 \le \mu \le 1. \tag{2}$$

With the above constraints, we construct a Lagrangian function L. Which is expressed by Equation 3:

$$L = \theta \cdot V - C_S - C_C + \lambda \cdot (\theta + \nu - \mu) \tag{3}$$

We find the first-order derivatives of θ, λ, ν, and μ in the above equation. Which is expressed by Equations 4–7:

$$\frac{\partial U}{\partial \theta} = \frac{\partial}{\partial \theta}\left[\theta \cdot V + \lambda \cdot (\theta + \nu - \mu)\right] = V + \lambda = 0 \tag{4}$$

$$\frac{\partial U}{\partial \lambda} = \frac{\partial}{\partial \lambda}\left[\theta + \nu - \mu\right] = \theta + \nu - \mu = 0 \tag{5}$$

$$\begin{aligned} \frac{\partial U}{\partial \nu} &= \frac{\partial}{\partial \nu}\left[\theta \cdot V - \frac{\partial C_S}{\partial \nu} + \lambda \cdot (\theta + 1)\right] = V \cdot \frac{\partial \theta}{\partial \nu} - \frac{\partial C_S}{\partial \nu} + \lambda \cdot \left(\frac{\partial \theta}{\partial \nu} + 1\right) \\ &= -V - \frac{\partial C_S}{\partial \nu} = 0 \end{aligned} \tag{6}$$

$$\begin{aligned} \frac{\partial U}{\partial \mu} &= \frac{\partial}{\partial \mu}\left[\theta \cdot V - \frac{\partial C_c}{\partial \mu} + \lambda \cdot (\theta - 1)\right] = V \cdot \frac{\partial \theta}{\partial \mu} - \frac{\partial C_c}{\partial \mu} + \lambda \cdot \left(\frac{\partial \theta}{\partial \mu} - 1\right) \\ &= V - \frac{\partial C_c}{\partial \mu} = 0 \end{aligned} \tag{7}$$

As $\frac{\partial C_S}{\partial \nu} > 0$, $\frac{\partial U}{\partial \nu} = -V - \frac{\partial C_S}{\partial \nu} < 0$. As $\frac{\partial U}{\partial \nu} < 0$, an increase in ν decreases U. Therefore, consumers tend to reduce the level of effort to maximize utility. In the same way, it is possible to show that $\frac{\partial C_c}{\partial \mu} < 0$, $\frac{\partial U}{\partial \mu} = V - \frac{\partial C_c}{\partial \mu} > 0$. As $\frac{\partial U}{\partial \mu} > 0$, increasing cognitive ability ν will increase total U. Therefore, consumers tend to increase their cognitive abilities to maximize their utility.

In this study, consumers' effort and cognitive ability for unsafe food recall information were related to the intensity of personalization, professionalism, and intuitiveness of the information itself. Al-Bahrani (60) argues that researchers should emphasize the relevance and potential benefits of information to better communicate effectively with social audiences, while lay people have difficulty in grasping complex concepts and specialized outcomes; moreover, the use of clear and concise language, visual aids such as icons or infographics, and examples, without compromising on accuracy, can appeal to and

motivate people to understand and appreciate the results. Yu et al. (61) argued that innovative new media can more effectively convey information visually than traditional media. Accordingly, we propose the following hypotheses:

> *Hypothesis* 2a: Consumers' access to information on unsafe food recalls can lead to an increase in their own utility.
>
> *Hypothesis* 2b: Consumers tend to choose information that has a high search cost, such as "*Store Quantity*," or a low cognitive cost, such as "*Hazardous substance*" and "*Video style*."

2.3 Altruism, the bystander effect, and unsafe food recall information preference

Hallman et al. (62) suggested that consumers who have fallen ill from consuming unsafe food or whose friends or family members have had such experiences may be more vigilant and concerned about food safety issues. In such cases, if products from a certain brand are recalled, these consumers may receive the news more quickly and take appropriate actions, such as not purchasing products from that brand or promptly checking whether they have consumed the recalled products. If consumers have not experienced similar incidents, they may lack sufficient awareness and vigilance regarding food safety issues and may even ignore recall information (63, 64). This difference may be attributed to the "Bystander effect," as exemplified by the parable of the "Good Samaritan" in Christian culture and the Chinese proverb "It's none of my business" (65, 66). Many scholars (67–69) have argued that Chinese residents exhibit a collective consciousness. This collective consciousness, along with altruism, is a key component of Chinese moral values. Similar conclusions were drawn in studies of Western populations by Van (70) and Persson and Petri (71), who suggested that increased emotional empathy enhances altruistic values. Social norms can help cultivate children's sense of fairness and generosity (72). Children or pregnant women need the care of their families, and families that take on caregiving roles are more empathetic (73).People develop a sense of collective identity during the empathy process, leading to altruistic behaviors (74, 75). Based on this argument, we propose the following hypotheses:

> *Hypothesis* 3a: Consumers who have experienced unsafe food are able to derive more utility from unsafe food recall information than consumers who have not experienced unsafe food, prefer information that is relevant to them, and focus on socially relevant recall information owing to altruism arising from empathy.
>
> *Hypothesis* 3b: Families with pregnant women or children are more likely to empathize and pay more attention to information such as "*Number of food products recalled*" and "*Handling of recalled food*," as2 well as socially relevant recall information such as "*Sales quantity*."

2.4 Education and unsafe food recall information preferences

Education enhances cognitive abilities by improving skills, and those with higher levels of education tend to show greater cognitive functioning throughout adulthood (76). Extensive research has also revealed a positive association between educational level and behaviors such as charitable giving and volunteering, possibly because people with higher levels of education have more altruistic tendencies (77). For example, increasing the years of education positively affects both formal and informal volunteering (78). Individuals who have completed more than 7 years of schooling are more likely to be volunteers and donors (79). Those with higher education donate 77% more to charity than those with primary education (80). A similar pattern exists for Chinese residents, with rural households in some regions individually donating more as the number of years of education increases (81). Three rounds of data from the China Labor Force Dynamics Survey show that the likelihood of sustained household giving increases as the level of household education increases (82). These studies show that well-educated people have a greater cognitive ability to recognize the public interest of society and that the knowledge, moral literacy, and competence gained through education are stronger. Based on this argument, we propose the following hypothesis:

> *Hypothesis* 4: Higher education improves altruistic behavior; consumers with higher education pay more attention to socially relevant recall information such as "*Sales quantity*" and "*Handling of recalled food*" than those without higher education; consumers with higher education have better cognitive abilities and are more receptive to visual "*Hazardous substance*" and new media expressions.

Based on the above analyses, consumers theoretically suffer from cognitive dissonance in the current unsafe food recall disclosure. Thus, improving information disclosure to reduce consumers' search and cognitive costs can increase consumers' utility. Differences in information preferences among consumer groups with different characteristics demonstrate the bystander effect and altruism. Education can play a role in cognitive ability and moral literacy, allowing consumers to show greater altruism in their information preferences.

The research framework is shown in Figure 3.

3 Materials and methods

3.1 Data source

Data were collected through field surveys conducted between 2022 and 2023. A pre-survey sample of 160 questionnaires from Jiangsu and Anhui Provinces was used to determine the final questionnaire and selection set. The formal survey, employing a random sampling method, was conducted from April to July 2023, using face-to-face interviews with one person per household. In some remote western areas, data collection was assisted by recruited surveyors who were trained and supervised in real time by the researchers via phone and WeChat. The questionnaires were cross-checked for quality assurance and labeled, and ineligible questionnaires were discarded. The study covered the Xinjiang Uygur Autonomous Region and Anhui and Jiangsu Provinces, representing western, central, and eastern China, with 300 questionnaires distributed in each region. During the survey, data were collected

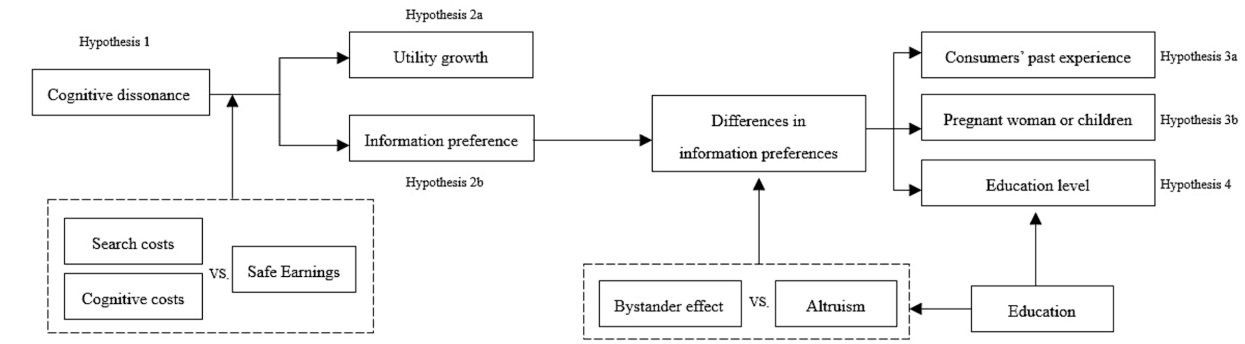

FIGURE 3
Research framework.

sporadically from Ningxia, Sichuan, Yunnan, Guangdong, Zhejiang, and other areas, and supplemented with scattered samples from urban areas provided by the researchers' relatives, friends, and classmates. A total of 1,192 questionnaires were distributed in the formal survey. After removing incomplete or inaccurate questionnaires, 1,010 valid samples were obtained, for a validity rate of 84.73%, ensuring the broad coverage and universality of the sample.

The Chinese government attaches great importance to food safety issues and has revised and improved relevant laws on food recalls multiple times. Once food testing results indicate unsafe conditions, market supervision authorities are responsible for promptly issuing unsafe food recall information to convey food safety risk information to consumers. However, Chinese consumers face low levels of acquisition and cognition of food safety risks (3, 56). Therefore, it is necessary to analyze whether cognitive dissonance exists in consumers' understanding of unsafe food recall information and their actual preferences to enable market supervision departments to improve the disclosure of unsafe food recall information and compel recalls of unsafe food products.

3.2 Correlated variable selection and measurement

3.2.1 Emphasis on quality

This is an important foundational variable in this study. If consumers do not place high emphasis on food quality, they will not care about it. Their survey results were not carefully considered but rather randomly chosen, and the research findings based on this may not convince others. This study follows Nie (83) in assessing consumers' emphasis on food quality, which we measured by asking consumers, "Which of the following pieces of information do you value most when buying food? Please select and rank according to your purchasing habits, or you can choose not to answer." Options include taste, price, quality, brand, manufacturer, shelf life, packaging, and certification, and the score is assigned based on the ranking of the "quality" option by consumers. If consumers do not choose the "quality" option, it is considered not important and scored 0 points; if consumers rank "quality" in nth place out of N choices, the score is calculated as $10 - 9n/N$ (assigning scores from 0 to 9). Table 1 shows that participants' average emphasis on the quality score was 5.020, indicating that their emphasis on food quality was moderate.

3.2.2 Levels of understanding

This is also an important foundational variable in this study. If consumers have a high level of understanding of unsafe food recall information and their understanding aligns completely with the intentions of unsafe food recall information disseminators, there is no cognitive dissonance and no need for further research. This study measured consumers' understanding of unsafe food recall information by asking, "Do you know about food recalls?" and assigning scores based on the consumers' descriptions of this type of information during the interviews (scored from 0 to 3; see Table 1 for details). Table 1 shows that participants' average understanding score of this information is 0.949, indicating that they have a low overall level of understanding of food recalls, basically at the level of not understanding.

This study collected information such as gender, presence of pregnant women or children in the household, educational background, and income of the respondents and elicited whether participants had consumed unsafe food, their level of emphasis on food quality, and their understanding of unsafe food recall information. The demographic characteristics of the survey participants and key variables are summarized in Table 1.

3.3 Experiment design and characteristics

Since 2016, market supervision authorities at all levels in China have announced all food sampling results and comprehensive unsafe food recall information on their official websites. We collected recall announcements regarding unsafe food products from 31 provincial-level market supervision and administration departments in mainland China. The analysis revealed that after detecting unsafe food products through sampling, the content and presentation of the unsafe food recall information announced by local market supervision authorities were not entirely consistent. In particular, in cases of severe quality violations or when the food is widely consumed, the news media may report and track certain batches of unsatisfactory sampled food products. This real-world scenario provides the practical and policy simulation background used in this study. Given that unsafe food recall information, which is crucial negative information in food safety, has not been widely disseminated to consumers, there is a need to organize, analyze, and redesign the relevant elements of unsafe food recall information that consumers are concerned about. This study pre-collected and screened the content of existing information announcements, combined with pre-survey data on unsafe

TABLE 1 Sociodemographic characteristics of the sample.

Variables	Description and assigned values	Mean	SD
Sex	Man = 1; Woman = 0	0.443	0.497
Experience	Whether have bought unsafe food Yes = 1; No = 0	0.560	0.496
Pregnant woman or children	The presence of pregnant women and children in the household Yes = 1; No = 0	0.322	0.467
Educational experience	High school diploma or less = 1; High school or technical secondary school = 2; Regular college or junior college = 3; Postgraduate and above = 4	2.842	0.772
Income (per month)	Below ¥3,000 = 1; ¥3,000–¥5,000 = 2; ¥5,001–¥8,000 = 3; ¥8,001–¥10,000 = 4; ¥10,001–¥15,000 = 5; ¥15,001–¥20,000 = 6; ¥20,001–¥30,000 = 7; more than ¥30,000 = 8	3.941	1.900
Emphasis on quality	The level of attention to quality Score from 0 to 9	5.020	3.103
Levels of understanding	Never heard of it = 0	0.949	0.856
	Have heard of it but do not know about it = 1		
	Know about it but do not know the details = 2		
	Understand it and know what is going on = 3		

food recall information that consumers believe needs to be understood, to form selectable elements for designing choice sets.

3.3.1 Attribute selection

In the first pre-survey phase, we invited 30 primary food purchasers from diverse backgrounds for face-to-face interviews lasting approximately 20–30 min each to understand the key attributes of unsafe food recall information that consumers prefer, allowing them to verbally express the information they desired without providing leading options to prevent distortion of the interview results. This information is classified into three categories (Table 2). For instance, phrases like "How many stores are still selling unsafe food after inspection?" were classified as "*Number of food products recalled*"; "What items were found to be unsafe during inspection and do they pose significant health risks?" as "*Reasons for food recall*"; and "What happens after food is recalled?" as "*Handling of recalled food*."

3.3.2 Level of selection

In the second phase of preliminary research, we randomly selected 80 consumers on the street for face-to-face interactions in which they described and selected details of the unsafe food recall information provided. We sought to identify the description and selection most commonly chosen by consumers, while ensuring that the information levels under the same attribute were mutually exclusive. Regarding the number of unsafe food recalled, we translated the colloquial expression "How many such foods are still being sold in the market?" into "*Sales Quantity*"; "How many unsafe foods are there near my home?" into "*Store Quantity*"; and "How many unsafe foods has this company produced?" into "*Production Quantity*." Concerning the reason for the recall, authentic official announcements presented two forms for testers to choose from: One used text to indicate the hazardous substances found in the food and the degree of harm to humans, referred to as "*Hazardous substance*"; the other used specific numerical values to indicate the items tested in the food, standard levels, and detected levels, known as "*Disqualified item*." Regarding the handling of recalled unsafe food, the investigators showed consumers several announcement formats that appeared on official websites or in the media in different regions. The "*Text style*" displayed the legal provisions and procedures for handling unsafe food without showing the results of the handling process. The "*Image style*" showed pictures of the handling process, indicating that the food had been destroyed, without displaying the legal provisions and procedures for handling. The "*Video style*" showed short videos of the food handling process without displaying the legal provisions for handling. These three methods of handling unsafe foods differ in their contents (see Table 2).

TABLE 2 Selected attributes and levels for experimental design.

Attributes	Attributes levels
Number of food products recalled	Sales quantity Stores quantity Production quantity*
Reasons for food recalls	Hazardous substance Disqualified item*
Handling of recalled food	Video style Image style Text style*
Information fitness(*IF*)	0, 25, 50, 75, 100%

*indicates that the variable is a reference level.

3.3.3 Constraint selection

The disclosure of unsafe food recall information is a public good provided to consumers by the Chinese government. First, we have to make sure that the information provided is complete, so we have to avoid the appearance of "*No-reference information*" when setting the horizontal level. Second, public goods are rights that taxpayers should enjoy, and the government's disclosure of food safety-related information enhances public welfare and is therefore mandatory. As this study simulates policy implementation scenarios to elicit consumer preferences, constraints should not appear. In this study, the "information fitness" of unsafe food recall information to meet consumers' actual needs is a constraint under which consumers choose unsafe food recall information and information composition in the options box. Information fitness was divided into five levels between 0 and 100% by the degree of fitness, such that the higher the information fitness level, the more complete the consumer's unsafe food recall information needs. Consumers may choose whether to refer or not to refer, and the option "I choose neither" is included to provide a real choice environment. In this study, the Alternative Specific Constant (*ASC*), which indicates the strength of consumer preference for unsafe food recall information, was used to replace the constant term when processing the sample.

Full factorial designs can result in consumers being unable to answer a large number of choice sets; therefore, it is more appropriate

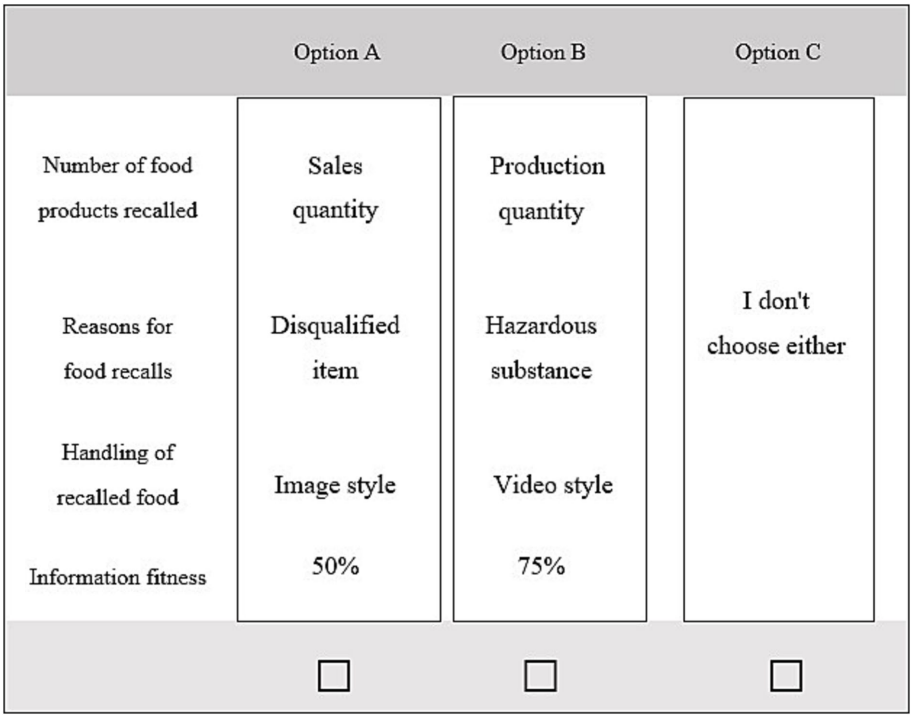

FIGURE 4
Example of a choice set for food recall information.

to use partial factorial designs (84). In this study, an orthogonal design was constructed using D-efficiency, and a stata17 design was used to generate eight choice sets, each containing two alternative options and one *ASC* option. In the third stage of the pre-survey, 50 consumers were invited to comment on the design of the choice sets[2] and the wording and description of the questions in the questionnaire, and corrections and adjustments were made accordingly. The questionnaire ensures that each choice set ultimately maintains a balance in the distribution of all levels for each attribute, that the combinations of different attributes satisfy balance, and that the utility of the alternatives in each choice set is approximately equal (84). To ensure that consumers understood all the available information when presented with the choice sets (Figure 4), explanatory appendices were compiled, providing detailed explanations of each attribute and the specific meanings represented by each level. For instance, under "*Hazardous substance*," we present information such as "Benzoic acid and its sodium salt are relatively safe; a small amount of benzoic acid is non-toxic to the human body and can be excreted through urine. Prolonged excessive intake of food with excessive benzoic acid may have a certain impact on liver function." Under "*Disqualified item*," we display inspection results of a certain soy product, indicating "Disqualified item ‖ Inspection results ‖ standard value → Benzoic acid and its sodium salt (as benzoic acid) ‖ 1.34 g/kg ‖ not to be used." For food recall handling, we downloaded historical data from official websites and media for presentation purposes.

3.4 Empirical model

The general principle of the Discrete Choice Model (*DCM*) is based on Lancaster's (85) random utility theory, which posits that the utility of a good does not come from itself but from the utility attributes that it possesses, and consumers' preferences determine the utility, which in turn affects their payment behavior (86). Therefore, information is an important commodity. There is variability in the utility that consumers derive from similar goods with different attributes. Conventional food safety certification information is optional, and consumers have the right to make their own choices of references when making purchase decisions. However, food companies are obligated to inform consumers when unsafe food is detected under China's recall system, and consumers will maximize their own safety utility in the process of information transfer.

The Discrete Choice Model, based on Luce's (87) Independence of Irrelevant Alternatives (*IIA*) assumption, defines the available profiles of unsafe food recall information, denoted as choice set A, as having J options. Let the n_{th} consumer in scenario t choose the i_{th} information profile from choice set A to obtain the utility U_{nit}. The total utility of the consumer is stochastic and can be divided into

2 In the third stage of the pre-survey process, consumers indicated that options with 0% information fitness and certain level combinations in the initial computer-generated choice set appeared too frequently. This caused sensory discomfort and made them more likely to discard the 0% counterpart of the alternative option during the choice process. Therefore, to prevent the alternative option from being discarded due to external factors, this study avoided the 0% information fitness scenario in the formal study. Additionally, the high frequency of certain combinations in the initial choice set caused respondents to feel bored, making them prefer the *ASC* option or another alternative. As a result, the choice set was adjusted in the formal questionnaire.

deterministic utility V_{nit} and random utility ε_{nit}, expressed as Equation 8:

$$U_{nit} = V_{nit} + \varepsilon_{nit}, i \in A. \tag{8}$$

When the utility obtained by the n_{th} consumer from unsafe food recall information profile i is greater than the utility obtained from another unsafe food recall information profile j ($j \in A$ and $j \neq i$), the consumer will choose unsafe food recall information profile i. The probability of a consumer selecting information profile i in scenario t is represented as the probability formula is expressed as Equation 9:

$$P_{nit} = Prob\left(V_{nit} + \varepsilon_{nit} > V_{njt} + \varepsilon_{njt}\right), i, j \in A \text{ and } j \neq i. \tag{9}$$

In this study, the deterministic utility V_{nit} is a function of the observed levels, referring to *Sales quantity*, *Stores quantity*, *Hazardous substance*, *Image style*, *Video style*, *Informatica fitness* (*IF*), and *ASC*. In Equation 10, the expression of V_{nit} is as follows:

$$\begin{aligned} V_{nit} = {} & ASC + \beta_1 \bullet IF_{nit} + \beta_2 \bullet Sales_{nit} + \beta_3 \bullet Store_{nit} \\ & + \beta_4 \bullet Hazardous_{nit} + \beta_5 \bullet Image_{nit} + \beta_6 \bullet Video_{nit} \end{aligned} \tag{10}$$

The assumption that individual consumers have identical preferences often does not reflect reality. Assuming heterogeneity in consumer preferences, in the deterministic part of utility $V_{nit} = \beta' X_{nit}$, where the random vector β' represents random coefficients following a certain distribution with probability density $f(\beta)$, then the probability of a consumer choosing information profile i is given by Equation 11:

$$P_{nit} = \int \frac{\exp\left(\beta' X_{nit}\right)}{\sum_j^J \exp\left(\beta' X_{njt}\right)} f\left(\beta\right) d\beta_n \tag{11}$$

The above equation represents the mixed logit model (MLM), which allows the coefficients of the explanatory variables to be random, thus overcoming the independence of irrelevant alternative (*IIA*) assumptions (88). The estimated coefficients of this model cannot be directly interpreted in terms of magnitude but rather by the significance and sign of the parameters, indicating preferences relative to the baseline level.

Willingness To Pay (*WTP*) in this study is defined as the extent to which consumers fit to unsafe food recall information disclosure policies, which is expressed by Equation 12:

$$WTP_{ki} = \frac{E\left(\beta_{ki}\right)}{\beta_{IF}} \tag{12}$$

Relative Importance Value (*RIV*) is calculated to measure the relative importance of a certain information attribute within all available levels of unsafe food recall information profiles, indicating the degree of preference consumers have toward that attribute. The relative importance of information attribute k is the result of standardizing the difference between the maximum and minimum coefficients of that factor across the different levels, which is expressed by Equation 13:

$$RIV_k = \frac{\max\left(\beta_k\right) - \min\left(\beta_k\right)}{\sum_k^K \left[\max\left(\beta_k\right) - \min\left(\beta_k\right)\right]} \tag{13}$$

4 Results and discussion

4.1 Consumers have cognitive dissonance

In this study, consumer emphasis on food quality was categorized based on their scores. A score of 0 was defined as "*No emphasis*" (percentage is 15.45%); scores of 1, 2, and 3 were grouped as "*Low emphasis*" (percentage is 16.53%); scores of 4, 5, and 6 as "*General emphasis*" (percentage is 26.34%); and scores of 7, 8, and 9 as "*High emphasis*" (percentage is 41.68%). Figure 2 illustrates the level of understanding of food safety-related information among consumers with different levels of emphasis on food quality in the sample. Across the entire sample, the understanding levels were as follows: Level = 0 (31.74 to 40.38%), Level = 1 (31.95 to 38.48%), Level = 2 (21.38 to 31.14%), and Level = 3 (1.80 to 3.56%). Furthermore, from a statistical perspective, the correlation coefficient between these two variables, tested using Stata17 software, was 0.007, with a p-value of 0.269, indicating a very low correlation. This suggests that consumers' emphasis on quality does not align with their understanding of food safety information, leading to cognitive dissonance. Thus, Hypothesis 1 is validated. Next, we examined consumers' actual cognition and preferences regarding unsafe food recall information, as well as the differences in information preferences among different groups.

4.2 Consumer preference for unsafe food recall information

Table 3 presents the consumer preference results for unsafe food recall information. In this study, *ASC* and *information fitness* (*IF*) were set as fixed parameters, and the other level variables were set as random parameters.

Column (1) indicates that the mixed logit model estimated all fixed parameters to be statistically significant at the 1% level. The coefficient of *ASC* is negative, suggesting that the utility derived from selecting nothing (Option C) is negative, whereas consumers derive positive utility from selecting information combinations (Options A and B). The significance of *IF* at the 1% level suggests that consumers tend to choose information combinations with higher degrees of fit, indicating that a higher degree of fit results in higher utility. Thus, Hypothesis 2a is validated. All random parameters have significant means at the 1% level, indicating significant preferences for the overall sample. The standard deviation of the "*Image style*" variable in the table is not significant, indicating no significant preference compared to the "*Text style*." Compared to "*Production quantity*," Chinese

TABLE 3 Estimates for all samples.

Variables	(1)		(2)
	Mean	*SD*	Mean
Fixed parameter			
ASC	−0.735*** (0.093)		−0.809*** (0.088)
Information fitness(IF)	0.275*** (0.082)		0.225*** (0.077)
Random parameter			
Number of food products recalled			
Sales quantity	0.157*** (0.056)	0.295*** (0.095)	0.139*** (0.051)
Store quantity	0.428*** (0.049)	0.292*** (0.080)	0.354*** (0.043)
Reasons for food recalls			
Hazardous substance	0.656*** (0.049)	1.004*** (0.049)	0.563*** (0.033)
Handling of recalled food			
Image style	0.304*** (0.052)	−0.005 (0.145)	0.246*** (0.049)
Video style	0.248*** (0.039)	0.291*** (0.079)	0.218*** (0.035)
N	24,240		24,240
Log likelihood	−7176.3021		−7349.0990
LR $\chi^2(5)$	345.59		3055.38
Prob > χ^2	<0.001		<0.001

*, **, and *** denote significance at the 10, 5, and 1% levels, respectively.

consumers are most concerned about the quantity of unsafe food in stores relevant to them, followed by the quantity of unsafe food circulating in the market. This finding suggests that consumers prioritize self-interest over concern about the adverse effects of unsafe food on society, which reflects a sense of altruism. Compared with the specific quantity values annotated by professionals for unqualified items, consumers significantly prefer an indication of the degree of harm to the human body caused by "*Hazardous Substances*," even though such descriptions are vague for non-professionals (60). In terms of presenting unsafe food handling, consumers are more inclined to "*Video style*" than "*Text style*." Similarly, Yu et al. (61) argued that innovative new media can effectively convey information visually compared with traditional media. In our interviews, we observed notable regional differences among Chinese consumers in their demand for and perception of recall information. These variations appear to be influenced by regional, cultural, educational, and economic factors. In the eastern region, characterized by international openness, strong interactions between economic and educational development enhance consumer awareness beyond personal interests. Consumers in this region often consider public health-related recall of information alongside individual concerns. In contrast, the central region, an inland area with a more traditional and self-centered cultural orientation, tends to focus primarily on the health hazards of recalled food. This focus may stem from relatively lower levels of economic and educational development compared to the eastern region. Zhang (89) explored this relationship, emphasizing that groups in wealthier regions tend to pay greater attention to food safety issues. Meanwhile, the western region, known for its diverse ethnic composition, exhibits significant individual and cultural differences. Geographic, political, and cultural boundaries in this area lead consumers to prioritize recall information that is directly relevant to their personal circumstances. This finding aligns with the conclusions of Zhou and Liu (90), who argued that food safety in China's ethnic regions, especially in rural areas, is characterized by complexity, cross-boundary issues, and fragmentation. In addition, this study uses a conditional logit model as a robustness check. Column (2) shows that its results are fairly consistent with our other results, indicating that the estimation results are robust.

TABLE 4 RIV for Attributes and WTP for Levels.

Attributes	RIV	Attributes	WTP	95% confidence Intervals
Number of food products recalled	30.83%	Sales quantity	56.91%	[0.195, 0.943]
		Store quantity	155.52%	[0.790, 2.320]
Reasons for food recalls	47.26%	Hazardous substance	238.60%	[1.022, 3.750]
Handling of recalled food	21.90%	Image style	110.37%	[0.465, 1.742]
		Video style	90.04%	[0.265, 1.535]

Table 4 presents the *RIV* and *WTP* for overall consumer estimation. In terms of *RIV*, the rankings are as follows: "*Reasons for food recalls*" (47.26%), followed by "*Number of food products recalled*" (30.83%) and "*Handling of recalled food*" (21.90%). Without considering *IF*, consumers are most concerned about the reasons for problematic food being deemed non-compliant or harmful to human health, followed by concerns about the quantity of unsafe food and whether it poses a threat to personal health or public safety, and lastly, concerns about how the government orders companies to handle recalled unsafe food, including issues such as secondary sales or recycling for further processing. Regarding *WTP*, consumers have the highest surplus for "*Hazardous substance*," followed by "*Store quantity*" and "*Video style*," indicating that the disclosure of information of these types best satisfies consumers' cognition and preferences. The results show that consumers prefer unsafe food recall information, which reduces their search costs and lowers their cognitive costs. Thus, Hypothesis 2b is validated.

4.3 Impact of past experiences with purchasing unsafe food on preferences for unsafe food recall information

Columns (3) and (4) in Table 5 show that consumers without past experience purchasing unsafe food do not prioritize information fitness. Those with such experiences prefer "*Store quantity*," indicating that past experiences increase consumers' concern about information related to themselves. Regarding the reasons for food recall, there was little difference in the preferences between the two groups. However, consumers with past experience clearly showed greater interest in how recalled unsafe food was

TABLE 5 Estimates for consumers' past experience with unsafe food.

Variables	(3) Experience of buying unsafe food		(4) No experience of buying unsafe food	
	Mean	*SD*	Mean	*SD*
Fixed parameter				
ASC	−0.709*** (0.126)		−0.768*** (0.140)	
Information fitness(IF)	0.372*** (0.110)		0.152 (0.124)	
Random parameter				
Number of food products recalled				
Sales quantity	0.172** (0.075)	−0.117 (0.279)	0.135 (0.086)	0.420*** (0.108)
Store quantity	0.460*** (0.066)	0.321*** (0.100)	0.389*** (0.073)	0.284** (0.124)
Reasons for food recalls				
Hazardous substance	0.661*** (0.066)	1.029*** (0.066)	0.655*** (0.072)	0.980*** (0.073)
Handling of recalled food				
Image style	0.354*** (0.070)	0.024 (0.214)	0.240*** (0.079)	−0.020 (0.199)
Video style	0.237*** (0.054)	0.395*** (0.089)	0.261*** (0.058)	−0.023 (0.348)
N	13,584		10,656	
Log likelihood	−3986.7594		−3184.4087	
LR $\chi^2(5)$	207.69		142.50	
Prob > χ^2	<0.001		<0.001	

*, **, and *** denote significance at the 10, 5, and 1% levels, respectively.

handled, and they preferred to receive information in video formats. By contrast, consumers without such experiences showed no clear preferences; they said that how they handled the recalled unsafe food was of little concern to them and that the manner in which they communicated the recall handling information made little difference, as they would not care (insignificant standard deviation). These results were consistent with those of previous studies (62–64). This difference may be attributed to the "Bystander effect." Thus, Hypothesis 3a is validated.

4.4 Composition of household members impacts preferences for unsafe food recall information

Columns (5) and (6) in Table 6 present the impact of the presence of pregnant women or children in Chinese households on the preferences for unsafe food recall information. The results indicate that households with pregnant women or children tend to prefer "*Sales quantity*," "*Hazardous Substances*," and "*Video style*." By communicating with consumers, we identified several reasons for this preference. The presence of pregnant women or children in households prompts them to consider more factors because they are concerned that manufacturers may resell recalled unsafe food after processing it. Additionally, they worry about the possibility of unsafe food from other regions entering the local markets. During these discussions, we found that Chinese households with pregnant women or children tended to exhibit more empathy. They did not want other children or pregnant women to consume unsafe food, demonstrating a certain level of empathy-driven altruism. Conversely, consumers in households without pregnant women or children were more concerned about the presence of unsafe food in their local areas, and showed no significant interest in or preference for information on the handling of recalled unsafe food (insignificant standard deviation). This suggests that they are not concerned about how the recalled unsafe food is handled or whether it is resold or processed again. Previous studies reported similar findings (70, 71, 75). Thus, Hypothesis 3b is validated.

4.5 Influence of education level on preferences for unsafe food recall information

Chinese consumers who agreed to be interviewed were divided into two groups based on whether they had received education at the university or college level. Columns (7) and (8) of Table 7 show that consumers with higher education levels experience increased utility from *IF* improvement, whereas those without higher education do not. Higher education led consumers to pay more attention to "*Store quantity*" information regarding food recalls, indicating a stronger awareness of food safety risks, but they also paid attention to "*Sales quantity*." Upon inquiry, these individuals stated that they were concerned that unsafe foods circulating in the market might be accessed by older adults, children, or individuals with weakened immune systems. They also considered the possibility that these products would be sold at low prices, which could harm financially disadvantaged individuals. Conversely, consumers without higher education only focused on "*Store quantity*," their main concern being whether they or their family members had consumed unsafe food, showing no significant preference for "*Sales quantity*." This suggests that

TABLE 6 Estimates for the presence of pregnant women or children in the household.

Variables	(5) Have pregnant women or children under 12 years old		(6) No pregnant women or children under 12 years old	
	Mean	*SD*	Mean	*SD*
Fixed parameter				
ASC	−0.563*** (0.167)		−0.809*** (0.113)	
Information fitness(IF)	0.373** (0.146)		0.233** (0.099)	
Random parameter				
Number of food products recalled				
Sales quantity	0.311*** (0.102)	0.288* (0.169)	0.088 (0.068)	−0.288** (0.119)
Store quantity	0.550*** (0.088)	−0.224 (0.169)	0.375*** (0.059)	0.339*** (0.087)
Reasons for food recalls				
Hazardous substance	0.719*** (0.084)	0.958*** (0.086)	0.626*** (0.059)	1.030*** (0.060)
Handling of recalled food				
Image style	0.257*** (0.092)	−0.002 (0.184)	0.325*** (0.064)	−0.006 (0.256)
Video style	0.269*** (0.072)	0.431*** (0.110)	0.238*** (0.047)	−0.200 (0.126)
N	7,800		16,440	
Log likelihood	−2288.0311		−4884.3724	
LR $\chi^2(5)$	97.10		248.80	
Prob > χ^2	<0.001		<0.001	

*, **, and *** denote significance at the 10, 5, and 1% levels, respectively.

TABLE 7 Estimates for education level.

Variables	(7) Received regular college or junior college education		(8) Did not receive regular college or junior college education	
	Mean	*SD*	Mean	*SD*
Fixed parameter				
ASC	−0.590*** (0.106)		−1.225*** (0.200)	
Information fitness (IF)	0.341*** (0.094)		0.060 (0.174)	
Random parameter				
Number of food products recalled				
Sales quantity	0.209*** (0.064)	0.267** (0.118)	−0.019 (0.120)	0.282 (0.216)
Store quantity	0.449*** (0.056)	0.303*** (0.091)	0.373*** (0.102)	0.316** (0.152)
Reasons for food recalls				
Hazardous substance	0.686*** (0.056)	1.038*** (0.056)	0.583*** (0.099)	0.887*** (0.104)
Handling of recalled food				
Image style	0.333*** (0.059)	0.017 (0.120)	0.202* (0.116)	0.430*** (0.162)
Video style	0.291*** (0.044)	0.206* (0.122)	0.100 (0.085)	0.422*** (0.134)
N	18,912		5,328	
Log likelihood	−5600.0054		−1563.1292	
LR $\chi^2(5)$	299.54		53.67	
Prob > χ^2	<0.001		<0.001	

*, **, and *** denote significance at the 10, 5, and 1% levels, respectively.

higher education can enhance cognitive empathy among Chinese residents. Consumers with higher education showed a greater preference for video presentations of recall handling information, whereas those without higher education preferred image presentations. The latter group believed that it would take longer to process the information in videos, despite them containing more content than images, considering that images are simpler and more intuitive (91). Thus, Hypothesis 4 is validated.

5 Conclusion

From a theoretical perspective, government-led information dissemination is expected to benefit consumers (2). However, in practice, food recalls for unsafe products in China remain inefficient, with consumers often struggling to access complete recall information (3). This inefficiency reflects shortcomings in China's food safety information governance policies. A key finding of this study is that one-size-fits-all risk communication policies have resulted in cognitive dissonance among consumers by failing to address their diverse information needs and perceptions. Furthermore, cultural, regional, individual, and household factors significantly influence consumer information requirements. By analyzing the heterogeneity of these needs, this study offers valuable insights to enhance government information governance efficiency, improve consumer understanding, reduce potential food safety risks, and support public health initiatives.

This study employs the search and cognitive cost theories to explain and validate consumer preferences for recalling information. Consumers prioritize information such as the reasons for food recalls, the number of food products recalled, and the handling of recalled food. They prefer information with high search costs, such as the "*Store quantity*," and low cognitive costs, such as "*Harmful substances*" and "*Video style*." While consumers tend to focus on information related to personal interests, collectivist values, and moral education also encourage altruistic awareness. For instance, they pay attention to public interest-related information, such as "*Sales quantity*." These findings demonstrate that recall information enhances consumer utility.

This study also examined variations in recall information preferences among different consumer groups. Results revealed a strong preference across all groups for information about "*Hazardous substances*," aligning with cognitive levels and interests. Groups that have experienced harm from unsafe food place greater emphasis on "*Store quantity*" and "*Handling of recalled food*," whereas those without such experiences show less interest in recall process details. This "bystander effect" implies that consumers who have experienced harm are more vigilant about recall information and are more inclined to engage with public health-related information. Moreover, households with pregnant women and children demonstrated stronger preferences for recall information. They not only focus on the "*Store quantity*" but also pay attention to the "*Sales quantity*" of affected food in the market and whether "*Handling of recalled food*" could cause secondary harm to society. In contrast, households without pregnant women or children primarily prefer information about "*Store quantity*." Influenced by traditional cultures and emotional empathy, mothers exhibit a strong sense of collective identity and altruism.

The role of education in recall information cognition was also explored. Results show that individuals with higher education levels not only prefer the "*Store quantity*" but also pay attention to public health-related information, such as "*Sales quantity*." whereas less-educated groups focus solely on "*Store quantity*." This indicates that education positively influences moral awareness and public-interest cognition, fostering altruistic behavior through enhanced cognitive empathy. Moreover, individuals with higher education levels prefer "*Video style*" information presentation, while those without higher education prefer "*Image style*" formats. This finding suggests that higher education enables consumers to comprehend complex new media formats. Therefore, continuously improving education levels can enhance public participation in food safety information governance and improve the ability to process new media information.

6 Policy implications

Based on these findings, we recommend that the Chinese government enhance the systematic and comprehensive disclosure of unsafe food recall information. Improving the transparency and clarity of such disclosures can help consumers better understand the specific reasons for recalls, the scope of affected products, potential health risks, and necessary actions. This would reduce consumers' cognitive and search costs while preventing cognitive dissonance. To address the diverse and complex demands for food safety information, governments can leverage modern technologies such as big data and cloud computing to provide tailored and differentiated information and services for consumers. This approach not only strengthens consumers' right to know but also builds public trust in food safety. In addition to reinforcing oversight of food safety, the government should encourage public participation in food safety monitoring. Increased societal awareness and engagement would contribute to an improved food safety governance system. Our findings, which reveal differing levels of attention to food recall information among various consumer groups, offer new perspectives for fostering societal empathy and compassion. Special attention should be placed on enhancing public food safety education, particularly for households with pregnant women or children, to increase their sensitivity and ability to assess food safety information. This would promote greater public health awareness and elevate health standards. As an open and globally integrated nation, China must align with international standards while considering cross-national differences in addressing the realities of transnational population flows. The government should ensure the complete disclosure of food recall information to foreign residents in China as well as to export destination countries for Chinese goods, thereby upholding its global public health responsibilities.

7 Limitations and future research

This study had several limitations. First, while it examines the role of social media in disclosing unsafe food recall information, it does not further analyze the impact of different social media platforms, such as WeChat groups or TikTok, on consumers' information needs and perceptions. Second, this study focused on aligning the content of information disclosure with consumer needs and perceptions. However, a more comprehensive comparison of dimensions, such as the medium, method, and content of information disclosure, should also be conducted. This would help governments allocate resources and prioritize efforts more effectively across channels. Finally, explanations of regional and cultural differences in consumer perceptions and preferences are primarily derived from qualitative insights obtained through interviews. These insights lack empirical analysis of how factors such as regional culture, economic development, and religious beliefs. Future research should further explore these areas.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval were not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

TL: Conceptualization, Investigation, Writing – review & editing. XJ: Conceptualization, Data curation, Formal analysis, Investigation, Writing – original draft. DZ: Conceptualization, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This work was supported in part by the National Natural Science Fund of China (grant number: 72374105) and National Social Science Fund of China (grant number: 23BJY150).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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frontiers | Frontiers in Public Health

TYPE Perspective
PUBLISHED 19 December 2024
DOI 10.3389/fpubh.2024.1530018

OPEN ACCESS

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RECEIVED 18 November 2024
ACCEPTED 10 December 2024
PUBLISHED 19 December 2024

CITATION
Xue Z, Zheng Y, Wei L, Tian T, Wu J, Jin A and Sun L (2024) Traditional Chinese medicine strategies to optimize antibiotic use and reduce the burden of antibiotic resistance in Chinese children.
Front. Public Health 12:1530018.
doi: 10.3389/fpubh.2024.1530018

Traditional Chinese medicine strategies to optimize antibiotic use and reduce the burden of antibiotic resistance in Chinese children

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Antibiotic resistance is one of the greatest threats to human health, especially children's health. Traditional Chinese medicine encompasses several documented treatments for pediatric infectious diseases. The antibacterial efficacy and potential of traditional Chinese medicine to reverse bacterial resistance are gaining increasing research attention. This study explores the strategies that have been used to implement traditional Chinese medicine to optimize antibiotic use and reduce the burden of antibiotic resistance in children, as well as the challenges encountered. The findings emphasize the necessity for the Chinese government and the health community to take coordinated action, leveraging the unique strengths of traditional Chinese medicine to address the global health challenge posed by antibiotic resistance.

KEYWORDS

traditional Chinese medicine, antibiotic, antibiotic resistance, pediatrics, children

1 Introduction

Antibiotic resistance is one of the greatest threats to human health. A recent study investigating the global burden of antimicrobial resistance showed that an estimated 1.14 million deaths occurred as a result of antibiotic resistance in 2021, and this number is expected to reach 1.91 million by 2050 (1). Antibiotic overuse and misuse are the primary drivers of antibiotic resistance. Therefore, identifying methods to optimize antibiotic use and reduce the burden of antibiotic resistance is crucial.

A recent survey showed that the prevalence of antibiotic use in Chinese children is high. Specifically, the overall prevalence of antibiotic use among outpatients was 63.8%, among inpatients was 81.3%, and at home was 37.8% (2). The 2023 National Antimicrobial Resistance Surveillance Report showed that the detection rates of erythromycin-resistant *Streptococcus pneumoniae* and methicillin-resistant coagulase-negative staphylococci in children were 88.1% and 75%, respectively (3). Notably, the prevalence of erythromycin-resistant Streptococcus pneumoniae in children was higher than in adults and older adults (3). Given the special physiological characteristics of children, antibiotic abuse and misuse not only increase the burden of antibiotic resistance, but they also lead to adverse events and drug toxicity (4). Therefore, optimizing antibiotic use and reducing antibiotic

resistance in children has become an urgent problem that needs to be addressed (5, 6). In line with the objectives of the World Health Organization's Global Action Plan on Antimicrobial Resistance, the Chinese government attaches great importance to the issue of antimicrobial drug resistance.

2 Current strategies of the Chinese government

Traditional Chinese medicine (TCM) is one of the popularly applied health resources across the globe (7). The antimicrobial effects of Chinese herbal medicines and their ability to facilitate the reversal of bacterial drug resistance have become international research hotspots in recent years (8). Chinese researchers have collaborated with the Karolinska Institute in Sweden and the University of Southampton in the United Kingdom to conduct research on the application of TCMs to address the issue of global antibiotic resistance (9, 10).

China has an original advantage in TCM, which is a scientific and technological resource (11). The Chinese government strongly promotes research that contributes to improving the understanding of the role of TCMs in reducing antibiotic use and antimicrobial resistance in children. With the support of the National Key Research and Development Program of China, TCM researchers have conducted demonstration studies on the use of TCMs to reduce antibiotic use for bacterial infectious diseases in children (12). The aim of this demonstration study was to clarify the efficacy and mechanism of action of TCMs and to use this understanding to formulate guidelines for the clinical application of TCMs and produce guiding principles for the co-administration of antibiotics with TCMs. Additionally, with funding from various TCM research projects, TCM researchers have conducted a series of clinical studies, showing that TCM can effectively reduce the reliance on antibiotics and decrease antibiotic resistance in children (13–24) (Table 1).With respect to clinical guideline development, the National Administration of Traditional Chinese Medicine has actively promoted the formulation of 11 diagnosis and treatment plans for dominant pediatric diseases using TCM (25), as well as four guidelines for the clinical application of Chinese patent medicines in treating these diseases (26–29) (Table 2). Furthermore, the China Association of Chinese Medicine has published the "Clinical Practice Guideline on Traditional Chinese Medicine Alone or Combined with Antibiotics for Patients with Acute Upper Respiratory Infection in Children" (30). Additionally, the World Federation of Chinese Medicine Societies has initiated the development of "Clinical Guidelines on Traditional Chinese Medicine Alone or Combined with Antibiotics for Children with Bacterial Acute Tonsillitis, Acute Bacterial Infectious Diarrhea, Acute Bacterial Infectious of the Lower Urinary Tract, and Bacterial Pneumonia" (31).

In terms of policy support, the Chinese government formulated the Implementation Plan for Promoting Traditional Chinese Medicine in the Field of Maternal and Child Health

TABLE 1 Clinical efficacy of TCM: exemplified by the treatment of respiratory diseases in children.

Classification	TCM treatment method	Clinical efficacy
Using TCM alone	Chinese herbal compound (13)	**Acute bronchitis-caused cough in children**: Reduces cough severity, relieves both daytime and nighttime coughs, alleviates thirst and sputum symptoms, and accelerates cough resolution.
	Acupuncture (14)	**Acute purulent tonsillitis in children**: By regulating cellular immunity, it can decrease the level of inflammation in patients and expedite the resolution of symptoms and signs.
	Cupping therapy (15)	**Cough**:Significant improvement in clinical symptom scores.
	Scrape therapy (16)	**Upper respiratory tract infections in children**:Significant fever reduction.
	Infantile massage (17)	**Recurrent respiratory infections in children**: Reducing the number of episodes, relieving clinical symptoms, enhancing humoral and cellular immune functions, and reducing recurrence rates.
	Sachet (18)	**Childhood pneumonia susceptible groups**:Improvement of symptoms during the recovery period of pneumonia, promotion of physical rehabilitation, and reduction of recurrent respiratory infections in people susceptible to pneumonia.
TCM combined with antibiotics	Chinese herbal compound (19)	**Community-acquired pneumonia in children**: Improves clinical symptoms, shortens the course of the disease, reduces the need for antibiotics, and is safe for clinical application.
	Acupuncture (20)	**Community-acquired pneumonia in children**: Alleviating children's clinical symptoms and reducing the use of antimicrobials and the number of hospitalization days.
	Cupping therapy (21)	**Bacterial pneumonia in children**: Significantly reduces the number of days required for complete remission of fever in children.
	Scrape therapy (22)	**Community-acquired pneumonia in children**: Immediate and sustained antipyretic efficacy.
	Infantile massage (23)	**Mycoplasma pneumonia in children**: Improvement of clinical symptoms, restoration of lung function, and significant reduction in the adverse effects of drugs.
Integrated TCM and Western medicine	TCM comprehensive therapy (24)*	**Community-acquired pneumonia in children**: This treatment is effective in improving the signs of pulmonary wet rales in children, and it offers better safety and economy compared to the Western medicine treatment plan.

*TCM comprehensive therapy include Chinese herbal medicine compound oral, external application of Chinese herbal medicine (Chinese herbal medicine acupoint application, Chinese herbal medicine umbilical therapy, and Chinese herbal enema), and TCM techniques (Infantile massage and cupping therapy).

(2021–2025) (32), which encourages the strengthening and optimization of TCM in the field of pediatrics. It encourages the screening of diseases for which TCMs may have significant advantages and good clinical efficacy. Moreover, the plan promotes the use of the "Guidelines for the Use of Traditional Chinese Medicine Medical Techniques and Chinese Patent Medicines in Pediatrics"(33) and supports the in-depth fusion of disease prevention using TCM with children's healthcare services. The Action Plan to Improve Child Health (2021–2025) has been issued (34), which focuses on strengthening TCM services for children and promoting TCM healthcare for children, both within households and in the community as a whole. Continuing to develop and refine the National Action Plan to Contain Antimicrobial Resistance (2022–2025) (35), emphasizes the urgency of strengthening research to develop antibiotics that are suitable for children. Moreover, it specifically mentions the importance of developing Chinese patent medicines as alternative antimicrobials.The Opinions on Promoting the High-quality Development of Children's Medical and Health Services has also been issued (36), giving thorough insights into the distinctive advantages of TCM in safeguarding children's health.

TABLE 2 The treatment of dominant diseases with TCM/Chinese patent medicines.

Classification	Disease
TCM treatment of dominant diseases (25)	Bronchiolitis
	Mycoplasmal pneumonia
	Acute tonsillitis
	Mesenteric lymphadenitis
	Viral myocarditis
	Purpura nephritis
	Acute glomeru-lonephritis
	Primary nephrotic syndrome
	Neurogenic frequent micturition
	Hand-foot-mouth disease
	Infectious mononucleosis
Chinese patent medicine treatment of dominant diseases	Neonatal jaundice (26)
	Acute upper respiratory infection (27)
	Recurrent respiratory tract infections (28)
	Diarrhea (29)

3 Challenges

Fully harnessing the benefits of TCM in safeguarding children's health still faces challenges. The latest China Statistical Yearbook of Chinese Medicine indicates that there are only 0.518 practicing (assistant) TCM physicians per 1,000 people in China (37), but this number is too small to effectively meet the healthcare needs of children. A national survey evaluating the healthcare service capabilities of grassroots physicians revealed that the competency rate for providing TCM services among these physicians is only 52.7% (38), indicating that the capacity for TCM services at the grassroots level is relatively low. Moreover, the health promotion and popularization of TCM are insufficient, as recent survey data indicate that the level of TCM health literacy of Chinese citizens in 2023 was only 24.62%, with television remaining the primary channel for disseminating TCM health knowledge to the general public (39). In addition, among the seven published clinical practice guidelines on TCM alone or combined with antibiotics to treat common infectious diseases, only one is specific to children (30). Therefore, the existing clinical guidelines are not sufficient to meet clinical needs.

4 Future directions

To fully leverage the unique advantages of TCM in reducing antibiotic use in children and lessening the burden of antibiotic resistance, the Chinese government and health community must take coordinated action. First, the size of the TCM workforce should be continuously expanded, and more TCM professionals, especially TCM pediatricians, should be trained to meet the health needs of children with respect to the provision of TCM. Second, the training of grassroots physicians in the knowledge and skills required for the provision of TCM should be strengthened. Moreover, appropriate technology for facilitating the delivery of TCM to children should be promoted. Additionally, the capacity of grassroots medical and health institutions to provide children's TCM services should be strengthened, and children's TCM health services that are equivalent in quality between urban and rural areas should be developed. Third, channels for the dissemination of TCM health knowledge need to be innovated, and new media should be fully leveraged to emphasize the advantages of TCM in the context of children's health among citizens and the community, which would in turn increase the awareness and acceptance of TCM. Moreover, TCM health culture should be comprehensively incorporated into the curricula of primary and secondary schools to cultivate healthy living concepts and lifestyle habits among students. Finally, the development of more clinical practice guidelines on the use of TCM alone or in combination with antibiotics for the treatment of common infectious diseases in children should be prioritized to standardize the clinical use of TCM as a therapeutic approach.

5 Conclusion

TCM plays an irreplaceable role in optimizing antibiotic use and reducing the burden of antibiotic resistance in children. The joint efforts of the Chinese government and the health community will help promote the use of TCM, bringing it to the front line of primary healthcare for children. This will be conducive to lowering healthcare costs, reducing the reliance of physicians on antibiotics when treating pediatric diseases, and preventing the emergence of an even more widespread problem of antibiotic resistance. TCM is not only highly important for enhancing the health of

Chinese children, but it also contributes positively to the vigorous improvement of children's health worldwide.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Author contributions

ZX: Investigation, Writing – original draft. YZ: Investigation, Writing – original draft. LW: Methodology, Writing – original draft. TT: Visualization, Writing – original draft. JW: Visualization, Writing – original draft. AJ: Conceptualization, Writing – review & editing. LS: Conceptualization, Funding acquisition, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This work was supported by the National Key Research and Development Program of China (No. 2017YFC1703202), National Natural Science Foundation of China (No. 82374522), Health Science and Technology Capacity improvement Project of Jilin Province (No. 2022JC042), and the Academic Inheritance and Communication Project of the China Academy of Chinese Medical Sciences (No. CI2022E001XB).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

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frontiers | Frontiers in Public Health

TYPE Policy Brief
PUBLISHED 20 December 2024
DOI 10.3389/fpubh.2024.1501326

OPEN ACCESS

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RECEIVED 24 September 2024
ACCEPTED 25 November 2024
PUBLISHED 20 December 2024

CITATION
Peters BU, McArthur N and Titus A (2024) Strengthening tobacco control research: key factors impacting policy outcomes and health equity.
Front. Public Health 12:1501326.
doi: 10.3389/fpubh.2024.1501326

Strengthening tobacco control research: key factors impacting policy outcomes and health equity

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In this policy brief, we explore several potential drivers of heterogeneity in policy outcomes that can be examined in tobacco control policy evaluations, expanding the evidence base to contribute to continued, equitable progress in reducing tobacco-related health outcomes. We discuss these factors in the context of a hypothetical evaluation of the impact of smoke-free laws on current smoking and quit attempts in the Tobacco Nation. Despite a similar policy environment within the Tobacco Nation, there is variation in the strength of smoke-free law coverage across states. This commentary considers how policy design and other contextual factors, including co-occurring policies, and differential impacts across subgroups, may influence policy-attributable outcomes across time and space.

KEYWORDS

smoke-free, policy, tobacco, smoking, Tobacco Nation

Introduction

The United States (U.S.) has made substantial gains in recent decades in reducing tobacco use and associated health outcomes. This progress has occurred in the absence of strong federal tobacco control laws. States and localities across the U.S. have implemented tobacco control legislation to protect their communities from the dangers of tobacco use and promote public health benefits. However, substantial geographic and sociodemographic disparities in tobacco use impede equal progress. These disparities stem in part from uneven coverage by tobacco control policies across time and space, as some states/localities have particularly strong tobacco control environments, while others have lagged (1). Similar policies may also lead to different outcomes across different contexts. For example, while a number of studies have found that smoke-free laws are associated with public health benefits (2) – including reduced exposure to second-hand smoke, increased smoking cessation, decreased smoking initiation, decreased smoking quantity, and decreased current smoking among adults (3) – findings are not consistent. An interrupted time-series analysis comparing impacts of smoke-free laws across multiple locations found no evidence of changes in trends of smoking prevalence after policy introduction in 13 out of 21 jurisdictions included in the study (4).

The fragmented tobacco control policy landscape creates opportunities to evaluate policy impacts using natural experiment study designs. While there have been many tobacco control policy evaluations, there are also gaps in comprehensively understanding the impacts of tobacco control policies. These gaps intersect with increasingly complex regulatory environments, emerging tobacco products, and widening tobacco-related health disparities, among other factors. In this policy brief, we explore several potential drivers of heterogeneity in policy outcomes that can be examined in tobacco control policy evaluations, expanding the evidence base to contribute to continued, equitable

progress in reducing tobacco-related health outcomes. These drivers include factors related to policy design, co-occurring policies, and heterogeneity in policy outcomes across population subgroups. We discuss these factors in the context of a hypothetical evaluation of smoke-free laws in "Tobacco Nation" (hereafter, TNa), a group of 12 states throughout the U.S. Midwest and South (5). We focus on TNa for two reasons. First, TNa states have higher smoking prevalence compared to the rest of the U.S. (6), underscoring the urgency of understanding how tobacco control policies can contribute to reducing tobacco-related health outcomes in this region. Second, while TNa states have relatively weak tobacco control policy environments overall, there is considerable heterogeneity in smoke-free law coverage across TNa states, which can be examined in a policy evaluation.

Tobacco control policies within TNa

In 2021, TNa states (Alabama, Arkansas, Indiana, Kentucky, Louisiana, Michigan, Mississippi, Missouri, Ohio, Oklahoma, South Carolina, Tennessee, and West Virginia) had the highest adult smoking prevalence in the country with an average of 17.2%, compared to all other non-TNa states with an adult smoking prevalence of 12.6% (6). TNa states also have weak tobacco control policy environments. The American Lung Association (ALA) collates a report card annually that scores every state's tobacco policies and provides letter grades, A (excellent) to F (inadequate) based on policy characteristics (7) across five key areas: prevention and cessation funding, excise taxes, access to cessation services, flavor bans and smoke-free air laws. According to the ALA, all but one of the TNa states (Oklahoma) have F letter grades on their overall tobacco policies (7). There are multiple reasons for weak policy environments in TNa, despite high levels of support within the population for specific tobacco control initiatives (8). Some of these reasons include pre-emption laws that prevent local jurisdictions from implementing strong local tobacco control policies, the influence of the tobacco industry, or economic dependence on tobacco farming, or ineffective local coalitions (9).

Despite an overall 'F' grade in most TNa states, there is considerably more heterogeneity within specific policy domains. For example, six TNa states have implemented comprehensive smoke-free laws, which ban smoking in workplaces, restaurants, bars, and/or other venues. To contextualize smoke-free laws within broader smoking trends within TNa, we analyzed the patterns of smoking prevalence and quit attempt trends pre-and post-smoke-free laws within the TNa states. We focused on describing trends over time, rather than assessing causal impacts or associations with smoke-free laws. Using Behavioral Risk Factor Surveillance Survey (BRFSS) data for all six states with smoke-free laws, we descriptively assessed the yearly weighted prevalence of current smoking (Figure 1) and quit attempts (Figure 2). Current smoking was defined as having smoked 100 or more cigarettes in a respondent's lifetime and smoking 'every day' or 'some days' now and quit attempts was defined as having stopped smoking for a day or longer in the past 12 months because the respondent was trying to quit. Data included 3 years pre-policy and 4 years post-policy; OH (2003–2010), IN (2009–2016), AR

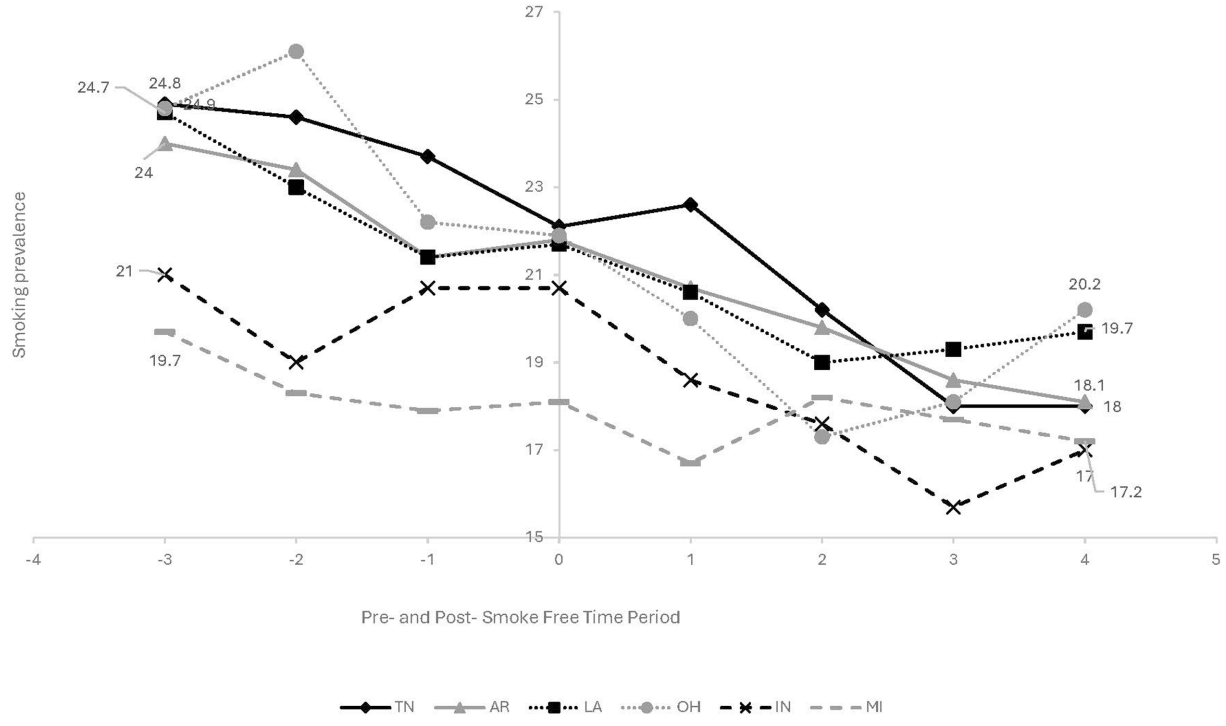

FIGURE 1
Current smoking yearly trends pre-and post-smoke free law among 6 Tobacco Nation States – Behavioral Risk Factor Surveillance Survey. Year policy passed (0)-OH & AR - 2006, TN & LA - 2007, MI - 2010, IN - 2012; shaded area represents the period the smoke-free law was passed. Each State's trend is represented by a unique line style (solid, dashed, dotted) and marker type (circle, square, triangle). Data were plotted directly from raw annual prevalence rates for each state, with no regression modeling performed.

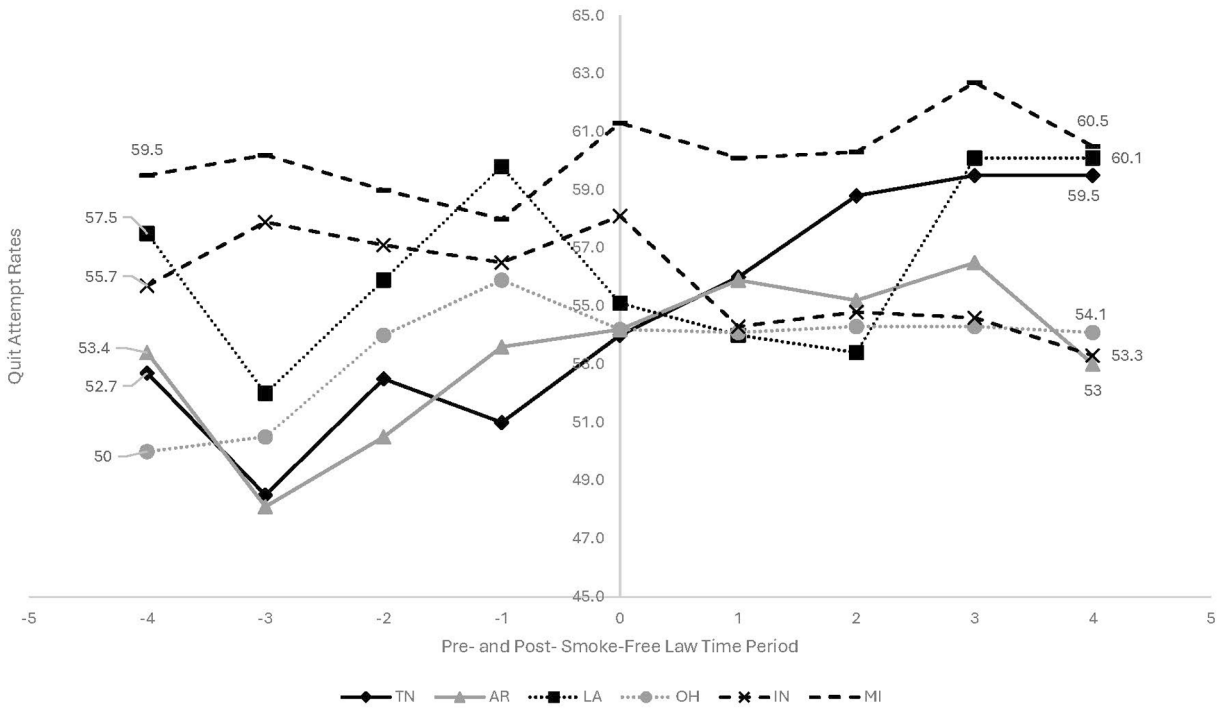

FIGURE 2
Quit attempt yearly trends pre-and post-smoke free law among 6 Tobacco Nation States – Behavioral Risk Factor Surveillance Survey. Year policy passed (0)-OH & AR - 2006, TN & LA - 2007, MI - 2010, IN - 2012; shaded area represents the period the smoke-free law was passed. Each State's trend is represented by a unique line style (solid, dashed, dotted) and marker type (circle, square, triangle). Data were plotted directly from raw annual prevalence rates for each state, with no regression modeling performed.

(2003–2010), TN (2004–2011), MI (2007–2014), and LA (2003–2010). More information on the BFRSS methodology can be found here (10).

There are several takeaways from these figures.

First, in most TNa states, current smoking prevalence was declining and quit attempts were increasing, prior to smoke-free policy adoption. In other words, smoke-free laws were introduced in the context of strong secular trends in combustible tobacco use. Second, despite these overall trends, pre-and post-policy slopes differ across states. The remainder of this policy brief uses this example of smoke-free laws in TNa as a starting point for considering how contextual, policy, and population factors may be incorporated into tobacco control policy evaluations and shed light on drivers of policy effect heterogeneity. We explore three factors: policy design considerations, co-occurring policies, and differential impacts across subgroups.

Policy design considerations

Individual tobacco control policies may vary considerably from one jurisdiction to another. In addition to grading overall tobacco control policy environments, the ALA also grades the strength of policies within each area (e.g., smoke-free laws), shedding light on policy variation across areas. For example, regarding smoke-free laws, grading is based on how many venues are covered and whether e-cigarettes are included in the policy. There is considerable variation in smoke-free policy design across TNa states. While Ohio boasts one of the most robust smoke-free laws in the nation, earning an A grade, other states—Indiana, Arkansas, Michigan, Tennessee, and Louisiana—have weaker smoke-free laws that fully or partially exclude certain venues or exclude e-cigarettes, earning a weaker grade. For example, TN and AR have only partial bans on smoking in restaurants, as restaurants can allow smoking on outdoor patios (7).

When evaluating tobacco control policies, and particularly when combining information across multiple states or jurisdictions, researchers often must make explicit decisions about which types of variation can reasonably be ignored and which types of variation may be relevant to the outcome being studied. However, there is a relatively limited body of evidence for making these judgments. While some prior research suggests that "comprehensive" tobacco laws (e.g., smoke-free laws that prohibit smoking in all public places and workplaces, some including vape products) (11) have a more significant positive impact on health outcomes compared to partial or nonexistent laws, this finding is not consistent (11, 12). Considering various aspects of policy design may be particularly important in the context of emerging tobacco products. For example, in one recent analysis of smoke-free laws, the authors note that their results "do not rule out" the possibility that adding vaping restrictions to smoke-free workplace laws could modestly attenuate the impacts of these laws on current smoking behavior among emerging adults (11). Future studies that further explore variation in tobacco control policies across jurisdictions may shed additional light on the potential for different dimensions of policy design to be salient across a range of tobacco-related outcomes.

Co-occurring policies

Individual tobacco control policies are not implemented in a vacuum. Considering other aspects of the policy environment in a policy evaluation is important for two reasons. First, other policies—alongside other sociodemographic and population characteristics—may be important confounders that could bias the estimated effect of a policy on a health outcome if not accounted for in statistical models. Prior research suggests that many social policies, including tobacco control policies, are highly correlated, and that policy evaluations often may not adequately address such policy co-occurrence, in part because accounting for highly correlated policies could lead to decreases in statistical precision (13). However, recent scholarship has also outlined several approaches for addressing this collinearity, including applying Bayesian methods and evaluating policy "clusters" rather than individual policy interventions (14).

Second, co-occurring policies may be important to consider from the perspective of effect modification or statistical interaction. At present, there is very limited and mixed evidence regarding the impact of policy interactions on tobacco outcomes (15). Studies suggest that the potential for positive synergistic effects of policies may depend on the specific outcome being studied. For instance, in a recent study, smoking bans were independently associated with reduced social smoking, while high excise taxes were linked to reduced heavy smoking. However, excise taxes only seemed to influence reduced social smoking in the absence of a smoking ban (16). On the other hand, other research suggests that the odds of adolescent electronic nicotine delivery system (ENDS) use is lower when smoking bans and age-of-purchase laws are both implemented relative to age-of-purchase laws alone (17). Furthermore, communities with stronger tobacco industry denormalization initiatives (commonly introduced through media and educational campaigns) tend to reap greater benefits from individual or multiple tobacco control policies in place (18). A prior study using BRFSS data found that the extent to which tobacco control laws reinforce one another with regard to lowering smoking rates may vary across population subgroups, including by age and race/ethnicity (19). In the context of TNa, since TNa states generally have relatively weak tobacco control environments, evaluating the effects of smoke-free laws in these states may shed light on policy outcomes in places without strong funding for prevention or cessation services, or other types of tobacco control policies.

Differential impacts across subgroups

Examining the impacts of tobacco control policies on different population groups – particularly groups who have been disproportionately harmed by tobacco – is essential to understanding the impacts of tobacco control policies on health equity. While the TNa region represents a geographic disparity in smoking prevalence, there are disparities in tobacco use within TNa states by urbanicity (20), markers of socioeconomic status (21), and other factors. Increasingly, tobacco control evaluations are examining subgroup variation in policy effects using regression-based strategies, including stratification and interaction models. While these approaches add to our understanding of the impacts of tobacco control policies on health equity, other forms of data collection, including the adoption of implementation science approaches or community-based research principles can further illuminate context-specific factors that influence policy-related outcomes (21). For example, a recent analysis smoke-free policies in public housing developments in New York City paired quantitative and qualitative methods to highlight potential reasons why these policies were not associated with short-term improvements in air quality, including barriers to compliance and enforcement (22). Compliance challenges may extend to other types of smoke-free policies within TNa. A 2007 report from the University of California showed that enforcement for the Ohio smoke-free law started 4 months after the policy implementation. In those 4 months, there were efforts by pro-tobacco interest groups to sow confusion and undermine public support, which subsequently hindered compliance with the law (23). In considering the impacts of policies on health equity, examining subgroup variation and integrating different disciplinary perspectives can shed light on important factors that may drive heterogeneity in policy impacts across groups.

Actionable recommendations

- Studies that use aggregate data from different states and jurisdictions must carefully determine what types of policy variation can be ignored and which is critical to the outcome being observed.
- Particularly in the context of emerging tobacco/nicotine products, there is a need to focus on different aspects of the policy design, e.g., what products, locations, or age-groups are included or exempted. Future studies that examine the variation in policy designs will provide valuable insight into how different elements of policy design impact a variety of tobacco-related outcomes.
- Examining the effect of tobacco laws in TNa states, given their overall weak policy environments, might reveal more about policy impacts in locations without strong funding for prevention or cessation services, or other types of tobacco control policies.
- As we focus on improving policies to achieve health equity, evaluations should examine subgroup variation and incorporate different disciplinary perspectives to reveal key factors that may drive heterogeneity in policy impacts across groups.

Conclusion

Using the example of policy environments in TNa as a starting point, this policy brief highlights how policy strength or other contextual factors can play a role in shaping policy-attributable outcomes across time and space. Several of these factors have been relatively overlooked in the empirical literature. Enhancing data collection, incorporating interdisciplinary analysis approaches, and centering equity in tobacco control policy evaluations can add to the evidence base for reducing the harms of tobacco use and addressing persistent tobacco-related health disparities.

Author contributions

BP: Conceptualization, Funding acquisition, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. NM: Investigation, Visualization, Writing – review & editing, Data curation, Formal analysis, Methodology, Software. AT: Investigation, Visualization, Writing – review & editing, Conceptualization, Writing – original draft.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 09 January 2025
DOI 10.3389/fpubh.2024.1417832

OPEN ACCESS

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RECEIVED 15 April 2024
ACCEPTED 27 December 2024
PUBLISHED 09 January 2025

CITATION
Wei C, Xu J, Wang Z, Wu H and Wang J (2025) How to implement pairing assistance during fighting COVID-19 in China: collaborative governance between local governments under the authoritative regulation. *Front. Public Health* 12:1417832. doi: 10.3389/fpubh.2024.1417832

How to implement pairing assistance during fighting COVID-19 in China: collaborative governance between local governments under the authoritative regulation

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Background: The pairing assistance policy represents a distinctive instrument utilized by the Chinese government to address major public crises. This study examines the development of a pairing assistance policy by the Chinese Government through its central authority to foster collaborative governance among local governments in areas affected by COVID-19.

Methods: The aim of the study was to gain a clear understanding of how the policy of pairing assistance in public health emergencies is successfully implemented through the top-down application of authority. A case study design was used as a methodology to present an explanatory framework for implementing pairing assistance policies during major public crises. We focus on the operational process of pairing assistance, using the assistance provided by Jiangsu Province to Huangshi City in Hubei Province as an illustration.

Results: This paper finds that responding to a crisis requires the guidance of a central authority and the cooperation of local governments. The process is driven by three key factors: the vertical intervention of the crisis, the inevitability of horizontal cooperation and the policy allocation and incentives of the bureaucracy. The three stages of co-operative governance based on authoritative regulation work together in a step-by-step manner to enhance the effectiveness of crisis response.

Conclusion: The results of the study indicate that collaborative governance under the authoritative regulation is the main reason why provincial counterpart support mechanism plays a great role in COVID-19. This study is the first to approach the study of pairing assistance from the perspective of government authority. It broadens the research horizon of local government cooperation and provides a model for future collaboration.

KEYWORDS

authoritative regulation, collaborative governance, pairing assistance, COVID-19, public crisis

1 Introduction

"Pairing assistance" is a distinctive regional cooperation policy unique to China, designed to provide targeted assistance to underdeveloped regions or those facing major crises that they cannot overcome independently. Pairing assistance is a governance mechanism with Chinese characteristics for the horizontal resource transfer and cross-border cooperation in China (1). The mechanism of pairing assistance is a living practice of cross-sector, cross-level and cross-regional coordination in emergency management (2). Its effectiveness was particularly demonstrated during the unprecedented challenge of COVID-19. At the dawn of 2020, the outbreak of COVID-19 in Wuhan, China. In this context, the Chinese government launched an initiative called "Pairing Assistance for Hubei." This initiative orchestrated a strategic allocation of resources by enlisting the support of various provinces to assist 16 cities in Hubei Province (3).

A notable example of this support policy was the dispatch of 310 medical personnel from 10 cities in Jiangsu Province to Huangshi City, Hubei Province, on 11 February 2020 (4). After days of work, the Jiangsu provincial medical team successfully treated 880 cases, achieving a cure rate of over 96% (5). The impact of this intervention was profound, with Huangshi City reporting zero confirmed cases, suspected cases, and close contacts of local COVID-19 cases on 27 March (6). The policy of pairing assistance has proven to be a critical component in China's arsenal against the COVID-19. Faced with a rapid surge in cases and an initially limited effective treatment or isolation strategies, the rapid activation of the pairing assistance policy by the Chinese government was an example of an adaptive and resilient response to the crisis.

Pairing assistance is a policy instrument that is unique within the Chinese governance framework. While scholars have studied local intergovernmental cooperation and regional mutual aid during crises, the Chinese model of pairing assistance stands in contrast to the experience of other nations, such as the United States, a country of comparable economic scale. Studies have indicated that cooperation between local governments in the U.S. has been less effective during crises (7). For example, Mallinson's analysis of the dynamics between federal and state governments during the COVID-19 outbreak revealed a landscape characterized by independent action and a lack of cohesive strategy, leading to the uncontrolled spread of the virus (8). Joyce and Suryo's examination of the legal and financial responses to COVID-19 in the United States highlighted the inadequacy of federal policies and resources to contain the pandemic (9). They found that COVID-19 had continued to spread despite a series of measures enacted by the US federal government and the corresponding financial appropriations passed by Congress. South Korea is one of the few countries that has effectively controlled the COVID-19 in early stages. As a neighboring country to China, South Korea shares a similar crisis culture with China (10). The Korean government has responded to COVID-19 with greater rigor than many other countries. Scholars such as Kim et al. have examined South Korea's crisis response system and found a comprehensive national framework developed through inter-agency cooperation and expert consultation (11). Yoo et al. have further highlighted the roles and responsibilities of various government and private sector agencies in South Korea's response, emphasizing the importance of strong leadership and coordination (12). They emphasize the importance of strong national leadership and coordination in this process. Chen et al. explained the process and effects of China's "pairing assistance" policy during COVID-19, arguing that "the implementing of pairing assistance is a turning point in China's fight against epidemics" (13). Pan et al. examined the activation of the pairing assistance mechanism by the Chinese government in the face of the critical emergency posed by COVID-19, deploying a contingent of over 10,000 medical personnel nationwide to support Hubei Province (14).

Through a case study analysis of Jiangsu Province's assistance to Huangshi City, this paper identifies collaborative governance under authoritative regulation as a critical facilitator of the pairing assistance policy. The findings highlight the potential of such a policy for effective crisis management, particularly in contexts where resources are scarce and the urgency of the situation demands a coordinated and decisive response.

2 Materials and methods

Numbers of studies have attempted to identify the logic and potential of collaborative disaster response through case studies. Smith and Dowell explored the challenges of coordination by examining a railway accident in the UK and identified two key sources of complexity (15). Similarly, Raju and Van Niekerk explored issues of public sector coordination and sustainable disaster recovery through a case study of the Eden District Municipality in South Africa (16). Steigenberger's work provided insights into disaster response coordination through an analysis of multi-agency collaboration in different disaster scenarios (17). Kapucu et al. investigated the collaborative network dynamics between non-established relief groups (NERGs) and other emergency management agencies in the context of Hurricane Irma (18). As Chao has articulated, the case study design is favored for its capacity to provide researchers with nuanced understanding of particular individuals, problems, or unique situations through an intensive and in-depth examination of the phenomenon (19). The utility of case studies in disaster research is well-acknowledged, as they facilitate a detailed analysis of the complex interplay between multiple agencies and levels of governance in disaster response. In keeping with this scholarly tradition, this paper constructs a comprehensive database, the research gathered publicly available information from government websites, relevant news reports, and case data accessible through local health commissions. Through an in-depth examination of textual and quantitative information, this study re-evaluates the introduction, operation, and rationale of the pairing assistance policy, thereby contributing to the understanding of multi-agency and multi-level interactions in disaster response.

The study selected the case of Jiangsu Province's assistance to Huangshi City, Hubei Province, firstly because the COVID-19 was a representative outbreak which, as a spillover crisis, had far-reaching consequences for the whole country and the world (20). China's efforts to control the COVID-19 were a comprehensive process that highlighted the roles and relationships between the central and local governments (21, 22). This process provides valuable insights into Chinese politics and government. At the same time, COVID-19 attracted a high level of social concern (23), and the high level of information disclosure had a direct and far-reaching impact on economic and social development (24). The Chinese government was able to control the spread and number of new

infections within a short period of time, at a time when the Spring Festival in China coincided with a sharp increase in population movement, demonstrating the effectiveness of the pairing assistance policy. The central government designated Jiangsu Province as one of the regions to support Huangshi City, following the principle that the regions should be matched based on their capacities to provide assistance and the extent of their needs. In previous pairing assistance initiatives, Jiangsu Province, as a developed province in China's eastern coastal region, was often paired with regions more severely affected by disasters. On 9 February, 2020, Huangshi City reported 805 confirmed cases of COVID-19. The city's proximity to Wuhan, coupled with its convenient transportation links, meant that a significant number of Huangshi residents worked and lived in Wuhan. Furthermore, the relatively lower level of economic development in Huangshi resulted in a weaker healthcare infrastructure. The return of a large number of migrant workers to Huangshi City further exacerbated the increase in local infections (25). These factors collectively informed our decision to select this case as the subject of our study.

We divide the operation of the pairing assistance policy into three stages, describing the ways in which the Chinese government orchestrates the emergency response behavior of local governments through central intervention and control, culminating in a model of collaborative governance. This paper aims to synthesize relevant theories and research to analyzes the outcomes of collaborative governance under authoritative regulation, building on the successful results of pairing assistance.

3 Results

3.1 Stage 1: launch

In December 2019, an outbreak of the COVID-19 epidemic occurred in Wuhan, Hubei Province, and rapidly spread throughout China, which brings a huge impact on China (26). The outbreak of this highly infectious disease g attracted a great deal of national and international attention. However, this concentration of resources also inadvertently strained the control and prevention capacities of other cities within Hubei Province, highlighting the complex challenges of resource allocation during large-scale public health emergencies. As shown in Table 1, due to geographical proximity and the government restrictions on inter-provincial movement (27), there was a large influx of people from Wuhan to other urban areas in Hubei Province (28). This migration pattern has resulted in the reporting of confirmed COVID-19 cases in other cities in the province, with an observed acceleration in the rate of case increase (29). Despite this, the attention and assistance received by the rest of Hubei Province has been markedly limited in comparison to Wuhan. As the COVID-19 outbreaks in these cities, it became clear that local communities were insufficiently equipped to mount an effective response on their own. The combination of internal pressures and uneven external support acted as a catalyst for local governments to seek additional assistance.

The implementation of the pairing assistance policy was gradually developed under conditions of restricted population mobility. As large numbers of infected people appeared in other cities in Hubei Province, the central government, in an effort to contain the spread of the disease, enacted measures to restrict population mobility, including the imposition of city lockdowns. Pairing assistance served as a complementary policy to these restrictions. It facilitated the transport of medical resources from other provinces to Hubei Province without compromising the effectiveness of disease control and prevention efforts, thus providing a solution to the mobility restriction measures.

3.2 Stage 2: decision

During the decision stage, the central government of each country must play a key role (30). The Chinese central government has multiple roles in the entire process of pairing assistance, from decision-making to implementation. By regulating with authority, it has continuously

TABLE 1 The proportion of people departing from Wuhan to other cities in Hubei Province from January 10th to January 22nd (%).

Xiaogan	10.94	13.80	13.47	12.04	12.64	13.76	12.57	12.56	13.16	14.47	14.24	13.87	13.34
Huanggang	10.52	11.75	11.19	11.39	12.56	13.30	13.35	14.21	14.87	12.20	12.45	13.50	12.95
Jingzhou	5.74	5.91	5.74	5.80	5.84	6.03	6.00	5.93	6.29	6.93	7.29	7.17	7.80
Xianning	5.22	5.95	5.32	4.94	4.97	5.10	4.96	5.07	5.14	4.95	4.75	4.77	4.38
Ezhou	4.12	4.53	4.83	4.77	4.36	4.10	4.04	4.23	4.39	3.91	3.53	3.28	3.26
Xiangyang	4.12	3.92	3.66	3.72	3.68	3.44	3.44	3.58	3.63	3.81	4.08	4.44	4.74
Huangshi	3.42	3.81	3.74	3.70	3.69	3.68	3.84	3.94	4.21	3.75	3.70	3.74	3.40
Jingmen	2.85	2.95	2.72	2.76	2.73	2.82	2.81	2.75	2.96	3.31	3.59	3.76	3.91
Suizhou	2.52	2.71	2.65	2.67	2.68	2.82	2.89	2.98	3.11	3.21	3.38	3.54	3.66
Xiantao	2.38	2.81	2.80	2.66	2.59	2.88	2.80	2.76	2.91	3.07	3.11	3.23	3.19
Yichang	3.08	3.24	2.76	2.43	2.35	2.48	2.50	2.54	2.69	2.95	3.05	3.05	3.49
Tianmen	1.47	1.76	2.01	1.77	1.95	1.97	2.07	1.95	2.10	2.33	2.43	2.28	2.28
Enshi	2.12	1.92	2.11	1.83	1.89	1.79	1.80	1.74	1.80	1.74	1.87	1.83	1.80
Shiyan	2.02	1.85	1.88	1.76	1.65	1.60	1.50	1.56	1.65	1.84	1.97	2.00	1.99
Qianjiang	1.10	1.14	1.28	1.18	1.04	1.01	1.03	1.02	1.03	1.04	1.17	1.19	1.43
	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22

promoted the implementation of the pairing assistance policy. First, as a decision-maker, the Chinese central government takes responsibility for responding for responding to policy appeals from local governments. Upon receiving requests for assistance, the central government conducts a comprehensive assessment of the actual circumstances to determine the appropriateness of a response. Second, as a coordinator, the central government is tasked with making decisions based on the specific conditions in each region. This involves deploying corresponding policies, coordinating relevant relationships, and orchestrating the allocation of resources, thereby acting as the coordinator of policy implementation. Third, the central government also plays a critical role as a supervisor in the implementation of the pairing assistance policy. It is responsible for monitoring the implementation efforts of each region and, if necessary, providing rewards or penalties to ensure the effective implementation of the policy. This supervisory function is essential in guaranteeing that the pairing assistance policy is executed with efficacy.

The COVID-19 outbreak coincided with Chunyun, the period of mass migration for the annual Chinese Spring Festival (31). During this time, a large number of people left Wuhan for other parts of Hubei and other provinces in the country, which may have contributed to the spread of the virus. The Chinese government is facing a challenging internal environment due to a combination of factors: China's economy has come to a standstill due to the strict containment and prevention measures implemented (32). The outbreak has spread throughout the country, increasing fears of a pandemic and resulting in considerable public and media attention. On 20 January, Chinese President Xi Jinping made important instructions on the COVID-19, emphasizing the importance of prioritizing people's safety and health and resolutely controlling the epidemic (33). The safety of citizens' lives is paramount in the prevention and control of COVID-19.

In 2018, the gross domestic product (GDP) of Wuhan was the highest in Hubei Province, equal to the combined GDP of the second to sixth largest cities in the province. This economic disparity is reflected in the healthcare sector, where significant differences in resource allocation are evident. Wuhan, with a permanent population of 11.081 million, has more than thirty A-level tertiary hospitals, while Xiangyang, the second largest city in the province with a population of 5.5 million, has only five such hospitals. This was evidenced by the high number of cases and deaths in cities such as Huanggang, Xiaogan, Ezhou, Tianmen, and Huangshi. These regions, which have a high proportion of migrant workers in Wuhan, were severely affected by the outbreak. Huanggang and Xiaogan consistently occupied the second and third positions in terms of confirmed cases for an extended period. Tianmen, which is at the lower end of the economic spectrum in Hubei, had a significantly higher mortality rate than Wuhan due to its relatively underdeveloped healthcare facilities. In response to Hubei's request for assistance, the central government took 3 days to establish a provincial counterpart support mechanism (Table 2), with 19 provinces supporting 16 cities in Hubei Province, in the form of one province being responsible for one city (34). The elevation of pairing assistance to a "political task "highlights the central government's emphasis on responding to COVID-19.

TABLE 2 Table of cities in Hubei with pairing assistance from each province released by the National Healthcare Commission (Data up to February 10, 2020).

Cities	Confirmed Cases	Supporting provinces
Xiaogan	2,541	Chongqing, Heilongjiang
Huanggang	2,252	Shandong, Hunan
Suizhou	1,049	Jiangxi
Jingzhou	1,045	Guangdong, Hainan
Xiangyang	1,019	Liaoning, Ningxia
Huangshi	805	Jiangsu
Yichang	749	Fujian
Ezhou	725	Guizhou
Jingmen	641	Inner Mongolia, Zhejiang
Xianning	507	Yunnan
Shiyan	481	Guangxi
Enshi	187	Tianjin
Xiantao	416	Shanxi
Tianmen	217	
Qianjiang	85	
Shennongjia	10	Hebei

3.3 Stage 3: implementation

Jiangsu Province, as one of the designated entities tasked with executing the central government's pairing assistance policy, has been instrumental in providing support to Huangshi City in Hubei Province. The commitment to this policy was underscored during a meeting on 10 February, when the Jiangsu Provincial Government emphasized, "We stand shoulder to shoulder, hand in hand with Huangshi, committed to overcoming COVID-19." The Jiangsu provincial government has demonstrated its acceptance to this policy through both political rhetoric and concrete actions. This is evidenced by the following initiatives: First, in response to the pairing assistance policy, Jiangsu Province conducted a special meeting to strategize and deploy the necessary measures for its implementation. Second, the Governor of Jiangsu Province personally saw off the medical team, underscoring the province's dedication to the cause. Third, the provincial government established a high-level emergency command center, which was directly stationed in Huangshi City, to coordinate the assistance efforts effectively.

In the response to the COVID-19, the 13 cities of Jiangsu Province demonstrated a high level of inter-regional cooperation, with hundreds of medical personnel from 13 cities participating in the medical team that assisted Huangshi City (Table 3). From 11 February, when the first group of medical personnel from the Jiangsu-Huangshi medical team left, until 13 April, when all the medical teams returned, the Jiangsu-Huangshi medical team worked tirelessly for almost 2 months. They were stationed at eight designated hospitals, including the Huangshi Central Hospital, where they participated in the treatment of 419 critically ill patients, 860 severe cases, 5,884 moderate cases, and 1,209 mild cases. After the arrival of the Jiangsu-Huangshi medical team, the number of new cases in the local area decreased significantly. Of the 1,015 cases reported in Huangshi City, 86.1% were pre-existing cases before the team arrived (35). Local NGOs also play an important supporting role. For example, volunteer associations in Wuxi have established a partnership with volunteer associations in Huangshi, while Nantong and Huangshi have collaboratively organized the "Jiangsu-Huangshi Festival" in a virtual format. Through these frequent interactions, the local governments are not

TABLE 3 Composition of the first medical team dispatched by Jiangsu Province to assist Huangshi City.

Composition of medical teams	
Cities	Nanjing, Xuzhou, Changzhou, Nantong, Lianyungang, Huai'an, Yancheng, Yangzhou, Zhenjiang, Taizhou
Medical Institution	Jiangsu Provincial People's Hospital, Jiangsu Provincial Hospital of Traditional Chinese Medicine, Jiangsu Provincial Centre for Disease Control and Prevention, The Second Affiliated Hospital of Nanjing Medical University, Jiangsu Provincial Organs Hospital, Jiangsu Provincial Cancer Hospital, Jiangsu Provincial Hospital of Integrative Medicine, Jiangsu Provincial Hospital of Traditional Chinese Medicine, Jiangsu Provincial Hospital of Traditional Chinese Medicine, The Second Hospital of Traditional Chinese Medicine of Jiangsu Province, The Affiliated Hospital of Xuzhou Medical University, The First Affiliated Hospital of Soochow University, The Affiliated Children's Hospital of Soochow University, The Affiliated Hospital of Nantong University, The Affiliated Hospital of Southeast University The Affiliated Yat-Fu Hospital of Nanjing Medical University, Jiangsu University Hospital, Yangzhou University Hospital
Staff	Including 103 doctors, 200 nurses, 4 public health personnel and 3 cadres assigned by the Jiangsu Commission of health, totaling 310 personnel
Age	The oldest is 60 years old and the youngest is 23 years old

only actively demonstrate their commitment to central government but also delivering a sense of warmth to the local communities. This dynamic engagement underscores the proactive approach of local governments in implementing the pairing assistance policy, thereby highlighting the multifaceted dimensions of policy execution that encompass both practical support and symbolic gestures of solidarity.

4 Analysis

The previous case provides an overview of common scenarios in which local governments have taken over directive control from higher authorities in the midst of crises, thereby effectively implementing local cooperative governance mechanisms. This section aims to refine the framework of collaborative governance between local governments under authoritative regulation. This refined framework is posited to elucidate the factors that contribute to the successful execution of pairing assistance policy, thereby providing a structured understanding of the underlying dynamics of policy implementation in contexts of crisis management.

4.1 Authoritative regulation: vertical intervention in crisis

Authoritative regulation is the process by which the central or higher-level governments use the bureaucratic pressure to promulgate policy on particular issues. This process facilitates cooperation with local governments by reallocating authority from the local to the central bureaucracies (36). In China, where the central government has significant influence over key decision-making processes, the implementation of cooperative governance at the local level is largely dependent on directives issued from higher levels of government. To facilitate the way in which local governments work together to address public issues or pursue specific policy objectives, the central government uses a number of measures.

The first policy tool is to focus the attention of governments at all levels. The involvement of local governments in inter-regional governance has the potential to effectively dismantle the traditional management and control governance model that is confined within the boundaries of administrative divisions (37). However, the formation of cooperative relationships between local governments is challenged by a dilemma of "transaction costs," which complicates the establishment of the relationships. Crisis is not only a material fact that affects society (38), but also draws attention to the importance of collaborative governance. The occurrence of crisis enables the central government to focus the attention of governments at all levels, facilitating intervention and the optimization of collaborative governance for major crises across regions.

The second stage is the emphasis on political discourse. The establishment and maintenance of government authority is crucial to the formation of authoritative regulation, which is continuously interpreted, upheld, and solidified within the practice of national governance. While adapting to the changes of the times, the Chinese government has enhanced the central government's influence over local jurisdictions and strengthened its control through the innovation of systems and mechanisms. In achieving this objective, it has also ensured the vitality of local governments. The tax-sharing reform of the 1990s serves as an example of this governance practice.

The third element concerns the establishment of principal-agent relationships. China's decentralization model exhibits characteristics of a principal-agent relationship (39). The central government coordinates and plans national public affairs, and regulates policy implementation based on actual diverse choices to achieve strategic objectives. Local governments, functioning as extensions of the central government, primarily act as the entities responsible for policy execution. In the process of bureaucratic coordination for crisis prevention and control, the Chinese government's approach to governance predominantly adopts a "pressure-based system combined with campaign-style governance," which swiftly and effectively mobilizes various elements of governance (40).

4.2 Collaborative governance: horizontal synergies in a crisis

According to Chris et al., "Collaborative governance, as it has come to be known, brings public and private stakeholders together in collective forums with public agencies to engage in consensus-oriented decision making" (41). Kirk et al. argued that collaborative governance broadly as the processes and structures of public policy decision making and management that engage people constructively across the boundaries of public agencies, levels of government, and/

or the public, private and civic spheres in order to carry out a public purpose that could not otherwise be accomplished (42). In the Chinese context, collaborative governance is a model that spans the boundaries between government and society, and aims to protect the public interest while achieving a win-win situation for all parties involved. Previous experiences have shown that relying solely on traditional national approaches is inadequate in responding to complex crises (43). The characteristics of an infectious public health emergency have a significant impact and can cause spillover effects (44). This type of public crises often requires collaborative governance, which needs institutional mechanisms for collaboration, multi-level and effective cross-sectoral leadership (45).

The basic premise for collaborative governance among local governments is, first, the shared vulnerability to trans-boundary crises. The governance of public crises inherently possesses a cross-regional character. The public crises often arise from the confluence of multiple risk factors, rendering them intricate, diverse, and unpredictable (46). Such crises can manifest both within specific regions and across regional boundaries, with the latter transcending the confines of traditional administrative jurisdictions and necessitating collaborative regional governance strategies. Second, the uneven distribution of governance resources presents significant challenges in public crises. Effective crisis management demands substantial governance resources, which are frequently in short supply across different regions. The disparity in the distribution of governance resources across regions is pronounced (47), with less developed regions exhibiting significantly lower capacity for risk bearing compared to their more developed counterparts, thereby rendering them more susceptible during crisis response efforts. Meanwhile, public choice theory posits the existence of an "economic man" (48), implying that local governments are likely to pursue cost minimization and may adopt a "free rider" strategy in the face of crises. Consequently, the governance of crises necessitates the coordination of intergovernmental relations to ensure a cohesive and effective response.

The second element to consider is the strong foundation for cooperation inherent in China's political system. The systemic advantages of the Chinese model, characterized by the "national system," the ethos of "the whole nation working in unison," and the capacity to "marshal the resources necessary to undertake grand endeavors," empower the Chinese government to mobilize administrative resources and public authority swiftly (49). Concurrently, the establishment of a series of laws and regulations, such as the Emergency Response Law of the People's Republic of China and the National Emergency Response Plan for Public Health Emergencies, signifies the institutionalization of pairing assistance in public crises. On the other hand, China's cultural tradition, epitomized by the adage "Sailing in the same boat and helping each other," boasts a rich historical heritage, and the principle of "When one side is in distress, all sides offer support" has long been a societal consensus in China. Culture plays a key role in crisis response (50). This collectivist approach to disaster response provides a significant cultural and societal foundation for the application of pairing assistance, thereby facilitating its practical implementation.

The third foundational element is the practical experience. David Miller noted that "within a community, the likelihood of cooperation is enhanced by a higher level of trust" (51). The concept of paring assistance has been an important part of the Chinese Government's policy agenda. Over the course of several decades, the practice of pairing assistance in ethnic and border areas has evolved, with notable examples including the "Great Western Development Strategy" (52). Similarly, pairing assistance for major projects was manifested in the implementation of the Danjiangkou Reservoir Project (1973) and the Three Gorges Dam Project (2003) (53). Pairing assistance in disasters and emergencies was also mobilized in response to the outbreak of Avian Influenza A (H1N1) outbreak in 2009. The policy program of pairing assistance, a unique feature of China's governance approach, has been implemented over many years and has accumulated considerable practical experience.

4.3 Driving mechanisms: policy allocation and incentive in the bureaucracy

The driving mechanism underlying the governance framework can be divided into two distinct components. The first component is the policy allocation within the bureaucratic structure. Bureaucracy has been characterized as a complex, hierarchical system of governance designed for the purpose of policy decision-making (54). Bureaucratic institutions operate under the regulatory authority of the central government, which has the power to define issues, allocate attention to different issues, and control and realign key tasks. In times of crisis, central government facilitates the implementation of mating support policies by allocating resources and reinforcing policy directives through increased vertical intervention.

The second component is the incentives and constraints inherent in the system. n China, career advancement within the bureaucracy is influenced by the institutional landscape of political centralization (55). The central government directly influences the promotion of local government officials (56). Within the Chinese governance apparatus, higher-level governments evaluate the performance of critical policy tasks and key policy decisions when considering the appointment or dismissal of officials. Historically, during major public crises, officials are given increased responsibility and a high degree of trust (57). Exceptional performance in crisis management can serve as a direct pathway to promotion. The mechanism of incentives and constraints for lower-level governments is strategically designed by higher-level governments to "reward diligence and punish indolence" through appointments and dismissals. Given the measurable and highly visible outcomes of pairing assistance missions, their successful implementation can easily serve as a basis for career advancement.

4.4 Mechanism update: collaborative governance under the authoritative regulation

Bryson and colleagues note that multisectoral governance approaches have matured in response to major challenges such as natural disasters, rising inequality and deteriorating health systems (58). These approaches are often conceptualized under the rubric of collaborative governance (59). Pairing assistance becomes essential when dealing with crises that have impacted or have the potential to affect multiple regions or even the whole country. The provision of assistance in the wake of major public crises is not just a consequence of central government regulation; it is also a practical imperative for

local governments to collaborate in addressing these crises. Central government can achieve effective governance of public crises through authoritative regulation that encourages cooperative behavior between local government. Defining specific governance objectives can mitigate the tendency of local governments to engage in speculative behavior within the framework of authoritative regulation. Authoritative regulation can serve to complement and facilitate horizontal cooperation between local governments, playing a pivotal role in its enablement.

As shown in Figure 1, we have refined the original collaborative governance model to elaborate a novel framework for collaborative governance under the authoritative regulation. The initial stage, called the launch stage, is characterized by the outbreak of a public crisis, triggered by natural disasters or public health incidents, which initially manifests in one or more districts. Local governments are often ill-prepared for such emergencies due to the abrupt nature of the outbreak, leading to the spread of the crisis. As the impact of the major public crisis intensifies, the capacity of local governments to manage the situation diminishes, increasing the risk of adverse spillovers. At the same time, secondary crises, such as economic downturns (60), begin to emerge, compounding the crisis. As public crises exceed the capacity of local governments, and as the crisis expands, higher levels of government become involved. Reflecting the situation to higher levels of government and requesting assistance becomes the only viable option for local governments.

Moving on to the second stage, the decision step involves the assessment by the higher-level government of whether to provide assistance to the requesting jurisdiction. This decision should be based on a comprehensive assessment of the request, based on the specific circumstances of the crisis, to determine the appropriateness of activating pairing assistance. Following the evaluation, the higher-level government should set explicit objectives for cooperative governance in response to the major public crisis facing the requesting government and proceed to enact an appropriate cooperative governance. The central government, exercising its authority and taking into account the specific circumstances of each local government, designates supporters for crisis governance. Each supporting government is assigned specific tasks, establishing a one-to-one cooperative relationship between the supporting and requesting parties. At this point, collaborative governance moves into the implementation phase, as the two basic requirements—well-defined objectives and well-defined relationships—have been established.

Throughout the implementation stage of collaborative governance, the supporting government provides the recipient with governance resources, including personnel, material and financial support. It also sets up a coordination mechanism to facilitate collaboration around specific tasks. Throughout this process, the central government monitors the interactions between local governments and mediates any conflicts that may arise, thereby ensuring the integrity and stability of the cooperative relationship. The existing cooperative relationship is continuously refined in response to the evolving situation to ensure the seamless fulfillment of crisis governance objectives. It is important to note that collaborative governance in public crises is often of a temporary nature. Nevertheless, the collaborative efforts during this period can lay the foundation for a lasting cooperative relationship between the parties, which can have a positive impact on fostering ongoing interaction between them.

5 Conclusion and discussion

5.1 Key results

Pairing assistance in public crises is a quintessential form of collaborative governance under authoritative regulation. In contemporary society, major public crises span multiple academic disciplines and transcend various boundaries (61). For example, COVID-19 has rigorously tested the emergency preparedness efforts of governments at all levels, especially at the local level (62). This study, seeks to synthesize previous research on pairing support during public crises, using collaborative governance under authoritative regulation as a conceptual framework. The validity and applicability of this framework is substantiated through case reviews and

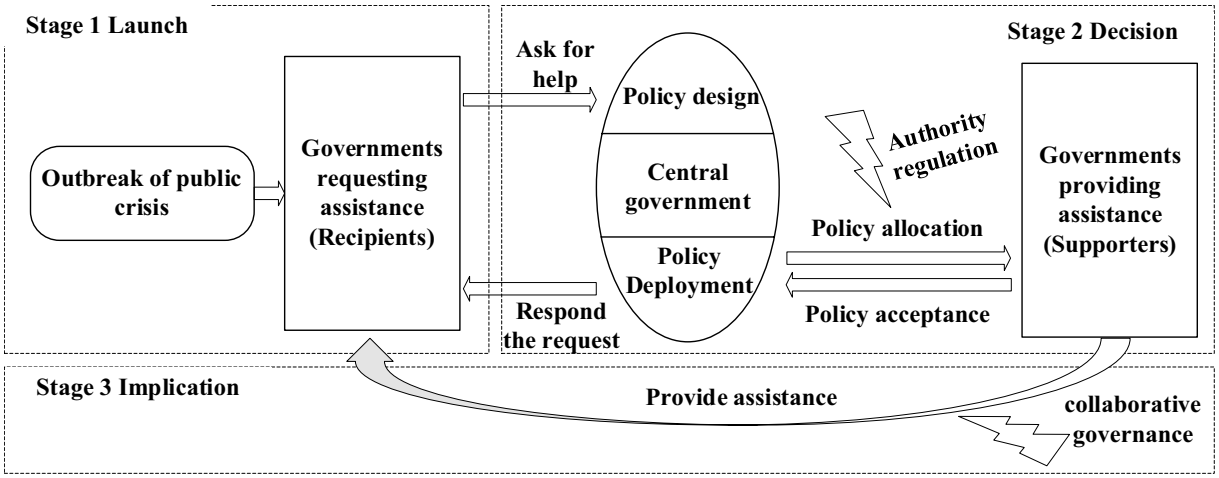

FIGURE 1
Operational model of collaborative governance under the authoritative regulation.

discussions, and offers utility and guidance for future research in the area of central-local partnerships and crisis response.

This research extends the understanding of the pairing assistance system by examining the practical outcomes of Jiangsu Province's assistance to Huangshi City in Hubei Province through a detailed case study. It also introduces an analytical framework relevant to collaborative governance under authoritative regulation. The argument argues in this paper is that crisis response requires the guidance of a central authority in conjunction with the cooperation of local governments. This process is motivated by three key factors: the vertical intervention of the crisis (including the intensification of political discourse and the reinforcement of principal-agent relationships), the inevitability of horizontal cooperation (including the nature of transboundary crises, the foundation for cooperation, and the accumulation of practical experience), and the policy allocation and incentives within the bureaucracy (including policy allocation mechanisms and the interplay of incentives and restraints).

The three stages of cooperative governance, based on authoritative regulation, operate in a sequential manner to enhance the effectiveness of crisis response. Given the limited and uneven distribution of crisis management resources across regions, local governments may find it difficult to manage major public crises independently, necessitating collaboration with other government agencies. Although local governments may have a common interest in crisis response and a willingness to cooperate, the collaborative management of public crises may be hampered by factors such as a lack of willingness to cooperate, local opportunism and the risks associated with cooperation, which make it difficult to reach agreements. The authoritative government, typically the central government, can facilitate the resolution of barriers to collaborative governance among local governments. By setting governance objectives and delineating specific governance tasks through its authority, the central government can transform the potential cooperative tendency of local governments into actionable behavior, thereby effectively achieving the cross-regional deployment of crisis governance resources.

In conducting this case study, we found that a distinctive feature of pairing assistance during the epidemic is the delegation of resource allocation authority from the central to the local level, with specific assistance plans communicated and negotiated between the providing and receiving jurisdictions. In some provinces, such as Jiangsu, cities at the prefecture level are responsible for implementing assistance after receiving requests for assistance. Hubei Province, the center of the epidemic, is located in the central region of China, and Wuhan is a strategic crossroads linking several provinces. The high volume of population movement facilitates the rapid spread of COVID-19, particularly as it coincides with the Chinese Spring Festival, a period characterized by mass migration in a short period of time. The uncontrollable nature of COVID-19 is thus magnified exponentially. Given the severity of the epidemic and its propensity for widespread transmission, the task of epidemic prevention transcends provincial boundaries and requires assistance from other provinces. Subjectively, the implementation of pairing assistance in the wake of the epidemic outbreak has a strong political significance in China. Faced with the sudden emergence of COVID-19, the Party Central Committee and the State Council, adhering to the principle of prioritizing people's well-being and lives, are compelled to act swiftly to contain the spread of the virus, alleviate social panic and minimize its negative impact on the functioning of society. Systematically, the central government is exercising its authority to mobilize local governments to form pairing assistance, thereby achieving an efficient and rational allocation of resources across different regions and effectively responding to major public crises such as COVID-19.

5.2 Policy side effects

When dealing with major public crises and emergencies, China's model of pairing assistance is undoubtedly a viable tool for other nations to consider. From this case study and historical precedents, it is clear that targeted assistance can significantly aid the response to public crises. However, it is important to recognize that no system is universally effective. The system of pairing assistance following a public crisis is no exception, and it may have certain side effects.

First, there is uncertainty about the effectiveness of pairing assistance. While previous research has largely emphasized its positive outcomes, a practical perspective reveals that pairing assistance can facilitate the rapid recovery of production and daily life in recipient areas in the short term. However, it is imperative to acknowledge and address potential problems. For example, research suggests that the intensity of aid provided by coastal provinces following the Wenchuan earthquake exceeded the standards set by the central government, potentially leading to the "Dutch disease" in the short term due to local competition (63). The influx of large-scale aid projects has resulted in a surge in prices in the post-disaster reconstruction areas.

Second, the application of pairing assistance in epidemic response presents specific challenges that cannot be overlooked. For example, when the aid-providing jurisdiction itself is affected by an epidemic, the outflow of epidemic prevention forces and resources may compromise the local ability to manage the crisis. The process of cross-regional mobility may give rise to new outbreaks of the epidemic. Particularly at the outset of COVID-19, the highly contagious nature of the virus poses a risk of infection during the supply of aid, the deployment of aid workers to affected sites, and the transfer of close and sub-close contact cases within aid locations. In additioon, the assistance agencies assume considerable risks in the execution of their duties, which extends beyond the provision of financial and material support to necessitate courage and perseverance.

Third, there is an absence of comprehensive legal protection for pairing assistance. The current practice of pairing assistance resembles a political task promoted by the Party Central Committee and the State Council to be undertaken by local governments, rather than a legally binding obligation. There is currently no clear legal document in China to confirm and limit this policy.

Fourth, the sustainability of pairing assistance remains a subject of debate. From a practical point of view, pairing assistance depends on pressure mechanisms such as political authority, target setting and accountability to encourage local governments to fulfill their responsibilities. Local governments are expected to comply with administrative directives from superior and central government authorities. The provision of support, including medical supplies, daily necessities, and medical personnel, often involves substantial unpaid investments with limited prospects for return, leading to potential sustainability challenges. As a result, the initiative and enthusiasm of the supporting parties may be constrained, posing challenges to the long-term viability of the pairing assistance model.

5.3 Limitation and future research

Due to the constraints of information availability, material resources, and the scope of this study, certain aspects were not discussed in detail. China has demonstrated considerable success in managing epidemic prevention efforts through the mechanism of pairing assistance. However, this model has distinctive Chinese characteristics, and its replicability in other countries around the world may be influenced by a variety of factors, including cultural context and political infrastructure. Despite these considerations, the concept of pairing assistance offers a viable and optional strategy for the effective prevention and control of similar events in the future. The unique characteristics of this approach, while shaped by the specific context of China, may still provide valuable insights and a potential framework for international cooperation in the face of public health crises. Further research is encouraged to explore the adaptability and applicability of pairing assistance in diverse settings, thereby contributing to the global repository of knowledge on crisis management and cooperative governance.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

CW: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. JX: Data curation, Formal analysis, Validation, Writing – review & editing. ZW: Conceptualization, Methodology, Resources, Writing – original draft. HW: Data curation, Methodology, Resources, Writing – review & editing. JW: Data curation, Resources, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This article was funded by the Fundamental Research Funds for the Central Universities of China, the grant number is 2020ZDPYSK08, 2023ZDPYSK10. It was also supported by the National Social Science Fund Youth Project of China, the grant number is 19CGL059.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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frontiers | Frontiers in Public Health

TYPE Study Protocol
PUBLISHED 30 January 2025
DOI 10.3389/fpubh.2025.1490244

OPEN ACCESS

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RECEIVED 02 September 2024
ACCEPTED 14 January 2025
PUBLISHED 30 January 2025

CITATION
Lontano A, Regazzi L, Tona DM, Di Pumpo M, Porcelli M, Cacciuttolo MG, Parente P, Gasbarrini A, Grandaliano G, Panocchia N, Lopetuso L, Pasciuto T, Cadeddu C, Bruno S, Laurenti P, Pascucci D and Pastorino R (2025) Digital integration between hospitals and local health authorities for enhanced vaccination coverage among frail patients: the CareVax study protocol.
Front. Public Health 13:1490244.
doi: 10.3389/fpubh.2025.1490244

Digital integration between hospitals and local health authorities for enhanced vaccination coverage among frail patients: the CareVax study protocol

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Background: The 2022–2025 Italian Plan for vaccine prevention (PNPV), recognizes vaccine-preventable diseases (VPDs) as significant contributors to mortality, morbidity, and healthcare expenditure. The digitalization of the national vaccine registry is underway. Initiatives aimed at enhancing digital integration between hospitals and territories are limited, and there is still a gap in the development of automated systems for identifying patients who could benefit from vaccinations directly offered from hospitals.

Methods: Adult frail patients who access the hospital will be recruited over 4 years, following the acquisition of informed consent. With the assistance of a privacy-preserving automated algorithm, electronic hospital and vaccination records will be utilized to assess eligibility for vaccinations against *SARS-CoV-2*, *Herpes Zoster*, *Influenza*, *Streptococcus pneumoniae,* and *Hepatitis B*. Eligible patients will be invited to schedule a vaccination appointment and will be asked to fill in a questionnaire evaluating patient-reported experience measures (PREMs). Outcomes of interest are the feasibility of the pathway, patients' satisfaction and concerns with it, and its impact on vaccination coverage.

Ethics and dissemination: The study has been approved by the ethics committee of the "Fondazione Policlinico Universitario Agostino Gemelli" -FPG- (comitato.etico@policlinicogemelli.it), with approval number 5819. Furthermore, it has been published on ClinicalTrial.gov with the approval number NCT06127563.

The results of the study will be disseminated via conference presentations and peer-reviewed publications.

Clinical trial registration: ClinicalTrials.gov, identifier NCT06127563.

KEYWORDS

vaccination, digital public health, hospital-territory integration, fragility, primary prevention

1 Introduction

The 2022–2025 Italian Plan for vaccine prevention (PNPV, Piano Nazionale Prevenzione Vaccinale), furthering the legacy of the 2017–2019 PNPV and accordingly with the guidelines of the 2030 Agenda for Immunization, recognizes vaccine-preventable diseases (VPDs) as significant contributors to mortality, morbidity and healthcare expenditure. It also defines populations at higher risk of developing VPDs, susceptible to complications and severe sequelae (1–3).

Individuals at increased risk include those with chronic diseases (e.g., cardiorespiratory, neurological, metabolic, neoplastic, and immunological diseases), severe disabilities (physical, sensory, intellectual, or mental), pregnant women, and those more susceptible to severe disease due to age (4).

The Global Vaccine Action Plan 2011–2020 urged countries to achieve a 90% coverage threshold with all vaccines in their national immunization program by 2020 (4). In this context the pandemic had mixed effects, accelerating the development of innovative prevention paradigms such as COVID-19 online vaccination booking and in-hospital immunization while, on the other hand, leading to a significant decline in vaccination coverage across all age groups (5).

In response, the PNPV underscores the urgency of implementing initiatives for accessible vaccination options, bringing them closer to patients at treatment centers, including Hospital, General Practitioners' offices and Community Health Houses (6–8).

Since the reform of Title V of the Constitution in 2001, delocalizing competence over healthcare, there has been a marked regionalization of the Italian health system, with only a few regions being able to boast collaborative examples between local health authorities and hospitals to enhance vaccination coverage in particular categories of patients. Even then these models often lack the feasibility for broader application to other contexts and do not rely on integrated information systems to improve efficiency and optimize the allocation of resources (9).

Mission 6 of the National Recovery and Resilience Plan (PNRR) aims to capitalize on healthcare delivery opportunities presented by technological innovations, emphasizing the analysis of clinical and administrative data flows (10). Italy's delayed digitization process in healthcare, compared to other European countries, necessitates a strategic focus on technology-enhanced healthcare initiatives (11).

Currently, Italy is in the process of digitizing the Vaccine Registry in accordance with the 2022–2025 PNPV, intending to create a Digital Vaccine Record. Accessibility varies across regions, with some offering comprehensive access through Electronic IDs (e.g., SPID, Public system for electronic identification) (12) while others limit access to anti-COVID-19 vaccinations (13, 14) or require contact with the Health District. Lombardy region (14) even provides vaccination information via a QR code, akin to the European Green Pass for anti-SARS-CoV-2 vaccination.

Regarding vaccine booking, some regions offer digital platforms (15–17), but no automated systems are in place to identify patients eligible for vaccination based on specific risk factors.

The challenge lies in improving the identification of patients eligible for vaccination, a key barrier to better vaccination strategies for frail populations. Currently, no fully automated digital systems to identify eligible patients within integrated frameworks are described in the literature. However, existing examples of hospital-based vaccination show promising potential and could serve as foundational steps toward increasingly digitalized models.

Hospital-based vaccination is critical for reaching at-risk groups, encouraging vaccine uptake through patient trust in healthcare providers, and benefiting from hospital logistics. In Italy, while initiatives such as those described by Veronese et al. (18) and Ridolfi et al. (19) show promise, they remain largely manual and lack integration with community health systems.

Globally, similar challenges exist. In the United States, Canada, and Australia, hospital-based programs for vaccines like influenza and pneumococcal disease are common but lack automation and integration with national registries (20). For instance, a 2023 Portuguese study (21) on diabetic patients used hospital reminders but required vaccines to be administered in community centers. Similarly, the PANDA II study (22) in China provided hospital-based influenza vaccinations but lacked automation or coordination with community services.

In the United States, interventions such as nurse-led models, patient reminder letters, and physician prompts have improved vaccination rates (23, 24). However, these efforts are not automated or integrated with local health systems, limiting their scalability and overall impact.

1.1 Primary objectives

The CareVax study (Caring for frail patients through vaccination) aims to evaluate the feasibility of implementing a privacy-preserving integrated hospital-territory pathway for vaccinations against influenza, pneumococcal disease, Herpes Zoster, Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), and Hepatitis B Virus (HBV). These vaccinations have been selected through a joint

Abbreviations: CareVax, Caring for frail patients through vaccination.; FPG, Fondazione Policlinico Universitario "A. Gemelli" IRCCS, Rome; ASL Roma 1, Local Health Authority Roma 1; PNPV, Italian National Plan for Vaccine Prevention (Piano Nazionale Prevenzione Vaccinale); HBV, Hepatitis B Virus; VPD, Vaccine Preventable Disease; PNRR, National Recovery and Resilience Plan, Italian implementation of NextGenerationEU; eID, Electronic Identifier; SPID, Sistema Pubblico Identità Digitale, a form of eID; SARS-CoV2, Severe Acute Respiratory Syndrome Coronavirus 2; CEMAD, Center for Diseases of the Digestive System; HBM, Health Belief Model; ICD9CM, International Classification of Diseases 9 - Clinical Modification.

evaluation with the involved hospital departments and the competent Local Health Authority (ASL Roma 1) because they are included in the national prevention plan, lack sufficient coverage at the local level, and can help reduce the burden of care for the participating hospital departments, thereby increasing safety, quality, and appropriateness of care. The underlying hypothesis is that the establishment of an in-hospital pathway, supported by an automated alert system for clinicians, may facilitate the development of a personalized vaccination program for vulnerable patients requiring hospital care.

1.2 Secondary objectives

The secondary objectives of this study are to verify the effectiveness of enhancing vaccination coverage among frail patients and to assess their opinions on vaccination and the vaccination pathway.

2 Methods

2.1 Study design

CareVax is designed as a Single-Arm, Pre-Post Intervention Study.

2.2 Population

The CareVax model will be tested within the teaching hospital Fondazione Policlinico Universitario Agostino Gemelli IRCCS (FPG) located in the Metropolitan Area of Rome (in the Lazio Region). The departments of Internal Medicine & Gastroenterology, Geriatric Internal Medicine, Nephrology, Gynecologic Oncology, and Dermatology have agreed to partake in the study, hence only their patients will be enrolled.

2.3 Study duration

The study will last for 4 years.

Patient recruitment will occur throughout the entire study period, utilizing a dynamic cohort approach.

2.4 Inclusion criteria

Patients who:

- are treated in one of the departments involved in the study.
- are over 18 years old.
- have their medical residence in Lazio Region, as only the regional vaccine registry is accessible.
- provide informed consent to be enrolled in the study.

2.5 Procedures and collected variables

The personalized vaccine pathway, exemplified in Figure 1, involves the following procedures and collected variables:

I Informed consent for algorithm screening and patient contact:

- Patients visiting the inpatient and outpatient clinics of the participating departments will be informed about the study. Those who express interest in participating will provide written informed consent, which will be recorded using a REDCap electronic Case Report Form (eCRF). This consent will enable the retrievement of information on their health status, relevant risk factors, and vaccination history from the Institutional ERP (Enterprise Resource Planning) TrackCare. The data will then be analyzed by a well defined algorithm to determine their eligibility for a personalized vaccine offer. Additional details about the use of the REDCap eCRF are provided in a dedicated section.
- The consent will also grant FPG personnel the permission to contact patients feligible for specific vaccinations according to the algorithm output.

II Algorithm operation:

- The algorithm, based on national guidelines on vaccinations, utilizes a decision tree incorporating data on age, season (e.g., for influenza), Regional Disease Exemption Codes (25) and ICD9-CM (26) codes for procedures and diseases increasing the risks posed by VPDs (such as cardiovascular diseases, diabetes, immunosuppressive drugs therapy, malignant neoplasms lung diseases, kidney failure or dialysis). The algorithm has already been developed using SAS code by the Information and Communication Technology team at FPG, accessing data directly from the hospital's IT system. It operates in with a privacy preserving approach exclusively on patients who have provided informed consent.
- Data retrieved from the Hospital Information System are cross-referenced with the Regional Vaccine Registry to exclude vaccines already received.
- If direct information is unavailable (for example pregnancy status, type of diabetes), surrogate data, such as access to gynecology-obstetrics departments or recent delivery, may be used.

III Algorithm output:

- The algorithm will periodically generate a list of patients eligible for each vaccine, which will be recorded directly in the eCRF. This list will present their health records and highlight the specific conditions that warrant vaccination.
- Physicians at the FPG vaccination center will review this list, flagged by an alert on the eCRF, and, in accordance with the PNPV national guidelines (3), reassess vaccination indications to determine the appropriate administration setting.

IV Patient contact and vaccination sessions:

- Eligible patients will be contacted directly by physicians from the vaccination center via phone calls (mobile or landline) to assess their interest in receiving the recommended vaccinations. Patients will be able to discuss the benefits and risks of the proposed vaccination(s).
- Vaccination sessions will be booked by the physician who contacts the patient, based on the severity of the patient's condition and the

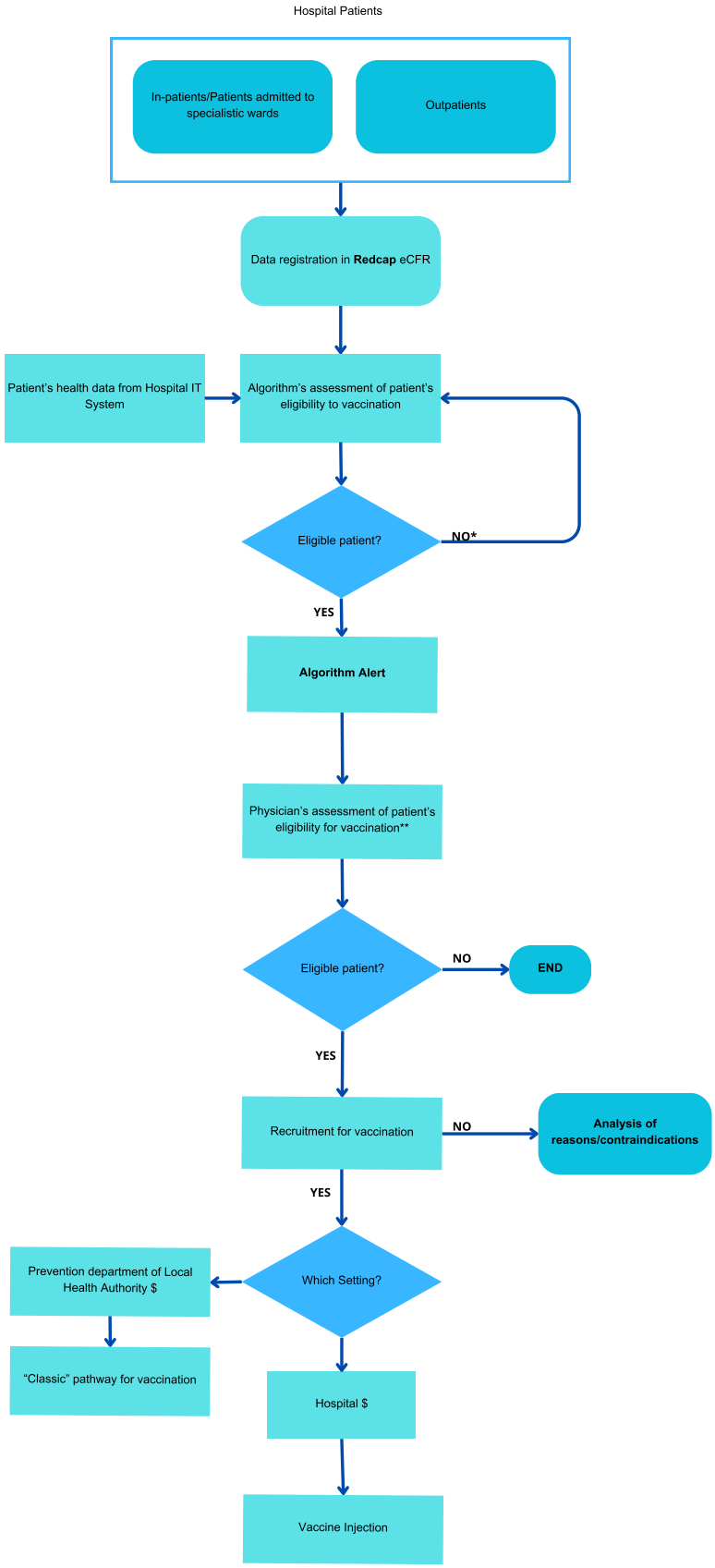

FIGURE 1
Personalized vaccine pathway.

physician's clinical judgment. Patients with more complex conditions will be scheduled for vaccination at the hospital vaccination center of FPG, while those with less severe conditions will be referred to vaccine centers of Local Health Authority ASL Roma 1. Based on the appointment date, patients will arrive to receive the vaccination in the setting determined at the time of booking.
- Where feasible, a co-administration schedule for multiple vaccines in the same session will be employed, as performed during previous vaccination campaigns at FPG (27).

V Clinical reassessment and informed consent:

- In both hospital and local health authority settings, vaccination physicians will reassess the vaccination indications for algorithm-identified patients.
- Vaccination physicians will administer informed consent specific to vaccinations.

VI Post-vaccination questionnaire:

- Following vaccination, patients will complete a questionnaire assessing satisfaction with organizational aspects, healthcare personnel, and opinions on vaccinations (Supplementary File S1) using the Health Belief Model domains (28), which will also be recorded in the eCRF.

A pilot study will be conducted with 10 participants to ensure that all aspects of the personalized vaccine pathway are thoroughly evaluated and validated. This initial phase aims to identify potential challenges and refine the procedures, thereby enhancing the overall feasibility of the pathway prior to its full implementation.

2.6 Patient protection and confidentiality

The processing of the personal data of patients taking part in the study, and, in particular, regarding data concerning consent, shall comply with European Regulation on the Privacy of data (UE 2016/679) (29). Investigators will guarantee that all persons involved in this study will respect the confidentiality of any information concerning the study. All parties involved in this study will maintain the strict confidentiality to assure that neither the person nor the family privacy of the patient participating in the study is violated; appropriate measures shall be taken to avoid the access of non-authorized persons to the study data. The patient can withdraw consent whenever s/he wants and further data will not be collected (unless they accept to still be contacted for long term outcomes), even if the already collected data will be used for the analyses of the study. Clinical data already collected will be destroyed only if the right to be forgotten will be requested according to GDPR-22 (30). In this case, to comply with regulatory obligations, the progressive patient ID, will be maintained, and the reason for withdrawal will be recorded in the electronic eCRF.

2.7 Data collection and management

A customized eCRF will be created for the study. Data will be collected and managed using REDCap electronic data capture tools hosted at https://redcap-irccs.policlinicogemelli.it/. The REDCap (Research Electronic Data Capture) is a secure, web-based software platform fully compliant with the 21 CFR Part 11 and GDPR and designed to support data capture for research studies, providing:

- an intuitive interface to acquire validated data;
- audit trail to monitor data handling and export procedures;
- automated export procedures to download data into common statistical software;
- data integration procedures and interoperability with external sources (31).

The research core facility Data Collection of the Scientific Technology Park of Fondazione Policlinico Universitario A. Gemelli-IRCCS is in charge for the management of REDCap platform used for the study. This facility is focused on collecting and managing research data for all no-profit projects of the above mentioned Institution in compliance with good clinical practices (GCP), current legislation on data protection (GDPR), and data quality, assessed through Accuracy, Completeness, Consistency, Integrity, and Timing (ACCIT) criteria (32–34).

Recorded information is confidential and the database is privacy-protected; i.e., no data can be traced back to the patient in research reports and no unauthorized individuals may have access to the data about individuals in the database. Only people officially registered as investigators or data managers will receive a user login to access with a multifactorial authentication the REDCap web platform and enter/manage data.

2.8 Data quality and standards

The eCRF will be designed according to protocol, dataset set-up and validation, edit checks programming. Only when reviewed and fully tested, the dataset will be activated to receive the data. The Investigators involved in the study will be responsible to ensure that the CRFs are properly and completely filled in. CRFs must be completed for all patients who have given informed consent. Sources of clinical information include the physician's patient record, hospital notes, original laboratory records. Data will be entered into the CRF in a truthful, accurate and timely manner and each participating Investigator will be responsible for ensuring data quality. Personal medical information may be reviewed to ensure patients' safety and will always be treated as confidential. Whenever possible, data will be imported directly from institutional management systems through interoperability processes.

During data collection a remote monitoring and data quality rules will be activated to manage discrepancies and inconsistencies, and to generate queries. The "Data Resolution Workflow" module will allow a workflow for documenting the process of resolving issues with data in the project (i.e., opening, responding to, and closing data queries). Different user privileges may be given to users that control whether users can view, open/close, or respond to data queries.

2.9 Endpoints

The feasibility of the pathway will be assessed on various levels, encompassing the integration of digital systems, the practicality of

proposed interventions to implement the integrated hospital-territory pathway, patient participation, and the effectiveness of enhancing vaccination coverage.

2.9.1 Primary endpoints

2.9.1.1 Integration of digital system

- Concordance between the clinician's and the algorithm's judgments on patient eligibility for vaccination, measured on a sample of patients.
- Proportion of vaccinations confirmed by physicians compared to those proposed by the algorithm.

2.9.1.2 Practicality of proposed interventions

- Number of patients successfully contacted to offer a vaccination appointment after being considered eligible compared to the number of patients flagged by the algorithm.

2.9.1.3 Patient participation

- Number of patients consenting to vaccination appointments compared to the number of patients contacted.
- Number of patients presenting to vaccination centers (Hospital or Local Health Authority) compared to the number who have booked a vaccination appointment.
- Number of patients who drop out or are lost to follow-up versus the total number of patients recruited in the study.
- Number of patients who agree or strongly agree with the questionnaire's statements on the algorithm, the clinical pathway, and the medical personnel (Sections A and B of the attached questionnaire – Supplementary File S1).

2.9.2 Secondary endpoints

- N° anti-influenza vaccinations at 6, 12, 24 months.
- N° anti-pneumococcal vaccinations at 6, 12, 24 months.
- N° anti-Herpes Zoster vaccinations at 6, 12, 24 months.
- N° anti-SARS-CoV-2 vaccinations at 6, 12, 24 months.
- N° anti-HBV vaccinations at 6, 12, 24 months.
- Percentage increase in the number of patients vaccinated against influenza/Pneumococcus/Herpes Zoster/SARS-CoV-2/HBV at 6, 12, and 24 months compared to the baseline vaccination rate, measured within the same cohort of patients. This baseline will be established from the initial vaccination rates within the same cohort of patients enrolled prior to the implementation of the personalized vaccine pathway.

2.10 Statistical plan

2.10.1 Sample size calculation

Participation in the study will be offered to all eligible patients referred to the involved departments during the study period, with an expected number of 1,500 subjects. This sample size is sufficient to detect a 10% increase in vaccination coverage from 50% before the intervention to 60% after the intervention, with a significance level of 0.05 and a power of 80% using McNemar's test for paired data.

2.10.2 Statistical analysis

The sample recruited in the study will be described in its clinical and demographic characteristics using descriptive statistical techniques. In particular, qualitative data will be expressed as absolute and relative percentage frequency, while quantitative variables with mean and standard deviation or median and interquartile range, as appropriate. Algorithm-physician agreement will be evaluated with Cohen's k coefficient. To evaluate changes in vaccination coverage before and after the implementation of the new pathway, we will use McNemar's test for paired data. For each vaccination the comparison with baseline values will be conducted at 6, 12 and 24 months post-implementation. Additionally, to evaluate the impact of different factors on vaccination uptake over time, we will use a mixed-effects logistic regression model. This model will account for both fixed effects (such as time, gender, and age) and random effects (to handle the correlation of repeated measures within participants). We will also consider additional potential confounding factors such as socioeconomic status, access to healthcare, and prior vaccination history. By including these variables, we will examine whether they contribute to variations in vaccination coverage over time, identify significant trends or disparities, and adjust for any confounding influences that might affect the outcomes of the vaccination program.

Descriptive statistics will be performed on the questionnaire designed to assess satisfaction with organizational aspects, healthcare personnel, and opinions on vaccinations (Supplementary File S1).

The statistical analysis will be conducted using StataCorp 2023. Stata Statistical Software: Release 18. College Station, TX: StataCorp LLC.

3 Discussion

The CareVax study endeavors to assess the feasibility of establishing an integrated hospital-territory pathway for vaccinations targeting influenza, pneumococcal disease, Herpes Zoster, Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV-2), and Hepatitis B Virus (HBV) for vulnerable patient populations, intercepted in hospital and supported by the assistance of an automated alert system.

As the place where a significant portion of frail patients seek treatment, the hospital setting may represent a potential focal point for improving vaccine coverage. However, even if about 50% of hospital patients have been estimated as being eligible for pneumococcal vaccination, as of today limited efforts have been directed toward reaching this population (35). The provisions of the new PNPV seek to address this gap by promoting a vaccine distribution strategy aligned with patients' points of care.

Hospitals, often overlooked as vaccination sites in Italy, can play a pivotal role in this process. Various hospital-based vaccination plans have already proven effective, including opportunistic vaccination pathways and the utilization of standard operating procedures to enable allied professionals to gather patient history, obtain consent, and administer vaccines themselves (36–38). Similarly, automated algorithms have been validated to identify eligible patients for vaccination, presenting a promising tool to remind clinicians of the possibility of offering specific vaccinations to selected patients (24, 39, 40).

CareVax has macro-level implications, as it could represent a exemplary organizational model, useful for cost containment and computerized exportability in various public health domains beyond vaccinations. At the meso level, it constitutes a fundamental tool for increasing vaccination coverage and achieving vaccination coverage goals set by Regions and, consequently, Local Health Authorities within the Vaccination Prevention Plans. A similar integrated model might serve as a stimulus for mapping the information systems of hospital and territorial facilities, identifying common elements and obstacles to be resolved to ensure their interoperability.

Finally, at the micro level, CareVax represents an opportunity to improve the quality of care and patient satisfaction, increasing their engagement and participation in primary prevention programs. Similarly, such a project increases awareness and enables the active involvement of clinicians in primary prevention practices, which are often overlooked in favor of less effective secondary or tertiary prevention practices.

CareVax effectively addresses several shortcomings in existing international vaccination protocols by implementing a fully integrated digital infrastructure that seamlessly connects hospital and community health services. Unlike the manual or partially digitized systems commonly observed in other countries (20–24), CareVax leverages an advanced automated algorithm to identify at-risk patients based on their clinical profiles and vaccination histories, minimizing delays and inefficiencies. By streamlining patient selection and enabling the delivery of personalized vaccination offers, this system empowers dedicated clinicians to efficiently manage alerts, follow up with patients, and provide tailored vaccination options directly within the hospital setting. This integrated and innovative approach not only enhances accessibility and adherence but also lays the groundwork for broader public health improvements through better vaccination outcomes.

This protocol builds upon this foundation by presenting the design of a comprehensive computerized system aimed at increasing vaccination coverage, a step forward compared to the analogous or non-integrated experiences previously described in the literature (18–24). In addition, our algorithm holds promise for cost-effective implementation in major Italian hospitals and might serve as a potential model for smaller institutions. Furthermore, other strengths of our study lie in the extensive patient volume treated in the FPG, which can provide a robust study sample, and the extended duration of the study, which enables the assessment of the program's impact over time.

However, the large size of FPG could also pose an issue, as some elements of the model may not align with realities with a simpler organization, necessitating adaptations. Similarly, even in hospitals of comparable size, some rearrangements of the model might be needed to adapt the model to other data frameworks (e.g., other proprietary EHR software), especially for data extraction. On the same line, the use of ICD9-CM codes will facilitate the model's diffusion in Italy, but it represents an obstacle to international exportation, where more updated and/or country-specific versions of ICD codes might be employed.

The protocol is also limited by its monocentric design, which might hinder the generalizability of findings across the country, and by the involvement of a selected number of departments that were opportunistically chosen, which might further compromise the generalizability of results.

Similarly, the inclusion of both inpatient and outpatient patients will ensure an equal representation of different care settings and of different care needs in the project, increasing the overall generalizability of results. At the moment, privacy laws in Italy, particularly concerning the processing of certain categories of data (such as those related to HIV positivity), present challenges for proactive initiatives like CareVax, leaving some very frail patients potentially excluded from their benefits. However, the CareVax system will be sufficiently flexible to include this kind of data, should these restrictive laws be reassessed in the future.

A valid criticism of CareVax might be that, despite its claim of offering an automated solution, it still necessitates a substantial amount of human effort. However, as healthcare digitization advances, the potential for easier patient contact and vaccination appointment scheduling becomes apparent, contributing to the widespread dissemination of personalized vaccine offers. The creation of a national vaccine registry, currently in progress, will make it easier to access information on patients' vaccination status, allowing this model to be extended to patients without a family doctor in their region of residence.

In conclusion, this study contributes a novel approach to increasing vaccination coverage, offering a potential paradigm shift in public health practices. Despite its limitations, CareVax holds promise for broader application, emphasizing the need for ongoing refinement and adaptation to various healthcare settings.

Ethics statement

This study has been approved by the ethics committee of the "Fondazione Policlinico Universitario Agostino Gemelli" (comitato.etico@policlinicogemelli.it), with approval number 5819. Furthermore, it has been registered on ClinicalTrial.gov, with the identifier: NCT06127563.

Author contributions

AL: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. LR: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. DT: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. MPu: Conceptualization, Methodology, Writing – review & editing. MPo: Conceptualization, Methodology, Writing – review & editing. MC: Conceptualization, Methodology, Writing – review & editing. PP: Methodology, Writing – review & editing. AG: Methodology, Writing – review & editing, Supervision. GG: Methodology, Writing – review & editing, Supervision. NP: Methodology, Writing – review & editing. LL: Methodology, Writing – review & editing. TP: Methodology, Writing – review & editing, Writing – original draft. CC: Methodology, Writing – review & editing. SB: Methodology, Supervision, Writing – original draft, Writing – review & editing. PL: Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing. DP: Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing, Conceptualization. RP: Methodology, Supervision, Writing – review & editing, Project administration, Writing – original draft.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This research was co-funded by the Complementary National Plan PNC-I.1 "Research initiatives for innovative technologies and pathways in the health and welfare sector" D.D. 931 of 06/06/2022, DARE-DigitAl lifelong pRevEntion initiative, code PNC0000002, CUP: (B53C22006400001).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2025.1490244/full#supplementary-material

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 21 February 2025
DOI 10.3389/fpubh.2025.1519981

OPEN ACCESS

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RECEIVED 30 October 2024
ACCEPTED 10 February 2025
PUBLISHED 21 February 2025

CITATION
Stöllman Å, Stoetzer U, Svartengren M and Molin F (2025) Organizational factors behind low sickness absence in Swedish municipalities—An explorative qualitative study. *Front. Public Health* 13:1519981. doi: 10.3389/fpubh.2025.1519981

Organizational factors behind low sickness absence in Swedish municipalities—An explorative qualitative study

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Introduction: This study explores organizational factors that contributes to low sickness absence in Swedish municipalities.

Methods: A qualitative, explorative design was used, including semi-structured individual interviews with 63 managers across 12 municipalities with either high or low sickness absence. Interviews were conducted with Human resources managers, Administration managers and Unit managers in senior care and schools.

Results: The results revealed that municipalities with low sickness absence demonstrate leadership practices that emphasize proximity and accessibility, promote employee development, integrate systematic work environment management, including employee participation into daily routines. Additionally, an open and effective communication was identified as a crucial factor in fostering sustainable organizations. The results show that municipalities with lower sickness absence rates tend to have more sophisticated organizational strategies, especially in clear and manageable areas, it requires strategic planning and well-defined structures.

Discussion: A recurring theme in the analysis is the proximity and interconnectedness observed in leadership, communication, and employee participation, with leaders that show a high degree of involvement in day-to-day activities. This "proximity principle," emerges as a potential significant factor influencing health outcomes in working life.

KEYWORDS

public organizations, organizational factors, organizational health, leadership, employee participation, communication, psychosocial work environment, systematic work environment management

1 Introduction

Sickness absence is a significant issue for many organizations, not least public organizations, affecting not only the health and wellbeing of employees but also organizational productivity and financial stability. It can have significant negative impacts on both employees and organizations, including decreased productivity, higher healthcare costs, increased personal suffering, and reduced employee morale. Despite this, some public organizations, such as municipalities, have managed to achieve low levels of sickness absence (1, 2).

Sweden comprises 290 municipalities, which bear the primary responsibility for delivering a majority of public services. Certain obligations are mandated by law, encompassing critical areas such as schools, day-care centers, senior care, social services, urban planning, emergency services, and libraries. Municipalities are governed by elected

politicians, while day-to-day operations are managed by a variety of employees at different hierarchical levels. Legislation and national guidelines regulate these activities in a uniform way across the country, despite significant variations in geographical size, population structure, and labor force size (3). The sizes of the workforce in the municipalities exhibit substantial diversity, ranging from 299 employees in the smallest municipality to 43,308 employees in the largest (4).

Although sickness absence is mostly related to sickness, its causes are multifactorial, relating to both organizational and individual factors (5–12). MacDonald and colleagues (13) emphasized the importance of organizational factors in studying health outcomes, such as sickness absence. Organizational factors interact in the making of psychosocial working conditions and can also affect health directly, e.g., through decision-making processes. While there are studies aiming at exploring reasons for sickness absence on an organizational level, they are scarce (14–16).

The concept of "organizational health" refers to the overall wellbeing, sustainability, and effectiveness of an organization. There are several perspectives and frameworks that contribute to the understanding of this concept, one of which is the field of organizational psychology and management studies. This perspective often draws on theories of organizational behavior, leadership, culture, and systems theory to explain how different factors contribute to an organization's health (17–20).

In today's working life, key factors for success go beyond merely avoiding risks; they also include promoting motivation, cooperation, creativity, and good health (21). To identify factors that have a positive impact, it is not enough to simply reverse known negative factors. Positive factors may be qualitatively different. Most studies have tried to find explanations at the individual level, although sometimes aggregated to the group level. This project, however, focuses on the organizational, strategic level. It considers the factors associated with low sickness absence among employees (22, 23). Positive organizational scholarship (POS) is a subfield of organizational studies that focuses on the positive aspects of organizations, such as positive emotions, strengths, virtues, and flourishing (24–26). It aims to understand how organizations can foster positive experiences, behaviors, and outcomes for their employees, customers, and stakeholders, and how these positive elements can lead to improved performance and wellbeing. POS seeks to provide a balanced view of organizations, moving beyond a narrow focus on problems and negative aspects, and instead highlighting the potential for organizations to be sources of positive impact and growth (27). The intended contribution of this study is to provide scientific insights into the relationship between POS and employee health, including organizational factors that may contribute to lower sickness absence rates.

The term positive deviant cases refers to organizations, individuals, or communities that demonstrate exceptional performance, attitudes, or outcomes in a particular area, despite facing similar challenges or constraints as their peers (28). In other words, these cases are outliers that deviate from the norm in a positive direction. Often studied in the context of organizational or social change, positive deviance highlights examples of organizations or individuals that have found innovative and effective solutions to problems. By examining these outliers, researchers can identify best practices that may be replicated in other settings. Positive deviant cases can provide valuable insights and serve as a source of inspiration and learning for others.

Another theoretical framework to consider is the theory of sustainable healthy organizations, which emphasizes creating and maintaining organizational environments that promote the wellbeing of both employees and the organization as a whole, while also contributing positively to society and the environment (29). The principles of this theory are important factors in creating organizations that prioritize employee health and wellbeing, leading to reduced sickness absence.

Furthermore, the role of human resource management (HRM) practices in achieving low sickness absence is of significant interest (30, 31). Managers in public organizations play a crucial role in promoting the health of employees and reducing sickness absence within their organization (32). However, little is known about how managers in municipalities with low levels of sickness absence integrate health promotion activities into their daily work, so that they become part of the organizational structure and permeate the organization as a whole. By focusing on positive deviant cases (municipalities with low levels of sickness absence), the study identifies specific strategies and practices on an organizational level, used by several managers within the same organization. These practices contribute to their success in promoting employee health and reducing sickness absence (33). Additionally, it provides insights into the role of leadership, communication, and collaboration in promoting employee health.

A previous study in the Swedish private sector identified key health factors in organizations with low levels of sickness absence. The most prominent factors included clear leadership structures, competence, communication, participation, knowledge, and health status procedures. The organizations classified as healthy were also organized in a fair and considerate manner (34, 35).

Thus, the aim of this study was to explore the organizational level factors that characterize municipalities with low sickness absence. In the study, these organizations are referred to as "healthy organizations."

2 Methods and materials

2.1 Setting/study context

This qualitative study is part of a larger project focusing on organizational level factors that characterize Swedish municipalities with low sickness absence. An initial register study within the same project revealed no major differences between public organizations concerning quality indicators, such as the number of employees in senior care or in schools, or the operational costs of these services (36). This meant that the conditions for the participating managers did not differ significantly, either in terms of budget or in terms of the number of subordinates.

2.2 Design

To achieve the aim of this study, an explorative design was used, with semi-structured individual interviews for data collection.

Before the interviews got started, two municipalities served as pilots to test the interview guide. After the data analysis was conducted, the preliminary results were presented to the participants, who were invited to a 3-h meeting for discussion, allowing them an opportunity to share their opinions and reactions. Additionally, a senior researcher not involved in the project read all the interviews to ensure the quality of the conclusions.

2.3 Selection of the study group

To identify a selection of healthy organizations, a selection was made based on long-term sick leave statistics. A "healthy organization" is defined as an organization with low levels of sick leave. The selection of municipalities was based on sickness-related absence registers from 2005 to 2007. For the database used in this study, an insurance company provided data on sickness absence over 90 days among employees in municipalities. Since the main focus of the study was to identify healthy organizations, this criterion was prioritized during the selection process.

2.4 Sampling of organizations

To ensure representativeness, the selection of organizations included average-sized municipalities (Table 1). Another criterion was to include both healthy and less healthy municipalities from different regions across Sweden, to avoid regional differences that may affect the results. There are big geographical differences in Sweden, with, for example, higher sickness absence in the northern areas. Moreover, municipalities with the highest levels of sick leave were excluded, since these organizations may have specific problems, and any differences that emerge could be attributable to factors that are unique to municipalities with high sickness absence. The focus of this study was to identify factors that distinguish healthy organizations. Finally, municipalities where sickness absence had changed dramatically between 2005 and 2007 were excluded. The reason for this was that other factors may explain the difference. It requires stability over time to avoid other factors that are extraordinary in explaining the difference.

(1) In the first step, a sample of 213 municipalities with between 500 and 2,999 employees was selected from a total of 290 municipalities in Sweden.
(2) In the next step, 10 percent of the municipalities with the highest sickness absence rates were discarded.
(3) From the remaining 193 municipalities, the 35 with the highest and the 35 with the lowest sickness absence were identified.
(4) From the 70 municipalities selected, those where sickness absence had changed dramatically between 2005 and 2007 were excluded.
(5) Thereafter, 15 municipalities with low sickness absence and 15 with high sickness absence were selected to ensure geographical representation across Sweden.
(6) From these remaining 30 municipalities, five with low sickness absence and five with high absence were selected. This was done by using paired selection (1 high sickness absence−1 low sickness absence), to achieve geographical balance, adding them to the selection group as they accepted to participate in the study.
(7) To broaden the investigation, two metropolitan municipalities (in large Swedish cities) were included, each with one district council with low sickness absence and one with high sickness absence.

2.5 Participants

The data included a total of 63 semi-structured individual interviews with managers from the 12 selected public organizations (Table 2).

In 10 municipalities, interviews were conducted with Human Resources managers and Administration managers, as well as Unit managers with a maximum of fifty subordinates in senior care and schools, respectively, the two largest units within the municipalities. In one municipality, two additional managers at a different level were interviewed to obtain additional information. In one municipality, a Unit manager canceled and a replacement could not be found. In the two metropolitan municipalities, interviews were conducted in two districts within the municipality with Human Resources Managers as well as the Directors and Heads of senior care. However, interviews with school personnel were not included in these metropolitan districts, since school-related issues are handled centrally rather than at the district level.

Regardless of the level of sickness absence in the municipality, the unit managers in senior care had between 36 and 40 subordinates, and unit managers in school between 22 and 26 subordinates (data from 2006/2007).

The participants were informed that they could withdraw from the study at any time for any reason and that all material collected would be kept confidential. They accepted participation by telephone and received information about their rights to cancel their participation by email.

2.6 Data collection

The interviews for this study were conducted on-site between April 2010 and June 2011, with data collection occurring at or near the participants' workplaces by trained interviewers. Although the data was collected several years ago, it is only now being presented in a scientific context. The study has received notable attention in Sweden across various sectors, including trade unions, the health sector, occupational health services, and the Swedish Agency for Work Environment Expertise (22). The findings have been utilized to create a digital tool for improving the psychosocial work environment, contribute to a Chief Executive Program in municipalities, and disseminated in popular science (23, 37). Unfortunately, the study was not published concurrently in a scientific journal; instead, it is now being reported retrospectively, despite the time gap, because the findings remain relevant and applicable.

One interviewer led the interview, and the other had a more observational role to ensure that all subjects were covered. Each interview lasted ∼1.5 h. All interviews were

TABLE 1 Description of participating municipalities.

Municipality	Geographical location**	Employees*** (N)	Sickness absence**** (%)	Sickness absence per 1,000 employees (N)
A	N	1,816	8.5	45.5
B	M	2,717	8.2	42.3
C	M	1,243	8.3	41.0
D*	M	1,091	7.2	20.8
E	M	1,593	N.A.	41.5
F Metropolitan	S	20,725	8.5	35.0
G*	S	991	N.A.	29.9
H	S	1,129	9.0	43.3
I*	S	811	6.0	21.4
J*	S	886	5.1	23.8
K Metropolitan	M	44,857	9.5	25.4
L*	M	1,474	N.A.	19.2

Data from 2006.
*Low sickness absence.
**North, middle, or southern Sweden.
***Data from 2007.
****Prevalence of sickness absence over 90 days among employees.

TABLE 2 Number of interviews.

Municipality	Human resources managers	Administration managers	Unit managers	Other managers	Total number of interviews
Municipalities, 500–2,900 employees	10	20	19	2	51
Metropolitan municipalities in municipalities >20,000 employees	4	4	4		12
Total	14	24	23	2	63

digitally recorded, transcribed verbatim, and then analyzed. The semi-structured interviews were performed by the author (ÅS) and three other researchers in the project: two psychologists (US), one social scientist, and one physiotherapist/behavioral scientist. The interviewers had a broad knowledge of research on the relationship between work and health, and experience in qualitative methods. The interviewer group had regular meetings to discuss interview techniques and the project's methodological approach. Before the interviews started, the interview team was informed about the municipalities' organizational structure to better understand the context. This information was given during a meeting with The Swedish Association of Local Authorities and Regions (SALAR).

An interview guide was developed using the results from a previous similar study conducted in the private sector by the same researchers and covered important insights from earlier research on work environments and organizations (35). The data collection process was preceded by piloting the interview guide in two municipalities, followed by revisions based on feedback.

The guide included open-ended questions to ensure that all relevant topics were covered during the interviews. Additionally, several follow-up questions were asked to gain a deep understanding and description of the situations and narratives presented by the participants, and to make sure that they were understood in the right way. An important aim of the study was to capture and describe the structures and elements within the organization, as opposed to focusing only on personal experiences and impressions. This method is characterized by the interviewer asking the interviewee to provide specific examples of procedures (38).

Areas covered by the interview were:

- Management strategies
- Personnel policy
- Market analysis
- Strategies for organizational change
- Communication
- Employee Participation/Influence
- Work organization and work tasks and resources
- Work Environment

In addition to the interviews, written materials such as occupational health and safety and rehabilitation policies were also taken into account.

2.7 Data analysis

A checklist (COREQ) of items that should be included in reports of qualitative research was used as a guide (39).

The transcripts of the semi-structured interviews were analyzed using Qualitative content analysis [QCA; (40, 41)], with a directed approach starting with earlier research findings as guidance for the initial analysis (42). A starting point for both the content and methodology of this study was the experiences gathered from the first part of the research program, performed in private companies (35).

The interviews were analyzed by the four researchers who also performed the interviews, using the software program NVIVO 9 (43) to help categorize the manifest contents of the interviews.

Since the purpose of the study was to explore health factors at an organizational level, it was decided early on to focus on statements that clearly described the strategies of the organizations. The data were initially handled without knowledge of the level of sickness absence, and the first part of the analysis was conducted on material from each of the 10 municipalities.

The analysis was conducted in several steps. In the initial phase, the researchers analyzed the selected interviews individually. Each interview was read through to identify quotes that, on a manifest level, reflected a systematic approach or an established value-system. The contents of the selected quotes were summarized in short sentences, referred to as meaning units. In the next step, the researchers cooperated in pairs, and the same interviews were read through by another researcher. The analysis from both researchers was compared and thoroughly discussed in order to get an overall grasp of the content of the material and to identify similar meaning units. The material was then divided into condensed meaning units, which were merged into categories/themes. These categories/themes captured something important about the data in relation to a specific research question. Once categorization was done, they were compared and discussed within the research group to achieve a consensus on the analysis of the municipalities. The categories/themes from municipalities with low levels of sickness absence were compared with those from municipalities with high levels of sickness absence. The next step involved a deeper analysis of the themes that showed the greatest differences between municipalities with low and higher absenteeism, both in terms of the number of individuals quoted and the total number of citations. Furthermore, these themes were tested in the two metropolitan municipalities. The tests showed no differences regarding the themes between the five municipalities and the two metropolitan municipalities.

The analysis was concluded when saturation was reached, i.e., no new unique or contradictory information was found. An external, skilled researcher, not involved in the project, read through all the interviews in order to find factors that potentially could have been missed in the structured analysis model. At the end of the analysis, two workshops were conducted with municipal representatives in order to get feedback and discuss the findings. The themes that remained after all analysis steps are presented in the results section and will be referred to as health factors at the organizational level.

This is a qualitative study comprising individual semi-structured interviews with managers. Ethical approval was not required from the Regional Ethical Review Board, since the research did not collect or analyze personal data or sensitive information about individuals. The study focused only on the organizational level and did not involve direct interactions with individuals or the handling of their personal data.

3 Results

The analysis of the interviews identified four themes: proximity in leadership, learning and development, communication, and systematic work environment management and participation. These themes that characterize municipalities with low sickness absence are more clearly and systematically described, compared with the municipalities with higher sickness absence. There is no ranking of the strength of the results or their importance for health.

3.1 Proximity in leadership

Leadership was identified as an important practice in municipalities with low levels of sickness absence. Municipal managers described how they aspired to be in direct contact with as many subordinates as possible, often through unplanned and informal meetings. The managers actively sought information regarding organizational effectiveness through direct contact with lower levels in the organization. For example, this could be done through workplace meetings or by impromptu meetings in the corridor. In some municipalities, the managers' offices are sometimes located close to the lower-level managers in the organization to facilitate communication.

> "We are close./.../when I have the time and opportunity, I'm out in the field talking with people. I prefer spontaneous conversations, rather than a scheduled meeting."
>
> "We are always three or four managers in services, and one functions as site manager. It's 'the chief of the day'; it is the one who knows how the business flows."

This direct contact between managers and employees was described by several managers at different levels within the municipalities. It helps managers become familiar with daily operations and handle problems as they arise. Through personalized contact, managers can also follow up on the implementation of decisions. Another manager points to the importance of being visible and accessible:

> "I drink a lot of coffee. I like small talk in the hallway, showing myself, seeing people, taking time."

3.2 Learning and development of employees

General training is often conducted based on needs arising from activities associated with changes in laws and regulations, reorganizations, new systems, etc. In some organizations, individual needs for training and development are identified

through annual performance reviews. Various levels of management describe opportunities for staff to have their individual wishes met in conjunction with staff training and development, in addition to addressing the immediate and direct needs of the organization.

> "I allocate money for [training and development] in my budget. It's important that development is strategic, based on both personal wishes and on goals that [the organization] must achieve."

Employee training and development were seen as key factors in promoting learning, motivation, and engagement among employees in the municipalities. The municipalities strived to offer a wide range of opportunities for employees to improve their skills and knowledge, and funding for this was allocated within the budget. Another type of learning described by the managers was providing opportunities and encouraging job rotation. The managers stated they encourage employees to try new tasks, acquire new skills, or move to other jobs within the municipality. In some cases, they regard an employee's departure from the municipality for further studies as an inspiration for the rest of the staff.

> "We encourage [job rotation]./…/sometimes [an employee] comes to me and wants to work six months somewhere else."

Job rotation comes more naturally to the larger municipalities:

> "There is a lot of rotation, and I think that's great. The municipality is large and has many possibilities."

3.3 Communication

Effective communication and collaboration within a positive communication climate were identified as important factors by managers in organizations with low levels of sickness absence. Municipal managers described how they strived to communicate clearly and openly with their subordinates and employees. The municipalities implemented systems and strategies for feedback and the communication of criticism, establishing explicit structures for voicing concerns.

> "I try to encourage [employees] to dare to say things about me [as a leader] because I think they influence me as a manager by saying both negative and positive [things].

There are also possibilities for employees to forward criticism and ideas to higher levels in the organization.

> "- I: Is it OK to go to you directly?
> - A: Yes, there's a reason when they say 'I have raised this with my boss on several occasions and nothing happens' or 'we're not talking the same language' or 'the boss treats me differently' or whatever… It is assured that I will act directly…"

3.4 Systematic work environment management and participation

The municipalities with low levels of sickness absence work in a structured and strategic manner, with systematic work environment improvements as part of daily operations. An important part of this is involving employees in the analysis and discussion of safety issues, assigning them different responsibilities. Additionally, making work environment responsibilities visible throughout the organization is described as important.

Clear routines, incorporating employee dialogue, collaboration groups, and documentation are important. In addition to annual audits, it is important to monitor risk assessments regularly and follow up on corrective measures. Managers expressed a desire to work collaboratively with employees to develop and implement these activities, which they believe fosters a sense of shared ownership and engagement among employees.

The municipalities have made it easier for middle-level and first line managers to work systematically with work environment management by using standardized forms and digitalized systems for documentation and follow-up:

> "Then, we don't have to run around searching, acquiring, and fixing in the moment; rather, it's about creating a good work environment by thinking about it all the time."
> "So it feels like now, at last, we have it in place, and it's like a toolbox. If there is a work-related incident, then you'll know as a boss exactly what to do."

The municipalities were found to have high levels of employee involvement, with employees participating in decision-making and problem-solving processes. This was deemed to contribute to employee motivation, engagement, and job satisfaction.

Well thought-out and developed strategies to promote participation were identified as another important factor by managers in organizations with low levels of sickness absence. Municipal managers described how the organization consciously promoted employee participation and encouraged employees to take part in improvement work.

> "When I'm out, I try to connect with each one … and ask 'how do you feel about these changes?'

The employees also had opportunities to escalate concerns and share ideas with those higher up in the organization. Managers described how they appreciated the possibility that employees share their ideas and actively created forums for employees to so.

3.5 Summary of findings

The results indicate that managers in municipalities with low levels of sickness absence actively work to foster a culture of health within the organization, prioritizing the integration of systematic work environment management into their daily routines. The results also show that managers in organizations with low levels of sickness absence utilize leadership, effective communication,

participation, collaboration between managers and employees, and a deep understanding of the unique context and culture of public organizations.

The study provides an insight into the activities of public organizations and shows that the work of running a complex organization in many respects is carried out by competent and committed people, many with extensive experience.

There are sometimes significant differences between different activities within the same municipality, but the exchange of experience is often limited. As a result, good and creative solutions are not always shared across the organization.

4 Discussion

This study aims to explore organizational factors that distinguish Swedish municipalities with low sickness absence, denoted as healthy and sustainable organizations. It exemplifies an approach to examining positive, health-promoting elements at the organizational level. Specifically, the study seeks to ascertain whether the factors crucial for fostering a healthy environment in the public sector align with the health-promoting elements identified and examined in a prior Swedish study conducted in the private sector (35).

Several health promoting organizational factors were identified, which were basically the same main factors as identified in the previous study in the private sector. They were related to management, skills development, communication, employee participation, and sickness absence and health procedures. An additional organizational health factor was found among the municipalities with low sickness rates, indicating that they have managed to integrate health and safety management into their daily routines and have a good knowledge of how systematic work environment management is maintained. The results primarily highlight contrasts and seldom involve clear-cut distinctions between municipalities with low vs. high sickness absence; instead, they present more of a nuanced spectrum.

The key health promoting factors at the organizational level that characterize a healthy public organization are as follows:

- Proximity in leadership
- Learning and development of employees
- Communication
- Systematic work environment management and participation

The objectives and tasks of public organizations in sectors such as healthcare, senior care, and education are largely governed by laws and regulations; therefore, the differences between the organizations in public service seems to be smaller than those in the private sector. A key difference is that municipalities are politically controlled, whereas private sector organizations can more easily organize to be profitable. Public services, on the other hand, are more unpredictable. In municipalities, trade unions also have more influence and power, which allows them to contribute to change and influence the work environment to a greater extent (3).

This inquiry holds particular interest due to the divergent nature of organizational structures and conditions between the public and private sectors. For managers to be able to manage stress within their organizations, they must have a reasonable workload. A study of local public governments found that first-line managers, particularly female managers, often experience high levels of stress and workload, increasing their risk of stress-related mental illness (44). The organizational context that surrounds a leader has an impact on leadership development. Research has shown that the risk of stress and mental illness among managers can be reduced through feedback, encouragement from senior management and supportive standards and principles (45). To prevent the emergence of destructive leadership, organizations should strive to clarify leaders' roles, ensure that leaders' workloads are reasonable, and strive to reduce leaders' stress, as well as assess leaders' personalities during recruitment (46).

The complexities of municipal organizational structures further compound this investigation, given the considerable variations in organizational designs across different municipalities. Additionally, significant distinctions exist in work environments and organizational conditions, with the public sector often characterized by a higher prevalence of female-dominated workplaces and elevated sickness rates. Notably, in 2023, sickness rates stand at 5.9% in municipalities and 3.7% in the private sector (47).

The study drew significant inspiration from the field of Positive Organizational Scholarship (POS), an area of research that delves into the positive processes and attributes of successful organizations and their members. POS places emphasis on understanding how organizations can achieve success, envisioning employees and the organization as exemplifying characteristics such as wellbeing, appreciation, effective collaboration, meaningfulness, resilience, trustworthiness, positive social relations, loyalty, and positive energy, among other factors (24–26). The organizational factors that the current study shows as important for employee health are closely related to the characteristics of positive organizational scholarship. These factors contribute to higher productivity and help strengthen an organization's resilience.

Trust is a key element of the concept "Relational Justice" (organizational justice). This concept incorporates whether employees perceive the organization as fair and benevolent, and depicts how relationships between employees and managers are perceived, where managers are seen as representatives of the organization. Strong relationships between employees and managers increase trust and loyalty, which, in turn, should affect productivity. A range of health outcomes have also been found related to this concept. The theory behind these effects suggests that good relationships and trust within an organization help reduce stress (48–55). It is reasonable to assume that leadership characterized by close involvement with employees' daily operations increases the likelihood of creating good and fair relationships, but also being perceived as an organization that "cares" (34, 35).

Health-promoting leadership stands out in the result as a crucial factor for creating a sustainable organization. A compelling insight is that a key approach to leading health promotion is to be readily available and accessible when employees require support. This entails managers to possess strong social skills and an ability to discern the dynamics within the workplace, as well as understanding what assistance employees might require. In doing so, managers stay informed, not only about day-to-day operations

but also about potential signs that someone may be on the verge of falling ill or experiencing other issues that could impact their job performance. Such leadership fosters trust, commitment, and wellbeing among employees, which can contribute to lower rates of sick leave (56–58).

The findings align with the classic Demand-Control-Support model and are corroborated by contemporary research indicating that managerial support is paramount in the workplace. Cultivating a positive relationship with one's supervisor not only promotes employee health, but it is also correlated with heightened motivation among employees. Support from one's superior is a well-known modulating factor in the demand and control model and a lack of support means increased vulnerability to the imbalance between high demands and low control. Supportive leadership has an impact on the perception of wellbeing and quality of life, as well as job satisfaction. It can also be assumed that a present and engaged leader also influences and clarifies tasks and roles, creating fewer conflicts in the workplace (59–64).

The leadership behaviors found in healthy organizations align with the principles of transformational leadership, which emphasizes inspiring employees, articulating a clear vision, and demonstrating consideration of their needs. Past research has established the significance of transformational leadership in fostering job satisfaction and overall wellbeing (65–67).

Another health-promoting factor that emerges is the importance of an open communication climate. Effective communication between colleagues, managers, and across different units/levels is required for well-organized work. Strategies for feedback within healthier organizations enhance employees' capacity to give and receive feedback, facilitating the expression of opinions, ideas, and constructive criticism on work-related matters. The importance of workplace relationships for occupational health is underscored, as effective communication is recognized as a vital component. Robust social support and positive working relationships not only contribute to individual wellbeing but also foster creativity and enhance the assimilation of new knowledge and information.

The findings of this study suggest that healthier organizations cultivate an open communication climate, characterized by clear channels and receptivity to both formal and informal feedback. These organizations actively encourage employee participation, which promotes the emergence of innovative ideas and constructive criticism. This proactive approach raises management awareness and allows for complaints to be addressed more quickly. As a result, employee engagement increases, leading to a greater sense of commitment and satisfaction. A climate of trust also facilitates the smooth implementation of organizational changes (34, 35).

The results of the present study highlight the importance of creating a positive psychosocial work environment within the organization. This needs to do be done in a systematic and persistent manner, as part of a continuous process that incorporates recurring activities into systematic work environment management (68, 69). This aspect emerged as a new health factor compared to the previous study conducted in the private sector. The healthy municipalities had a good knowledge of work environment management and had managed to integrate it into their daily routines. This may be due to the fact that the issue of work environment is more often raised in trade union organizations within municipalities. Healthcare and sick leave procedures are also highlighted as important parts of the work environment management.

The results show that different themes are clearly linked to each other; for example, participation and communication go hand in hand with closeness in leadership. For employers who want to improve their psychosocial work environment, the most important thing is to start by implementing one of these health factors, as this will facilitate positive effects on other factors as well. A common thread in the results is that it is the organizations that understand the value of having a healthy workforce, emphasizing the need to focus on measures that promote this goal.

A review from 2006 summarizes the international research linking healthy organizations to employee wellbeing. Links are identified and presented in five categories: work-life balance, employee growth and development, health and safety, recognition, and employee involvement. It also suggests that these links are contingent on the effectiveness of communication within the organization and the alignment of workplace practices with the organizational context. While these findings are relevant at the individual level, they also connect to the organizational health factors identified in the current study (19).

4.1 Methodological discussion and future research

In all organizational research, it is often difficult to control for other factors in the organizational context that might have an impact on the research question. This can make it difficult to attribute the results of a study solely to the particular phenomena being studied, in this case, the factors on an organizational level that have a health-promoting impact. This was addressed by interviewing several managers within the same organization and choosing a time when there were no major changes in the organizations, such as political elections.

The study uses sick-leave as a measure of health, which, while somewhat narrow, provides a concrete indication of whether the organization is able to have employees who stay healthy and can be active and productive in the organization. It would also be interesting to see if there is a difference between staff turnover as a measure of sustainability. Staff turnover is probably a measure that differs greatly depending on where in Sweden the organization is located and what the labor market looks like there.

This study's findings of factors on an organizational level behind low levels of sickness absence are theoretically related to well-known psychosocial and managerial factors related to the work environment. These work environment factors are essential for creating a healthy working life, which characterizes low sickness absence within organizations. These factors are considered stable over time and resilient to external societal pressures, including economic fluctuations.

Historically, these factors have been recognized as essential to workplace health. They address fundamental human needs for social support, personal development, and autonomy, as evidenced by Deci and Ryan's work on self-determination theory (70, 71). The classic demand-control-support model emphasizes the importance

of participation and social support as stable, health-promoting elements in the workplace (72). Recent studies further affirm that management support is an important form of workplace support (32, 73–75). Another established model, Siegrist's effort-reward imbalance theory, highlights the significance of opportunities for development and constructive feedback, both vital for fostering workplace health (76). The findings also emphasize the importance of managerial style of the leaders and also their prerequisites related to the concept of organizational justice, which also can be seen as a stable factor (34). These foundational theories support the relevance of the factors identified in this study, regardless of external pressures.

More recent research on health-promoting workplaces has identified similar factors as those presented in the current study, reinforcing the validity of these findings (74, 77–79). The current research has garnered significant attention in Sweden, from trade unions, the health sector, occupational health services, and the Swedish Work Environment Authority (22, 23).

Given that these factors continue to hold importance, our results from the earlier Swedish report are likely to be of interest to a broader international audience. There appears to be a growing emphasis on measuring workplace factors rather than utilizing data to enhance worker health. While factors such as immigration and the COVID-19 pandemic certainly influence the work environment, the foundational concepts outlined remain vital.

Interview studies with a qualitative analysis method require methods to make generalization of the results feasible. This study ensured credibility through triangulation and respondent control. However, a limitation of interview studies is that interviewees may provide responses they think the researcher wants to hear, reflecting on what is socially desirable. To mitigate this, we conducted several interviews within the same organization.

Employee participation is recognized as a critical determinant of workplace health and wellbeing. Future research should explore the mechanisms through which change management strategies can be effectively implemented to enhance employee engagement. This could involve conducting intervention studies that examine the relationship between leadership transformations and corresponding shifts in employee behaviors, with a specific focus on how these changes influence participation levels. For instance, research could investigate how varying leadership styles or management approaches impact employee involvement and workplace communication. Understanding these links may provide valuable insights into optimizing organizational health and performance.

Future research should also focus on developing organizational health metrics that assess current conditions and predict potential work environment challenges, enabling continuous adjustments. These could include measures of employee engagement, perceived wellbeing, and productivity, while encouraging employee participation. Some initial work has been done in this area (80). Regular use of these tools, along with follow-up, will support continuous improvement, helping to refine assessments and improve the accuracy of outcome predictions.

5 Conclusions

The results indicate that municipalities with lower sickness absence rates tend to have more sophisticated organizational strategies, especially in clear and manageable areas. Creating a foundation for healthier organizations undoubtedly requires intricate strategic planning and well-defined structures, especially during periods of organizational change and development.

A recurring theme in the analysis is the proximity and interconnectedness observed in leadership, communication, and employee participation among the divisions, department managers, and employees of robust municipalities. This closeness is exemplified by leaders who actively participate in various operations, maintain regular communication, or have a comprehensive understanding of ongoing activities. Leaders in such organizations also often show a high degree of involvement in day-to-day activities. This phenomenon, known as the 'proximity principle,' emerges as a potentially important factor influencing health outcomes, which should be explored further.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

ÅS: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. US: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. MS: Conceptualization, Data curation, Funding acquisition, Methodology, Project administration, Resources, Supervision, Writing – review & editing. FM: Supervision, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This research was funded by AFA Insurance, Grant Number 090048, and the Swedish Research Council for Health, Working Life and Welfare (Forte), Grant Number STY-2021/0005.

Acknowledgments

The authors wish to acknowledge professor emeritus Eva Vingård, for initiating and leading this project, and the researchers involved in the study, Tomas Eriksson and Marianne Parmsund.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships

that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 04 March 2025
DOI 10.3389/fpubh.2025.1538000

OPEN ACCESS

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RECEIVED 02 December 2024
ACCEPTED 12 February 2025
PUBLISHED 04 March 2025

CITATION
Zhu W and Du Z (2025) Configuration path analysis of Chinese government sports expenditure promoting national participation in physical activity.
Front. Public Health 13:1538000.
doi: 10.3389/fpubh.2025.1538000

Configuration path analysis of Chinese government sports expenditure promoting national participation in physical activity

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Focusing on the theoretical logic of Chinese government sports expenditure promoting public participation in sports, this study takes 31 provinces (cities, autonomous regions) in China as research objects and uses fsQCA to explore the configurational pathways of government sports expenditure affecting public participation in sports. Using the fuzzy set qualitative comparative analysis (fsQCA) method, and taking *the Sports Industry Statistical Yearbook (2020 data)* as the data source, this paper discusses how government sports expenditure can improve the level of public participation in sports through different combinations of driving factors. The results show that there are four effective condition combination paths, which can be summarized as the dual-core drive of "technological innovation + sports culture promotion and dissemination" and the "key housing support guarantee type" path, both of which are particularly crucial for improving public participation in physical activity. The findings of this study emphasize the importance of diversified investment in government sports expenditure for enhancing public participation in physical activity, suggesting that the government should adopt a cross-departmental resource integration strategy to build a comprehensive ecosystem supporting physical activity participation.

KEYWORDS

government sports expenditure, physical activity participation, configurational pathway, fsQCA, fiscal expenditure

1 Introduction

1.1 The present situation of mass participation in physical activity

Physical activity participation pertains to the engagement of individuals in sports-related activities, either directly or indirectly. This involvement can be conscious or unconscious and is often influenced by personal emotional cognition and attitudes, leading to a series of related activities (1). The correlation between physical activity participation and individual physical health, social development, and the economic and social advancement of a country is well-established (2, 3). Research indicates that an increase in physical activity participation can lead to a reduction in healthcare costs (4) and an enhancement in labor productivity (5), thereby stimulating economic growth. Furthermore, physical activity participation holds significant social value as it fosters social interaction (6) and strengthens social cohesion (7), contributing positively to the construction of a harmonious society. However, as of the end of 2023, despite the fact that 37.2% of the Chinese population regularly engages in physical exercise (8), there remains a substantial gap from the target of "achieving a 38.5% proportion of regular physical exercise participants by 2025" as outlined in *the National Fitness Plan (2021–2025)* (9). The

prevalence of mass physical activity participation in China is still lacking, necessitating further investment to boost public enthusiasm for sports. Consequently, the formulation of effective strategies to encourage mass physical activity participation and thereby elevate the national fitness development level is an urgent issue that requires immediate attention.

1.2 The importance and existing issues of government sports expenditure

The national government has demonstrated significant commitment to the development of a comprehensive fitness public service system, as evidenced by the issuance of documents such as *the National Fitness Program* and *Opinions on Building a Higher-Level National Fitness Public Service System* (10, 11). These initiatives underscore the government's dedication to ensuring broad participation in sports activities. Fiscal expenditure serves as a crucial mechanism through which the government can facilitate the provision of public services and address societal needs. Specifically, government sports expenditure constitutes a vital component of overall fiscal spending, acting as an essential conduit for delivering sports-related public services and fulfilling the public's athletic needs (12). This expenditure is pivotal in advancing national fitness objectives and enhancing the general health of the populace (13). However, there are notable challenges confronting China's government sports fiscal expenditure at present. These include: an imbalance in the distribution of sports fiscal funds across various projects, inefficiencies in both the allocation and utilization of these funds, and a flawed internal structure of fiscal expenditure (14–16). Consequently, this results in a supply that fails to meet demand, culminating in a scenario characterized by both low efficiency and subpar quality (17). The persistence of these issues not only hampers the potential of sports investment to foster national fitness but also impedes the enhancement of governance efficiency within government sports public services. Resolving these challenges necessitates urgent policy adjustments and a strategic realignment of resource allocation.

Government sports fiscal expenditure empowers mass sports participation (18, 19). Sufficient financial investment can improve sports facilities, providing the public with convenient sports venues and lowering the barriers to participation. At the same time, funding supports the organization of sports events and activities, stimulating the public's enthusiasm for sports and creating a positive sports atmosphere. Moreover, fiscal expenditure on sports education and training enhances the public's sports skills and health awareness, further promoting the popularization and development of mass sports, forming a virtuous cycle, and driving the in-depth implementation of the national fitness strategy, improving the physical fitness and health level of the nation.

2 Research framework

2.1 Theoretical support

A strong correlation exists between governmental sports expenditure and public engagement in sports. Firstly, augmenting investment in sports enables the government to enhance sports infrastructure, offer additional sports-related public services, thereby fostering an environment conducive to public participation in sports (20–23). Conversely, a surge in public involvement in sports can stimulate the growth of the sports industry, boost the physical fitness of citizens, and consequently contribute to the nation's economic development and societal stability (9).

From an "input-output" theoretical standpoint, government expenditure on sports significantly influences public participation in physical activities. As a pivotal component of public finance, such expenditure can bolster public engagement and awareness in sports by enhancing infrastructure, augmenting the availability of sports events and activities, and improving the quality of sports education and training (24). Government fiscal allocation toward sports is instrumental in advancing national fitness and elevating public health standards. Nevertheless, certain irrationalities in its expenditure structure, including inadequate investments in infrastructure development, educational outlays, and healthcare, constrain the potential of sports investment to foster national fitness. Consequently, policy refinements and resource optimization are imperative to refine the structure of government sports expenditure and augment fund utilization efficiency. This not only stimulates public fervor for sports but also enhances the quality and efficiency of sports public services. It addresses the escalating sports demands of the populace and underpins the high-quality evolution of sports public services. Such measures lay a robust groundwork for modernizing the national sports governance system and capabilities, act as a pivotal support for building a sports powerhouse, and form the cornerstone for effectively executing the national fitness strategy.

Public finance theory, which emphasizes the government's pivotal role in the provision of public goods and services, is instrumental in understanding the allocation of government sports expenditure with sports public services being a significant representation of these functions (25). Sports public services are a critical component of these public goods, and the strategic deployment of government funds can significantly enhance the efficient use of resources and technology. This, in turn, improves the quality and accessibility of sports services, which are essential for fostering public participation in physical activities. New institutional economics provides a complementary perspective on the optimization of government sports expenditure structures. This theory posits that robust sports financial investment, as an institutional arrangement, is crucial for stimulating mass participation in physical activities (26). The structural optimization of government sports expenditure can reduce transaction costs and increase institutional efficiency, thereby promoting the effective distribution and utilization of sports resources (27). From the vantage point of new institutional economics, government sports expenditure is not solely focused on direct economic benefits but also takes into account the motivational impact of the institutional environment on public engagement in physical activities. This dual focus aims to achieve the maximization of social welfare by creating an environment that incentivizes and facilitates widespread participation in sports and physical activities.

2.2 Research objective

Government fiscal support invigorates the sports sector by encouraging the organization of sports events and promoting mass

physical exercise, thereby stimulating residents' enthusiasm for sports participation (28–30). The existing literature has accumulated a wealth of theoretical achievements on the academic study of national fitness and sports participation, laying a solid foundation for subsequent research. However, most studies focus on the micro-level aspects such as facility provision, with few exploring the characteristics from a macro-perspective and the micro-implications of fiscal policy. Specifically, issues concerning the optimization of sports finance to foster logical configuration of mass physical activity participation have not been systematically addressed. To address this gap, this study employs the fuzzy set qualitative comparative analysis (fsQCA) method to identify key configuration factors that influence physical activity participation through government sports expenditure. This will offer both a theoretical basis and practical guidance for the government in formulating sports policies and optimizing sports financial expenditure. This holds significant theoretical and practical implications for advancing the comprehensive development of national fitness participation and enhancing the health level of the population.

3 Research methods and data sources

3.1 Analytical framework

Government expenditure on sports encompasses various facets, each with distinct characteristics and potential impacts on mass sports. As outlined in *the Sports Industry Statistical Yearbook (2020 Data) (National System [2020] No. 12)*, sports fund revenue and expenditure items can be categorized into eight primary groups: diplomacy, education, science and technology, culture, sports and media, social security and employment, medical health, housing security, and miscellaneous. This categorization underscores the multifaceted roles and broad reach of government sports expenditure, with different financial contributions aligning with diverse aspects of basic public sports services (as shown in Figure 1).

① Diplomatic engagement plays a pivotal role in amplifying a nation's international influence and competitiveness in the realm of sports, primarily through international sports exchanges and collaborations. For example, by hosting stages of the International Climbing Federation World Cup, both Keqiao District of Shaoxing City in Zhejiang Province and Wujiang District of Suzhou City in Jiangsu Province have elevated their global profiles and attracted increased investment for sports infrastructure. This has subsequently drawn more rock climbing enthusiasts and local residents to engage in sports activities. Consider the case of the 2024 Thomas and Uber Cup, set to be held in Chengdu. In preparation, the Chengdu municipal government has expanded the construction of badminton venues, thereby enhancing the comprehensiveness of sports facilities and boosting public participation in sports. Financial backing for sports diplomacy is instrumental in bolstering a nation's international standing and competitiveness in sports, serving as a cornerstone for sports diplomacy and the shaping of international image.

② Investment in education is intrinsically linked to the development of sports talent and the dissemination of sports knowledge, forming the bedrock for enhancing national physical literacy. Such investment significantly influences public engagement in sports, serving not only to bolster the physical literacy of the youth but also to ignite their interest in sports through school-based activities and competitions (31). The funds allocated to physical education are channeled toward infrastructure development, teacher training, and the organization of sports activities, thereby providing students with ample opportunities to engage in physical exercise and cultivate consistent exercise habits. These investments enable students to derive pleasure from physical activity, improve their fitness levels, foster well-rounded personalities, and build resilience, ultimately leading to a higher rate of public participation in sports.

③ Investment in scientific and technological advancements fosters innovation in sports equipment and the application of science to sports training. This is achieved by supporting research activities within the sports domain, which in turn enhances sports performance and safety. The integration of advanced sports equipment, such as high-performance athletic shoes and smart fitness trackers, augments the safety and comfort of physical activities. These innovations not only mitigate the risk of sports-related injuries but also facilitate real-time monitoring of athletic data, thereby encouraging broader public

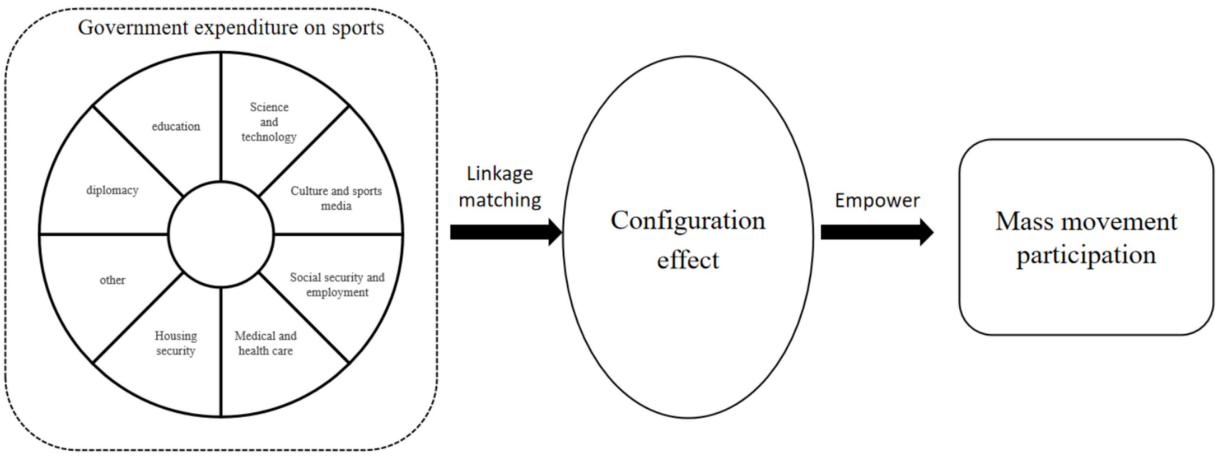

FIGURE 1
Analysis framework of government sports expenditure input to empower mass movement participation.

engagement in sports (32). For instance, the advent of intelligent wearable technology offers users tailored fitness insights and regimens, thereby amplifying both the enjoyment and challenge of sports. Furthermore, strides in sports science and technology have ushered in evidence-based training methodologies, such as exercise prescriptions grounded in sports physiology research. These methods augment the efficacy and professionalism of sports while promoting widespread participation. Regulatory documents like the "Extracurricular Sports Training Behavior Norms" issued by the General Administration of Sport of China serve to standardize youth sports training, elevate its quality, and cater to the training requirements of young individuals (33). Such investments and regulations not only amplify the scientific rigor and appeal of sports but also bolster the growth of sports education. Consequently, this provides the populace with an array of sports options and accessible conditions, thereby boosting public engagement in sports.

④ Investments in cultural, sports, and media encompass contributions to administrative operations, overarching administrative management, institutional services, project management within sports, competitions, training, venues, mass sports initiatives, exchanges and collaborations in sports, along with other expenditures categorized under cultural media. Such investments are pivotal in molding the sports culture and amplifying public engagement with sports, thereby epitomizing the soft power of culture.

⑤ Investment in social security and employment within the sports industry signifies the government's commitment to providing social security for practitioners, as well as offering financial support to encourage employment through sports activities. This plays a crucial role in maintaining stability within the sports industry and fostering social harmony. Such investment promotes widespread participation in sports by facilitating job training and supporting entrepreneurship (34). Government funding aids in the training of sports professionals, such as fitness coaches, thereby ensuring the provision of high-quality sports services. This, in turn, stimulates enthusiasm for mass sports, such as the transformation of old facilities into sports consumption venues (35). These initiatives create convenient sports conditions for various demographic groups, including young people, middle-aged and older adult individuals, and enterprise employees (36). They also foster an interest and habit of sports, thereby enhancing the participation of the general public in sports.

⑥ Investment in healthcare for athletes emphasizes medical protection and hygiene safety during sports activities, thereby ensuring the healthy progression of these events. Such investment offers medical rehabilitation support and preventive healthcare services, providing a safety net for public participation in sports and encouraging widespread involvement in physical activities (37). The dissemination of sports health knowledge has heightened public awareness regarding the prevention of sports injuries. The implementation of scientific physical monitoring and health education initiatives has bolstered the efficacy of fitness programs. Furthermore, the introduction of sports insurance services has mitigated concerns about sports-related risks, collectively amplifying public enthusiasm for participation in sports.

⑦ Investment in housing security, which encompasses both athlete accommodation and land tenure for sports facility construction, is pivotal for retaining sports talents and enhancing the quality of sports infrastructure. Such investments bolster sports facilities by funding community sports infrastructure and allocating governmental special funds, thereby offering accessible exercise venues for the populace (38). Notably, the enhancement of community sports facilities has significantly benefited various demographics, including the older adult, youth, and families (39). The older adult benefit from a secure exercising environment, while young individuals gain diverse opportunities for physical activity and social interaction. Families, on the other hand, find these facilities conducive to strengthening parent–child bonds. The accessibility of these amenities encourages the cultivation of regular exercise routines across all age brackets, leading to a surge in overall physical activity participation rates.

⑧ Other inputs encompass sports-related expenditures that cannot be explicitly categorized into the aforementioned categories, thereby providing flexible financial support for the comprehensive development of sports. These additional sports inputs enhance public awareness of sports by funding public welfare activities and regional sports events. They also offer a variety of sports activities for different regions, collectively promoting the development of national fitness (40). These inputs serve as a supplement and emergency response capability for sports development, and are a crucial guarantee for its diversified growth.

3.2 Research methods and variable measurement

3.2.1 Qualitative comparative analysis

This study employs Qualitative Comparative Analysis (QCA) as its primary research methodology, a technique introduced by Charles Ragin in 1987 and grounded in set theory and Boolean logic (41). QCA is an approach that bridges qualitative and quantitative research, offering the ability to discern various factor combination pathways (42). It is particularly adept at handling small to medium-sized datasets, revealing intricate causal links between diverse conditional factor configurations and specific outcomes (43). Within QCA, there are crisp set strategies, fuzzy set strategies, and multi-valued set strategies. Given the nuanced nature of factors influencing public due to government sports expenditure, it's impractical to categorize either the conditional or outcome variables with a straightforward binary "yes" or "no." The inherent ambiguity in the degree and level of these variables suggests a significant potential for information loss. Consequently, this study opts for the fuzzy set strategy within QCA (24).

Given the complexity of the system involving multiple interacting factors in this study, fuzzy-set qualitative comparative analysis (fsQCA) is well-suited to examine the impact of government sports expenditure on mass physical activity participation. Firstly, the relationship between these two variables is inherently complex, encompassing numerous interdependent factors. Unlike traditional regression methods, fsQCA is better equipped to handle non-linear relationships within complex systems, elucidating systematic characteristics and asymmetries resulting from element interactions. This is crucial for understanding the multifaceted ways in which government sports expenditure influences mass physical activity participation. Secondly, the factors influencing the impact of government sports expenditure on mass physical activity participation exhibit a degree of fuzziness that traditional quantitative methods fail to accurately capture. By employing fuzzy set data, fsQCA can more precisely delineate the intricate relationships between variables,

thereby uncovering potential mechanisms and diverse pathways leading to varying levels of physical activity participation. Thirdly, fsQCA underscores the concept of "equivalent causal chains," suggesting that different combinations of conditions can yield identical outcomes. This allows for a more comprehensive exploration of the diversity and complexity inherent in the ways government sports expenditure facilitates mass physical activity participation, offering a broader perspective for the study.

3.3 Variable measurement

3.3.1 Sample selection

In adhering to the normative standards of QCA modeling, the selection of samples for fuzzy-set qualitative comparative analysis (fsQCA) must adhere to the following criteria: Firstly, sample homogeneity should be ensured, meaning that factors external to the outcome and condition variables ought to be largely consistent to prevent any undue influence on the model's outcomes. Secondly, it is imperative to guarantee sample diversity, encompassing various categories of case samples (44). Thirdly, sample comparability is crucial; selected case samples must exhibit consistency or a high degree of similarity in defining outcome and condition variables, as well as in their measurement methodologies. Lastly, sample sufficiency must be observed, ensuring that the sample size is adequately large to encompass all potential configurations of condition variables, thereby mitigating the risk of logical remainders (45).

In light of the stipulated criteria and taking into account data availability, completeness, and comparability, this research incorporates 31 provinces (autonomous regions, municipalities) in China as its sample base, employing provincial-level data for configuration analysis (refer to Table 1). The year 2020 is designated as the data benchmark, representing a pivotal juncture when China achieved comprehensive construction of a moderately prosperous society and initiated its second centenary goal. This year also marked the culmination of *the National Fitness Plan (2016–2020)* (46) and the strategic layout for the *14th Five-Year Plan for Sports Development* (47). In 2020, national fitness, recognized as a national strategy, underscored its multifaceted functions and values, with its popularization serving as a significant barometer of the nation's modernization trajectory. Consequently, this study leverages pertinent data from government sports expenditures in 2020 to bolster mass physical activity participation as the analytical sample, thereby ensuring data timeliness and judicious contemplation of potential lagging effects from various determinants.

TABLE 1 Provinces from which samples were selected for this study.

Number	Province
1	Beijing
2	Tianjin
3	Hebei
4	Shanxi
5	Neimenggu
6	Liaoning
7	Jilin
8	Heilongjiang
9	Shanghai
10	Jiangsu
11	Zhejiang
12	Anhui
13	Fujian
14	Jiangxi
15	Shandong
16	Henan
17	Hubei
18	Hunan
19	Guangdong
20	Guangxi
21	Hainan
22	Chongqing
23	Sichuan
24	Guizhou
25	Yunnan
26	Xizang
27	Shaanxi
28	Gansu
29	Qinghai
30	Ningxia
31	Xinjiang

3.4 Indicator system

3.4.1 Measurement of outcome variables

The primary focus of this study is the extent of mass physical activity participation, thus the rate of such participation in each province is considered as the outcome variable for physical activity participation level (refer to Table 2). This research employs the proportion of individuals who regularly engage in physical activities relative to the permanent population of each of China's 31 provinces (including autonomous regions and municipalities) in 2020. This ratio serves as the measurement indicator for the degree of mass physical activity participation within a given region. The data utilized in this study is sourced from the *14th Five-Year Plan for Sports Development* (47) and the *National Fitness Implementation Plan (2021–2025)* (48) released by each province, supplemented by relevant government work reports.

3.4.2 Conditional variable measurement

The *Sports Industry Statistical Yearbook* stands as the foremost authoritative statistical publication on sports in China. It offers a comprehensive overview of the nation's sports development and is primarily derived from the annual sports industry statistics reports of every province, autonomous region, and municipality under direct central government administration. Currently, the Sports Economic Department of the General Administration of Sport of China produces this volume annually (49).

TABLE 2 Description of variable indicators and data sources.

	Variable	Describe indicator	Data sources
Outcome variable	Physical activity participation rate	The ratio of the number of people who frequently participate in sports in each province in 2020 to the permanent population of that province in 2020. (Data unit: %).	*The 14th Five-Year Sports Development Plan*, *the National Fitness Implementation Plan (2021–2025)*, and related government work reports released by various provinces.
	Diplomatic Investment	The amount invested by provincial government departments in sports diplomacy in 2020. (Data unit: RMB 10,000)	*Statistical Yearbook of Sports Industry (Data for 2020)*
	Educational Investment	The amount invested by provincial government departments in sports education in 2020. (Data unit: RMB 10,000)	
	Scientific and Technological Investment	The amount invested by provincial government departments in sports science and technology in 2020. (Data unit: RMB 10,000)	
Condition variable	Culture and Sports Media Investment	The amount invested by provincial government departments in sports under the culture and sports media investment in 2020. (Data unit: RMB 10,000)	
	Social Security and Employment Investment	The amount invested by provincial government departments in sports social security and employment in 2020. (Data unit: RMB 10,000)	
	Healthcare Investment	The amount invested by provincial government departments in sports healthcare in 2020. (Data unit: RMB 10,000)	
	Housing Security Investment	The amount invested by provincial government departments in sports housing security expenditures in 2020. (Data unit: RMB 10,000)	
	Other Investments	The amount invested by provincial government departments in other sports-related endeavors in 2020. (Data unit: RMB 10,000)	

10.3389/fpubh.2025.1538000

The typological capability of fsQCA (42), in conjunction with *the Sports Industry Statistical Yearbook (2020 Data) (National Statistics [2020] No. 12)*, allows for the establishment of conditional variables based on the categorization of sports funding revenue and expenditure. These categories encompass diplomacy, education, science and technology, culture, sports and media, social security and employment, medical health, housing security expenditure, among others, resulting in a total of eight conditional variables (refer to Table 2). The *Sports Industry Statistical Yearbook* stands as the most authoritative official statistical resource on sports in China, offering the sole comprehensive insight into the development of national sports. The data primarily originates from the annual sports industry statistics reports, which are compiled by the sports commissions of each province, autonomous region, and municipality directly under the central government. Currently, a volume is produced annually by the Sports Economic Department of the General Administration of Sport of China.

① Diplomatic Investment in Sports. The allocation of resources toward sports diplomacy fosters international collaboration, facilitates the introduction of cutting-edge facilities and technologies, and augments the development of domestic sports infrastructure. This, in turn, amplifies the rate of participation in mass sports (50). Governmental investment in this domain encompasses financial backing for international sports interactions and collaborations, which includes expenses related to bidding for global events and membership dues for international sports associations.

② Investment in Education. The investment in sports education encompasses both general and vocational education, with a particular emphasis on the allocation of funds for sports-related instruction and training. This investment is intrinsically linked to the development of sports talent and the dissemination of sports knowledge.

③ Investment in Science and Technology. This encompasses the allocation of resources toward scientific and technological advancements in sports, including applied research and technical development. It involves the application of scientific principles to sports training and the innovation of sports equipment.

④ Investment in Cultural, Sports, and Media. This form of investment encompasses the promotion of sports culture and the distribution of sports events, which includes acquiring broadcasting rights for such events and fostering sports culture to stimulate public interest (51). Specifically, it involves expenditures related to administrative operations, general administrative management, institutional services, sports project management, competitions, training, venues, mass sports, exchanges and cooperation, as well as other sports-related expenses within the cultural media sector.

⑤ Investment in Social Security and Employment. This category represents the government's commitment to providing social security for professionals within the sports industry, as well as retirees. It also encompasses financial incentives aimed at fostering employment opportunities through sports-related activities.

⑥ Healthcare Investment. The allocation of resources toward sports healthcare primarily emphasizes the medical safeguarding of athletes and the maintenance of hygiene standards in sporting events, thereby ensuring the sustainable development of such activities.

⑦ Investment in Housing Security. The financial commitment to sports-related housing security primarily encompasses expenditures associated with housing reform. This includes the provision of housing support for athletes and economically disadvantaged groups, as well as ensuring land security during the construction of sports facilities.

⑧ Miscellaneous Expenditures. This category encompasses sports-related expenditures that do not fit neatly into the aforementioned categories, thereby offering flexible financial support for the holistic development of sports.

3.5 Data calibration

The calibration procedure for fuzzy set qualitative comparative analysis necessitates the assignment of membership degrees, ranging from 0 to 1, to the cases under investigation. The primary objective of this process is to ascertain the precise position and significance of these values, essentially interpreting their degree of membership to either high or low score sets. In this study, we employ the conventional direct calibration method, establishing three anchor points: "complete membership," "crossover point," and "complete non-membership." These are determined by scrutinizing the actual value distribution of variables across the cases. Guided by extant research practices and the inherent data characteristics of our cases, we use the 95, 50, and 5% quantiles of the sample data as anchor points for both the outcome variable—mass movement participation rate—and the eight conditional variables: government sports expenditure in diplomacy, education, science and technology, culture and sports media, social security and employment, medical health, housing security, among others. Specifically, these anchor points are denoted as (0.95, 0.5, 0.05) (52), ensuring both the precision of calibration and the reliability of the ensuing results. Consequently, fsQCA3.0 software is utilized to calibrate these nine variables, transforming them into fuzzy set membership variables within a 0–1 range. The specific settings for these calibration anchor points are detailed in Table 3.

4 Research results and analysis

4.1 Univariate conditional necessity test

Prior to conducting the configuration analysis, it is imperative to perform a necessity analysis on the conditional variables. This is done to ascertain whether a single factor acts as a necessary condition for the outcome variable (53). Initially, this study carried out a necessity test on the eight conditional variables of government sports expenditure. The aim was to determine if there exists a single factor that has a decisive impact on mass physical activity participation (the results are presented in Table 4). The analysis of the data revealed that none of the consistency values of all conditions surpassed the critical value of 0.90. This suggests that no single condition can be deemed as a necessary condition for explaining its result under the high or low level of mass physical activity participation.

The findings underscore the intricate nature of the factors influencing the impact of government sports expenditure on mass physical activity participation at the provincial level. This suggests that a combination of conditional variables is essential to foster elevated levels of mass physical activity participation through their collaborative interaction and alignment. Consequently, various dimensions of government sports expenditure—including diplomacy, education, science and technology, culture and sports media, social security and employment, medical health, housing security, among others—need to collectively activate the motivational mechanisms for

TABLE 3 Calibration of variables.

	Variable	Complete membership 95%	Crossover point 50%	Complete non-membership5%
Outcome variable	Physical activity participation rate	0.49	0.39	0.30
	Diplomatic investment	125.18	0.00	0.00
	Educational investment	25143926.94	22478.58	169.48
	Scientific and technological investment	5382.41	72.06	0.00
Condition variable	Culture and sports media investment	367357.88	112637.69	36099.59
	Social security and employment investment	16791.62	2326.00	190.54
	Healthcare investment	6925.70	1732.10	236.80
	Housing security investment	24352.58	2291.51	161.37
	Other investments	242169.07	21795.70	2813.88

TABLE 4 Univariate necessary condition analysis.

Conditional variables	High participation level		Low participation level	
	Consistency	Coverage	Consistency	Coverage
High Diplomatic Investment	0.786	0.716	0.779	0.779
Low Diplomatic Investment	0.757	0.757	0.716	0.786
High Education Investment	0.591	0.795	0.574	0.847
Low Education Investment	0.886	0.655	0.861	0.698
High Science and Technology Investment	0.569	0.73	0.522	0.728
Low Science and Technology Investment	0.786	0.6	0.801	0.671
High Culture and Sports Media Investment	0.737	0.701	0.655	0.684
Low Culture and Sports Media Investment	0.667	0.638	0.713	0.749
High Social Security and Employment Investment	0.610	0.688	0.586	0.725
Low Social Security and Employment Investment	0.756	0.625	0.747	0.678
High Medical and Health Care Investment	0.654	0.727	0.609	0.742
Low Medical and Health Care Investment	0.768	0.642	0.609	0.742
High Housing Security Expenditure Investment	0.627	0.720	0.587	0.740
Low Housing Security Expenditure Investment	0.774	0.630	0.779	0.696
High Other Investments	0.664	0.712	0.638	0.752
Low Other Investments	0.769	0.659	0.756	0.712

mass physical activity participation by leveraging their combined effects.

4.2 Conditional configuration sufficiency analysis—fsQCA

This study employs the fsQCA method to perform a truth table analysis, scrutinizing the sufficiency of government sports expenditure configurations across various provinces in relation to high and non-high physical activity participation levels. To ensure precise case distribution and establish an appropriate frequency threshold based on sample size, the minimum case frequency is set at 1 and the threshold is established at 0.8.The standard rows with PRI values less than 0.65 underwent manual zeroing processing (54). Using the fsQCA 3.0 software, multiple paths were computed, yielding three distinct solutions: simple, intermediate, and complex. Given the limited adaptability of both the simple and complex solutions, this study opted for the simple solution as a reference point. The intermediate solution was selected as the final path outcome. This research identified four composite scheme conditions for government sports expenditure to bolster mass physical activity participation (55). The core and edge conditions for each configuration were then delineated, and metrics such as consistency, original coverage rate, and other pertinent characteristic values for both individual and overall solutions were meticulously detailed (24) (refer to Table 5).

TABLE 5 Configuration of conditions for enabling mass physical activity participation by government sports expenditure.

Conditional item	Path ①	Path ②	Path ③	Path ④
Diplomatic Investment	·	·	·	·
Educational Investment		·	⊗	·
Scientific and Technological Investment	●	●	·	·
Culture and sports media Investment	●	●	·	·
Social security and employment Investment	·	⊗	⊗	⊗
Healthcare Investment	⊗	⊗	·	·
Housing security Investment	·	⊗	●	●
Other Investments	·	●	⊗	·
Consistency	0.943203	0.942514	0.943735	0.952393
Raw Coverage	0.337077	0.255142	0.295061	0.257172
Unique Coverage	0.067118	0.021042	0.036604	0.008863
Consistency of Solution	0.934799			
Coverage of Solution	0.417118			

● indicates the presence of a core condition; · indicates the presence of a marginal condition; ⊗ indicates the absence of a core condition; ⊗ indicates that this marginal condition does not exist, and "blank" means that this condition can either exist or not exist.

The analysis results reveal that, based on the actual cases in 2020, there are four configurations for government sports expenditure that can enhance mass physical activity participation (see Table 5). Path ① has a coverage rate of approximately 33.71%, accounting for about 33.71% of the high physical activity participation level cases; Path ② has a coverage rate of around 25.51%, explaining roughly 25.51% of the high physical activity participation level cases; Path ③ has a coverage rate of about 29.50%, accounting for approximately 29.50% of the high physical activity participation level cases; and Path ④ has a coverage rate of approximately 25.72%, explaining roughly 25.72% of the high physical activity participation level cases. The consistency levels of both individual solutions and overall solutions for government sports expenditure to boost mass physical activity participation are relatively high, at 0.942514 and 0.952393, respectively. This indicates that the identified four condition combinations have a high degree of internal consistency, with an overall consistency of 0.934799. This suggests that among the cases conforming to these four configurations, about 93.48% have higher project governance efficiency. The total coverage rate reaches 0.417118, indicating that the four configurations can cover about 41.71% of the cases where government sports expenditure enables a higher level of mass physical activity participation. This provides robust empirical support for how government sports expenditure can effectively promote mass physical activity participation.

4.3 Robustness test

The current robustness tests for QCA encompass: the adjustment of the consistency threshold and the elimination of certain samples (56), alteration of the measurement method (57), and reverse testing of outcome variables (58). This study employs the technique of adjusting the consistency threshold for robustness testing, setting the consistency level to 0.85. The configuration path obtained post-adjustment aligns with the promotion path identified in the original analysis, thereby further corroborating the stability of the research findings.

5 Influence path and analysis

Adhering to the principles for naming configurational solutions as outlined by Furnari et al. (59), which emphasize "concise expression," "capturing the whole," and "evoking the essence of the configuration," this article strives to ensure the rationality of the naming while considering the integrity and uniqueness of the configurations. In line with these principles and to provide clearer and actionable implementation pathways for enterprises, this study refrains from individually naming each configuration. Instead, it categorizes configurations based on the principle of capturing overall patterns (60). Consequently, configurations with identical core conditions from the analysis results in Table 5 are consolidated into two patterns: the "Dual-Drive Model of Science and Technology Innovation and Sports Culture Promotion and Communication" and the "Key Housing Support and Security Model." These patterns are

explored to understand how government sports expenditure empowers mass sports participation.

The discussion section of this article will focus on these two core pathways. Initially, the "Dual-Drive Model of Science and Technology Innovation and Sports Culture Promotion and Communication" will be explored, highlighting the pivotal role of science and technology as well as media and culture in enhancing mass sports participation. Subsequently, the "Key Housing Support and Security Model" will be examined, analyzing how housing security expenditure can improve residents' living environments and sports conditions, thereby further promoting sports participation. The analysis of these pathways aims to provide theoretical support for the optimized allocation of government sports expenditure, facilitate the effective utilization of resources, and advance the development of national fitness goals to a higher level.

5.1 "Technology innovation + sports culture promotion and dissemination" dual-core driven model

The explanatory power of both Configuration Path ① and Configuration Path ② is robust, with their consistency rates being approximately 93.32 and 94.25%, respectively. The findings from the configuration path analysis suggest that when scientific and technological investment, along with cultural and sports media investment, are considered core conditions—and are bolstered by auxiliary conditions such as diplomatic investment—government sports expenditure can significantly enhance mass participation in sports. When scientific and technological investment and cultural and sports media investment are viewed as core conditions, Configuration Path ① furthers high levels of mass physical activity participation through investments in diplomacy, social security, employment, housing security, among other sectors. Conversely, Configuration Path ②, while considering scientific and technological investment, cultural and sports media investment, and other investments as core conditions, facilitates high levels of mass physical activity participation via diplomatic and educational investments. In the dual-core driven configuration mode of "technological innovation + sports culture promotion and dissemination," the sports expenditure strategies of the Beijing, Jiangsu, and Hebei governments in 2020 serve as prime examples of elevating mass physical activity participation in their respective regions. Taking Beijing as an example, in terms of investment in sports science and technology, the Beijing Municipal Government supports scientific research activities in the field of sports, promotes innovation in sports equipment and scientification of sports training, thereby improving sports performance and safety. In 2020, the Beijing Municipal Bureau of Sports underscored the integration of technology in sports. This included exploring advanced technological applications such as "blockchain," "5G," "8 K," and "VR." These technologies not only elevated the professionalism of sports training and competitions but also piqued public interest and participation in emerging sports activities (61). The Beijing municipal government has played a pivotal role in fostering a positive sports culture by endorsing sports culture promotion, event management, and dissemination. Furthermore, Beijing has been proactive in organizing a diverse range of national fitness competitions and sports events. Districts have cultivated branded sports events, adopting themes like "one district, one product," "one street (township), one product," and "one community (village), one product." This has led to a dynamic scenario where communities engage in daily activities, monthly competitions, and annual sports meetings. Leveraging the potential of "Internet+," Beijing has spearheaded an innovative operational model for the Olympic City Sports Culture Festival. This festival, based in Beijing, extends its reach nationwide and globally, further propelling the legacy of the Olympics and bolstering urban development (62).

The government's investment in technological innovation within the sports sector has catalyzed advancements in this field. As scholars such as Huang Qian have posited, technological innovation plays a pivotal role in enhancing public participation in sports, offering the masses scientific, efficient, and intelligent methods of engagement, as well as comprehensive health management solutions (63). Echoing this sentiment, Srikanth and Srikanth (64) also asserts that technological innovation in sports can boost participation levels. Key technological advancements, including wearable devices, fitness applications, virtual and augmented reality, performance analysis tools, and smart sports equipment, are instrumental in increasing engagement among students and athletes (64). Technological innovation offers novel platforms and tools for enhancing the promotion and dissemination of sports culture. Through data analysis and intelligent devices, it enables more precise and personalized delivery of sports information, individualized recording of physical activity participation, and the development of smarter sports venues (65). Concurrently, as discovered by scholars such as Huang Zhuo, investments in culture and sports media can significantly enhance public participation in sports (66). In this process, the advancement of sports infrastructure is particularly crucial, providing a solid foundation for the development of mass sports. Scholars like Wang Zhihui further point out that by strengthening infrastructure, the popularization and development of mass sports can be effectively promoted, thereby improving the health levels and quality of life of the public (67). Investments in culture and sports media bolster administrative operations, general management, institutional services, sports project oversight, competitions, training, venue management, mass sports initiatives, and international sports collaborations. This is achieved by refining sports supply services, advancing facility construction, and elevating training standards. In this context, technological innovation acts as both a technical conduit and a medium for fostering a sports culture ambiance, subtly nurturing public interest and engagement in sports, leading to a collective impact. The interplay between technological innovation and sports culture promotion results in a mutually reinforcing synergy. By elevating the intelligence and digitalization of sports infrastructure, technological innovation ensures a more judicious and efficient distribution of sports resources, thereby enhancing accessibility and participation in sports activities.

5.2 Key housing support security type

According to Table 3, the consistency of Configuration Path ③ and Configuration Path ④ reached 94.37 and 95.23%, respectively, with Configuration Path ④ demonstrating the strongest explanatory power among the four paths. Configuration Paths ③ and ④ indicate that, against the backdrop of inadequate social security and employment

investment, the government can effectively enhance the level of public physical activity participation by increasing expenditure on housing security. The practices of the Shanghai and Guangxi governments in 2020 serve as a typical example of this empowering process, successfully stimulating the public's enthusiasm for physical activity participation through government expenditure on sports housing security. Taking Shanghai as an example, the government has paid attention to and supported the housing security of practitioners in the sports field. The Shanghai Sports Bureau allocated 30.3 million yuan in the 2020 budget for expenses such as the payment of housing provident funds for on-duty personnel. This financial investment not only improved the welfare of sports industry practitioners but also indirectly promoted the construction and maintenance of sports facilities, providing a better sports environment for the public.

In the "14th Five-Year Plan," the Shanghai Sports Bureau proposed to achieve full coverage of urban sports centers at the district level, and essentially cover all streets and towns with community fitness centers and citizen fitness stations (68). This means that by supporting the construction and improvement of community sports facilities, convenient sports venues are provided for residents, enabling them to easily participate in sports activities within their communities, thereby enhancing their enthusiasm for sports. By the end of 2020, there were a total of 19 district-level sports centers in the city, essentially achieving a balanced layout of high-grade sports facilities. The Citizen Sports Park (Phase I) Soccer Park has been completed and opened, the Pudong Football Stadium is essentially completed, the Xujiahui Sports Park and the Jiushi International Equestrian Center projects have commenced construction, and the development of sports facilities for major events and public sports facilities continues to advance. Shanghai has also strengthened the integrated development of sports facilities through investment in sports housing security, adopting models such as "Sports + Greening," "Sports + Transportation," and "Sports + Education," making full use of urban space resources, increasing the supply of fitness facilities, and improving the efficiency and quality of sports facilities (69). The completion of these projects has not only increased the quantity and quality of sports facilities but also enhanced the public's participation and satisfaction with sports activities.

Increasing investment in housing security can effectively promote public participation in sports. Fiscal expenditures on housing security are capable of enhancing the basic living conditions and housing circumstances of the public. Li Xiaotian and the German sociologist Karl Mannheim have both noted that individuals engaging in fitness activities exhibit a stratified characteristic, with family income, housing ownership, housing size, and education serving as elements for social class differentiation (70–72). According to scholar Zheng Jiakun, under the premise of increased fiscal investment aimed at improving the basic living and housing conditions of the public, the development of mass sports can be effectively advanced (73). The increase in housing security expenditure provides a more stable living environment for low-income families, thereby reducing life pressures and increasing the time and energy available for these individuals to engage in sports activities (74). The implementation of housing security policies is often accompanied by the construction and improvement of community sports facilities (75). While providing housing support, governments often concurrently build sports venues and public sports facilities, the convenience and accessibility of which directly promote public physical activity participation. The construction and improvement of sports venues provide a foundational guarantee for the development of mass sports, offering venue support to increase the willingness and ability to participate in sports (76).

6 Conclusion and implications

6.1 Research conclusion

The study discerned four distinct governance pathways through which governmental sports expenditures bolster mass participation in sports, categorized into two primary levels. The first level pertains to the "technological innovation + sports culture promotion and dissemination" dual-core driven path, wherein investments in scientific and technological advancements, as well as cultural and sports media, serve as the pivotal conditions. Conversely, the second level is characterized by the "key housing support guarantee type" path, where investment in housing security emerges as the principal driving factor.

The examination of the prerequisite conditions for the QCA method reveals that no single condition variable is indispensable for facilitating government sports expenditure to augment mass physical activity participation. Furthermore, no individual condition variable can independently induce such an outcome. In other words, the influence of a solitary governance element on empowering mass physical activity participation through government sports expenditure is constrained. Consequently, to enhance governance efficiency, it is imperative to prioritize core conditions and amalgamate them with supplementary conditions to harness the combined potency of multiple elements. This multifaceted collaborative governance approach offers a novel perspective and strategy for optimizing the impact of government sports expenditure on national fitness.

6.2 Managerial implications

Initially, it is recommended that the government prioritize the integration of science and technology in sports, alongside the development of sports infrastructure. Additionally, enhancing sports services and promoting widespread dissemination of sports culture should be considered during resource allocation.

Secondly, expenditure on housing security is a crucial factor. This underscores the significance of ensuring a stable living environment for low-income families and constructing basic sports facilities within residential areas to encourage widespread participation in sports. Consequently, when developing housing policies, the government should take into account its potential indirect impact on physical activity participation. It should also strive to increase residents' awareness of physical activity participation by building community sports facilities.

Ultimately, it is imperative to recognize that no single measure can independently foster an increase in mass physical activity participation levels. Therefore, governments should implement comprehensive strategies in their practical approach. This can be achieved by fostering inter-departmental collaboration, integrating resources, and creating a unified effort to optimize governance effectiveness.

6.3 Limitations and prospects

In the analysis of the configuration paths through which government sports expenditure promotes universal sports participation, this study has unveiled the diverse driving factors and their combinatorial effects using the fsQCA approach, offering novel insights for sports policy formulation. While the study has achieved certain results, it is not without limitations. For instance, the sample is confined to 31 provinces (municipalities and autonomous regions) in China, which may restrict the generalizability of the findings. Future research could expand the sample size and include international comparisons to enhance the global applicability of the conclusions. Moreover, the study primarily relies on data from the year 2020, failing to fully capture the long-term dynamic effects of policy impacts. Subsequent studies could employ longitudinal data to provide a more comprehensive assessment of the sustained effects of policies. Currently, fsQCA mainly supports cross-sectional data analysis. In the future, time series or panel data can be processed in combination with other methods. Looking ahead, this study provides an initial dissection of the complex relationship between government sports expenditure and public sports participation, and it is anticipated that future research will build upon these findings to contribute further wisdom to the development of national fitness initiatives.

Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: the data of sports participation is calculated by the author through searching and collecting relevant data and building indicators. The amount of government financial expenditure is derived from the sports yearbook issued by the General Administration of Sport of the State, but this bibliography is not publicly distributed. If necessary, you can contact the author to provide relevant data sources. Requests to access these datasets should be directed to Wenxin Zhu, wenxinzhu_cumt_edu@126.com.

Author contributions

WZ: Conceptualization, Data curation, Formal analysis, Investigation, Software, Visualization, Writing – original draft. ZD: Funding acquisition, Methodology, Project administration, Resources, Supervision, Validation, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 04 April 2025
DOI 10.3389/fpubh.2025.1562915

OPEN ACCESS

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RECEIVED 18 January 2025
ACCEPTED 17 March 2025
PUBLISHED 04 April 2025

CITATION
Wei C, Wang J, Wu H, Xu Z and Zhang J (2025) The dynamic capabilities of county-level government in China during the outbreak of large-scale epidemics: a study based on three cases. *Front. Public Health* 13:1562915. doi: 10.3389/fpubh.2025.1562915

The dynamic capabilities of county-level government in China during the outbreak of large-scale epidemics: a study based on three cases

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Background: After China entered the stage of normalized epidemic prevention and control, county-level government became the leading force and responsible body for prevention and control. In some counties, the epidemic was initially sporadic but later evolved into large-scale transmission. This situation posed a severe challenge to their dynamic capabilities. The dynamic capacity of county-level government largely determines the effectiveness of dealing with large-scale epidemics.

Methods: This study selected three counties with a large-scale outbreak of COVID-19 in 2022 as samples for multi-case analysis, and used insight ability, integration ability, learning ability and innovation ability as dimensions for comparative analysis. Data and information were collected from the official websites of these three county-level governments using the octopus collector.

Results: The dynamic capabilities of county-level government are related to the results of large-scale epidemic prevention and control. This topic has been less explored in existing research. Compared to Si County and Linshui County, Jiutai District clearly lacks dynamic capabilities in large-scale epidemic prevention and control. The different abilities of county-level government play different roles in epidemic prevention and control.

Conclusion: County-level government are at the weakest stress point in the hierarchical structure of China's power system. They are at the forefront of public crisis management playing an important role, which further increase their pressure. Enhancing the dynamic capabilities of county-level government can greatly help them effectively respond to crises and alleviate their vulnerability.

KEYWORDS

COVID-19, county-level government, dynamic capabilities, large-scale epidemics, crisis

Introduction

At the beginning of 2020, COVID-19 broke out in Wuhan, China. It was a serious crisis and a severe test for all levels of government. To effectively combat the pandemic, the Joint Prevention and Control Mechanism of the State Council of China (JPCMoSCC) issued *the Guidelines on Taking Science-based, Targeted, Region-specific, and Tiered Measures for COVID-19 Prevention and Control* on February 17.

Subsequently, the number of newly confirmed cases gradually decreased to single digits. By the end of April 2020, epidemiological containment had been achieved in both Wuhan City and Hubei Province. The last hospitalized COVID-19 patient in Wuhan was discharged. Post-containment, the epidemic pattern transitioned to sporadic occurrences with localized clusters (1). That means epidemic prevention and control shifted from comprehensive planning and deployment to precise implementation of policies at the county-level. In practice, county-level administrations were designated as primary units for epidemic risk classification, employing population demographics, and infection metrics to formulate context-specific containment strategies. This administrative reorientation abruptly concentrated pandemic management pressures on local governments. Inadequate epidemic response at this level not only risked public condemnation but also entailed political accountability. To mitigate resource constraints, these administrations were required to implement adaptive containment measures calibrated to real-time epidemiological developments. Empirical evidence suggests that dynamic policy making constitutes an essential mechanism for alleviating resource allocation challenges in public health emergencies.

In the governance structure, local governments such as counties are the most important units (2). On the one hand, these local governments serve as primary interfaces for citizen-state interactions, directly receiving and processing demands from civil society organizations and individual constituents (3). As key implementers of policies, county-level government provide services to citizens and respond to their needs (4). The part of the pressure on local governments is to meet the demands of the public (5). On the other hand, county-level government have relatively limited resources and weaker ability to absorb additional resources. They have less ability to raise revenue through taxation, especially in rural areas where local government finances face challenges (6). Therefore, county-level government sometimes fail to meet the demands of citizens and interest groups due to the lack of management resources, resulting in conflicts (3). Moreover, county-level government are politically marginalized. With the recentralized, vertical, and hierarchical control of power, local governments are weakened in the process of public policy management. A series of problems such as lack of coordination, overlapping, and conflicting competencies may also occur (7). Especially during crises, county-level government lack the power to respond promptly in emergency situations. They need to consult with the central government on actions or countermeasures, which may delay the timing. Additionally, it is difficult for local governments to access emergency resources through effective coordination (8). For example, many local governments faced the problem of insufficient medical resources, isolation facilities, and vehicles during the COVID-19 epidemic (9).

The COVID-19 pandemic necessitates a dual governance capacity framework at the county level, integrating foundational decision-implementation competencies with real-time adaptive responsiveness to epidemiological developments. This operational context underscores the criticality of analyzing dynamic capabilities within local government crisis management systems. Teece and Pisano defined "dynamics" as the changing characteristics of the environment, while "capabilities" emphasized the key role of strategic management in adapting, integrating, and reconfiguring internal and external organizational skills, resources, and capabilities (10). Subsequently, they further pointed out that dynamic capabilities were the abilities of organizations to utilize existing internal and external specific capabilities to cope with constantly changing environments. They explicitly proposed that dynamic capabilities were composed of three dimensions: integration, construction, and reconstruction ability (11). Eisenhardt and Martin expanded the application areas of dynamic capabilities, believing that dynamic capabilities not only play an important role in dynamic environments, but can also have a significant impact on organizations in static environments (12). Although there are inevitably some differences, most scholars believe that dynamic capabilities are the effective development and implementation of new opportunities. It can be seen that it depicts more about the organization's ability to face new situations and problems.

The dimensions within dynamic capabilities are not isolated from each other. The three abilities of sensing opportunities (insight), seizing opportunities (integrating resources), and reconfiguring resources (innovation) interact with each other. They need to be synergized to respond to environmental change (13). When analyzing how learning mechanisms promote the development of dynamic abilities, Zollo argued that knowledge codification learning could improve the efficiency of resource reorganization. He emphasized that learning capabilities provided the knowledge base for innovative capabilities (14). Helfat systematically explored the microfoundations of the dimensions of dynamic capabilities, including resource reorganization and innovation path dependence. The empirical study showed that environmental insights and technological iterations needed to form a linkage through organizational learning (15). Barreto revealed a framework for the interaction of the dimensions of dynamic capabilities (perception, integration, learning, and innovation). Integration capability was proposed as a key mediating variable linking insight and innovation (16). Schilke proposed a multidimensional model of dynamic capabilities (perception, learning, integration, and coordination). They validated the complementarity of the dimensions in the context of environmental turbulence. Insight ability needed to be combined with rapid integration ability to drive innovation. Conversely, the strengths of a single dimension cannot compensate for the weaknesses of other dimensions (17). Wilden argued that learning ability was positively correlated with innovation ability. They emphasized the importance of integration skills in translating insights into innovation (18).

Although the goals and operational processes of the public sector are significantly different from those of private organizations, they are often driven by environmental pressures and have to undergo reforms. Dynamic capabilities can improve the efficiency and effectiveness of public resources, helping governments better fulfill their commitment to providing services (19). Scholars also hold different opinions on the composition of dynamic capabilities in the public sector. Based on the perspective of knowledge management, Wang and Feng divided dynamic capabilities into absorptive, integrative, learning, and innovative dimensions (20). Fernandes identified five different methods for implementing

dynamic capabilities: digital ability, knowledge ability, absorptive ability, strategic ability, and resource ability (21). Wirtz et al. believed that dynamic capabilities were the core challenge that governments faced in achieving digital transformation in the digital age, namely the ability to perceive, seize and transform digital technologies (22).

Of course, there are differences in the dynamic capabilities possessed by different levels of the public sector. For example, dynamic capabilities in public value creation differ between the central governments and local governments. The central government has significant advantages in resource integration and cross-regional coordination. However, the central government's response speed is relatively slow in terms of quickly adapting to specific local needs. Local governments are more flexible and responsive at the local level and are able to adjust service provision quickly (23). Hartley explored differences in dynamic capabilities in innovation management across different levels of the public sector (24). The central government drives innovation by virtue of institutional legitimacy, but bureaucratic procedures can inhibit rapid trial and error. Local governments achieve rapid innovation through informal networks and collaboration with social enterprises, but face sustainability challenges. The innovation capacity of central-level government is more in the form of "policy incubation." This ability is reflected in the "practice diffusion" of local level governments.

Some studies have also found that there are also differences in the dynamic capacities of central ministries and local organizations in crisis response. The strengths of the central department lie in strategic foresight and cross departmental coordination. The weakness of the central government is its slowness to act. In contrast, local institutions are outstanding in their ability to implement quickly. Their problem is that they do not have a sufficient stock of strategic resources (25). Comfort analyzed the differences in collaboration between federal, state and local governments in the United States during the events of September 11th. The federal government (e.g., FEMA) had the advantage of scale of resources. They were able to mobilize national rescue forces quickly. But there was a delay in the transmission of initial information. Local government failed to timely report on-site intelligence. The local government in New York responded quickly to localization. Fire and police departments acted quickly based on local knowledge. Local government resources were fragmented. Cross-sectoral communication systems were also incompatible. As a whole, the advantage of the central government was resource coordination, while the advantage of local governments was situational action. However, the synergy between the two leads to the problem of "information silos" (26).

In the context of crises, dynamic capabilities can be divided into three dimensions: the ability to perceive crises, the ability to seize new opportunities in crises, and the ability to reconfigure resources to respond to crises (27). When dealing with public crisis, the dynamic capabilities that the government needs mainly include the ability to adapt and learn, the ability to coordinate public services and citizen needs, the ability to manage flexible production systems, and the ability to manage data and digital platforms (28). Some scholars also advocated that the government needed strategic emergency planning, analysis, organizational management, and collaboration abilities to effectively respond to crises (29). Although scholars have not reached a consensus on the dimensions of dynamic capabilities, most of their views include perceptual ability, resource allocation ability, and knowledge learning ability, innovation ability. This means that scholars believe that these four abilities are the most important. Based on existing research and crisis situations, this study defined the dynamic capabilities of the government as a capability package that integrates internal and external resources to adapt to the constantly evolving environment and achieve its own functions. This paper analyzed the dynamic capabilities of county-level government from four aspects: insight ability, integration ability, and learning ability and innovation ability.

At present, many studies have applied dynamic capabilities theory to the field of enterprise strategic management. Some scholars introduced it into the study of the public sector. However, no scholars have yet focused their attention on the dynamic capabilities of county-level government. Based on the foundation laid by the above research, this study will expand and supplement from the following aspects. Firstly, this paper paid attention to analyze the problems of China's county-level government during dealing with COVID-19 from the perspective of dynamic capabilities. Secondly, the multi-case comparative analysis was used to analyze how dynamic capacity affects and increases the vulnerability of county-level government in a crisis. It is hoped that the dynamic capabilities of county-level government and their ability to adapt to the external environment will be enhanced.

Methods and cases

Research method

Multi-case comparative analysis is a social science research method. Instead of exploring a single case, this research method selects several cases for in-depth analysis. It systematically compares and analyzes multiple cases so as to reveal the commonalities and differences, as well as the underlying causal relationships or patterns behind these cases. This approach helps the researcher to go beyond the limitations of a single case. This approach can refine theories, test hypotheses, or identify new research questions from a broader perspective.

In this study, the multi-case comparative analysis method was used to investigate the impact of dynamic capabilities on the county's handling of COVID-19. Changchun Jiutai District, Si County, and Linshui County were selected as typical cases. This paper collected data and information on the three county-level government' responses to the COVID-19. Using the four dimensions of dynamic capabilities sorted out above as an analytical framework, this paper compared the dynamic capabilities situation of the three county-level government in responding to COVID-19. Through the comparative study, we summarized the challenges faced by different county-level government. We analyzed in depth the role of dynamic capabilities for county-level government in emergency management based on the results of the study.

Cases selection

According to *the guidance on accurate prevention and control of COVID-19 from the JPCMoSCC* on February 17, 2020, the cumulative number of cases exceeds 50 was a high-risk area. If the number of confirmed cases in a county exceeds 50 in a short term, it is considered that there has been a large-scale outbreak. Based on this, we selected Jiutai District, Si County, Linshui County as typical cases to analyze the dynamic capabilities of county-level government. These three samples have regional representativeness. Jiutai District in Jilin province is located in the northeast of China. Linshui County in Sichuan province is located in the inland southwest region, and Si County in Anhui province is located in the eastern region of China. Although the geographical locations of the three regions are different, the level of economic development is comparable and the differences are not significant. In 2022, the GDP of Jiutai District, Linshui County and Si County were respectively 24.35 billion yuan, 26.74 billion yuan, and 29.324 billion yuan. Additionally, the outbreak of the epidemic in three regions received widespread attention. According to the Baidu Index, the search index for "Si County Epidemic" reached a maximum of 33,040, while the index for "Linshui County Epidemic" was 31,071. Although the index for "Jiutai Epidemic" was only 3,632, the search index for "Changchun Epidemic" was as high as 94,657. Due to Jiutai being a district under the jurisdiction of Changchun City, along with the outbreak in Changchun, there has also been a large-scale outbreak in Jiutai. Therefore, the public's attention to Jiutai was reflected in their attention to the epidemic in Changchun. We can refer to the search index for "Changchun Epidemic."

Overall, these three cases firstly meet our criteria for defining large-scale epidemics. Secondly, these cases have attracted widespread attention from society and have a certain level of exposure. Finally, three regions represent different areas. They have similar levels of economic development, making them representative as research subjects. Therefore, this paper chooses Changchun Jiutai District, Si County, and Linshui County as typical cases to study.

After the outbreak of COVID-19 in Wuhan, China, in 2020, in addition to the strictest blockade and traffic control in Hubei Province and Wuhan, social prevention, and control measures were also taken nationwide, such as banning assembly activities and controlling public places. The premise of these measures is that at the beginning of the outbreak in 2020, only Hubei Province had a more severe situation, while other provinces in China did not have frequent or severe outbreaks of epidemics. After entering the stage of normalized prevention and control, China has taken different prevention and control measures for each county. According to the comprehensive study of population and disease incidence rate, the counties are divided into low, medium and high-risk levels. Therefore, the main body of epidemic prevention has become the county-level government. The prevention and control situation has shifted from large-scale prevention and control to precise prevention and control led by county-level government. 2022 is a period of normalized prevention and control, which is fundamentally different from the epidemic prevention situation and measures in 2020.

In 2022, the COVID-19 strain had changed. This new strain was generally not highly pathogenic, but it was highly contagious. In epidemic prevention and control, tracking and detecting mutant strains became more difficult. In this context, the phenomenon of concentrated outbreaks of the epidemic in county-level areas was more prominent, because when the epidemic was found to be more serious in the county, the local government immediately adopted strict prevention and control measures. In this study, Octopus Collector captured data and found that after the mutation of COVID-19 virus strains in 2022, large-scale outbreaks occurred successively in Shaanxi, Jilin, Henan, and Shanghai, which was more common in county areas. The mutation of the virus and changes in the social environment posed challenges to the dynamic capabilities of county-level government, testing their ability to quickly mobilize various resources and effectively control the epidemic. Based on the changes in the social situation mentioned above, we selected three cases that occurred in counties in 2022.

The age structure of the population in the three counties is shown in Table 1. In terms of population, Si County has a population of 763,310 according to the seventh national census. There are 707,537 people in Linshui County and 569,976 people in Jiutai District. In the population demographics, individuals aged 65 and above constitute 14.6% in Si County. Comparatively, the proportion of residents aged 65 and above in Linshui County and Jiutai District are higher, at 18.26% and 16.62% of their respective populations. The population density of the three counties is shown in Table 2. Jiutai District has a population density of 169 individuals per square kilometer, while Si County boasts a higher density with 411 people per square kilometer. Linshui County falls in between, with a population density of 371 people per square kilometer. Not only that, Jiutai District, with the smallest resident population, has the highest administrative cost per unit under the same level of public expenditure. Both lower population density and higher administrative cost per unit provide Jiutai District with good conditions for epidemic prevention and control. And in terms of the number of beds in medical institutions per capita and the number of medical personnel per capita, Si County, Linshui County, and Jiutai District are all at the same level. This indicates that the medical conditions in these three districts are comparable. The data provided reveals that the population size, age composition, and medical conditions of Si County, Jiutai District, and Linshui County are largely comparable.

The basic situation of the development of the epidemic in the three samples is as follows.

TABLE 1 Age structure of the population in the three counties (China, 2022).

County name	Under 14 years old	15–59 years old	Over 60 years old	Over 65 years old
Si County	24.2%	58.1%	17.7%	14.6%
Linshui County	19.39%	57.94%	22.67%	18.26%
Jiutai District	11.34%	64.6%	24.04%	16.62%

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TABLE 2 Basic fact sheet for the three counties (China, 2022).

Basic information	Si County	Linshui County	Jiutai District
Resident population (n)	763,310	707,537	569,976
Area (km^2)	1,857	1,907	3,371
Population density (n/km^2)	411	371	169
Fiscal size (billion yuan)	29.32	26.74	24.35
Public health costs per unit (yuan)	1,513.49	1,581.57	1,417.53
Administrative cost per unit (yuan)	8,928.12	7,882.30	10,588.17
Total number of beds in medical institutions	4,524	3,480	3,171
Number of hospital beds per capita	0.0059	0.0049	0.0055
Number of medical staff	4,584	3,488	3,642
Number of medical personnel per capita	0.0060	0.0049	0.0063

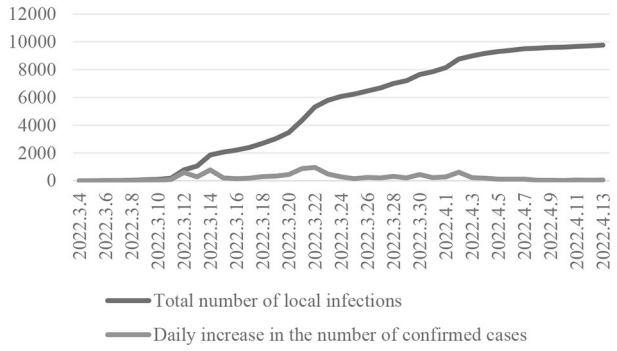

FIGURE 1
Infection of the COVID-19 in Jiutai District (China, 2022).

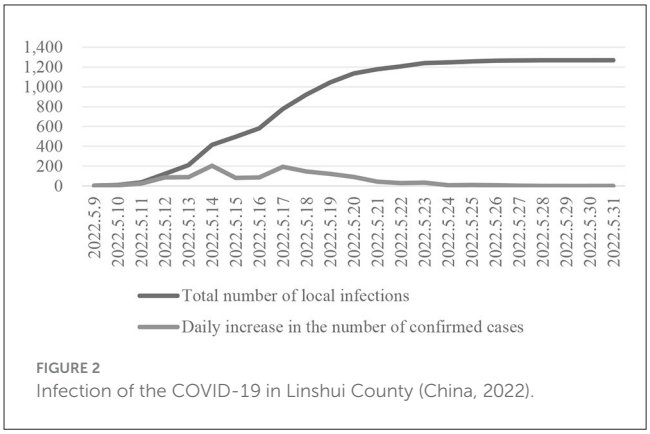

FIGURE 2
Infection of the COVID-19 in Linshui County (China, 2022).

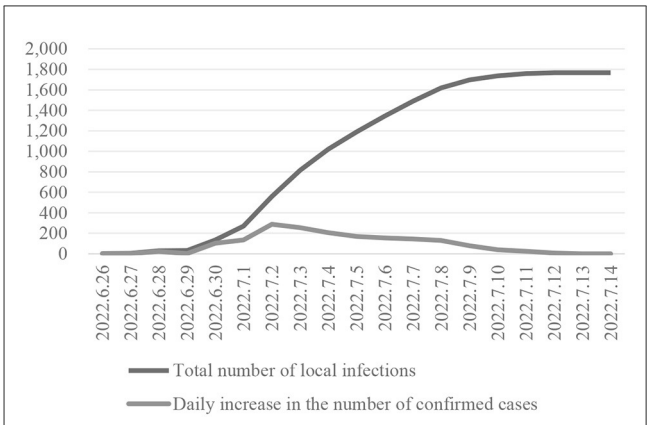

FIGURE 3
Infection of the COVID-19 in Si County (China, 2022).

Case 1

At the beginning of 2022, a new round of epidemic broke out in Jilin province, especially in Jiutai District of Changchun City. Since the first positive case was reported on March 3rd, and by April 8th, the total number of reported infections in this region was nearly 10,000 (as shown in Figure 1). On April 27th, Jiutai held a work meeting to gradually lift static control and orderly restore production and living order. As can be seen in Figure 1, the number of new infections per day increased rapidly from March 11 to April 3 in the Jiutai District. This trend continued for about 23 days. After April 3, the increase in the number of new daily infections slowed down.

Case 2

In May 2022, a sudden COVID-19 caused the small county of Linshui to press the pause button. This epidemic began on May 9th and did not reach zero social coverage until May 22nd. Finally, on May 30th, Linshui gradually lifted static management and orderly restored production and living order. The cumulative number of infections in Linshui exceeded 1,200 cases (as shown in Figure 2). The period from May 11 to May 20 was the most significant period of new daily infections in neighboring counties. This process lasted for 9 days.

Case 3

In June 2022, a large-scale epidemic broke out in Si County. The first case was discovered on June 26th, and the social coverage was cleared to zero on July 8th. The static management of the entire area was lifted on July 14th. The cumulative scale of infections in Si County this time was 1,767 cases (as shown in Figure 3). Confirmed diagnoses began to appear on June 29 and then continued until July 11, when the number of new daily infections in Si County increased rapidly and remained at a large scale. This period lasted approximately 12 days.

Data collection

This study used the octopus collector to collect the required data and information. Octopus Collector is a data collection tool based on a graphical interface. It can easily obtain a large amount of standardized data from various websites or web pages in a short

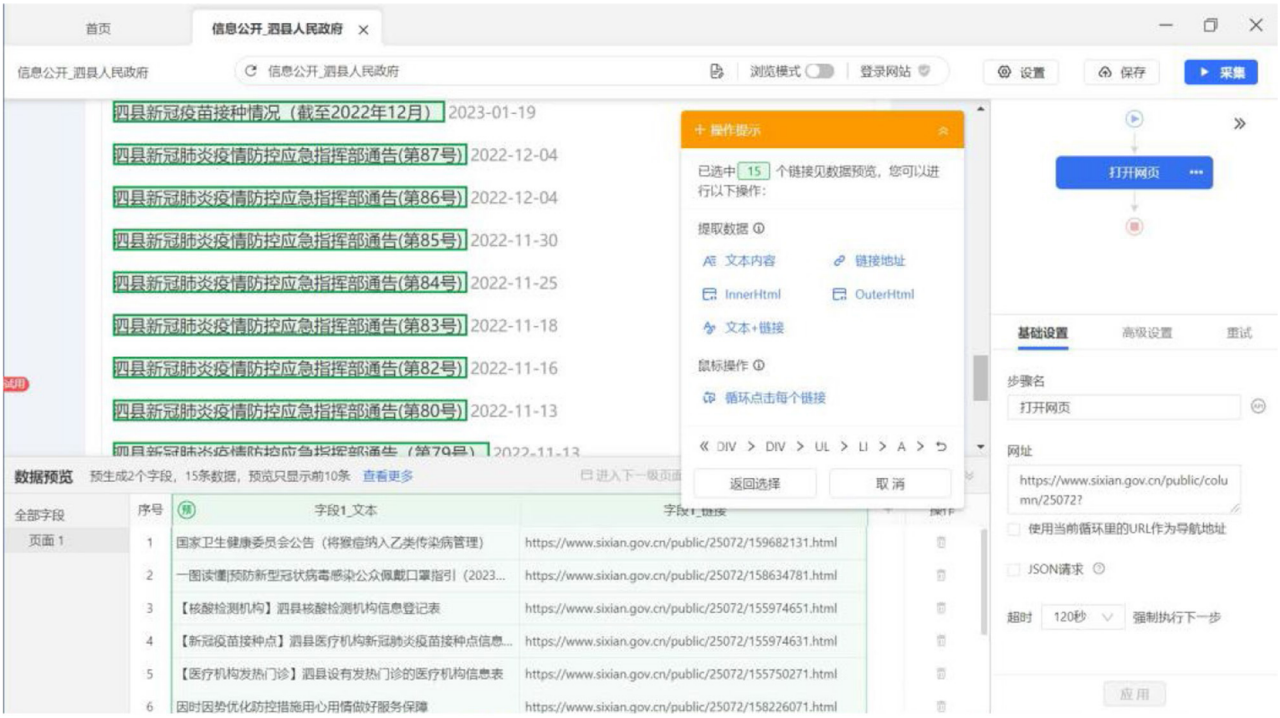

FIGURE 4
Operation of using octopus collector to collect epidemic data in Si County.

period of time. This tool helps any customer who needs to obtain information from web pages to achieve automated data collection, editing, and standardization. Its use reduces the cost of obtaining information and improves efficiency. Octopus Collector is one of the software used by many Chinese scholars for data scraping endeavors (30). This paper used Octopus Collector to capture various information related to epidemic notifications on the official websites of the governments of Si County, Linshui County, and Jiutai District.

This study employs Si County as a case study to elucidate the operational workflow of the Octopus Collector system. First, a new data collection task labeled "COVID-19 Infection Monitoring in Si County" is initialized within the Octopus Collector platform. Subsequently, the target URL corresponding to the Epidemic Prevention and Control announcements published on the official government portal of Si County is entered into the designated URL field. Following initial configuration, systematic rule formulation was conducted through the following technical procedures: Click on the title "Si County New Crown Pneumonia Epidemic Prevention and Control Emergency Response Command Notice" and then click on "Select All Similar Elements." The Octopus Collector will display the screen in Figure 4. After selecting "Cycle through each element" and coming back, the page will go to the detail page. The operator selects the text that reports the number of new infections and then selects "Text Content." In order to ensure that the Octopus Collector can automatically turn the page, the operator can click on the "cycle page" in the flowchart, and then click on the "next page." The automatic page will be set up. The final flowchart is shown in Figure 5. After the rules are set up, the last step is to save the rules. Click the "Start Task" button, Octopus Collector can start to perform the task.

In order to verify the accuracy of the extracted data, this study conducted small-scale test collection before the formal large-scale collection. We selected a small amount of sample data for collection to check whether the collection results were complete and accurate. This verification process mainly included four aspects. The first was to randomly check the integrity of the information to determine whether it contained the expected main fields. The second was to determine whether the obtained information was consistent with the directly visible content on the webpage. The third was to verify the logic of the information, such as whether the information expressed as area, population, fiscal expenditure, and other data conformed to logic. The fourth step was to conduct data comparison, which utilized the data comparison function of Excel to check the differences between the crawled data and the original data. Based on the accuracy results of small sample collection, this paper can initiate large-scale collection. After the collection was completed, this study obtained the number of newly confirmed infections per day in Si County during the epidemic period. We organized the data and made a line graph by summarizing the extracted data through an excel sheet. The epidemic data collection in Jiutai and Linshui County also followed the same steps.

Indicators and measurement

As mentioned above, four dimensions of dynamic capacities were selected for this study. This paper analyzes the factors that

FIGURE 5
Flowchart of octopus collector collecting data.

influence county-level government in dealing with COVID-19 in these three areas.

Insight ability means that the governments must be able to grasp the trend and direction of the current state of affairs. When an epidemic occurs, the governments must promptly issue warnings. Timely notices can make the public more alert. *The Emergency Response Law of the People's Republic of China* also stipulates that local governments at or above the county level should promptly issue warnings at the appropriate level (31).

The Novel Coronavirus Pneumonia Prevention and Control Plan (ninth version) clearly stipulated that the local joint prevention and control mechanism should release the epidemic situation, risk areas and other relevant information within 5 h after the outbreak of the epidemic. Epidemic information should be based on online direct reporting data. The press conference must be held no later than the following day (32). Therefore, this study uses the duration of warning information and notifications issued by the county government after the outbreak as an indicator. If the county government issued a notice on the day of discovering the epidemic, it can score 25 points in this indicator section. If it issued a notice on the 2nd day, it can score 15 points. If the notice was issued on or after the 3rd day, the score was 0 points. At the same time, the governments should take immediately measures. The ability of the public sector to perceive risk is demonstrated by the speed and responsiveness with which it reacts immediately and delivers services to beneficiaries quickly (33). It was stipulated in the work plan for the prevention and control of COVID-19 during the New Year's Day and the Spring Festival in 2022 that efforts should be made to implement relevant emergency response measures within 24 h (34). Thus, this study selects the time interval between measures taken after the outbreak of the epidemic as an indicator. If the county government took response measures on the day of discovering the epidemic, it can score 25 points. If these measures were taken on the 2nd day, they would receive 15 points. If the interval was 3 days or longer, there would be no score. The ability of governments to think ahead requires that they must act quickly to respond to the uncertainty of an epidemic. As the primary agent of the crisis, the governments must be able to anticipate future scenarios that could jeopardize the system and people's lives (35). The government's insight capacity is not only reflected in the state of crisis, but also in the norm. According to *the Emergency Response Law of the People's Republic of China*, people's government at the county level have the responsibility to carry out systematic investigation, registration and risk assessment of risk sources and hazardous areas, and to implement regular inspection and monitoring (31). Before a crisis occurs, county-level government should take responsibility for identifying sources of danger, and should also conduct regular inventories of emergency supplies. The State Council, in its *National Emergency Response System Plan for the 14th 5-Year Plan*, emphasizes the importance of emergency supplies (36). Based on the above combing of policy texts and related literature, this paper determines whether the government has insight ability based on the following four criteria: (a) The inspection of hazardous sources related to such incidents was carried out prior to the incident. (b) Whether the county-level government regularly conducts an inventory of emergency relief materials. (c) Whether warning information and notification are issued immediately after an incident. (d) The time interval for taking measures after the accident.

Integration ability refers to the ability of the government to access resources at the onset of a crisis, and to be able to integrate internal and external resources at the first opportunity in order to stop the crisis from producing more serious harm. In the process of dealing with COVID-19, the resources that the government has to integrate include financial and human resources. The financial power possessed by the county-level government is firstly reflected in the financial capacity possessed by the county-level government itself. GDP per capita, as a core indicator of a region's economic development level, has been used by some scholars to assess the emergency management capacity of local government (37). When an emergency occurs within a county and exceeds its response capacity, the county-level government may seek necessary assistance and support from the people's governments at

the provincial and municipal levels. According to the *Emergency Response Law of the People's Republic of China*, if the county-level people's government is unable to eliminate or effectively control the serious social hazards caused by an emergency, it shall promptly report to the higher-level people's government. The higher-level people's government should take timely measures (31). In the state of emergency, the government's budget allocation for COVID-19 prevention and response is part of the funding for the response to the outbreak (35). Another part of the resources comes from donations of money and goods from the community (33). In turn, the number of health care workers is an important resource for county-level government when responding to COVID-19. Accordingly, this paper chooses the following five indicators: (a) The per capita GDP of the county in the year of the accident. (b) The financial income and expenditure of each county health care commission. (c) The number of social donation amounts received by each county during the epidemic. (d). The number of people served per health technician. (e) Whether assistance is provided by higher levels of government in terms of financial, human and material resources. These five indicators are used to determine whether county-level government have the ability to integrate and coordinate external resources in emergency management.

Learning ability refers to the ability of a government to learn about a crisis to better understand the crisis itself. In order to improve the government's crisis learning ability, the first step is targeted learning and training for government officials. Strengthening the capacity of government officials to deal with public emergencies can improve the overall quality of government officials (38). Secondly, government officials try to learn from past or other national crisis events to deal with unprecedented crisis issues (39). Finally, governments should carry out crisis publicity activities. *The Opinions of the General Office of the Central Committee of the Communist Party of China and the General Office of the State Council on Further Enhancing the Emergency Management Capabilities of Grassroots Levels* mentions that grass-roots governments should carry out extensive public information campaigns (40). The ability to learn is not only in the acquisition of knowledge, but also in the application of knowledge (41). County-level government need to conduct regular emergency exercise activities. Starting from 2021, more and more municipal governments have stipulated that regular drills should be conducted at the county level according to the needs of epidemic prevention and control, with a principle of no less than once per quarter (42). According to this regulation, this study evaluates the frequency of emergency drills conducted by county governments. If the county government had conducted 3 or more drill in the year before the outbreak of the epidemic, the score would be 25 points. If 1–2 drills were conducted, the score would be 15 points. If no drill had been conducted, the score was 0. Therefore, this paper compared the learning ability of county-level government in the following aspects: (a) Number of training courses conducted by county-level government in the year prior to the accident. (b) Number of emergency drills conducted by county-level government in the year prior to the accident. (c) Whether it has taken the initiative to learn from the experience of other incident areas in handling emergencies. (d) Whether to publicize crisis knowledge on the official website.

Innovation ability requires the government not only to systematically organize and deeply integrate existing knowledge. It also needs to reconstruct and innovate its own organizational structure and technical means to better adapt to the continuously changing and developing environment. The innovation ability of the county-level government is firstly reflected in the system innovation. It is the innovation of the emergency plan in the field of emergency management. Due to the scale and severity of the COVID-19 outbreak, government should designate contingency plans based on the changing environment and the needs of beneficiaries. Without contingency plans, organizations will have to reconfigure existing operational capacity and resources in a crisis situation (33). The ability to innovate is also reflected in the innovation of technology. Data empowerment has a significant impact on the effectiveness of government emergency management. The use of big data technology can improve the ability of government to monitor, forecast, early warning, response, collaborate, and communicate (43). The innovative ability of county-level government is also reflected in the innovation of information dissemination channels. *Law of the People's Republic of China on Emergency Response* explicitly proposes to "establish and improve the system of news interviews and reports on emergencies." This law provides that after the occurrence of emergencies, the relevant people's governments and departments shall promptly publicize to the society the information related to emergencies and the decisions, orders, measures, and other information related to the response to emergencies. The law makes it clear that the government is obliged to release information in a timely and accurate manner through various media channels, including new media, in order to safeguard the public's right to know (31). Organizational innovation is also part of the innovation ability of county-level government. *Law of the People's Republic of China on Emergency Response* stipulates that county-level government may, according to actual needs, set up under this framework relevant categories of emergency response command agencies or working groups and other organizational forms to organize, coordinate and direct emergency response work (31). This study used four indicators to measure whether the government has the ability to innovate: (a) Full use of new media tools for information dissemination and public opinion guidance. (b) Whether the overall emergency response plan was updated within 1 year prior to the accident. (c) Establishment of a special task force across departments within the county-level government after the incident. (d) Establishment of an emergency intelligent management system before the incident.

Cui Li and other scholars assessed the government's emergency management capability in terms of risk perception capability, pre-safety function, monitoring and warning capability, emergency response capability, emotional guidance and reconstruction capability, and emergency audit function. Among them, risk perception ability has the highest weight. Emergency response capability is second (44). Shen also assigned weights to indicators when assessing government emergency preparedness and response capabilities. In his research, command and decision-making capacity was given the highest weight. Rescue capacity was given the second highest weight. Emergency knowledge dissemination as well as emergency training were given lower weights than the first

TABLE 3 Comparative dimensions of dynamic capabilities.

Variable name		Indicator variables		Scoring rules	
Insight ability	30%	Hazardous Source Identification	Hazardous source inspections related to such incidents were conducted prior to the incident.	Yes	25
				No	0
		Material Inventory	Whether the county-level government regularly conducts an inventory of emergency relief materials.	Yes	25
				No	0
		Early warning notification	Whether warning information and notification are issued immediately after the accident occurs.	Same-day	25
				1-day delay	15
				2-day delay	0
		Measures to be taken	The time interval for taking measures after an accident occurs.	Same-day	25
				1-day delay	15
				2-day delay	0
Integration ability	30%	GDP per capita	GDP per capita for the county in the year of the accident.	Highest	20
				Medium	10
				Least	0
		Epidemic prevention funds	The financial income and expenditure of each county health commission.	Highest	20
				Medium	10
				Least	0
		Social assistance	The number of amounts of social donations received by the county during the outbreak.	Highest	20
				Medium	10
				Least	0
		Number of employees	Number of people served per health technician.	Least	20
				Medium	10
				Highest	0
		Assistance from higher-level government	Whether assistance is provided by higher-level government in terms of financial, human and material resources	Yes	20
				No	0
Learning ability	20%	Crisis communication	Whether to publicize crisis knowledge on the official website.	Yes	25
				No	0
		Emergency Training	Number of training courses conducted by county-level government in the year prior to the accident	3 times and more	25
				1–2 times	15
				No	0
		Emergency Drill	Number of emergency drills conducted by county-level government in the year prior to the accident	3 times and more	25
				1–2 times	15
				No	0
		Specialized Learning	Whether it takes the initiative to learn from the experience of other places and regions in dealing with emergencies.	Yes	25
				No	0
Innovation ability	20%	Institutional Innovation	Whether the overall emergency response plan was updated within 1 year prior to the accident	Yes	25
				No	0
		Organizational Innovation	Establishment of special working groups across departments within the county-level government after the incident.	Yes	25
				No	0
		Technological innovation	Establishment of an intelligent emergency management system before the event.	Yes	25
				No	0
		Information dissemination innovation	Make full use of new media tools for information dissemination and public opinion guidance.	Yes	25
				No	0

two (45). Based on the above, this study assigned weights to the primary indicators, and the results are shown in Table 3.

Results

Insight ability of county-level government

Prior to the large-scale outbreak, the county-level government of all three districts had conducted risk source screening. The outbreak prevention and control command steering group in Jiutai District conducted a field inspection of the outbreak prevention and control work in the urban area on January 19, 2022 (46). Government personnel conducted field inspections of the implementation of standing epidemic prevention and control requirements. Supervisory and inspection activities for epidemic prevention and control were carried in Linshui County on January 30, 2022 (47). Si County also conducted district-wide nucleic acid testing on March 18, 2022. Timely hazard identification enabled county-level government to prepare for emergencies. The governments of all three regions demonstrated a high level of risk preparedness.

Linshui County people's hospital medical supplies reserve warehouse categorized storage of more than 10,000 medical protective masks, 7,000 sets of medical protective clothing, more than 1,800 sets of isolation gowns and other anti-epidemic materials. Si County also requested the Commerce Bureau to map out the county's large shopping malls and supermarkets living supplies reserve situation before the epidemic. This move to ensure the county's supply of essential goods is sufficient. The government of Jiutai District, however, did not conduct an inventory and liquidation of anti-epidemic supplies before the epidemic. This suggests that the government of Jiutai District lacks a dynamic monitoring mechanism for emergency epidemic supplies. Supplies are consumed at different rates in different epidemic prevention scenarios. Without an inventory of the supplies, the rapid consumption of the supplies could not be detected in time. The county-level government's inability to warn and replenish supplies in advance may lead to the risk of supplies being cut off at certain critical points.

There were also slight differences in the time intervals between the release of notification bulletins in the three regions following the outbreak. When the first confirmed case was found on June 26 in Si County, a notice was issued on the same day. In contrast, both Linshui County and Jiutai District released announcements on the government's official website only the day after the first confirmed case was found. Timely release of exact announcements by the government not only raises the alertness of government officials, but also enables the public to take early precautions. Si County's immediate announcement allowed local citizens to be prepared. Citizens reduced the likelihood of contagion by taking steps such as going out less and increasing protection.

The attitudes of these three county-level governments toward taking measures to the first confirmed case varied significantly, with two county-level government promptly implemented measures to prevent and control the epidemic, as shown in Table 4. After the discovery of confirmed case on March 3, Jiutai District did not carry out the first round of nucleic acid testing throughout the district until March 6, and adopted social static management. The local government made an inaccurate assessment of that epidemic, delayed the best control time, and caused the virus to spread for 3 days, resulting in a sharp increase in the number of infections in Jiutai. It was not until 56 days later that the local society returned to normal.

TABLE 4 Insight ability of three county-level government (China, 2022).

The manifestation of Insight Ability	Si County	Jiutai District	Linshui County
Start date of the epidemic	2022.6.26	2022.3.3	2022.5.9
Time of publication of the notice	2022.6.26	2022.3.4	2022.5.10
Start date of static management	2022.6.26	2022.3.6	2022.5.10
Interval duration	0 day	3 days	1 day
Date of social zeroing	2022.7.8	2022.4.8	2022.5.22
Date of removing static management	2022.7.14	2022.4.27	2022.5.30
Duration of the epidemic (time from start to removing static management)	19 days	56 days	22 days
Total number of infected individuals	1,767	10,000+	1,269
Number of health technicians	4,584	3,642	3,488
Number of people served per health technician	167	157	203

TABLE 5 Insight ability assessment of three counties.

Indicators		Si County	Linshui County	Jiutai District
Insight ability	Hazardous source identification	25	25	25
	Material inventory	0	25	0
	Early warning notification	25	15	15
	Measures to be taken	25	15	0
Aggregate score		75	80	40

After the first confirmed case appeared in Linshui County on May 9th, closed static management was implemented throughout the county from the 2nd day onwards, and large-scale nucleic acid testing was carried out in the county's urban area. By comparison, after the first confirmed case was discovered on June 26th, Si County immediately implemented control measures throughout the county, conducting the first nationwide nucleic acid test, implementing differentiated prevention and control, strengthening social control, and strictly limiting gatherings of people. Comparatively, Jiutai District's delayed response—taking control measures only 3 days after the first confirmed case—allowed the virus to spread locally, exacerbating the severity of the outbreak.

Based on the actual performance of the three county governments in various indicators in Table 5, this study evaluates

TABLE 6 Health revenues and expenditure and donations of the three county health committees (unit of money: million yuan) (China, 2021–2022).

Health Revenues, Expenditure and Donations	Si County	Jiutai District	Linshui County
GDP per capita in 2022	0.039	0.032	0.038
Income in 2022	1,093.91	820.76	1,136.32
Expenditures in 2022	1,155.26	807.96	1,119.02
Income in 2021	1,320.36	785.60	992.08
Expenditures in 2021	1,335.28	777.28	966.51
Donations	17.98	14.21	15.58

their insight ability. Among them, Linshui County has the highest score. The rating of Jiutai District is the lowest. This indicates that the insight ability of Jiutai District is relatively weak. As shown in Table 5, Jiutai District has a significant gap in taking action compared to the other two counties. This results in a lower overall rating for insight ability.

Integration ability of county-level government

The epidemics in Si County, Linshui County, and Jiutai District all occurred in 2022. As can be seen in Table 6, the GDP per capita in Si County in 2022 was 0.039 million. Jiutai District's GDP per capita in 2022 was 0.032 million. Linshui County's GDP per capita in 2022 was 0.038 million. The GDP per capita of Jiutai District in 2022 was the least.

Since 2020, Chinese governments at all levels have become familiar with the operation of epidemic prevention, especially with clear expectations for resources and funding investment in epidemic prevention. The epidemic in all three counties occurred in 2022. Table 6 shows that the health expenditure in Linshui County and Jiutai District in 2022 was higher than that in 2021, while the health expenditure in Si County remained stable between 2021 and 2022. Overall, the health expenditure of three counties remained basically unchanged in 2022. In 2021 and 2022, the public health income and expenditure in Jiutai District were the lowest among the three regions, and were significantly lower than those of the other two.

The resources and funding required for epidemic prevention are undoubtedly enormous. In addition to government finances, resources from enterprises and society are also crucial for combating the epidemic. So, governments across China actively mobilize and seek support from external resources. During the large-scale outbreak of the epidemic, these three governments all received epidemic prevention materials and donations from enterprises and society. According to official information, Si County, Linshui County and Jiutai District respectively received social donations of 17.98 million yuan, 15.58 million yuan, and 14.21 million yuan during the epidemic. The donations received by Jiutai are the lowest among the three regions. This means that Jiutai District had a poor ability to absorb external resources. It had a weaker ability to coordinate internal and external resources, and was unable to timely draw on relevant resources to deal with the epidemic. So, it was difficult to purchase sufficient medical equipment and protective materials, and the construction of grassroots medical infrastructure was relatively lagging. These practical problems made Jiutai face greater difficulties in responding to the spread of the epidemic.

In terms of employees, by the end of 2021, there were a total of 4,584 health technicians in Si County, with an average of 167 people equipped with one medical staff. Jiutai District had 3,642 health technicians, with an average of 157 people equipped with one medical staff. Linshui County had the least number of medical staff, with 3,488, and an average of 203 people were equipped with one medical staff, as shown in Table 4. In comparison, there was no significant difference in the number of medical staff between Jiutai District and the other two counties. Due to the relatively small permanent population in Jiutai District, the average number of people served by each medical staff is also lower compared to the other two counties. There is no significant difference in the number of health technicians between Jutai District and the other two counties. Linshui County has the least number of health technicians. Jiutai District has a slightly higher number of health technicians than neighboring counties. Si County has the highest number. Due to the small permanent population in Jiutai District, the average number of people served per health technician is the lowest. This indicates that Jiutai District has the most adequate number of employees among the three districts.

During the response against the large-scale epidemic, Si County, Linshui County, and Jiutai District all received strong support from higher levels of government in terms of funding, manpower and material resources. During the outbreak in Si County, the governments of Anhui Province and Suzhou Municipality quickly deployed financial resources. These funds were used for key aspects such as material procurement, nucleic acid testing and patient care. The provincial government drew medical personnel from across the province to form a medical team to support them. A large number of protective clothing, masks, testing reagents, and other anti-epidemic materials were also delivered in a timely manner to build a solid material foundation for the fight against the epidemic. In Linshui County, the Sichuan Provincial Government quickly responded to increase financial inputs to protect the epidemic prevention and control funding needs. A number of medical teams and streaming teams from the province went to Linshui County to help carry out nucleic acid testing and streaming work. At the same time, provincial and municipal governments actively coordinated. Various kinds of living materials and epidemic prevention materials were constantly transported to neighboring water to meet the needs of residents' lives and the front line of epidemic prevention. During the epidemic in Jiutai District, the Jilin Provincial and Changchun Municipal Governments gave their full support and promptly allocated special funds for epidemic prevention and control expenditures. Medical personnel, community workers, and volunteers were deployed to enrich the anti-epidemic team. They also made every effort to guarantee the supply of epidemic prevention materials and living materials. Such assistance ensured that residents' lives were stabilized and the epidemic containment

10.3389/fpubh.2025.1562915

TABLE 7 Integration ability assessment of three counties.

Indicators		Si County	Linshui County	Jiutai District
Integration ability	GDP per Capita	20	10	0
	Epidemic Prevention Funds	10	20	0
	Social Assistance	20	10	0
	Number of Employees	10	0	20
	Assistance from higher-level government	20	20	20
Aggregate score		80	60	40

efforts progressed effectively. The official websites of the three governments did not publish information on the exact amount of support from higher levels of government. However, all three county-level government received assistance from higher government departments.

In the integration ability assessment results shown in Table 7, Si County has the highest score, while Jiutai District has the lowest score. In terms of financial capacity and mobilization of social donations, Jiutai District has the worst performance among the three counties. This result indicates that the integration ability of Jiutai District is relatively weak.

Learning ability of county-level government

During the period from 2021 to 2022, Si County, Linshui County, and Jiutai District each had different performances in terms of prevention and control emergency drills and training. Si County conducted three emergency drills for COVID-19 prevention and control during 2021–June 2022. Of these, one was organized by the county-level government and one each by Huangwei Town and Changgou Town. In addition, the Si County government organized one training course on the prevention and control of key infectious diseases and the management of epidemic reporting. In Linshui County, seven drills were held from 2021 to May 2022. The government of Linshui County organized 3 county-wide drills, and the remaining drills were conducted by some townships and schools. However, the Linshui County government did not conduct relevant training for government personnel. In contrast, Jiutai District held a single emergency simulation exercise during the 2021–2022 outbreak. The Jiutai District government did not train government personnel on infectious disease prevention and control and outbreak reporting management.

Before the epidemic, Si County held a management training course on the prevention and control of key infectious diseases and epidemic reporting. The training was used to improve the working ability of the management personnel in Si County. Although Linshui County did not explicitly conduct training related to COVID-19, they organized a study of the Animal Disease Prevention and Control Law of the People's Republic of China. In addition to training officials, Linshui County held several meetings of the leadership team for the response to COVID-19. The meetings incorporated best practices from Chengdu and Luzhou municipal responses. Jiutai District Government did not train government officials. This shows that both Si County and Linshui County had a sense of crisis learning. In contrast, the Jiutai District government lacked institutionalized crisis preparedness training.

TABLE 8 Learning ability assessment of three counties.

Indicators		Si County	Linshui County	Jiutai District
Learning ability	Crisis communication	25	25	25
	Emergency training	15	0	0
	Emergency drill	25	25	15
	Specialized learning	25	25	0
Aggregate score		90	75	40

County-level government in all three regions have been actively launching knowledge campaigns on COVID-19. Linshui County organized community staff to conduct a comprehensive door-to-door survey of family homes in the district. Staff distributed outbreak awareness materials in the district. Jiutai District's official government website had a column on epidemic prevention and control guidelines, which displayed several defense guidelines for COVID-19. A lot of knowledge about epidemic prevention and control was also posted on the WeChat official account of Si County. This shows that the governments of the three regions not only focus on the learning of the government itself, but also pay attention to the public's learning about the crisis.

Furthermore, information on epidemic prevention practical exercises were extracted on the government websites. The results showed that Linshui (48) and Si County (49) organized emergency response drills for COVID-19 on January 15 and April 26, 2022, respectively. The emergency drills in both counties were conducted before the outbreak. And the time interval between the drill and the outbreak was relatively short. To some extent, such exercises were effective rehearsals in response to the large-scale epidemic in both regions later on. Let's take a look at Jiutai again, its epidemic prevention and control emergency drill was held on October 25, 2021 (50). Its drill had the longest interval between the outbreak.

We can see from the results in Table 8 that Si County has the highest score in the learning ability, while Jiutai District has lower scores in emergency drills and specialized learning. This results in a low overall score for learning ability in Jiutai District.

Innovation ability of county-level government

The release dates of emergency plans of three counties were crawled. On December 21, 2021, the 58th executive meeting of the county-level government approved the "Overall Emergency Plan for Sudden Incidents in Si County" (51). On April 15, 2022, the official website of Linshui County released the "Linshui County Emergency Response Plan (Trial)" (52). Jiutai was the latest to issue

the "Overall Emergency Plan for Emergencies in Jiutai District, Changchun City" until December 2, 2022 (53). Si County also updated its Public Health Emergency Response Plan in July 2021 in a timely manner. The public health emergency response plans for Jiutai District and Linshui County were last updated in 2020. Public information shows that Linshui released the "Emergency Plan for Public Health Emergencies in Linshui County (Trial)" on January 7, 2023 (54). The Health Commission of Si County formulated the "Emergency Plan for Public Health Emergencies" on December 14, 2023 (55). In addition, the special emergency plan for Jiutai was not accessible through public online channels. In terms of time, the overall emergency plans for both Si County and Linshui were issued before the outbreak of a large-scale epidemic. The epidemic in Jiutai district occurred in March 2022, but the overall emergency plan was not issued until November 2022. During this epidemic, Jiutai still arranged relevant crisis management work in accordance with the overall emergency plan issued in September 2014. After the aftermath of the large-scale epidemic, Jiutai did not update its plans in a timely manner, let alone revise special plans specifically for public health emergencies such as the epidemic. Si County and Linshui had already revised their emergency plans before the large-scale epidemic outbreak, and were able to introduce specialized emergency plans to respond to public health events after the crisis, making more adequate preparations for future crises.

At the onset of the outbreak, county-level government in all three regions made timely use of new media platforms to guide public opinion. During the outbreak, the first item in the daily tweets of the WeChat official account "Linshui Release" of the Linshui County Unified Media Center was always a notice about the number of new infections and the level of risk in the region. Jiutai District also announced the number of new infections every day on its WeChat official account "Jiutai Rongmedia." Si County utilized multiple channels to disseminate information about the outbreak, for example, using the WeChat official account "Si Publishing" to disseminate information about the outbreak. This suggests that county-level government in all three regions have been innovative in their information dissemination channels.

In dealing with the outbreak, the county-level government of the three districts set up special working groups in a timely manner. In order to do a good job of sealing and controlling the district during the people's livelihood protection work, Jiutai District government set up a livelihood protection work task force. Linshui County set up a task force. It divided into sealing area, control area, preventive area to prevent and control COVID-19. Si County has established a set of "five types of responsible persons guarantee contact" community (village) epidemic prevention and control work system. Si County government has perfected the "five types of responsible persons guarantee contact" community prevention and control mechanism of township cadres, grid workers, grassroots medical workers, civilian police, and volunteers. The governments of the three regions have made organizational innovations in the prevention and control of epidemics.

In terms of technological innovation, governments in all three counties used new technologies in the fight against the epidemic. Place codes and health codes were used on a large scale during the outbreak. The county-level government in all three regions used place codes and health codes to automatically register information about people entering and leaving the premises. The use of this technology improved the efficiency of access. In the case of a localized outbreak, the venue code and health code facilitated the relevant departments to carry out accurate traceability and investigation. The development of online teaching and online office technology also greatly reduced the speed of the spread of the epidemic.

TABLE 9 Innovation ability assessment of three counties.

Indicators		Si County	Linshui County	Jiutai District
Innovation ability	Institutional Innovation	25	25	0
	Organizational Innovation	25	25	25
	Technological Innovation	25	25	25
	Information Dissemination Innovation	25	25	25
Aggregate score		100	100	75

TABLE 10 Evaluation of dynamic abilities in three counties.

	Weights	Si County (raw/weighted)	Linshui County (raw/weighted)	Jiutai District (raw/weighted)
Insight ability	30%	75/22.5	80/24	40/12
Integration ability	30%	80/24	60/18	40/12
Learning ability	20%	90/18	75/15	40/8
Innovation ability	20%	100/20	100/20	75/15
Aggregate score	100%	84.5	77	47

As shown in Table 9, the innovation abilities of the three counties are not significantly different. Among them, the score of Jiutai District is slightly lower than the other two counties. The score for institutional innovation in Jiutai District is 0. This is the reason why there is a gap between Jiutai District and the other two counties.

Discussion

In the process of responding to the epidemic, the dynamic capabilities of the three county governments are shown in Table 10. Si County had the highest score, the score in Jiutai District was the lowest. This indicated that the dynamic capability of Jiutai District government was the weakest. From the Table 10, it can be seen that Jiutai District had a medium level of innovation ability. But because of the weak insight ability of Jiutai District government, it pulled down the total score. In the dynamic capacity framework of the government's response to the COVID-19, the four abilities of insight, integration, learning, and innovation did not exist in isolation. They were interrelated and mutually reinforcing, together forming an organic whole. This overall drived

the county government to take rapid and precise actions in epidemic prevention and control. The insight capability provided the basis for action for the integration capability. Jiutai District's failure to assess the epidemic situation led to difficulties in integrating subsequent resources. It exacerbated the spread of the epidemic. Learning ability directly supported and promoted innovation ability. Si County and Linshui County promoted the updating of emergency plans through regular emergency drills (innovation capacity). Jiutai District, on the other hand, was also slightly less innovative due to a lack of learning. The innovation capacity then reinforced the effectiveness of the insight capacity on the ground. Linshui County quickly released outbreak information through new media, which improved public risk perception. Innovations in new technologies, such as the promotion of health codes and place codes, also improved the efficiency of prevention and control. The application of health codes and place codes enabled the county-level government to keep track of information about infected people, so that it could make correct decisions. These four capabilities interacted with each other to form a dynamic cycle.

From the basic situation of the three districts, Jiutai District had the smallest permanent population and the lowest population density. The outbreak of COVID-19 had the greatest impact on the older adult. In a study analyzing the factors associated with mortality among the older adult in Italian Coronavirus, older adult people over 65 years of age were chosen as a reference (56). The percentage of people over 65 years old in Jiutai District was in the middle of the three regions. In other words, Jiutai District was not the worst in terms of epidemic prevention. However, Jiutai had the worst epidemic prevention effect. This suggests that when a large-scale epidemic occurs, dynamic capabilities of county-level government are very important for effectively responding to crises. Si County and Linshui County have poor conditions for epidemic prevention. However, the governments of the two counties achieved better epidemic prevention and control because they possessed dynamic capabilities. The government of Jiutai District could not make effective epidemic prevention and control due to the lack of dynamic capacity.

After entering the stage of normalized epidemic prevention and control, the central government of China has delegated the leadership of epidemic prevention and control to county-level government. Since ancient times, county-level political power has always been crucial in China. Currently, Chinese national leaders have repeatedly emphasized that county-level governance is the cornerstone of governance. Because county-level government have relatively independent management authority, resource absorption power and decision-making power in the design of the institutional system. County in China's political system is the junction between the state and society, as well as between the government and the people. It can be said that the county is located in the weakest stress area of the hierarchical structure. Some studies have found that social conflicts in China are prone to occur at the most vulnerable points of political stress (57). Therefore, the county has the characteristic of stress vulnerability. After public crisis occurs, the county-level government, as the "front line" in responding to emergencies, directly faces the grassroots masses and plays an important role in emergency management, such as uploading and issuing, early handling, and policy implementation. This further increases the pressure on the county level. If county-level government are unable to effectively address various social problems, including crises, these problems will be transmitted to higher-level government. The crisis that has not been properly handled will spill over to other regions and ultimately require higher-level government intervention to resolve it. Therefore, the governance capacity of county-level government is crucial.

Faced with the large-scale epidemic, the performance of three counties differed significantly. Especially, Jiutai was unable to effectively implement epidemic prevention and control due to lack of dynamic capabilities. The vulnerability of counties in the face of crises can be improved from the perspective of dynamic capabilities, providing valuable experience for county-level government in the face of sudden public crises in the future. First, in terms of insight capacity, county-level government should establish a standing early warning mechanism to shorten response time. The successful experience of Si County shows that rapid release of early warning information and taking action is the key to controlling the spread of an epidemic. County-level government can introduce an intelligent early warning system that integrates data from multiple sectors to monitor potential risks in real time. It can also formulate graded warning standards and clarify response measures under different risk levels.

Second, county-level government should enhance their ability to integrate resources. On the one hand, it is recommended to increase financial investment in the field of public health, especially emergency supplies stockpiling, medical facilities construction and personnel training. And a special emergency fund should be set up for pre-preparation and post-recovery of emergencies. On the other hand, strengthening cross-sectoral collaboration is the key to improving the efficiency of emergency management. Although all three counties have established cross-departmental working groups, the efficiency of collaboration may vary. Therefore, county-level government can establish an incentive mechanism for cross-departmental collaboration to recognize and reward departments and individuals with outstanding performance. They can also establish a clear division of responsibilities and collaboration process to avoid shirking and inefficiency.

In terms of enhancing learning capacity, strengthening emergency training and drills is an important way to improve the dynamic capacities of the government. Si County has demonstrated a strong learning ability by setting up training courses, and Linshui County has demonstrated a strong learning ability by holding several leadership team meetings. This paper suggests organizing regular internal government emergency training and inviting experts to give lectures. It also carries out multi-hazard emergency drills to simulate emergencies in different scenarios and improve the practical ability. At the same time, a training effect evaluation mechanism should be established to ensure that the training content matches the actual needs. In addition, county-level government should take the initiative to learn from external experience.

The government can establish a cross-regional experience exchange mechanism and organize regular learning and exchange activities. It is recommended to create an emergency management knowledge base to collect and organize excellent cases and best practices at home and abroad for the government's internal reference.

Finally, governments should focus on the ability to learn from crises, whether in normal or abnormal circumstances. That is to say, learning from past or other regional crises and constantly innovating to cope with unknown future crises (39). With the rapid development of digital technology, the regular application of digital tools has become an important means of enhancing the efficiency of emergency management. The three counties extensively used digital tools such as health codes and web-based offices during the epidemic, effectively reducing the spread of the epidemic. County-level government should promote intelligent emergency management systems, utilizing big data, artificial intelligence, and other technologies to improve the efficiency of risk monitoring and decision-making. The development of mobile applications can facilitate the public's real-time access to information and feedback on issues. In addition, county-level government should establish a dynamic emergency plan update mechanism. Based on actual circumstances and changes in external environment, they should timely adjust the contents of the plan, and develop special emergency plans with detailed response measures for different disaster types. Before a large-scale disaster breaks out, county-level government can use scenario simulation technology and means such as virtual reality to test the feasibility and effectiveness of their plans.

Conclusion

This paper explored the performance of county-level government in dealing with large-scale epidemics from the perspective of dynamic capabilities, to find directions to improve their crisis management capabilities and alleviate the stress vulnerability of county-level government. By comparing the responses of three county-level government in the context of large-scale epidemics, good insight, integration, learning, and innovation abilities can promote county-level government to handle crises effectively. Furthermore, county-level government are more vulnerable to epidemic prevention. Therefore, this study believes that county-level government should formulate targeted policies and measures based on their actual situation to improve their dynamic capabilities to respond to public crises. In this study, the three cases were analyzed in depth and detail. However, it cannot be ignored that the conclusions drawn from the study based on only three cases have some limitations in terms of generalizability. Due to the limited number of cases, it may be difficult for the conclusions obtained to be fully applicable to all county-level government. Future research could increase the number of cases. This paper only starts the study from public health events. Emergencies include natural disasters, accidental disasters, public health events, and social security events, and future research can focus on the impact of the dynamic capacity of county-level government in responding to other types of incidents.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Author contributions

CW: Conceptualization, Methodology, Project administration, Supervision, Visualization, Writing – review & editing. JW: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Writing – original draft, Writing – review & editing. HW: Data curation, Resources, Software, Writing – review & editing. ZX: Data curation, Resources, Writing – review & editing. JZ: Resources, Software, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research and/or publication of this article. This article was funded by the Humanities and Social Sciences Research Project in Anhui Province's Universities, the grant number is SK2019A0392. It was also supported by the Anhui Philosophy and Social Sciences Planning Project, the grant number is AHSKQ2019D023.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

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frontiers | Frontiers in Public Health

TYPE Policy and Practice Reviews
PUBLISHED 10 April 2025
DOI 10.3389/fpubh.2025.1531208

OPEN ACCESS

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RECEIVED 20 November 2024
ACCEPTED 31 March 2025
PUBLISHED 10 April 2025

CITATION
Wang Q, Zhang X and Zhang Q (2025) China is actively implementing health impact assessment legislation.
Front. Public Health 13:1531208.
doi: 10.3389/fpubh.2025.1531208

China is actively implementing health impact assessment legislation

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The health impact assessment system is imperative for prioritizing prevention and establishing "people's health" as a central tenet. Implementing this system is contingent on the existence of "perfect legislation." Although China has already begun to implement health impact assessment legislation, it is still in the exploratory stage and faces numerous internal and external legislative challenges. The civil and criminal legal norms supporting the health impact assessment must be established and perfected within the framework of developing the fundamental law. Supportive measures are being implemented, such as training skilled professionals, prioritizing underdeveloped regions, and using government evaluations and incentives, to promote the integration of health impact assessment into Chinese legislation. These efforts are directed at improving China's legal system and health impact assessment coordination mechanisms, with the overarching objective of improving public welfare. This trend is in response to the growing social expectations of a better quality of life.

KEYWORDS

health impact assessment, legislation, primary health care and health promotion law, health, health equity in China

1 Introduction

In 2014, China implemented the "integrating health into all policies" strategy, which created opportunities to establish a health impact assessment (HIA) system. The outline of the "Healthy China 2030" plan issued in 2016 emphasizes the necessity of establishing a comprehensive HIA system (1). A systematic evaluation of the impact of various economic and social development plans, policies, and engineering projects on health is imperative. In 2021, the National Office of Health and Human Services and the Health China Action Promotion Office issued the "Notice on the development of the HIA system construction pilot work" and started the HIA pilot work.

Based on China's current policies and regulations, the so-called health impact assessment (HIA) refers to public policies, plans and major construction projects that are issued or approved by the prescribed procedures, content, and methods, systematic investigation, analysis, and comprehensive evaluation of the potential health effects of the population and recommended activities.

After several years of exploration, the corresponding pilot work has been carried out to date in 32 mainland provinces in China (excluding Hong Kong, Macao, and Taiwan), and a certain amount of experience has been accumulated, making the time ripe for the establishment of a comprehensive legal system for HIA (2). In marked contrast to extensive and well-established practice, there are still some issues in the legislation of HIA in China, such as the need for greater standardization and operability. Compared to foreign countries, it lags (3). China's legislation on the HIA needs urgent improvement.

This paper aims to systematically review the historical development of the Health Impact Assessment System, summarize the current legislative situation of the Health Impact Assessment in China and its legislative dilemma, and finally present the legislative ideas to improve the health impact assessment in China and the preliminary design of some important systems.

2 Development of a health impact assessment

In the 1980s, the HIA was a component of environmental impact assessment. It has been launched in developed countries such as Northern Europe and Australia. This parameter is used to assess the impact of large-scale infrastructure projects on health (4). Since the 1990s, with increasing concern about factors affecting health, HIA has developed rapidly. In 1993, the province of British Columbia, Canada, mandated that all bills submitted to the government by its Cabinet must be accompanied by an HIA report (5). The world's first HIA tool was developed and released by the Ministry of Health and Elderly Management of Colombia (6). In 1999, the European Office of the World Health Organization issued the Common Protocol of Göteborg (7). The core values, the main procedures, and the primary HIA methods were proposed (8). In 2002, the EU incorporated the HIA into EU regulations. HIAs are explicitly required for legislation and sectoral policy development (9). In the Goldenberg Common Protocol, the World Health Organization (WHO) defines HIA as "evaluating the impact of a policy, plan, or project on a specific population." A series of combined procedures, methods, and tools for assessing the potential impact on population health and its distribution in the population. In 2006, the International Association for Impact Assessment (IAIA) expanded the definition of HIA. HIA is a combination of processes, methods, and tools that can be used to systematically determine the potential (and often unintended) impacts on the health of a population. HIA can also determine the distribution of those impacts within the population. Finally, HIA can be used to identify responses to those impacts. HIA can be used when a policy is being formulated, a project is being implemented, or a plan is being prepared (10). The outline of the Healthy China 2030 Plan clearly states the need to establish a comprehensive HIA system. Systematically assess the impact of various economic and social development plans, policies, and engineering projects on health. The essence of the HIA system is to institutionalize health consideration throughout the formulation and implementation of public policy in various departments. It is essential to implement health policies and promote healthy city construction throughout the world. It is also a fundamental policy to implement the "prevention first" approach and advanced gateway development (11, 12). The international HIA system consists of two primary models. The first model is based on the breadth and complexity of health impact factors, highlighting the institutionalization of HIA and establishing a health impact assessment system independent of the environmental impact assessment. The second model integrates the engineering and project HIA into the environmental impact assessment system, without the establishment of an independent HIA system (13, 14). HIA in China is still in its infancy, and a comprehensive HIA system has not yet been established. Health impacts are addressed primarily through environmental impact assessments. Establishing a comprehensive HIA and evaluation system is fundamental for implementing the concept of "big health" and integrating health into all policies. The purpose is to eliminate all kinds of hidden danger that affect health at the source and maintain the "red line" of health.

The prevention of incidents that affect people's health is a fundamental institutional arrangement (15, 16). Therefore, China must clarify its organizational system, determine the main body of promotion, specify the object and scope of the evaluation, and improve technical support to accelerate legislation on the HIA. Article 6 of the General Provisions of the Basic Medical and Health Promotion Law, which came into effect on July 1, clearly states that governments at all levels should establish an HIA system. This provision provides legal support to establish an HIA system in China. The same year, the State Council issued an opinion on deepening the Patriotic Health Campaign, calling for the establishment of an HIA system. We will promote a systematic assessment of the impact of various economic and social development plans, policies, and regulations, as well as significant engineering projects, on health. Efforts have been made to integrate health into all policies to enhance the clarity of the objectives and scope of HIA. In 2021, the State Council promulgated a notice on the pilot implementation of the HIA system. The overarching objective of this initiative is to establish a comprehensive and systematic HIA system throughout the country.

Since China introduced the strategy of building a healthy China, research on HIA in Chinese academia has been consistently deepened and expanded. This study provides solid theoretical support and information on the establishment and optimization of the HIA legal system. Chinese academics generally have a positive attitude towards the necessity of legislation on the HIA system. Institutionalization of the HIA field in China still needs to catch up with countries that developed it earlier. Considering the current realistic demands for the scientific and practical implementation of the HIA, it is particularly urgent to intervene and standardize construction at the legislative level. However, scholars have different views on the path to establishment, and these differences focus on the relationship between HIA and environmental impact assessment (17, 18). Some scholars argue that environmental and HIAs share similarities in terms of connections and objectives. Therefore, the content of HIA could be incorporated into environmental impact assessment, challenging the autonomy of HIA legislation (19, 20). Some scholars argue that the impact assessment of the health environment is extensive and that the influencing factors are not limited to the environment but also include social and economic factors. The sole environmental impact on health cannot encompass the entire scope of the HIA. Thus, HIA and current environmental impact assessment legislation must be separated (21, 22). Scholars advocate two legislative logics in this view; one being to enact a single HIA Act. One suggestion is to establish a dedicated section on HIA within current health legislation, such as the Law of the People's Republic of China on Medical Health and Promotion of Health (23).

Little debate has been conducted on the content of this study, and most scholars agree that the health sector should lead the design of the HIA system. Attention must be paid to public participation, departmental cooperation, and information disclosure (24). In addition to this consensus, some differences in content and details will not be discussed in detail.

Most scholars studying HIA legislation are from public health, building science, and engineering. While only a few legal scholars

have delved into this core content, at the end of the draft, these research findings are scarce and focus primarily on integrating health-related assessment mechanisms into the traditional environmental perspective. Separate legislation has not been established for HIA. However, other professional scholars have addressed the legislative perspective of HIA. It has yet to be the central focus of the article, and most scholars consider it a subsidiary component of the measures (25). Therefore, most of them are concise and summarized. From a legal perspective, this study focuses on developing a legislative framework for HIA, including specific laws. The proposed model has a significant reference value to legalize HIA and improve the HIA system.

3 Development of legislation and legislative efforts to assess the health impact in China

With the widespread adoption of HIAs worldwide, several countries and regions, such as Thailand, Canada, Britain, and Spain, have passed legislation to formalize HIAs. In 2007, Thailand included the relevant provisions of the HIA in its constitution. It is expressly stipulated that "any project or activity that significantly impacts environmental quality, natural resources, and community health shall also impact public health." Impact assessment involves establishing the legal status of an HIA at the national level (26). In the same year, Thailand promulgated the National Health Act (27) to clarify the legal status of HIA. In 2002, Quebec passed the Quebec Public Health Act (28). Government departments and agencies should consult with the Health and Social Services Department regarding the sections of their acts or regulations that may significantly impact the population's health. Comments from the Department of Social Services. In 2008, British Columbia, Canada, province amended the BC Public Health Act, stipulating that "all government departments should conduct HIAs on legislative projects that may affect public health" (29). In 2016, Wales introduced the Welsh Public Health Act (30). A statutory requirement has been proposed for public bodies to conduct comprehensive HIAs under specific circumstances. In 2011, Spain adopted the Spanish Public Health Act (31). It is proposed that all government departments conduct HIA on regulations, policies, plans, and projects that may have significant health implications. Andalusia, a province in Spain, has taken the lead in institutionalizing HIAs as required by law.

The China legal system for the HIA is still in the process of exploration. HIA directly impacts the lives and health of people in the jurisdiction. The application of this method usually includes various construction projects and urban planning (32). It is an important index and basis for evaluating the feasibility of construction projects and urban planning and for proposing improvement suggestions. Given this, it should be considered that the scope of the HIA falls within the legislative scope of cities, with districts and autonomous prefectures highlighted in the legislative framework, both in urban and rural areas. Construction and management, environmental protection, historical and cultural preservation, grassroots governance, and other related issues. At the same time, this study also retrieved and organized policy documents related to the HIA developed by municipal and higher authorities. The function of a control group enhances the understanding of current legislative data.

On 18 March 2024, this paper employed the law database of Beijing University, the database of Chinese national laws and regulations, and the national regulations database as its main research sources. Acquire legislation related to the HIA and relevant policy documents. With "health, ""health impact assessment" and "HIA" as keywords, an accurate search is conducted in the title and full text, respectively. The invalid, revoked, modified, and repeated search results are excluded. The search results exclude non-normative content, such as "letter, ""reply, ""notification, "and "case." Finally, 23 pieces of legislation met the search criteria, including 7 laws (as shown in Table 1) and 16 regulations (see Table 2).

Although China's focus on the HIA started relatively late, rapid development has been achieved due to the attention and promotion of the central government. The approach adopted by China is directed by the central government, with local governments and policies taking the lead. As early as 2007–2008, several documents on the HIA were initially issued. Among them, the outline of the second cycle of healthy urban construction in Jing'an District, described by the Shanghai District Government, took the lead in integrating health considerations into urban construction. The application of HIA With the promulgation of the "Healthy China 2030" plan outline and the accumulation of experience in pilot cities, legislation has gradually accelerated. In 2023 alone, 10 laws and regulations were promulgated explicitly mentioning the establishment of an HIA system. It is sufficient to demonstrate the importance attached to it. China has developed a set of fundamental laws, specifically the Law of the People's Republic of China on Basic Medical Care and Promotion of Health (hereinafter referred to as the Health Law). The legislative framework for the HIA is beginning to take shape by implementing 20 sets of local laws and regulations (33).

4 The dilemma of HIA legislation in China

To shape the HIA legislative system with Chinese characteristics, HIA legislation in China needs to be improved with an adequate legal framework and complete content.

4.1 The paucity of HIA legislation is a concern and its classification is suboptimal, resulting in inadequate legalization

An issue is the scarcity of quantities. As indicated in Tables 1, 2, only one law on health promotion mentions the concept of HIA. The total number of laws and regulations is only 15, symbolizing that despite 31 provinces having conducted pilot work, most provinces and municipalities still need to translate the valuable experience into institutional safeguards for feedback on practice. However, all 16 pieces of legislation differ from a specific law on HIA. In contrast, 24 laws comprehensively address environmental impact assessment. There are thousands of laws and regulations, including one special law and six special regulations. The quantitative weaknesses of the HIA legislation were revealed through a comparison. The second issue is the low level of normative effectiveness. Within the legislation, the norms at the legal level are directly related to local laws and regulations. There should be more transition between administrative

TABLE 1 Statistics of current laws related to HIA in China.

No	Name of the law	The subject of the formulation	Implementation time	Elements related to the HIA
1	Constitution of the People's Republic of China (Revised in 2018)	The National People's Congress	March 11, 2018	Article 33 of the Constitution refers to the State's respect and guarantee of human rights. Article 21 states that the State develops medical and health services and protects people's health, providing a fundamental legal basis for establishing an HIA system.
2	Civil Code of the People's Republic of China	The National People's Congress	January 1, 2021	Natural persons enjoy the right to health, which is protected by law, and no organization or individual may infringe on it. This provides the proper basis and legitimacy for the health impact on private law.
3	Basic Medical and Health Care and Health Promotion Law of the People's Republic of China	NPC Standing Committee	June 1, 2020	Establish a principled norm for the health impact assessment system. However, there is no specific system.
4	Environmental Protection Law of the People's Republic of China	NPC Standing Committee	January 1, 2015	To safeguard public health as the purpose of the law, the State establishes and improves its environmental and health monitoring system and encourages and organizes research on the impact of environmental quality on public health.
5	Law of the People's Republic of China on the prevention and control of soil pollution	NPC Standing Committee	January 1, 2019	Legislation to protect public health The relevant departments will assess toxic and harmful substances in the soil. Based on its impact on public health and the ecological environment.
6	Law of the People's Republic of China on the prevention and control of water pollution	NPC Standing Committee	January 1, 2018	A public health risk assessment and a management system for toxic and harmful water pollutants should be established to ensure legislative public health purposes.
7	Law of the People's Republic of China on the Control of Atmospheric Pollution	NPC Standing Committee	October 26, 2018	A public health risk assessment and management system for toxic and harmful air pollutants should be established under legislation to protect public health.

regulations and departmental rules. Most of China's HIA norms require more legal validity. After searching, we found 510 policy documents on the HIA, accounting for 96% of all relevant texts. Taking into account the vast body of policy law, the perception of the existence of legislative norms is almost obliterated. Policy documents serve the unique purpose of improving the user experience when navigating a new system. They help mitigate risks and improve efficiency. However, policies may need to be developed to adapt to the diversity of interests under market conditions. This will hinder deep-rooted institutional innovation. Only when laws are abided by can there be good and effective governance. The most obvious consequence of the absence of laws is a weakened deterrence and a lack of binding force. Relying on temporary policies is a short-term solution (34).

4.2 The legal framework of China for the HIA must be more cohesive and complete

HIA is integrated as a core component of the concept of health under the Health Promotion Act. Health initiatives are prioritized and health principles are integrated into all strategies. This constitutes an expression of Article 6, with only 35 words in the entire text, which is simply a declaration norm. The same is true for other legislation. Throughout the health laws and regulation system, many sporadically include provisions stating that "an HIA system should be established." The content of the system, the subject of evaluation, legal responsibility, and the steps to follow in the evaluation process are key aspects to consider. The answer cannot be found in the current legislation. The design of the system must address the cases encountered in HIAs that are documented and hindered by inaction. This weakens the legislative function and deviates from the original intention of "extending the law" and "being effective." Refinement is an inevitable choice, but the process of evolution requires further discussion (35).

4.3 The local legislative HIA of China is rigid

Local government regulations have limited authority and supplement or elaborate on higher-level laws. In the absence of provisions of the superior law, more flexibility is needed, making it justifiable for legislation to align closely with the superior law. Consequently, the legislative initiative described in this section primarily targets local laws and regulations.

The number of 11 local laws and regulations is significant, but the level of innovation needs to be clarified. Although the legislative law emphasizes that local laws and regulations should generally not

TABLE 2 Statistics of current laws and regulations related to HIA in China.

No	Name of the statute or regulation	The subject of the formulation	Implementation time	Elements related to the HIA
1	Regulations on Henan Provinces' Basic Medical Care and Health Promotion	Henan Provincial People's Congress	June 1, 2023	Declarative provisions for establishing HIAs
2	Regulation of the Ningxia Hui Autonomous Region's Patriotic Health Work	Standing Committee of the People's Congress Ningxia Hui Autonomous Region	January 1, 2023	HIA of public policies and engineering projects
3	Regulations under the Patriotic Hygiene and Health of Shanghai Municipality Promotion	The Standing Committee Shanghai Municipal People's Congress	November 1, 2023	HIAs shall be carried out for significant plans, policies and engineering projects.
4	Patriotic Health Regulations in Dongying City	Donging Municipal People's Congress Standing Committee	March 1, 2024	Declaratory clause
5	Regulations on the Patriotic Hygiene of Jingdezhen Municipality	Standing Committee of Jingdezhen Municipal People's Congress	December 7, 2022	Declaratory clause
6	Regulations in Linyi Municipalities in Healthy Villages	Linyi Municipal People's Congress	July 1, 2021	Declaratory clause
7	Regulations on the Patriotic Health Work of Enshi Tujia and Miao Autonomous Prefecture	The Standing Committee of the People's Congress of Enshi Tujia and Miao Autonomous Prefecture	December 8, 2023	HIA for significant policies, plans, and projects should be conducted.
8	Chizhou Patriotic Health Regulations	The Standing Committee of Chizhou Municipal Congress	November 1, 2023	Declaratory clause
9	Measures for the Patriotic Health of Sanya City (Revised in 2023)	The Standing Committee of Sanya Municipal Congress	September 21, 2023	Declaratory clause
10	Regulations on Patriotic Health Work in Nanchang City	The Standing Committee of Nanchang Municipal Congress	January 1, 2023	Establish an HIA system and build an expert database for relevant policies.
11	Nanning Patriotic Health Regulations	The Standing Committee of Nanning Municipal Congress	September 1, 2023	Conduct an HIA on Significant policies, Plans and projects.
12	Regulations on the Health of Shenzhen Special Economic Zone	The Standing Committee of Shenzhen Municipal Congress	January 1, 2021	HIA of planning, engineering projects, and normative documents involving public health shall only be promulgated or implemented if the assessment is qualified. The municipal government shall develop specific measures for HIA, and the municipal and district governments shall set up assessment expert committees to encourage social organizations and institutions to participate in the evaluation.
13	Measures by Zhejiang Province to Guarantee Rural Water Supply	The People's Government of Zhejiang Province	February 1, 2024	Declaratory clause
14	Measures for the Administration of Administrative Normative Documents in Lianyungang City	Lianyungang Municipal Government	November 1, 2023	The HIA should be conducted to develop administrative normative documents on public health. The drafting unit shall provide materials for the HIA when submitting administrative normative documents Examination.
15	Administrative Measures for Patriotic Health Work in Longnan City	Longnan Municipal Government	November 10, 2023	Patriotic Health Committee is responsible for organizing HIA activities.
6	Measures for the Administration of Administrative Normative Documents in Jinchang City	Jinchang Municipal Government	August 18, 2022	The drafting department shall adopt an HIA to develop norms concerning public policies and significant engineering projects. When the drafting department submits its draft normative documents for examination, it shall provide materials for the HIA.

10.3389/fpubh.2025.1531208

duplicate provisions already stipulated in superior laws, this principle must be implemented. Many only incorporate "forwarding" documents from administrative management into local legislation. As shown in Table 2, there is a high duplication rate between regulations and the overarching health laws. The provisions of the health law are broad enough to establish an HIA system. The government's target responsibility assessment will include enhancing the primary health indicators of citizens. It is hoped that local laws and regulations will be tailored to the specific realities of each region. However, the local regulations of Chizhou, Dongying, Jingdezhen, and Henan province only emphasize the importance of conducting a "HIA." The system for improving essential health indicators for citizens as part of the government's accountability assessment must include significant detail. Among them, there is only a difference of two or three words between the original text of individual laws and regulations and almost identical health laws. The remaining local laws and regulations are also consistent across regions. This enhances the coordinating role of the evaluation object and the Aiwei Association, but lacks achievement with local characteristics. "Without local characteristics, local legislation will lose its value." Liu et al. (36) state that "homogeneous decorative legislation not only weakens enforceability but also wastes legislative resources".

Moreover, the content of local legislation on the HIA is conservative, and the main body of legislation consists of region-specific regulations. Therefore, local laws and regulations will be established differently. For example, the evaluation criteria for Shanghai, Enshi Tujia, Miao Autonomous Prefecture, and Nanning City include comprehensive planning, essential policies, and significant engineering projects. In Ningxia, evaluation focuses on public policies and major projects, while in Nanchang, only policies are evaluated. With the increasing interconnectedness of public affairs, which includes economic exchanges and environmental governance across various administrative jurisdictions, many construction projects, such as photovoltaic power plants and wastewater treatment facilities, often span multiple provinces and cities. How can you ensure compliance with local laws? There will be an embarrassed and contradictory between "different standards in the same case" and "different conclusions of colleagues"? Will the HIA incur high costs if conducted separately? In this way, traditional regulations of each government can only significantly decrease the impact of evaluation of specific projects (37).

4.4 The legislative framework for HIA in China needs to be improved

The CNKI database is a data source database. "HIA", "health impact rating", and "HIA" are search terms for precise subject searches. By eliminating laws, regulations, and documents that deviate from the subject headings, we obtained 176 documents in various forms. The retrieval date was March 30, 2024.

Theoretical research findings on HIA are relatively abundant. In addition to "HIA" and "health impact evaluation, "the top five keywords that frequently appeared in the literature were "urban planning," "public health," "healthy cities," "health risk" and "environmental impact." The evaluation, combined with the topics of the retrieved documents, reveals that the research focuses on assessing the health impacts and risks caused by individual projects such as urban planning, the environment, and urban construction. Methods and specific quantitative and qualitative aspects will be discussed in the 176 documents, with only 6.8% involved in in-depth research related to legislation or system construction. The findings reveal the need for research on HIA legislation. It cannot provide a strong legal foundation or technical support for legislation, which limits the legislative process to some extent.

4.5 Insufficient local legislative support for HIA in China

Local governments have responded to the central government's call by conducting pilot projects and introducing implementation plans for the HIA system. However, the comprehensive support conditions at the grassroots level still need to be improved from a legislative perspective. This is a pain point that legislative work must consider.

The assessment link in HIA is at the core of the entire process. The expert committee typically performs this step to determine the outcome of the evaluation project. In some pilot cities, the expert evaluation process can be completed in less than a day. For various reasons, some experts lack a comprehensive understanding of evaluation policy. This makes the feedback results irrelevant, and the entire evaluation process becomes a formality (38).

The need for more talent is even more severe. HIA is not only related to basic fields such as public health and law; it also extends to urban planning, construction technology, environmental science, and other specific areas based on the characteristics of the evaluation object. The complexity of this demand indicates that the experts involved in the evaluation must have high levels of expertise. Few experts have this background; most are in universities and scientific research institutions in economically developed cities. It is not easy to find such talent in economically underdeveloped areas. Regional differences make it challenging to establish a comprehensive and uniform HIA system.

5 Development of HIA legislation in China

Only through legalization can the national governance system be standardized and refined. The HIA normative system remains dominated by policy and requires a corresponding legal framework, which hinders its ability to ensure long-term quality and effectiveness. It is easy to fall into the trap of governing as if in a perpetual campaign where legislation becomes the prevailing trend.

5.1 Formulating a specific foundational law for HIA

There are two types of HIA legislation in the world. One way to enhance the HIA is to recognize its independence. Another option is to integrate HIA into the environmental impact assessment (39). Although HIAs and environmental impact assessments do indeed have much in common, they were previously based on environmental impact assessments (40). However, this does not negate the essential

difference between the two. International experience has shown that health considerations in environmental impact assessments typically focus on the effects of the physical environment, with limited attention given to the broader impact of the social and economic environment on health. The United States and Australia have integrated them and have gradually started independently practicing HIA (41). Furthermore, environmental impact assessment tends to be a positivist discipline, while social science disciplines influence HIA. The disconnect between the two fields indicates that environmental impact assessors should be more knowledgeable about the HIA. These are the inevitable drawbacks of integrating the two (42). According to the national conditions of China, the Environmental Impact Assessment (EIA) law excludes any provisions for HIA. This shows that, regardless of the cost of legislation, the corresponding content should be rewritten without concern for the cost of legislation. In conclusion, China should establish an independent HIA method.

5.2 Legislative mode: adopt a comprehensive legislative framework for laws

It is possible that the pilot process in China could have been executed with greater efficiency, thus exposing certain issues. Therefore, it cannot provide adequate empirical and theoretical legislative examples. In this case, it is imperative to respond at the legislative level and establish a foundation for implementing top-level design to force local governments to overcome bottlenecks. Therefore, a comprehensive legislative framework can be adopted to gather the commonalities of various HIAs during the initial legislative stage. As a fundamental and benchmarking standard, the exercise of dual functions is not only a component of the constitutional right to health and the declarative provisions of health law, but also an integral part of the constitutional right to health. It can also empower local practices and allow lower-level methods to adapt to changes in the situation. The increased inclusion of the law ensures its stability and respect for the authority of the rule of law.

Regarding structural arrangements, the framework of the environmental impact assessment law can serve as a reference. The concepts of health and the environment share similarities. For example, the right to health and a clean environment are fundamental human rights. The impact factors on health and the environment are complex. Implementing preventive measures in advance can lead to improved management and maintenance. Without legislation incorporating HIA as a primary component, HIA remains the only effective impact assessment method available. The legislative structure of the EIA law has a unique reference value (43).

Taking the EIA law as an example, the legislative structure of the HIA law is conceived as follows in the logical order of total points. The first chapter covers the general provisions. This includes legislative purposes and foundations, concept interpretation, evaluation criteria, fundamental principles, and advocacy standards. The second section discusses the HIA of the policy. The third section discusses the HIA of construction projects. The fourth section discusses the HIA of planning. The second and fourth sections cover the specific scope of the evaluation object, the evaluation content, the evaluation procedure, the relevant subjects, and their obligations. The fourth section discusses legal liability. The text covers the subject of responsibility, including its components and methods of assuming responsibility. The fifth section discusses supplementary provisions, such as authorization provisions, implementation timelines, and other ancillary matters that must be covered in the general and sub-provisions.

5.3 Main system design

5.3.1 Basic principles

Legal principles serve as the foundation of the legal system, directly influencing its fundamental nature, core content, and value orientation. HIA falls under public health and should adhere to the legal principles outlined in health law. Furthermore, we should consider the unique values of risk prevention and the green economy represented by HIA and China's focus on being 'people-centered'. The development concept and strategic implementation of "Healthy China" are carefully chosen. According to the WHO, the core values of HIA are defined as "democracy," "fairness," and "sustainable development." The principles of China's HIA law should first be people-centered, health equity, health promotion, health priority, and prevention. Sustainable development, collaborative cooperation, comprehensive evaluation, and objective openness are essential (2).

5.3.2 Appraisal object

According to international practices, HIA typically includes projects, plans, and policies. However, in the outline of the "Healthy China 2030" Plan, the evaluation objectives are more strictly defined. It is framed solely as economic and social development plans, policies, and major engineering projects (44). The evaluation objectives of local legislation and pilot projects vary within this scope. The 2030 Healthy China plan is a comprehensive long-term strategic health plan at the national level. This approach has a more forward-looking and practical significance in guiding the practice of HIA in China. Furthermore, the practice of HIA in China is still being explored and content settings should be carefully considered. Therefore, economic and social development plans, policies, and major engineering projects should be the primary focus of evaluation. The assessment is placed within the framework method and the specific scope of the assessment is subject to further refinement by the competent health department under the State Council in collaboration with relevant departments.

5.3.3 Obligation subject and assessment procedure

A competent health department leads and coordinates the HIA and ensures quality control. The relevant departments responsible for developing policies or plans, in collaboration with professional assessment institutions, should conduct the HIA of policies and plans. The proportion of individuals evaluated by the organizations responsible for developing policies and plans should not exceed a specific threshold to maintain impartiality. The HIA report must be submitted to the planning policy and the examination and approval authority; otherwise, approval will not be granted. Regarding the HIA of a construction project, the construction unit delegates this responsibility to a professional assessment institution. Assessment institutions must have legal qualifications and should not be associated with organizations responsible for developing policy plans or with bodies involved in examination and approval procedures. The evaluation conclusions must be accepted. Before deciding, the examining and approving authority

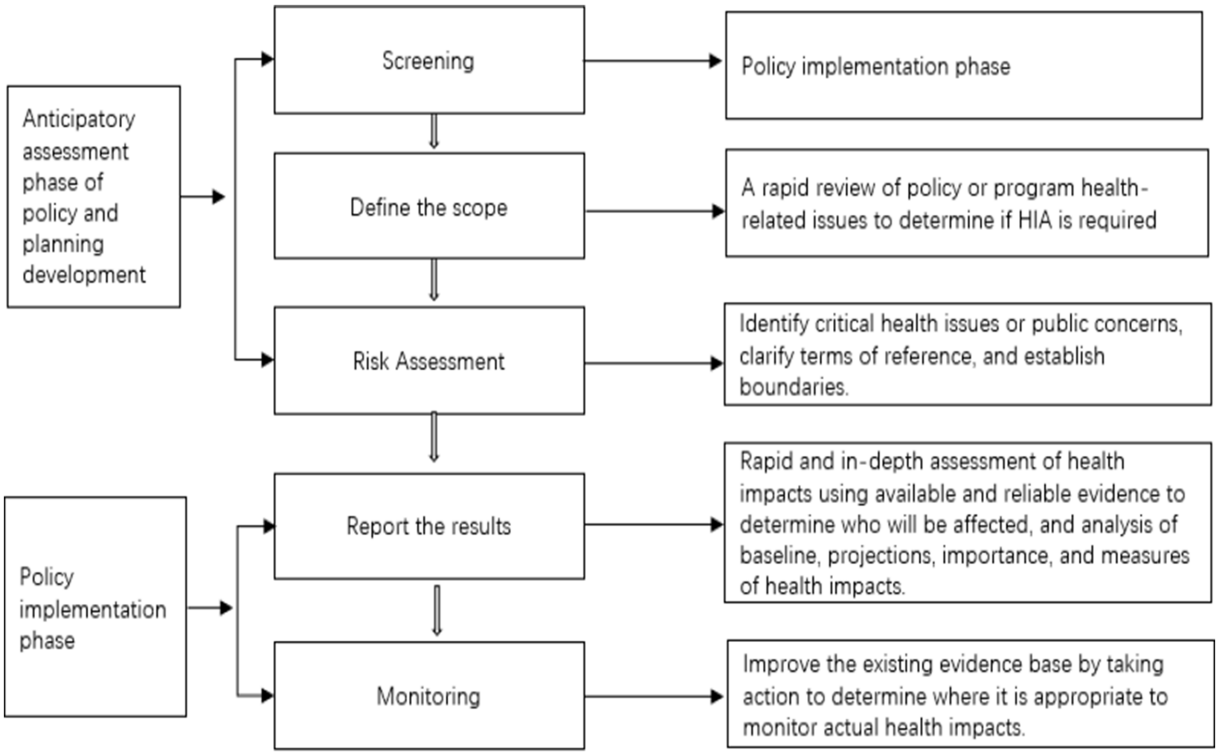

FIGURE 1
Basic procedures for assessing health impact.

must organize an expert review while ensuring confidentiality. All HIA documents must be submitted to the higher health administrative department for records. Monitoring and evaluation will be conducted during the implementation of policies, plans, and construction projects to assess their impacts on health. Institutions and individuals will assume legal responsibility if they violate their legal obligations. The evaluation procedure should only address laws-relevant issues, such as the responsibilities of the departments mentioned above, the implementation process, and public participation (45). A more standardized HIA procedure was established, with detailed implementation steps and technical processes provided to the health department (see Figure 1). Establishing guidelines for action, technical specifications, and subordinate laws for HIA is more appropriate.

5.3.4 Establish a system for public participation and information disclosure

All projects, plans, and policies directly related to public health rights and interests that are not confidential must be submitted for approval. Organizing hearings or other forms of active listening is necessary to gather public opinion on HIAs. Public opinions and the HIA documents should be submitted for approval, and the reasons for adoption or non-adoption should be explained. Establish a database of experts in counties (districts) to provide review support for HIAs before making approval decisions. Experts participating in the evaluation are selected from the expert pool based on their qualifications, and a specific percentage of external government experts are chosen randomly. The state will cover the payment of experts in a standardized manner. In addition to mandatory meetings, each department must organize demonstration meetings and symposiums periodically throughout the evaluation process. It is important to ensure effective safeguarding of the public's right to participate and express themselves. The entire process must prioritize the participation of the public and improve information disclosure to increase public trust in the effectiveness of their participation. The examination and approval authority will publish the final evaluation results and establish a period for objections after publication to allow the public to exercise their oversight power. Public reporting and supervision channels should be established during follow-up planning, policy development, and construction project implementation (10).

5.3.5 Establish a classification management system for HIA

Based on factors such as intensity, funding, and human resources, some countries categorize HIA into three types: rapid, intermediate, and comprehensive. There are similar methods in China's pilot programs. The evaluation tools' grades are integrated and selected based on the impact of policy changes on health, human resources support, and other variables. Using a focus on health priorities, classified management improves resource allocation efficiency. High-quality economic development and the concern for people's health are combined with effective strategies. This practice can continue under the Basic Law. HIA is divided into two categories: comprehensive assessment, which involves a wide range of assessments, has strong comprehensiveness, and has the most extended duration, and key assessment, which focuses only on essential content. Rapid, short-time assessment (a simple and quick evaluation). Which form has finally been adopted? Health authorities can compare the dynamics of human, technical, and financial support, the impact on health, and the

urgency of policy planning projects. The standard publishes a list of specific classifications (26).

5.3.6 The relevant legal support system should be improved

The basic principles of the HIA cannot be fully explained if the supporting legislation lacks specificity and direction. No matter how detailed the basic law is, it can only serve as a solitary vessel and an "effective norm" on paper. It can only meet the specific requirements of some regions and policy-planning projects. We should fully utilize the universal applicability of administrative laws and regulations, the detailed "rehabilitation" function, and local laws and regulations. We should actively explore new approaches to collaborative legislation to ensure a comprehensive legislative system for HIA.

According to this assumption, the basic law is based on the framework of law. This implies that administrative regulations, second only to laws, are the first to perform the refinement task. The regulations on the HIA of policies, the regulations on the HIA of major construction projects, and social and economic development plans should be established. The regulations for the HIA outline the assessment steps and content tailored to the characteristics of each assessment object. It is convenient for all locations and disciplines to adhere to the implementation.

Local legislation on HIA should eliminate redundancy in the overarching legislation and address local issues. The existing norms of the overarching law have been adapted into local regulations that align with the economic and social development, production, lifestyle and national customs and habits of the city. In regions characterized by heavy industry, clearly defining the HIA of construction projects related to the environment is crucial. To enhance the adaptability and acceptability of central legislation in local areas and increase people's willingness to abide by the law voluntarily.

The implementation of construction projects often crosses administrative boundaries. However, the fragmented legal system undermines the integrity of the HIA and hampers the effectiveness of a proper evaluation. The approval of "regional coordinated legislation" in the legislative law has introduced a new approach to solving this problem. Although there are still some disputes about the legitimacy and implementation of regional cooperative legislation, the first trial in Beijing-Tianjin-Hebei, the Yangtze River Delta, Guangdong Harbor, and other regions indicates that resolution of conflicts between local legislations, the establishment of an integrated regional legal environment, and the enhancement of regional in-depth cooperation is imminent (46).

5.3.7 Coordinate with existing civil, administrative, and criminal law systems

The basic law on health impacts should emphasize the need to pay special attention to the right to health of specific groups, including children, women, the older adult, and disabled individuals. This will create a harmonious resonance with the protection of specific groups as outlined in the General Principles of Civil Law of China (27). The right to health in civil law theory is related to the preservation of physiological functions of citizens and the promotion of a sustained, stable, and positive psychological state. The Civil Code adopts this approach by stipulating that "the physical and mental health of natural persons shall be protected by law." This aligns with the value orientation of the definition of health in the HIA. Establishing private rights and remedies for individuals involved in HIA can be facilitated by interpreting the right to health.

From an administrative law perspective, reviewing and approving the contents of an HIA are considered administrative acts. In particular, for an administrative license, the assessment and approval of the health impact of the project should adhere to the principles of the Administrative Licensing Law, which include fairness, transparency, and impartiality. In addition, the Administrative Procedure Law should define the "interested party" in the HIA with the plaintiff's subject qualification. Residents can initially file a complaint with the HIA administrator. If the result of the complaint remains unsatisfactory, the complainant can take further action (18).

In criminal law, the provision of false HIA documents by personnel from professional assessment institutions can be considered a punishable offense—the types of activities included in the crime of providing false certification documents. Falsifying HIA documents directly related to people's primary health rights and interests may be an aggravated offense (46).

5.4 Establishing implementation and enforcement mechanisms for China's impact assessment legislation

5.4.1 Clarify the regulatory body of China's health impact assessment legislation and its scope of responsibility

Establish appropriate regulatory bodies for different assessment objects and the scope of assessment objects. If the health impact assessment involves planning and policies, it is the superior government department that formulates the plan or the government. The subject of supervision of construction projects is the central and local construction management departments at all levels. Health departments at all levels uniformly supervise the implementation of the health impact assessment system. The regulatory responsibilities of different regulatory departments should be clear.

5.4.2 Strengthen the review of the evaluation report and publicize it to the public

The subject implementing the health impact assessment shall complete the health impact assessment report to a certain extent within a certain period of time and submit it to the corresponding health department. After carefully checking the health impact assessment, the health department shall disclose it to the public through the Internet, the media, and other means and accept the supervision of the society.

5.4.3 Improve the accountability mechanism for evaluation

The accountability mechanism for the assessment includes not only the legal responsibility of the subject of the assessment, but also the legal responsibility of the implementation subject, such as the planning, policy-making, and review organs. The examination and approval authority, the construction authority, the supervisory authority of the construction project. The effective implementation of

health impact assessment legislation can only be guaranteed by establishing a health legal accountability mechanism.

6 Conclusion

The most salient issue in China's HIA legislation can be encapsulated as the absence of legal norms. The establishment of an autonomous EIA statute in 2002 signaled a pivotal shift in the nation's legislative landscape. To further refine and strengthen this framework, it is imperative that China immediately enacts a foundational law on HIA, thus establishing a comprehensive and overarching legal framework for this crucial aspect of environmental governance. This fundamental legislative initiative will serve as the cornerstone on which the HIA system in China can be further developed and refined, paving the way for a more comprehensive and systematic approach to the protection of environmental health. The primary starting point of this document is to shape the legislative system of the HIA. However, because this paper only describes the general idea of the basic law of the HIA, some omissions could inevitably be made more explicit. It still needs to be followed up with a more rigorous and resilient portrayal of this unique system in the Basic Law. Protect the dignity of justice, well-being, and life.

Author contributions

QW: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Supervision, Visualization, Writing – original draft, Writing – review & editing. XZ: Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft, Writing – review & editing. QZ: Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. The work was supported by Shandong Provincial Philosophy and Social Science Planning Office (24CFXJ06).

Acknowledgments

The paper was written due to focused discussions among team members at the Shandong University Weihai Legislative Research Center.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 19 May 2025
DOI 10.3389/fpubh.2025.1601181

OPEN ACCESS

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RECEIVED 27 March 2025
ACCEPTED 28 April 2025
PUBLISHED 19 May 2025

CITATION
Jiang Q, Zhou J, Kuang X and Chen S (2025) Budgetary participation and organizational performance in Chinese public hospitals: facilitation or inhibition?
Front. Public Health 13:1601181.
doi: 10.3389/fpubh.2025.1601181

Budgetary participation and organizational performance in Chinese public hospitals: facilitation or inhibition?

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Introduction: Against the backdrop of deepening China's medical and health system reform, public hospitals are responsible for improving modern hospital management systems. This article aimed to understand whether and how public hospital budget participation affects organizational performance in China.

Methods: Based on the novel insights of Latour's Actor-Network Theory and self-efficiency theory, this article combines qualitative and quantitative research methods. In the qualitative research, this article used Grounded Theory and interviewed ten financial heads of public hospitals. In quantitative research, this article used an empirical research method and distributed 168 questionnaires, of which 164 valid responses were collected for analysis.

Result and discussion: This article reaches the following conclusions: (1) There is a positive correlation between budget participation and non-healthcare performance. (2) At the objective level, there was no significant correlation between budget participation and self-efficacy. From a subjective perspective, budget participation, planning self-efficacy, and interpersonal communication and coordination self-efficacy were significantly and positively correlated. (3) Budget participation could have an effect on NHP through planning self-efficacy, interpersonal communication and coordination self-efficacy The innovations of this article are: firstly, this article reasonably confirms the positive relationship between budget participation and organizational performance of public hospitals in China, providing useful references or subsequent research and other national and regional studies. Second, it analyzes the impact of budget participation on organizational performance based on a new perspective of Latour's Actor-Network Theory. This article is among the first to apply ANT in the context of hospital budgeting, offering novel theoretical insights. Finally, it uses a combination of qualitative and quantitative research methods to analyze the data.

KEYWORDS

budget participation, organizational performance, public hospital, Latour's Actor-Network Theory, self-efficacy

1 Introduction

Budget participation is defined as the practice of allowing subordinates to participate in and influence the budget-setting process (1). Over recent decades, the BP approach has drawn interest among researchers, practitioners, and policymakers (2). In terms of the impact of budgetary participation, existing studies have mainly explored its effects of budgetary participation on organizational performance (3), budgetary slack (4), job satisfaction (5), and self-efficacy (6). However, the existing research on the impact of budgetary participation on organizational performance is controversial (7). One view is that budget participation can

promote organizational performance (8). Another view is that budget participation has a negative or no effect on organizational performance (9). This controversy may exist because traditional theories fail to explain the relationship between budgetary participation and organizational performance. In terms of research methodology, most existing studies have used a single quantitative research approach to explore the relationship between budgetary participation and organizational performance (3). Although there have been many studies on the impact of budgetary participation on organizational performance (52), there are fewer studies on the impact of budgetary participation on organizational performance in China, with only six articles (3).

In 2015, the Ministry of Finance's National Health and Family Planning Commission's National Bureau of Traditional Chinese Medicine's Guidance on Strengthening Financial and Budgetary Management of Public Hospitals stated that all public hospitals should establish and implement a comprehensive budget management system by the end of 2016. Thus, the total budget management approach is also widely used in the health care sector (10). Public hospitals have responded to the requirements of the reform of the healthcare system and have implemented comprehensive budget management. The industry and theoretical community have achieved corresponding results in budget management in public hospitals. However, the focus of these results is on the more general issues of the construction of a comprehensive budget management system in public hospitals (10–12). Little research has been conducted on how to improve the overall performance of public hospitals by increasing staff motivation through budgetary participation in the overall budget (49, 51). Nevertheless, research on the impact of budgetary participation on organizational performance is important for improving both operational and budgetary management in public hospitals.

Based on the above analyses, this article attempts to fill the existing research gap. This article introduces Latour's Actor-Network Theory and self-efficacy theory and uses a combination of qualitative and quantitative research methods. This article investigates the impact of budgetary participation on organizational performance in public hospitals in China and explores the mechanism of self-efficacy to promote the improvement of the level of operational management and budgeting in public hospitals. The innovations of this article are characterized by the following three main points: First, this article confirms the positive relationship between budget participation and organizational performance of public hospitals in China, providing useful references for subsequent research and other national and regional studies. Second, it analyzes the impact of budget participation on organizational performance based on a new perspective of Latour's Actor-Network Theory. Finally, it uses a combination of qualitative and quantitative research methods to analyze the data.

2 Literature review

The main theoretical motivation for this article stems from the increasing number of recent studies that have begun to unify two disparate streams of literature: on one hand, the literature on public organizations and organizational performance and, on the other hand, the literature on budget behavior. Moreover, there is an increasing body of research on accounting practices using agency theory and other traditional theories that may lead to conflicting results. Therefore, a more appropriate and comprehensive method is required for in-depth analyses. In this section, this article offers in sub-sections 2.1, an insight into the positive correlation between the two variables and 2.2, an insight into the negative correlation between the two variables.

2.1 The positive correlation between the two variables

The contribution of budget participation to organizational performance can be systematically explained through multi-level theoretical mechanisms and differentiated practice scenarios. From an information integration perspective, the essence of budget participation is to break down information silos within the organization and optimize the quality of decision-making through a two-way flow of data (13). This effect is particularly pronounced in high-uncertainty environments (14). Behavioral science theories further reveal the deeper driving mechanisms of engagement in individuals and teams. The paths of action include the following three: The first is autonomy empowerment. Employees have a greater voice in equipment purchase budgets, and their commitment to production goals increases (15). Second, it enhances competence identity. The self-efficacy of junior managers increases through participation in setting phased budget goals, which directly reduces goal deviation behaviors (2). Third, there is a cross-sectoral synergy. The case of the Government's Cross-Departmental Budget Working Group demonstrates that collaborative budgeting has led to a higher frequency of information sharing between departments and a reduction in the project delivery cycle (16). Quantitative studies of the effects of weights and measures reveal the law of fit for the budgetary participation model (8). In decentralized organizations, participatory budgeting leads to increased policy responsiveness by shortening the "decision-implementation" chain (17). However, in highly centralized firms, limited participation is more effective than full participation because it avoids decision-making stagnation (18). Digital transformation has amplified the effectiveness of budget participation. Local governments that have deployed blockchain budget tracking systems have seen a significant increase in the frequency of citizen engagement and higher rates of budget execution (19).

2.2 The negative correlation between the two variables

While some studies hold the view that budget participation may have a negative effect or no effect on organizational performance. This is mainly because the core stems from a mismatch between the institutional and organizational contexts. In a scenario where strong performance pressures coexist with weak monitoring, budgetary participation may be alienated as a strategic gaming tool (20). Local government department heads create budgetary slack by overestimating costs or underestimating revenues, which directly leads to less efficient resource allocation (21). The mechanism by which this distorted behavior occurs can be divided into three motivating factors. First, under an incentive system that strongly links compensation to budget achievement, managers tend to set aside "safety cushions" to reduce appraisal risk and increase the size of

budgetary slack (22). Moreover, when participatory mechanisms lack social accountability, information rent-seeking behavior by management is systematically condoned by the board. Studies have shown that the size of budgetary slack is higher in the unsupervised group than in the supervised group (23). Thirdly, Lack of cultural appropriateness exacerbates formalized budget participation. Adoption of budget proposals by rank-and-file employees is grossly inadequate in countries with high power distances, resulting in participation being reduced to a symbolic process (24). A deeper contradiction is reflected in the disconnect between organizational capacity and the demand for participation (25). The contribution of budgetary engagement to performance plummets in firms where transformational leadership is absent. Managers are unable to translate employee suggestions into actionable programs (3). Weak technical support directly undermines the effectiveness of budget participation. Enterprises with paper-based budget processes experience delayed information integration and versioning confusion. This results in performance gains being offset by the increased time costs associated with budget participation (26).

In summary, existing studies have mainly used goal-setting, agency, and uncertainty theories and other traditional theories to analyze how budget participation influences organizational performance. However, these results are controversial. This may be because existing studies have considered factors within the organization and ignored those outside it. Therefore, this article introduces Latour's Actor-Network Theory to explain the impact of budgetary participation on organizational performance. More importantly, most existing studies have been conducted using quantitative methods. A single quantitative method may have problems such as scale mismatch and time window mismatch. Therefore, this article attempts to address the shortcomings of previous studies by adopting a combination of directional and quantitative research methods.

3 Theoretical framework

3.1 The sociology of worth of Latour's Actor-Network Theory for understanding the relationship between public hospital budget participation and organizational performance

Studies by Dunk and Nouri (27), Shields and Shields (28), and Derfuss (29) that focus on budget participation often only explain a small portion of budget efficiency and organizational performance. One possible reason for this problem is that research on budget participation often focuses on interactions within a binary system. However, budget goal setting spans the entire organization, with different actors involved in budget participation, such as the government, health agency management, healthcare personnel, and other human actors, thus exceeding the scope of the supervisor-subordinate binary (28, 30). Therefore, this article uses Latour's Actor-Network Theory, which can comprehensively consider various actors and their interrelationships.

It is evident that past theories can no longer explain the relationship between budget participation and organizational performance. Latour's Actor-Network Theory has attracted our attention. Latour emphasizes that science can only be understood through its practice; therefore, it is necessary to examine science in action, not just the results of science or simply facts (48). From this perspective, Latour developed an analytical method called "Actor Network Theory" (ANT). According to this method, science survives and develops in a network-like construction process, and this network needs to encompass all social resources and human strategies as much as possible. Latour's basic orientation is that science is a domain in which neither human nor nonhuman factors are given special priority. This can be seen as a radical form of symmetry theory, which sets the symmetry between human and non-human actors, or rather, super symmetry. Latour's Actor-Network Theory emphasizes the construction process of social networks and believes that social phenomena are formed by the interconnection of different actors. These connections are dynamic and can be changed through continuous interactions and exchanges. Therefore, the participation of each actor is crucial.

First, when this article applies Latour's Actor-Network Theory to the field of budget accounting in public hospitals, it views accounting budgeting as a network composed of multiple actors, including human actors (such as management, financial departments, doctors, and nurses) and non-human actors (such as documents, reports, and technical equipment). By analyzing the interactions and impacts between these actors, it is possible to gain a deeper understanding of the relationships between the various actors involved in the budget formulation process.

Second, Latour's Actor-Network Theory emphasizes the need for cooperation among actors in the budgeting process. Governments, health institutions, doctors, and nurses are all related.

Third, applying Latour's Actor-Network Theory, there may be competition and conflict between different actors. Government departments may want to control the budget size, while health institution management may want to obtain more budget resources to meet the demand for medical services. Doctors and nurses may want to increase budget investment to improve medical facilities and provide better services. This type of competition and conflict must be weighed and negotiated in the actual budget formulation process.

Finally, Latour's Actor-Network Theory emphasizes the interactions and influences between actors. During the budgeting process, government departments affect the behavior of health institution management and are also subject to feedback and adjustments from other participants. Through the analysis of Latour's Actor-Network Theory, researchers can reveal the direct and indirect impact paths of institutions on participant behavior and understand how institutional settings shape participant budgeting behavior. The direct impact path is as follows: the system setter establishes norms and requirements for budget preparation. For example, government departments require the management of health institutions to provide specific financial information in budget reports, which directly affects the financial decision-making and reporting behavior of management in budget preparation. Institutions also influence participants' behavior through other indirect channels. System setters may require transparency and accountability in the budgeting process, which motivates participants to handle budget-related matters more cautiously to avoid responsibility and punishment in the future.

Based on the above, this article innovatively introduces Latour's Actor-Network Theory and believes that it is reasonable and necessary to study the relationship between budget participation and the

organizational performance of public hospitals. Thus, this article formulates the following hypothesis:

> *H1*: Budgetary participation promotes organizational performance.

3.2 Experience, theory, and mediating variables

Budget participation is an incentive mechanism that can improve organizational performance (50) and budget effectiveness. Personnel involved in the budget who hold a positive attitude and receive a high degree of motivation can produce improved budget effects (31). This is mainly because the cognitive ability and level of motivation of organization members are greatly improved when they participate in budget management. In addition, the impact of budget participation on organizational performance is influenced by cognitive mechanisms. Budgetary participation can have an informational effect. Under the cognitive mechanism, participating in budgeting is a process of sharing and understanding the information. Therefore, in the process of participating in budgeting, more information can be mastered, role ambiguity can be reduced, and a clearer understanding of the work environment and job responsibilities can be obtained. Organizational performance can be improved by fully utilizing and effectively allocating controllable economic resources (32). Macinati et al. (33) studied the relationship between budget participation and organizational performance in the context of professional hybrids in the healthcare industry. The results showed that the relationship between budget participation and organizational performance was not significant, suggesting the existence of potential mediating effects. As mentioned above, previous experience has taught us that research on the relationship between budget participation and public hospital performance often relies on the involvement of intermediary variables.

Based on theoretical foundations and empirical literature, Latour's Actor-Network Theory emphasizes network construction and the equal importance of the roles of non-human and human actors. Therefore, when this article examines the relationship between budget participation and organizational performance in public hospitals, there should also be a network construction between the two. Combining the interactivity of theory, this article proposes self-efficacy as an intermediary variable to test the relationship between budget participation and public hospital performance.

Self-efficacy was first proposed by Bandura (34). Since its introduction, various fields have conducted numerous studies on this concept. Bandura (35) elaborated on self-efficacy as "an individual's evaluation and perception of their ability to complete a task." The so-called self-efficacy refers to the level of confidence an individual has in whether they can complete a task, which is not related to the skills themselves but to the level of confidence they have in whether they can use their skills to achieve the task. Current measurements of self-efficacy are generally in the form of Likert scales (36). The definition of self-efficacy in this article is based on Bandura's definition and measures the confidence level of members of public hospital organizations in completing work. However, it not only refers to the self-efficacy of specific job responsibilities but also includes planning self-efficacy, interpersonal communication and coordination self-efficacy, information processing self-efficacy, decision-making, and problem-solving self-efficacy. Western scholars propose that self-efficacy comes from four types of experiences: (1) past successful experiences. (2) Imitation or substitution. There is a lot of knowledge and experience that is not obtained through personal practice but through observation and imitation of the behavior of others (37). If the indirect experiential information conveyed by peer behavior is successful, it can promote the improvement of one's own self-efficacy. (3) Verbal or social persuasion: If others evaluate individuals as capable of performing a certain task, they will put in more effort, and correspondingly, their self-efficacy will improve. (4) The state of physiology and emotions. A stable, positive, and healthy emotional state can promote self-efficacy, whereas anxiety, tension, or fear can easily weaken it. Fatigue and pain can reduce task-related self-efficacy (38). Bandura's summary of the sources of self-efficacy is overly broad. Therefore, Gist and Mitchell (51) conducted a more detailed analysis of the factors that affect self-efficacy from three levels: controllability, internal and external sources, and plasticity, and proposed a three-dimensional model of self-efficacy. The model proposed by Gist and Mitchell is more refined and specifies the dimensional characteristics of the influencing factors. Regarding self-efficacy and work effectiveness, Judge and Bono (39) examined the relationship between general self-efficacy and work attitudes and found that employees with higher self-efficacy believe that they can complete tasks well, resulting in higher job satisfaction.

Based on the above analysis, this article formulates the following hypothesis:

> *H2*: Self-efficacy mediates between budgetary participation and organizational performance.

4 Methodology and results

This article combines directed and quantitative research methods. This is because purely quantitative studies may overlook the contextual factors and psychological mechanisms (e.g., dynamics of self-efficacy) of the participants. Qualitative studies have difficulty demonstrating statistical significance among variables. The mixed methods approach compensates for the shortcomings of a single approach through 'triangulation' and enhances the rigor of the article.

4.1 Qualitative research

4.1.1 Interview method

Qualitative research was conducted using Grounded Theory in interviews. Grounded Theory (GT) is a qualitative research approach that aims to establish theories based on empirical data (52). This article adopts Grounded Theory for the following reasons: First, the relationship between budgetary participation and organizational performance in public hospitals is multidimensional, dynamic, and context-dependent. Grounded Theory emphasizes the distillation of theory from raw data rather than relying on preconceived assumptions, which is suitable for exploring complex phenomena that are not yet fully understood. Second, budget management in public hospitals involves multiple stakeholders (e.g., government, management, healthcare workers, and patients), and their behavioral motivations and interaction logics need to be understood from the subjective perspectives of

the participants. Through open coding and axial coding, Grounded Theory can systematically sort out the core concepts (e.g., 'self-efficacy' and 'non-medical performance') in the interview data and reveal how budgetary participation affects organizational performance through psychological mechanisms. Finally, previous studies are mostly based on traditional theories (e.g., agency theory), leading to conflicting conclusions or insufficient explanatory power. Grounded theory allows researchers to generate new theoretical frameworks from data (e.g., incorporating Latour's Actor-Network Theory) to provide more contextualized explanations of the relationship between budgetary participation and performance.

The operational procedures of Grounded Theory generally include: (1) generating concepts from data and logging them step by step; (2) continuously comparing data and concepts and systematically asking generative theoretical questions related to concepts; (3) developing theoretical concepts and establishing connections between concepts; (4) theoretical sampling and systematic encoding of data; and (5) constructing theory, striving to obtain the density, variability, and high degree of integration of theoretical concepts. In the first level of coding (Open Coding), researchers require an open mindset, as much as possible, to "suspend" personal "biases" and research community "fixed opinions" and log all data in their own state. To address bias in data analysis, this article used the member check method. Initial analyses were fed back to the participants to confirm that their views were accurately understood and presented. The main task of secondary coding (also known as associative or axial coding) is to discover and establish various connections between conceptual categories to represent the organic relationships between various parts of the data. These connections can be causal, temporal order, or semantic relationships. Consider their language in the context of the time and the social and cultural context in which they are located, and from the following encoding points. To increase the credibility of the data, the results of the coding were further discussed using peer debriefing, in which no new ideas were generated.

Based on the above, this article uses the GT interview method with ten public hospital-related personnel in China as interviewees to study the relationship between budget participation, self-efficacy, and hospital performance. These 10 people were chosen for this article because they were all directors or financial heads of public hospitals. They started from the grassroots and have a better understanding of the business situation, budgeting, and organizational performance of public hospitals. The sample size was established following the principle of theoretical saturation, whereby the information obtained was collated for each number of readers interviewed, and the interviews ended when the 10th personnel was interviewed and no new significant information was provided. Part of the qualitative analysis of the interview content used the Nvivo software. The details are presented in Table 1.

TABLE 1 Layered coding.

Name	Code type	Folder location	List level	List order
Non-healthcare performance	Node	Node	2	13
Plan	Node	Node	2	5
Decision-making and problem-solving	Node	Node	2	9
Objective practice	Node	Node	2	2
Control	Node	Node	2	10
Interpersonal coordination and communication	Node	Node	2	7
Information processing	Node	Node	2	8
Healthcare Performance	Node	Node	2	12
Hospital performance	Node	Node	1	11
Budget participation	Node	Node	1	1
Staff management	Node	Node	2	6

TABLE 2 Interviewees.

No	Name	Professional status	Gender	Interview length
1	Tian Hong	Hospital leader	Male	20 min58
2	Ji Hua	Hospital leader	Female	19 min15
3	Shen Hong	Department Manager	Female	18 min18
4	Hu Ying	Department Manager	Female	25 min45
5	Zhong Yuan	Department manager	Male	19 min17
6	Na Xiaohong	Director of technical office	Female	16 min14
7	Zhang Haiming	Director of technical office	Male	17 min36
8	Fan Ruoyun	Staff	Female	18 min26
9	Li Pan	Staff	Male	19 min47
10	Li Jing	Staff	Female	26 min35

4.1.2 Data collection

As shown in Table 2, this article selected 10 respondents for in-depth interviews. The interviewees included two hospital-level leaders, three department managers, two business department managers, and three staff members from ten public hospitals. The article uses telephone interviews, and the average interview time is 20 min.

4.1.3 Interview topic

According to Latour's Actor-Network Theory, using the interview method of GT, five interview outlines were designed in the interview outline. Table 3 presents the first-level dimension involved in the interview outline as budget participation, and the second-level dimension as objective practice. The first-level dimension involved in the second interview outline is budget participation, and the

TABLE 3 Interview topic.

Serial number	Interview outline	First dimension	Secondary dimension
1	1. Do you think the hospital in question can implement a series of budgeting processes based on a combination of top and bottom processes? 2. Is there a clear budget meeting communication system and communication channel between the management structure and budget units? 3. Is there a multi-dimensional data warehouse technology used for budgeting work in information technology, and has interfaces been established with other systems?	Budget participation	Objective practice
2	1. Have you participated in the formulation of budget goals? 2. If you change the budget goals? 3. Will your superiors explain the reasons? 4. Can you proactively express your opinions and have a certain voice? 5. Have you invested more time and energy in the preparation work? 6. Have you received help and guidance from your superiors?	Budget participation	Self-awareness
3	1. Can you develop a reasonable work plan for your unit, allocate resources such as personnel, property, and other resources reasonably, and arrange and allocate time reasonably? (Leader interviewees) 2. Can you objectively evaluate the work performance of subordinates? If you find difficulties and negative emotions in subordinates, are you willing to provide help and believe that it can create a good team atmosphere? 3. Can you establish a good and trusting relationship with suppliers? And can you effectively communicate with others when there are disagreements? 4. Can you actively collect information and pass it on to subordinates, providing effective information for decision-makers? 5. Can you have a good understanding of the instructions conveyed by superiors?	Self-efficacy	Self-efficacy – Planning, Self-efficacy – Employee Management, Self-efficacy – Interpersonal Coordination and Communication, Self-efficacy – Information Processing
4	1. Can you effectively complete the tasks assigned by the unit, make decisive decisions, take timely action to solve crises, timely grasp information related to new tasks and projects, and believe that you can control work progress?	Self-efficacy	Self-efficacy – decision-making and problem-solving; Self-efficacy – Control
5	1. Do you feel that the medical quality and safety level of your hospital are constantly improving? 2. What is the performance related to it? 3. Has there been an improvement in patients and satisfaction? 4. Is there a growing trend in reputation and market share? 5. How is the cost control of the hospital?	Hospital performance	Hospital performance – healthcare performance; Hospital performance – non-healthcare performance

second-level dimension is the perspective of self-awareness. The first-level dimension involved in the third interview outline was self-efficacy, while the second-level dimension was self-efficacy planning, self-efficacy employee management, self-efficacy interpersonal coordination and communication, and self-efficacy information processing. The first-level dimension involved in the fourth interview outline was self-efficacy, and the second-level dimension was self-efficacy decision-making and problem-solving, and self-efficacy control. The first-level dimension involved in the fifth interview outline is hospital performance, and the second-level dimension is hospital performance – healthcare performance and hospital performance – non-healthcare performance.

4.1.4 Qualitative analysis findings

Through interviews with different subjects, this article obtained the relationship between budget participation and organizational performance in public hospitals and verified that the intermediary variable self-efficacy preliminarily determined under Latour's Actor-Network Theory framework does indeed promote organizational performance under budget participation.

(1) Public hospitals can establish a comprehensive budget platform by designing comprehensive budget participation processes and systems, establishing clear budget meeting communication systems and channels, conducting appropriate and diverse budget communication, and improving employee and patient satisfaction and the public hospital's reputation. From a subjective perspective, budget participation in non-healthcare performance is positively correlated. Therefore, public hospitals should strive to increase their staff's perception of budget participation, thereby improving work efficiency, employee and patient satisfaction, and their reputation.
(2) Self-efficacy is more biased toward subjective perception of confidence in completing tasks, and there is a cognitive variable between it and budget participation from a practical perspective. From a subjective perspective, there

is a significant positive correlation between budget participation and planning self-efficacy, and between interpersonal communication and coordination self-efficacy. Therefore, by promoting the participation of public hospital staff in budget preparation, improvement, and other processes, it is possible to encourage employees to reasonably and effectively allocate time, develop complete work task plans, carry out work according to plans, establish a frank and mutual trust relationship with other members, encounter disagreements in their work, and communicate effectively.

(3) Budget participation cognition influences non-healthcare performance through planning self-efficacy, interpersonal communication, and coordination self-efficacy.

4.2 Quantitative research

Researchers conducted an empirical research design to collect the information and data needed for the empirical study of this article by means of a questionnaire survey, and to refine and derive the corresponding scales with reference to domestic and international scholars' measures of budget participation, self-efficacy, and organizational performance in public hospitals.

4.2.1 Data collection

The quantitative data of our public hospitals cannot be disclosed to the public, as in the case of enterprises, due to sensitivity issues. Moreover, Budgetary participation, self-efficacy, and organizational performance variables are mostly measured in national and international studies in the form of Likert scales. Thus, this article used questionnaires to collect data. The main steps taken in this article to ensure the validity of the data are as follows: (1) To ensure the validity of the structure and content of the questionnaire, this article first sorted out the measurement items of budgetary participation, self-efficacy, and organizational performance of public hospitals based on domestic and international studies, drew on widely used scales, and improved them. Subsequently, the researchers asked experts in public hospital management to assist in judging the reasonableness of the design of each measurement item. (2) Pre-testing of the questionnaire, inviting people to complete the questionnaire, improving some of the content based on their responses, and estimating the time required to complete the questionnaire. (3) In this article, we designed a web-based questionnaire with reasonable prompts to remind participants of the precautions for completing the questionnaire to reduce non-response bias. (4) Reliability and validity tests were conducted for each variable of the questionnaire.

With the help of the financial leaders of relevant public hospitals, the questionnaires were distributed through seminars on comprehensive asset and price management in public hospitals. The distribution of respondents was random. A total of 168 questionnaires were collected, and invalid questionnaires were excluded from the analysis. Four were answered incorrectly, and the remaining 164 were analyzed using the statistical analysis software SPSS 25.0.

4.2.2 Variables measurement

4.2.2.1 Budget participation

Milani (40) defined participation in budgeting as a continuous variable to measure the level of involvement of organizational members in the process of budgetary activities and measured it in several ways. The budget participation scale designed by Milani is widely used by management accounting scholars. However, its measure is a budget participant's subjective perception of self-involvement and influence, which is likely to be subject to cognitive bias, leading to highly unstable results in testing the relationship between the two. Thus, this article adopts a methodology for measuring budgetary participation in terms of objectively occurring managerial practice activities that eliminate information asymmetry, combined with a scale designed by Milani to measure budgetary participation. See Table 4 for specific measurements.

4.2.2.2 Self-efficiency

The development of this part of the scale is based on the Self-Efficacy Scale for Managers in Chinese Enterprises constructed by Ling Wen wheel spokes and Fang Liluo (41), which is mainly used to measure managers' performance in the four areas of 'Planning', 'Interpersonal Coordination and Communication', 'Information Processing', and 'Decision-making and Problem-solving'. These dimensions were measured on a 7-point Likert scale of 'completely disagree – completely agree' (47), as shown in Table 5.

4.2.2.3 Organizational performance

This article focuses on Chinese public hospitals. China's healthcare system is still in its infancy, and public financial information and data are not readily available. During the field research, it was evident that the interviewees were very cautious about disclosing specific financial data and information, which is understandable. In addition, public hospitals are non-profit organizations with a greater emphasis on social benefits. Therefore, this article focuses on the non-healthcare service performance of public hospitals. Non-healthcare performance (NHP) mainly includes internal and external customer satisfaction, organizational financial and market performance, as well as the image and reputation of public hospitals in the eyes of the public, and the specific measures are shown in Table 6.

4.2.2.4 Control variables

Considering that other factors also affect the organizational performance of public hospitals, they were included in the model as control variables. The level of public hospitals (Level), type of public hospitals (Status), and area where the public hospitals are located (Area) were selected.

The level of the public hospital can be divided into Level I, Level II, and Level III. Status indicates the category of public hospital, which can be divided into general public hospitals and specialized public hospitals. The area indicates the region where the public hospital is located; 0 indicates Northwest China (covering Shaanxi, Gansu, Ningxia, Qinghai, and Xinjiang), 1 indicates Northeast China (covering Liaoning, Jilin, and Heilongjiang), 2 indicates Southwest China (covering Sichuan, Chongqing, Guizhou, Yunnan, and Tibet), 3 indicates Central China (covering Hubei and Hunan), 4 indicates North China (covering Beijing, Tianjin, Hebei, Shandong, Henan,

TABLE 4 Measurements of budgetary participation.

Measurement dimension	Item	Measurement of variables and related questionnaire items
Budget participation system	BP11	Your institution follows a top-down process for preparing, balancing, questioning and approving budgets
	BP12	There is a clear communication system for budget meetings and channels of communication between your institution's budget management body and budget units
	BP13	Your hospital has adopted a professional budget software based on a multi-dimensional data warehouse as a budget management platform to set up the budget logic and execute the budget process.
	BP14	Data interfaces have been established between your institution's budget system and other major financial and business systems to achieve synergy in functionality and integration at the data level
	BP15	Frequent and varied communication between your institution's budget management bodies and budget units, as well as between budget units, with timely feedback on the status of budget execution and reasons for variances, etc.
Budget engagement awareness	BP21	You participate in the development of all budget targets
	BP22	If your supervisor changes the budget target, he/she will explain the reasons to you
	BP23	You can often take the initiative to express your opinion
	BP24	You have an important say in setting budget targets
	BP25	You do a lot of preparation for budgeting
	BP26	Your supervisor has discussed setting a budget with you on several occasions

Shanxi, and Nei Menggu), 5 indicates South China (covering Guangdong, Fujian, Guangxi, and Hainan), and 6 indicates East China (covering Shanghai, Jiangsu, Zhejiang, Anhui, and Jiangxi).

In addition, since budgetary participation and self-efficacy are related to the judgment of one's own situation, based on the suggestions of previous studies (42–44), some control variables related to situational and individual factors that may affect the results were included in the model, including Tenure, Gender, Age, Background, and Education. Tenure was categorized as follows: Faculty Leaders, Functional Department Management, Operational Section Managers, and General Staff were denoted by 1, 2, 3, and 4, respectively; Age (Age) was categorized into three levels: less than 40 years old, between 40 and 50 years old, and more than 50 years old; and educational attainment was categorized into three levels: college, bachelor's degree, master's degree, or doctoral degree.

4.2.3 Descriptive statistics

The distribution of the sample is shown in Table 7. The vast majority of public hospitals in the sample public hospitals studied in this paper are public hospitals of level I, accounting for 89.02 percent, while 8.54 percent of public hospitals are at level II, and 2.44 percent are at level III; 71.95 percent of them are general public hospitals, and 28.05 percent are specialist public hospitals; the location of the public hospitals is mainly concentrated in East China, accounting for 69.51 percent, while the distribution in other regions is more even. The age of the sample's public hospital personnel was mainly concentrated between 40 and 50 years old, accounting for 56.10 per cent, followed by those under 40 years old, accounting for 28.05 per cent, and those over 50 years old, accounting for 15.85 per cent. The education level of the respondents was relatively high, with 65.85 per cent having a bachelor's degree and 28.05 per cent having a master's degree or PhD.

4.2.4 Correlation test

The results of the correlation analysis are shown in Table 8. From Table 8, the correlation coefficient between BPa and NHP is 0.368 which is significant at the 1% level. The correlation coefficient between BPb and NHP was 0.454 which was significant at the 1% level. This preliminarily verifies research hypothesis H1. The correlation coefficients between the variables are less than, and the VIF test is performed are less than 2, and the tolerance values are greater than 0.6. This indicates that there is no multicollinearity among the main variables of this article.

4.2.5 Reliability and validity analysis

In this article, the internal consistency coefficient (Cronbach's alpha value) was used to test the reliability of each variable in the questionnaire. The analysis results showed that the internal consistency coefficient of each variable exceeded 0.7, as shown in Table 9, indicating that the scale had good consistency and stability. Validity can be divided into content and construct validity. The measurement items used in this article were mature scales developed by scholars with good content validity. The standard factor loadings of each measurement index on their respective latent variables were all higher than 0.6, indicating that the scale could accurately measure each variable and had good convergent validity.

TABLE 5 Measurement of self-efficiency.

Measurement dimension	Item	Measurement of variables and related questionnaire items
Plan	SE11	I believe that I can set up a complete task plan for the unit
	SE12	I believe that I can make a reasonable deployment of resources such as people and materials in the unit
	SE13	I believe that I am always able to allocate and organize my time rationally and efficiently.
Interpersonal Communication and Coordination	SE21	I am confident that I can build good relationships with suppliers or patients
	SE22	I am confident that I can build open, trusting relationships with the people I work with
	SE23	I am confident that I can communicate effectively when faced with disagreements at work
Information processing	SE31	I am confident that I am able to proactively gather all applicable information and pass it on to my subordinates
	SE32	I am confident that I am able to provide effective information to decision makers (or am a decision maker)
	SE33	I am confident that I am able to understand and carry out instructions communicated to me by my superiors
Decision-making and Problem-solving	SE41	When a crisis event occurs, I am confident that I can take timely action to resolve it
	SE42	I am confident that I can perform well the tasks or jobs assigned to me by my organization

TABLE 6 Measurement of non-healthcare performance.

Measurement dimension	Item	Measurement of variables and related questionnaire items
Non-healthcare performance	NHP1	Increased internal and external customer satisfaction over the past 3 years
	NHP2	Increased financial returns and market share over the past 3 years
	NPH3	Increased reputation over the past 3 years
	NPH4	Increased cost control over the past 3 years

TABLE 7 Sample distribution.

Variables	Type	Frequency	Proportions
Level	I	4	2.44%
	II	14	8.54%
	III	146	89.02%
Status	General	118	71.95%
	Specialized	152	28.05%
Area	East	114	69.51%
	South	6	3.66%
	North	22	13.41%
	Central	6	3.66%
	South West	0	0.00%
	North East	4	2.44%
	North West	12	7.32%
Tenures	Faculty Leaders	24	14.63%
	Functional Department Management	86	52.44%
	Operational Section Management	8	4.88%
	General Staff	46	28.05%
Age	40	46	28.05%
	40–50	92	56.10%
	>50	26	15.85%
Genders	Men	52	31.71%
	Women	112	68.29%
Education	College	10	6.10%
	Bachelor's degree	108	65.85%
	Master's degree, or doctoral degree.	46	28.05%

10.3389/fpubh.2025.1601181

TABLE 8 Correlation analysis of key variables.

Variable	NHP	BPa	BPb	Education	Back ground	Age	Gender	Tenure	Level	Status	Area
NHP	1										
Bpa	0.368**	1									
BPb	0.454**	0.288**	1								
Education	0.113	0.148	0.136	1							
Background	−0.092	−0.161	−0.015	−0.361**	1						
Age	−0.015	−0.156	0.07	0.021	−0.085	1					
Gender	0.102	0.092	−0.071	−0.038	0.215*	−0.016	1				
Tenure	−0.125	0.057	−0.272*	−0.217*	0.266*	−0.518**	0.132	1			
Level	0.032	0.104	0.024	0.246*	−0.196	−0.069	−0.001	0.005	1		
Statues	−0.052	−0.069	0.007	−0.034	−0.071	−0.156	−0.033	0.064	0.159	1	
Area	−0.042	0.1	−0.01	−0.06	0.058	−0.146	0.09	0.144	0.054	−0.013	1

*$p < 0.05$; **$p < 0.01$.

TABLE 9 Reliability and validity analysis.

Measurement dimension	Item	Factor loadings	Cronbach's α	Variance contribution rate
Budget participation system	BP13	0.836	0.869	65.807%
	BP15	0.833		
	BP11	0.833		
	BP12	0.816		
	BP14	0.734		
Budget engagement awareness	BP26	0.860	0.847	57.424%
	BP24	0.823		
	BP23	0.782		
	BP25	0.780		
	BP21	0.691		
	BP22	0.574		
Non-healthcare performance	NHP1	0.884	0.864	71.181%
	NHP2	0.862		
	NHP3	0.862		
	NHP4	0.762		
Plan	SE11	0.835	0.749	57.548%
	SE12	0.831		
	SE13	0.651		
	SE14	0.699		
Interpersonal Communication and Coordination	SE21	0.732	0.733	65.361%
	SE22	0.858		
	SE23	0.830		
Information processing	SE31	0.799	0.877	73.261%
	SE32	0.813		
	SE33	0.607		
	SE34	0.711		
Decision-making and Problem-solving	SE41	0.892	0.749	80.115%
	SE42	0.880		

4.2.6 Regression analysis

4.2.6.1 Budget participation – organizational performance

As shown in Table 10, the regression analysis found that the budget participation system was significantly and positively correlated with NHP, with a correlation coefficient of 0.362. In the regression model, excluding the explanation part (6%) of Model 1, the incremental explanation for the change in the NHP in Model 2 was (Change in R^2) 11.8%. The above test results show that from an objective point of view, the higher the level of budget participation, the higher the NHP. The perception of budgetary participation was found to be significantly positively correlated with NHP, with a correlation coefficient of 0.486, excluding the explanation part of Model 1 (6%). The incremental interpretation of Model 2 for the changes in NHP was (Change in R^2) of 21.2%. The above test results show that from the perspective of self-perception, the higher the level of budget participation, the higher the NHP.

TABLE 10 Regression results of budget participation and non-healthcare performance.

Serial Number	Variables	Non-healthcare performance		Non-healthcare performance	
		Beta	*t*	Beta	*t*
1	Constant		0.000		0.000
	Level	0.029	0.230	0.029	0.230
	Status	−0.040	−0.342	−0.040	−0.342
	Area	−0.077	−0.657	−0.077	−0.657
	Tenure	−0.136	−0.968	−0.136	−0.968
	Gender	0.155	1.305	0.155	1.305
	Age	−0.125	−0.928	−0.125	−0.928
	Background	−0.073	−0.562	−0.073	−0.562
	Education	0.072	0.551	0.072	0.551
2	Level	0.010	0.081	0.023	0.206
	Status	−0.009	−0.083	−0.044	−0.428
	Area	−0.098	−0.887	−0.092	−0.886
	Tenure	−0.143	−1.085	0.025	0.196
	Gender	0.114	1.009	0.184*	1.746
	Age	−0.067	−0.521	−0.090	−0.755
	Background	−0.007	−0.056	−0.125	−1.086
	Education	0.041	0.337	0.032	0.273
	BPa	0.362***	3.221		
	BPb			0.486***	4.575
	R^2	0.060	0.178	0.060	0.271
	ΔR^2		0.118		0.212
	F	0.578	1.733	0.578	2.980
	ΔF		10.376		20.928

*** means $p < 0.01$, ** means $p < 0.05$, * means $p < 0.1$.

4.2.6.2 Budget participation – self-efficacy

After the regression analysis of self-efficacy in the budget participation system, it was found that there was no significant correlation between the two variables; therefore, the results are not shown here. After the regression analysis of budget participation cognition and self-efficacy, it was found that budget participation cognition and planning, and interpersonal communication and coordination self-efficacy were significantly positively correlated, with correlation coefficients of 0.340 and 0.239, respectively. In the regression model of budget participation self-perception and planning self-efficacy, excluding the explanation part of Model 1, the incremental interpretation of the self-efficacy change in Model 2 was (ΔR^2) at 10.4%. In the regression model of budget participation, self-cognition and interpersonal communication and coordination self-efficacy, excluding the explanation part of Model 1, the incremental interpretation of the self-efficacy change in Model 2 was (Change in R^2) 5.1%. The above test results showed that from the perspective of self-perception, the higher the level of budget participation, the higher the self-efficacy in terms of planning, and interpersonal communication and coordination. The details are presented in Table 11.

4.2.6.3 Budget participation, self-efficacy and organizational performance

Table 12 presents the results of the regression analysis, which found that planning, interpersonal communication and coordination, information processing, decision-making and problem-solving self-efficacy and NHP were significantly positively correlated, with correlation coefficients of 0.448, 0.523, 0.442, and 0.401, respectively. The results showed that the higher the self-efficacy of public hospital staff, the higher the NHP of public hospitals.

Planning, self-efficacy, and NHP were significantly correlated, with a correlation coefficient of 0.316. The perception of budget participation and NHP were significantly correlated, but the correlation coefficient (0.378) was smaller than the correlation coefficient without considering the mediation effect (0.486). Therefore, self-efficacy mediates the relationship between perceptions of budget participation and NHP. Interpersonal communication was significantly correlated with coordination self-efficacy and NHP, with a correlation coefficient of 0.436. The perception of budget participation and NHP were significantly correlated, but the correlation coefficient (0.381) was smaller than the correlation coefficient without mediating effects (0.486). Therefore, interpersonal communication and coordination self-efficacy mediate the relationship between the perception of budget participation and NHP. The details are presented in Table 13.

Figure 1 shows the factor-diameter analysis of the results. The 'Diameter Diagram' is essentially a summary of the regression analysis, showing the direct or indirect effects of budget participation (the independent variable) on the organizational performance (the dependent variable) of public hospitals (represented by the factor diameter coefficient, that is, the standard regression coefficients). Thus, this article aims to clarify the causal relationship between the three variables of public hospital budget participation, self-efficacy, and organizational performance.

5 Conclusion and discussion

5.1 Conclusion

This article obtained 164 valid questionnaires from public hospitals through a questionnaire survey, and the relationship between budget participation and organizational performance in

TABLE 11 Regression results of budget participation cognition and self-efficacy.

Variables	SEa		SEb		SEc		SEd	
	Beta	*t*	Beta	*t*	Beta	*t*	Beta	*t*
BPb	0.340*** (0.003)	3.116	0.239** (0.044)	2.046	0.183 (0.124)	1.558	0.189 (0.101)	1.661
R^2	0.231		0.114		0.108		0.162	
ΔR^2	0.104		0.051		0.030		0.032	
F	2.409		1.034		0.966		1.544	
ΔF	9.711		4.186		2.428		2.757	

*** means $p < 0.01$, ** means $p < 0.05$, * means $p < 0.1$.

TABLE 12 The regression results of self-efficacy and organizational performance.

Variables	NHP		
	Beta	*t*	Overall inspection
SEa	0.448*** (0.000)	4.058	$R^2 = 0.235$, $\Delta R^2 = 0.175$, $F = 2.453$, $\Delta F = 16.468$
SEb	0.523*** (0.000)	5.196	$R^2 = 0.316$, $\Delta R^2 = 0.256$, $F = 3.698$, $\Delta F = 27.003$
SEc	0.442*** (0.000)	4.134	$R^2 = 0.240$, $\Delta R^2 = 0.180$, $F = 2.526$, $\Delta F = 17.087$
SEd	0.401*** (0.001)	3.552	$R^2 = 0.200$, $\Delta R^2 = 0.140$, $F = 1.998$, $\Delta F = 12.620$

*** means $p < 0.01$, ** means $p < 0.05$, * means $p < 0.1$.

TABLE 13 Regression results of budget participation, self-efficacy and organizational performance.

Variables	NHP		
	Beta	*t*	Overall statistical test
BPb	0.378*** (0.001)	3.512	$R^2 = 0.348$, $\Delta R^2 = 0.288$, $F = 3.789$, $\Delta F = 15.699$
SEa	0.316*** (0.005)	2.887	
BPb	0.381*** (0.000)	3.954	$R^2 = 0.439$, $\Delta R^2 = 0.380$, $F = 5.567$, $\Delta F = 24.061$
SEb	0.436*** (0.000)	4.615	

*** means $p < 0.01$, ** means $p < 0.05$, * means $p < 0.1$.

public hospitals was analyzed using a combination of theoretical and empirical methods. Moreover, based on Latour's Actor-Network Theory, self-efficacy was introduced to examine its role in this. This article found that in the context of public hospitals, budget participation has a significant positive effect on organizational performance, with self-efficacy having a mediating effect. The main conclusions of this article are as follows:

(1) On an objective and subjective level, budget participation is positively related to the NHP. This further supports existing research that argues that budgetary participation promotes organizational performance (8, 15). Nevertheless, this is contrary to research findings that suggest that budgetary participation has a negative or no effect on organizational performance (20, 22, 24). This may be because this article introduces the new theory of Latour's actor network and an influx of quantitative research methods. Therefore, public hospitals should build a complete budget platform by designing a sound budget participation process and system, establishing clear communication channels to meet budgets, and conducting appropriate and diverse budget communication to improve employee and patient satisfaction, as well as the public hospital's reputation. From a subjective analysis perspective, research demonstrates a significant positive correlation between budget participation and NHP outcomes. To leverage this connection, public hospitals should implement the following strategies: First, enhance staff engagement in budgetary processes through training and transparent communication; second, optimize operational efficiency by aligning resource allocation with frontline insights; and third, elevate stakeholder satisfaction through dual-focused improvements in both employee workplace experience and patient care quality. These synergistic enhancements can ultimately strengthen the reputation of institutions within the competitive healthcare landscape.

(2) At the objective level, there was no significant correlation between budget participation and self-efficacy. These results are inconsistent with those of previous studies (6). This may be because self-efficacy is more biased toward the subjective perception of a person's degree of confidence in completing a task, and there is an intermediate cognitive variable with budget participation from a practical perspective. From a subjective perspective, budget participation, planning self-efficacy, and interpersonal communication and coordination self-efficacy were significantly and positively correlated. Therefore, by encouraging public hospital staff to participate in the process of budget preparation and improvement, it is possible to motivate staff to allocate their time reasonably and effectively, formulate a complete work task plan, and work according to the plan.

(3) Planning, interpersonal communication and coordination, information processing, decision-making, and problem-solving self-efficacy were significantly and positively related to NHP. Budget participation can affect NHP through planning self-efficacy, interpersonal communication, and coordination self-efficacy. Therefore, when using budget participation to improve organizational performance, this article suggests paying attention to the role of self-efficacy, especially in the formulation and implementation of plans, effective processing of

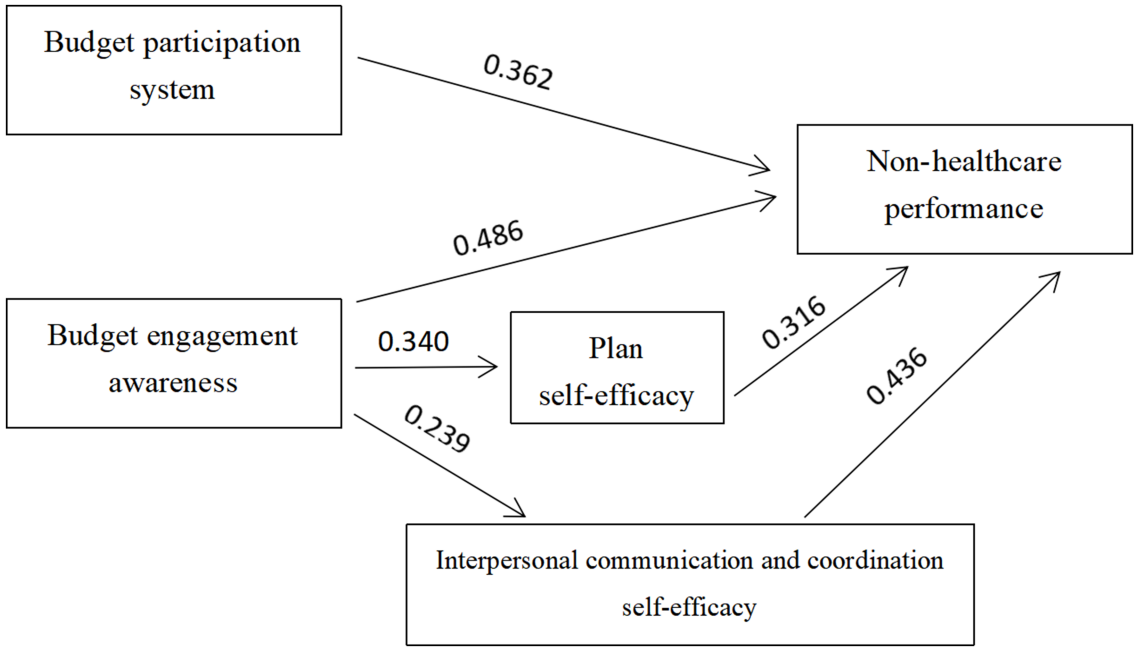

FIGURE 1
Path analysis of budget participation, self-efficacy and organizational performance in public hospitals.

information, and communication and coordination between employees.

5.2 Innovation

The main innovations of this article are as follows.

First, previous studies have conflicting conclusions on budget participation and organizational performance in public hospitals. Some studies suggest a positive relationship between budget participation and organizational performance in public hospitals, while others suggest a negative or no significant effect. In the face of such conflicting situations, this article summarizes and organizes past research viewpoints, and reasonably confirms the positive relationship between budget participation and organizational performance of public hospitals in China, providing useful references for subsequent research and other national and regional studies.

Second, the conflicting views in previous research were largely due to the use of traditional theories that lacked the characteristics of the times. This article innovatively uses Latour's Actor-Network Theory to identify reasonable mediating variables of self-efficacy. Qualitative methods were used to verify the scientific and rational nature of the model. To explore the relationship between budget behavior and organizational performance accounting, a more effective and comprehensive theoretical path has been found that can be referenced and used by follow-up researchers.

Finally, this article combines qualitative and quantitative analyses to verify the relationship between budget participation, self-efficacy, and organizational performance in public hospitals. Through quantitative analysis of broader survey questionnaire data, this article further verifies that budget participation has a promoting effect on organizational performance.

5.3 Limitation

5.3.1 Limitations of the sample

Only 164 valid questionnaires were collected for the quantitative analysis. A total of 69.51 per cent of the hospitals in the sample were concentrated in East China, and the sample was unevenly distributed in other regions, which may have led to geographical bias. Future studies could expand the sample size and cover more regions (e.g., less developed regions in the central and western parts of the country) to enhance the generalizability of the findings.

5.3.2 Methodological limitations of the article

This article uses cross-sectional data and cannot verify the long-term causal relationship between budgetary participation and organizational performance. Self-reported data relying on questionnaires may lead to measurement errors due to social desirability bias or subjective cognitive differences.

Future research could use longitudinal tracking studies to observe the dynamic impact of budgetary participation on organizational performance over time. Without violating academic ethics and morals, future studies could combine objective data (e.g., hospital financial statements, patient visit records) with subjective data to reduce self-reporting bias.

5.3.3 Limitations of theoretical applications

Latour's Actor-Network Theory emphasizes the reciprocal status of human and non-human actors. However, it was not possible to analyze the specific mechanisms of the role of non-human actors (e.g., budget software and policy documents) in budgetary participation in this article. Future research could further explore the impact of co-communication between human

and non-human actors on budgetary participation in the public sector.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

QJ: Funding acquisition, Writing – review & editing, Resources. JZ: Investigation, Writing – original draft, Data curation. XK: Writing – original draft, Software, Investigation. SC: Writing – original draft, Methodology, Supervision.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This work was supported by the Committee Project Research on Budget Management of Public Hospital of the National Social Science Fund of China (grant number 21FGLB010).

Acknowledgments

The authors would like to thank the National Social Science Foundation for funding this research so that the project can be carried out smoothly. The authors also thank those who contributed to this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2025.1601181/full#supplementary-material

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 26 June 2025
DOI 10.3389/fpubh.2025.1604293

OPEN ACCESS

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RECEIVED 01 April 2025
ACCEPTED 16 June 2025
PUBLISHED 26 June 2025

CITATION
Zhang Y, Xu Z and Xu J (2025) Administrative logic of grassroots community epidemic prevention from the perspective of attention allocation: evidence from Wuhan City. *Front. Public Health* 13:1604293. doi: 10.3389/fpubh.2025.1604293

Administrative logic of grassroots community epidemic prevention from the perspective of attention allocation: evidence from Wuhan City

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Background: Chinese grassroots governments utilize fewer administrative resources to carry out tasks assigned by higher levels of government. They have refined their attention allocation into two dimensions: intensity and span, and have developed different action models for routine and non-routine tasks. This management style is becoming increasingly common in Chinese grassroots government operations.

Methods: This paper presented a multiple case study of policy practices in Wuhan City, Hubei Province. The study analyzed the attention allocation practices of China's grassroots government in high-pressure situations, particularly during the COVID-19 outbreak.

Results: Grassroots governments can conserve attention resources by allocating attention efficiently and flexibly to deal with the dilemma of 'too many tasks with too little power'. We summarized three models of coping by grassroots governments: (1) Attention allocation model in routine tasks; (2) Attention model in non-routine tasks; and (3) Routinization model through attention diversion.

Conclusion: This paper presented a framework for explaining grassroots government behavior from an attention allocation perspective. We also identified some limitations of this model, both as a complement to attention allocation research and for a better understanding of grassroots government behavior in China.

KEYWORDS

grassroots government, attention allocation, attention intensity, attention spans, epidemic prevention, emergency management

1 Introduction

In early 2020, COVID-19 broke out in Wuhan and quickly spread throughout the country. The grassroots government, as the main body in charge of the epidemic prevention, were under tremendous pressure (1). As the destination of public policy implementation in China, public policies are created by the higher-level of governments but are implemented by the lower-level of governments (2). Grassroots governments have to deal with the almost comprehensive tasks of governance, though they have fewer human and administrative resources. In particular, in the major emergency, the fragmented responses of local authorities

and non-state actors have played an important role (3). Accordingly, grassroots governments have limited resources for attention, which is reflected in the limitations of their functional competence (4), insufficient material resources (5), and the impact of strong accountability pressures (6).

Many studies found that the rational allocation of attention was a central tenet of China's grassroots government in taking on these tasks. In China, various tasks were assigned and pressured from one level to another, and lower-level government functions were passively accepted (7). In response, local policy activism and experimentation were not only allowed but also largely encouraged so long as they were apolitical and able to generate innovative solutions for policy problems (8, 9). Through objective political practices such as meetings and policies, we can identify the unequal distribution of government attention in practice. In addition, specific behaviors of grassroots government, such as the degree of resource commitment to a particular task, continuity of behavior, implementation of policies and other behavioral-level moves, may also reflect the allocation of grassroots government attention.

As a model of policy and administrative, attention allocation is not only an activity of grassroots governments affected by various factors, but also reflects various relationships between central or higher-level governments and grassroots governments. So, in a general sense, it exists in the bureaucratic systems of the vast majority of countries. The process of policy implementation is not only a technical or procedural issue, but also reflects a political aspect, reflecting the power relationship between the central, higher-level, and grassroots governments. In the West, local autonomy is not a modern concept, but has a profound historical origin (10). This tradition emphasizes the self-management and decision-making of local communities, which has been developed and practiced for a long time in many European countries. Local governments have significant autonomy in areas such as education, transportation, and the environment (11). This means that local governments can formulate and implement corresponding policies based on local conditions and needs, without relying entirely on instructions from the central government. It makes local governments largely independent of the central government.

However, the complexity, suddenness, and spillover nature of social affairs and issues have changed this relationship. Andert and Nagel analyzed the controversy surrounding the tram project in Tübingen, Germany, revealing how the game between 19 stakeholders (including environmental organizations, transportation companies, and community groups) led to a governance deadlock in the "green demonstration city," confirming the dissolving effect of the complexity of social issues on local autonomy (12). Ruijer et al. demonstrated through research conducted by the Dutch Living Laboratory that open data work, through a triple mechanism of "intermediary agency coordination data problem definition public participation," can increase local government decision-making response speed, but requires the reconstruction of traditional hierarchical power structures (13). The financial impact of the central government on local governments cannot be ignored. A study found that excessive intervention by the central government of EU countries in local finances can lead to the failure of carbon price signals and weaken the efficiency of grassroots policy implementation (14). When the central government cuts social welfare spending, grassroots governments are forced to balance the budget by raising taxes or reducing public services, leading to policy implementation deviating from established goals (15). A study on performance contracts for local governments in New Zealand showed that setting quantitative indicators by the central government increased policy implementation efficiency by 19%, but led to 41% of grassroots officials choosing the "optimal solution of indicators" rather than actual demand orientation (16).

Of course, the COVID-19 also triggered a surge of interest in reviewing public sector responses. The epidemic exposed the inadequacy of government response at all levels and revealed the vulnerability of healthcare, insurance, and public sectors. A study found that Italy faced a "dual decision-making" problem between central and local governments in the early stages of the 2020 pandemic. The central government attempted to unify the blockade policy, but local governments (such as Lombardy) adjusted measures under the pretext of "local autonomy," resulting in policy fragmentation (17). A case study of Florida in the United States showed that the federal government's mask mandate and vaccination policies had been resisted by state governments on the grounds of "violating state rights." The governor even signed an executive order prohibiting local governments from implementing epidemic prevention restrictions, forming a three-level confrontation of "federal state city" (18).

The allocation of resources during the epidemic has also caused tension between the central government and local governments. For example, in the allocation of ventilators in Belgium in March 2020, the central government allocated resources based on the proportion of the population, but the severely affected Walloon region believed that the actual infection rate was not taken into account, resulting in local governments purchasing through EU channels on their own, causing the failure of the national reserve system (19). The UK National Audit Office report found that the central government initially monopolized the procurement rights of personal protective equipment (PPE), but the distribution efficiency was low. Manchester and other local governments were forced to establish parallel supply chains, leading to price hikes and repeated purchases, which ultimately prolonged the shortage of PPE in Britain for at least 3 months (20). The introduction of digital technology into epidemic prevention policies has not been smooth sailing. According to data from the Paris Regional Health Department, the Central Epidemic Command Center took an average of 52 h to process local reported data, resulting in an "information vacuum period" in Lyon and other areas. Local governments therefore established alternative monitoring indicators, but the differences in indicator calibers caused distortion in the national epidemic map (21). During the development of Germany's COVID-19 early warning APP, the federal government and the state government had differences on data standards and privacy protection rules, and Bavaria even suspended access to the national contact tracking system. This contradiction is rooted in the German tradition of "cultural federalism," and there is a natural vigilance among localities toward centralized data (22).

These studies have focused on the contradictions between the central and local governments in western countries in the process of COVID-19 prevention and control, which are mainly reflected in the allocation of policy implementation rights, resource allocation conflicts, information coordination mechanism defects, etc. These studies reveal that sudden public health emergencies have magnified the shortcomings in the allocation of rights and responsibilities in the existing governance system, and the efficiency of crisis response depends on the dynamic balance between central coordination and local flexibility. The

COVID-19 challenged local and national capacities to prepare and respond. It provided a renewed prospect for solidarity within the country.

During COVID-19, grassroots governments carried out tasks assigned by higher-level governments through various attention allocation strategies. By examining the epidemic prevention practices of grassroots governments in Wuhan City, Hubei Province, this paper analyzed the impact of attention allocation on government behavior by refining it into two dimensions, namely the attention intensity and attention span. At the same time, situations were created in which grassroots governments respond to three types of tasks: 'routine tasks', 'non-routine tasks', and 'routinization of non-routine tasks', in order to better explain the logic and effectiveness of grassroots governments' attention allocation.

2 Literature review

Herbert A. Simon, in proposing a model of finite rationality, argued that the scarcity of attention proves that decision-makers are not omniscient (23). Jones (24) built on this by modeling decision-making in democratic politics, distinguishing between decision-makers' attention and their preferences. Baumgartner et al. (25) explained that people's limited attention span was a very important factor in influencing political agendas. How to solve the problem of making the best decisions for each individual given the information available, and how to design efficient and flexible government institutions, was a major issue in the social sciences (26). Like individuals, government agencies suffered from the problem of attention scarcity when dealing with information (27). Bureaucracies in the political process, with conflicting goals and facing severe attention scarcity constraints, had to adopt certain simplified ways of filtering information in order to achieve these goals. Attention allocation had received much attention in the field of management and was a key factor in government decision making (28).

Since the beginning of the post-Mao reforms, the China's grassroots government reforms developed in response to socio-political changes (29). Grassroots governments were an extension of the central government and must act in accordance with requirements. This was reflected in the ability of the Party Committee to selectively and efficiently priorities the implementation of certain policies and the identification of issues to be addressed, as well as to control the development of certain key areas and the appointment and dismissal of officials (30). At present, effective control by the higher-level government over the lower-level government was exercised mainly through evaluation. This was both supervision of delegated authority and effective monitoring of the management of the agent (lower-level government). It not only strengthened the ability of higher-level government to implement governance, effectively resolved the conflict between jurisdiction and governance, but also effectively compensated for the limited attention of higher-level government itself (31). However, China's grassroots government also had full autonomy. For the government at the lower-level, because of attention scarcity, the main question that grassroots governments think about is how to use their limited attention resources to solve the key tasks.

Cheng and Yang (32) studied the allocation and evolution of the Chinese government's attention to the power industry based on 2,230 policy documents. Meng and Fan (33) explored the punctuations and diversity in attention allocation within China's national e-government issue from 2001 to 2018. Hu et al. (34) measured the change in attention allocation of the Central Committee of the CPC's land policy based on a comparative analysis of the Central No. 1 document. In summary, in the Chinese discourse context, the research on the government's attention allocation had included many aspects, but the current research was mostly based on the analysis using the Dirichlet allocation topic model, which lacked the logical exploration of the government's attention allocation, and lacked the analysis of the intrinsic reasons for the changes in the attention allocation.

Obviously, attention allocation also involves issues or influencing factors such as the relationship between local and central government, public attitudes and pressure from the public. After tracking the trend of European municipal mergers, Van Houwelingen concluded that local autonomy in Europe has, on average, increased since 1990 and has decreased (a little) since 2009. Residents of small cities were relatively more willing to participate in local affairs (35). Nabatchi et al. (36) criticized that traditional bureaucratic systems have a dual failure in addressing "wicked problems" such as climate change. Because it cannot maintain political neutrality and was difficult to integrate cross domain resources. It was also necessary to redefine the scope of local autonomy. Strebel and Kübler (37) found based on survey data from 12 Western European countries that the majority of citizens support strengthening local autonomy, but hold reservations about inter-local cooperation. They argued that citizens' attitudes toward local autonomy and inter-local cooperation are a function of their behavioral, emotional and ideological connection to the local (37). Under such circumstances, public attention undoubtedly influenced the allocation of government attention in different forms and to varying degrees. Jennings and John found that there was a long-term equilibrium state between public opinions and government attention, and they also discussed the responsiveness between policies and opinions (38). Xia and Shen (39) studied the dynamic relationship between public opinions and government attention after the return of Hong Kong to China, providing cases of non-Western societies. Aksoy et al. (40) analyzed how public attention (such as through Google search volume) during the COVID-19 period influenced the speed at which the government implemented non-pharmaceutical interventions, demonstrating the impact of public attention on the response time of policies. Bi et al. (41) discussed how the disclosure of food safety and environmental protection information affects government supervision through public pressure. It was a very good case analysis of the transformation of public demands into policy implementation.

As described by Xu et al. (42), "the government attention has become a scarce resource, and appropriate allocation is a necessary condition for obtaining effective safety information and improving safety management." The study of security management was enriched by examining the allocation of government attention. We found that existing research lacked attention to the allocation of government attention in crisis situations. There was ambiguity in examining the logic through which attention affected government behavior. At the same time, existing research lacked attention to the attention allocation of Chinese grassroots governments. We believed that the following three concepts deserved attention to address the above issues.

2.1 Attention allocation in organizations

Attention is the ability to focus one's cognitive abilities on a particular objection while ignoring others, the essence of which is

selectivity (43). Attention allocation is defined as our brain's ability to attend to two different stimuli simultaneously (44, 45), while responding to multiple demands around us. Attention allocation is influenced by passive attention (also known as non-casual attention) and active attention (also known as casual attention), and are a type of attention that allows us to process different sources of information simultaneously and successfully perform multiple tasks at once.

With the development of attention allocation theory, scholars have used it to explain government behavior (46). The government views attention allocation as a concept that can be divided into attention at the cognitive and behavioral levels (47). Government attention allocation refers to the decision-making behavior of officials in allocating their attentional inputs to issues that may rise to the level of a policy issue. Attention allocation is the starting point of the decision-making process. In the context of limited attention resources, decision-makers cannot deal with multiple public services simultaneously. "It is essential that officials gauge the task's priority according to its importance, so as to allocate attention resources efficiently" (48). Attention allocation is therefore the starting point of the decision-making process.

Generally speaking, bureaucratic control depends not only on how information is obtained, but also on how information is processed, that is, how attention is dispersed in specific fields or focused on specific issues (49). Under the Chinese system, the policy orientation of higher-level governments undoubtedly affects the policy priorities of local governments (50). For example, in the case where the central government has made environmental protection and resource conservation a national key policy, research has identified and quantified vocabulary related to the ecological environment in government work reports through word frequency analysis, in order to measure the level of concern of local governments for the environment (51). The attention of local governments and the allocation of policy resources largely reflect the priority and effectiveness of addressing social issues. The attention of local governments to environmental issues can improve the efficiency of environmental governance, especially in controlling air pollution (52). With the development of information technology, policy attention as a signal has predictability in guiding government actions related to e-government. After analyzing panel data from 333 prefecture level municipal governments in China, it was confirmed that policy attention can improve e-government performance (53).

This study acknowledges that attention investment is a critical factor influencing the task completion and governance performance of local governments. However, the attention investment of local governments varies when facing different tasks, particularly when sudden events occur, leading to a shift in focus, an aspect that has been under-researched in previous studies. Therefore, this study proposes a model for attention allocation in the context of both routine and extraordinary tasks faced by the government. Building on this, the study focuses on the attention allocation and shift in local governments during the COVID-19 pandemic.

2.2 Attention intensity

Attention intensity is a dimension of attention allocation that refers to the amount of resources allocated (54). If the government allocates more attention to a matter, it will allocate more resources to it. Attention intensity can be disturbed by a number of external factors, such as policy experts, the media, and focal events. Our discussion on 'attention intensification', 'attention recession' and 'attention focus' is based on the dimension of attention intensity.

2.3 Attention span

Attention span is the time for which the original intensity of attention is maintained after attentional resources have been allocated. The more stable the government's attention to a matter, the longer the attention span (55). The formation and diversion of the attentional focus are part of the change in attentional intensity, while the duration of the attentional focus before diversion is part of the attentional breadth. Attentional breadth is determined by the stability of attentional strength, although there is no correlation between attentional strength and duration. Attention can be either strong and stable or weak and stable.

3 Materials and methods

3.1 Study design

Simona et al. (56) analyzed collaborative services within government and between agencies in emergency management and proposed a 3C model based on communication, coordination and cooperation. Ufua et al. (57) examined the distribution of government supplies in Lagos State, Nigeria and proposed a model for a boycott approach to effectively address the challenges in the current distribution process of supplies in Lagos State, the center of the COVID-19 epidemic in Nigeria. It can be seen that the study on government behavior in public health emergencies is a common practice in the academic world and also has a strong value for practical analysis.

As Chao et al. (58) described, the popularity of the case study design stemmed from its ability to provide the researcher with a deeper understanding of specific individuals, an identified problem, or a distinctive situation by closely studying the phenomenon in intensive and great depth. A review of typical cases can better analyze the logic of attention allocation in disaster response at the grassroots government.

The cases come from a multi-year survey of urban public safety conducted by the lead author's institution. Since 2018, the School of Public Policy & Management of China University of Mining and Technology continuously organized students to conduct surveys and interviews on the public sense of security in 36 key cities in China, and wrote and published survey reports and interview reports. After the outbreak of the COVID-19, the school quickly took the sense of security of residents and the prevention and control practices of grassroots governments as the themes of the surveys. Wuhan, as one of the 36 key cities under investigation and as the place where the COVID-19 firstly emerged in China, the region with the most severe epidemic situation and the key area for prevention and control, a lot of relevant information and materials naturally became the best materials for research and, of course, the best resources that most intuitively reflected the attention allocation of grassroots governments during the pandemic period.

In the past 5 years, the school where the first author of this study is located has completed interviews and questionnaire surveys on the

epidemic prevention and control in more than seven subdistricts and 30 communities in Wuhan. These became the direct and original materials for this study. On this basis, Jiaxi Xu, one of the authors of this paper, was once a key member of the survey team and continued to conduct follow-up visits to the key communities among them and supplement relevant information according to the needs of the research after entering Wuhan University for postgraduate study. The practical surveys carried out as mentioned above have formed the foundation of this study and supported the main materials required for the research.

This study will examine how the Chinese grassroots government undertakes multiple tasks assigned by higher-levels through attention allocation under the constraints of limited attention resources, thus constructing the administrative logic of the Chinese grassroots government under the perspective of attention allocation.

In the surveys and studies, we selected subdistricts and communities as the basic units for observation. In China, the subdistrict is the grassroots unit for urban management, while the community is the basic unit of residents' lives. The subdistrict is the most basic unit in the hierarchy of the Chinese government. It not only undertakes the tasks of policy transformation and governance from higher-level governments but also bears the responsibility of reporting social concerns and social problems to higher-level governments. Although communities are positioned as self-governing organizations of urban residents in the institutional sense, they are actually doing the work of subdistricts, yet focusing more on the micro aspects of residents' lives. Communities will pay attention to the specific needs of residents, such as environmental improvement, cultural activities, neighborhood relations and so on, and meet these needs by organizing various activities and providing services. Together, they form the cornerstone of urban governance and social services.

After COVID-19 broke out and spread rapidly in Wuhan, subdistricts and communities became the front line of epidemic prevention and undertook direct and arduous epidemic prevention tasks. They were the main entities using attention and witnessed the micro-practices of government attention in special situations. In the face of the first outbreak and serious spread of COVID-19, the stories and responses of the grassroots government in Wuhan can provide direct reference experience for other local governments in China to do a good job in epidemic prevention. The facts also confirmed this view. Therefore, we chose the streets and communities of Wuhan as the sample for the case study.

3.2 Data collection

Control and prevention COVID-19 in Chinese cities was an example of grassroots governments allocating governance resources through attention allocation strategies, and was also a good way to observe the Chinese politics and government. COVID-19 had a high level of social attention and information disclosure, and had a direct and profound impact on economic and social development (59). This paper presented a multiple cases study of the grassroots government of Wuhan City during the COVID-19 epidemic. In addition to the information and data obtained from interviews and surveys over the years mentioned above, we analyzed data collected from public policy documents on government websites and news reports from the media, supplemented with daily observations. This study illustrated how grassroots governments in Wuhan prioritized tasks assigned by higher-level government and how this influenced their emergency response behaviors. We attempted to combine relevant theories and research results to innovate perspectives and ideas on allocation from attention allocation theory.

3.3 Cases presentation

3.3.1 Attention allocation model in routine tasks

At the beginning of COVID-19, the management of *Subdistrict A* in Wuhan arranged different duties for the staff in the community to cope with a variety of tasks such as service, publicity, patrol, transport, help and supply (Table 1). At this time, during the COVID-19 prevention and control period, each kind of task had different importance to the grassroots government, and the attraction situation of attention was also different. The key tasks can get more attention resources tilted by the grassroots government. Under the organizational arrangement, about 40% of the people in subdistrict A served in the supply tasks, and 17% were engaged in helping special groups. According to the Wuhan COVID-19 Command Circular (No. 23), the division of labor arrangement in this community ended on 13 June 2020 and lasted for more than 5 months. Routine tasks had a long attention allocation span, and it was difficult for the grassroots government to divert its attention. Most of the government staff were deployed to take charge of routine tasks, which were key to the assessment of the higher-levels of government and had a direct impact on the life satisfaction and happiness of the residents.

3.3.2 Attention allocation model in non-routine tasks

At the beginning of COVID-19, *Subdistrict B* in Wuhan received a huge amount of anti-epidemic supplies from all over the country. This subdistrict was faced with the extraordinary task of receiving and distributing these supplies due to their short-term and concentrated arrival. The subdistrict, which had only 13 regular employees, served a population of 5,635 permanent residents living in 2,751 households across 47 residential buildings. Following the donation, this subdistrict quickly mobilized party members, volunteers, and civil organizations to establish multiple teams for distributing materials. The task force was organized using the '1 + N' model, with each group led by a

TABLE 1 Assignment of responsibilities at the subdistrict A.

Work team	Numbers	Responsibilities
Team leader	1	Command the daily work of the team
Containment team	9	Infected area cordon duties and conduct daily patrols
Service team	7	Serving the community and publicizing government policies
Screening team	8	Identification of persons at risk
Special services team	7	Help for special groups
Supply team	35	Supplies for daily life, epidemic prevention
Volunteer team	7	Volunteering

government staff member and consisting of N party members or volunteers. The teams worked around the clock, with rationalized zones and divert rotations. In the process of distributing epidemic prevention materials, they also assisted residents in solving their daily life problems. The party secretary of subdistrict B provided guidance within the subdistrict and worked during his own rest time to assist in the distribution of epidemic prevention materials. The short-term organizational model of the grassroots government was effectively used to meet the challenges of the extraordinary task. The rapid concentration of attention and resources enabled the grassroots government to gather enough volunteers to distribute supplies, even in the face of a lack of manpower.

3.3.3 Routinization model through attention diversion

Since the outbreak of COVID-19 at the end of 2019, a number of places had entered a state of emergency, including Wuhan, which launched a first-level response on 24 January and adjusted to a second-level response on 2 May, lasting 98 days. In *Subdistrict J* of Wuhan City, a series of supportive measures were introduced. Staff were sent into enterprises to understand the difficulties they were facing in production and business activities, and coordinated with various departments to solve these problems. The government officials met with enterprise leaders to gain insight into the district's economic situation. Additionally, CPC members, volunteers, and staff from subdistrict J conducted sanitation campaigns to support the resumption of work and production in the area while maintaining effective epidemic prevention measures. The COVID-19 pandemic brought various industries in the city to a standstill, adversely affecting the economy. As the situation improved, the government's attention gradually shifted from epidemic prevention and control to other routine tasks, such as economy.

On March 20th, J subdistrict held a coordination meeting for resuming work and production, and established a special team for resuming work and production led by the main leaders of the street office. Establish a joint "resumption of work and production inspection team" consisting of regional development, safety supervision, food and drug supervision, fire protection, industry and commerce, public security and other departments, and a "resumption of work and production service team for individual industrial and commercial households" with the community as the core.

According to the minutes of this meeting, the key tasks that need to be implemented are as follows. Promote the types, time, process, channels, and required materials of enterprises that can be declared, and display the application process for resuming work and production in the form of charts and graphs; Actively communicate with enterprises in the jurisdiction to determine the list of employees returning to Wuhan, and implement the district government's "point-to-point" centralized transportation of out of town employees back to Wuhan; Conduct a survey on the situation of newly added enterprises resuming work, and adopt a combination of self-declaration by enterprises and proactive government services to assist enterprises, especially those above a certain scale, in applying for resumption of work and production; The responsibility lies with individuals entering the enterprise, without resorting to formalities, strictly inspecting the enterprise's epidemic prevention measures, and strengthening the service awareness of the "shop assistant"; Thoroughly investigate the practical difficulties encountered by enterprises within the jurisdiction in production and operation, and implement policy incentives such as rent reduction and subsidies, emergency financing funds for small and micro enterprises, etc.

4 Results

The examples above demonstrated the various attention allocation strategies employed by grassroots governments when faced with stressful tasks. A framework needs to be constructed to analyze how such a selective attention allocation model is achieved at the grassroots government.

4.1 An explanatory framework for attention allocation

Routine tasks are activities carried out by the government in a normal governance environment, in accordance with predetermined plans and objectives. These tasks are typically quantitative and diverse in nature (60). Task promotion is usually based on a bureaucracy. "There is generally a big gap between the routine tasks of governance and administration, on one hand, and the emergency, non-routine tasks that demand urgency in attention and action, on the other hand" (61). As shown in Figure 1, routine tasks generally only reap less attention intensity, but their duration can be longer. In routine tasks, the attention of grassroots governments is multi-level, but the intensity is not significant. The routine tasks of the government, such as public services, administrative processes, and budget execution, are the foundation for maintaining the operation of the national machinery and typically require stable human, financial, and time investments. These tasks often have rigid requirements and consume a significant amount of administrative resources. It is worth noting that grassroots governments have a traceable system and tacit understanding for resource and attention investment in completing routine tasks. The stockpiling of materials, information report development, joint notification and report release, epidemic announcements are typical tasks in epidemic prevention (62). These tasks are usually assigned by higher-level in a sectional system.

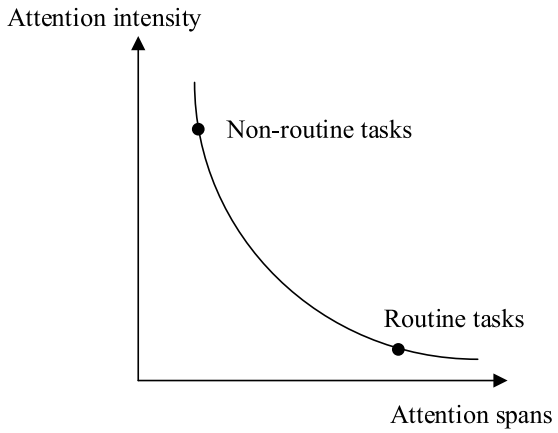

FIGURE 1
Attention allocation in routine and non-routine task scenarios.

Based on an interview with community worker Zhang Ling, after the lockdown of Wuhan on January 23rd, she stayed in a safe hotel in her jurisdiction for the convenience of work and did not go home for more than 2 months. Including the secretary, there are a total of six people working for up to 12 h a day, sometimes even up to 15 h. Daily work includes screening of fever patients, coordination of medical treatment, community disinfection and sterilization, recruitment and management of volunteers, management of sunk cadres, distribution of living materials for residents, group purchase and distribution, donation of love materials, and assistance in solving residents' difficulties. Until early February, as the epidemic continued, a group of volunteers had to be recruited through Civilized Wuhan. After screening, more than 90 cadres were added to support the sinking. These personnel have been trained, classified and assigned to their positions, and their responsibilities are in place. The volunteers responsible for community control work from 8 am to 8 pm, with two people guarding for 12 h and handing over shifts in the morning and evening to ensure 24-h community control. In addition, after the community is closed, residents' living security will be uniformly arranged by the community. The community where Zhang Ling resides has over 3,000 households with diverse needs. Community workers and volunteers are responsible for purchasing grain and oil supplies, daily necessities, medicines, etc. for residents. During the specific delivery process, in order to ensure that residents can stay at home with peace of mind, epidemic prevention personnel need to deliver these materials to their doorstep, sometimes lifting tens of pounds upstairs.

The indicators for this type of work are clear, and the operation is relatively simple, providing greater stability and predictability. At the same time, this type of work involves fewer relevant interest groups, is a routine matter for grassroots governments, and conflicts are not prominent. Based on the above analysis, we propose *Proposition 1*.

> *Proposition 1*: The grassroots government will carry out an attention allocation model in routine tasks, and allocate attention in the pattern of low intensity and high spans.

"Contingency and the need to develop new activities quickly make administrative coordination based on preplanning of routine tasks obviously difficult." (63) Most of the emergency management activities are urgent non-routine tasks. Non-routine tasks are governance activities carried out by governance actors in a non-routine or suddenly changing governance environment. They possess a strong attention intensity but short attention spans. These tasks are generally oriented toward specific events and goals, as shown in Figure 1. The main driving mechanisms for non-routine tasks are campaign-style governance (64) and project-based governance (65). The main characteristics of these changes are cross-sectoral, cross-system, cross-regional, and suddenness. They will result in a diversion in the power structure and routine operation mode of grassroots governments, leading to a reconfiguration of the unbalanced power distribution.

According to the epidemic prevention and control log written by Peng Li, a community worker, the Zhiyuan Community where she works is a resettlement community rebuilt from the shantytown renovation of a state-owned enterprise. There are 3,124 households and more than 8,000 people in total. At the toughest moment of the battle to defend Wuhan in 2020, among the 9 community workers in this community, one was in another city and one was placed under home quarantine. The remaining 7 were all women, with the youngest born in 1992 and her child just 6 months old. These 7 women had been sticking to their posts all the time. They were responsible for taking people's temperatures, conducting screening, carrying out community prevention and control work, delivering vegetables and medicines, collecting and distributing express deliveries, and visiting poor households to show care. They were busy from morning till night every day and did not go home for a single day.

Some typical tasks involved are as follows: every morning, after taking a series of preventive measures (such as wearing masks and spraying disinfectant alcohol), they would carry a small loudspeaker and play the knowledge about epidemic prevention and control in a loop around the community, ensuring that residents could hear the broadcast once every 30 min. In addition, the community would promptly post announcements about COVID-19, relevant bans and various prevention and control knowledge on the bulletin boards at the entrances of each community and at the entrances of each building every day, so that residents in the jurisdiction could learn about the real-time situation of the epidemic in a timely manner, enhance their awareness of self-protection and reduce unnecessary panic.

The attention of grassroots governments is characterized by high intensity and low persistence in the performance of specialized tasks, so we propose *Proposition 2*.

> *Proposition 2*: In non-routine tasks grassroots governments engage in flexible attention diversion, with high intensity, low duration patterns of attention allocation.

The relationship between grassroots governments and their departments in China depends on the political mandate of the party organization, which is easy to assess due to characteristics such as the short duration of the mandate and the ease of measuring its effects. As a result, grassroots governments face greater institutional pressure in non-routine tasks, and those in charge of grassroots governments are easily influenced by the pressure to make decisions that avoid responsibility (66). The short-term nature of unconventional tasks, in turn, makes it easier to influence changes in government attention allocation. Figure 2 shows the changes in grassroots government attention when routine tasks are transformed into non-routine tasks. However, when emergencies (such as epidemics or economic crises) occur, the attention of grassroots governments will quickly shift to emergency management, and routine tasks may be simplified or delayed. As tasks are completed, attention quickly diverts and reallocates. Figure 2 shows that when non-routine tasks are overloaded onto routine tasks, resulting in a shift to regularized governance, the intensity of attention acquired decreases from P1 to P2. Meanwhile, because of the long duration of routine tasks, their attention spans increase from T1 to T2.

Taking into account the aforementioned analyses, we propose the integrative idea that local governments can address the challenge of having too many tasks and limited resources by conserving attention resources through efficient and adaptable allocation. This can be accomplished by allocating attention to routine tasks and diverting attention to non-routine tasks.

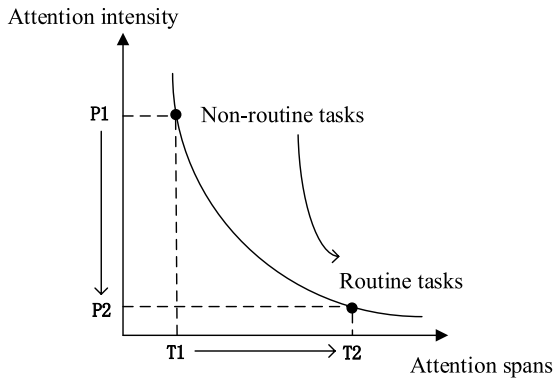

FIGURE 2
Attention changes in non-routine task scenarios.

4.2 Organizational behavior under the influence of attention allocation

Grassroots governments can effectively undertake tasks assigned by higher-level governments through effective attention allocation and attention diversion. The administrative behavior of grassroots governments is ultimately reflected in changes in the allocation of attention. Therefore, this analysis focuses on how grassroots governments influence changes in government administrative behavior through attention allocation. Meanwhile, in response to COVID-19, some grassroots governments in Wuhan also experienced issues such as attention fatigue, distraction, and attention mismatch. Analyzing the causes of these problems can help China's grassroots governments better cope with future challenges.

4.2.1 Attention intensity affects resource allocation

Resource allocation is an important task in organizational management (67). In governmental organizations, resources generally include political resources (administrative power), human resources (civil servants), customer resources (including enterprises, institutions and citizens), financial resources, asset resources (property, vehicles, office equipment, etc.), and information resources (official documents, declarations, statistical data, etc.), all of which are limited.

When the government carries out the planning and allocation of resources, out of the consideration of improving administrative efficiency and reducing the administrative cost of the government, it will tilt the resources to the affairs that the government considers important and need resources (68). This process is known as attention allocation within the organization and is influenced by the government's imperfectly rational decision-making (69). The government's attention can be deduced from its allocation of resources. More resources indicate a higher level of attention, while fewer or inadequate resources indicate a lower level of attention.

4.2.2 Attention span influences continuity of organizational behavior

Due to the scarcity of attentional resources, governments make decisions with limited rationality (70), often making decisions and taking actions before they have fully understood the information. The hierarchy rule is the initial stage in influencing the government's attention allocation and actions. Once the hierarchy rule is adhered to, bureaucratic interests will dominate the government's behavior. If external pressures are strong enough, the government's attention will quickly divert externally, disregarding rules and bureaucratic interests. Factors have varying degrees of dominance at different points in time, and their strength affects their dominance.

During attention allocation, attention diverts and stabilizes as influencing factors change. However, sudden changes in influencing factors can cause diversion in the grassroots government's attention. When these factors are stable, the government's attention allocation is also stable, resulting in policies and behaviors with continuity. When one influencing factor is significantly stronger than others, the government's focus diversion to that event. Therefore, attention span can be determined by the consistency of the government's actions in a given task. The more consistent the behavior, the longer the attention span, and conversely, the shorter the attention span.

4.2.3 Attention allocation affects the government's implementation of higher-level mandates

In China's pressure-based system, grassroots governments are both controlled by higher-levels of government and have a certain degree of autonomy, which means that they may engage in responsibility-avoidance behavior, which is closely related to the anti-function of the hierarchical system and the bureaucratic personality (71). As a result, there is a great opportunity for grassroots governments to man oeuvre in the details of work implementation, as well as passive and lax behavior toward tasks and misinterpretation of policies. The allocation of government resources and continuity of government behavior are affected by the intensity and spans of attention allocation discussed above. Poor task implementation results when the intensity and duration of attention allocation do not match the actual attention required for the task. In the specific process of task implementation, differences in attention allocation allow grass-roots governments to autonomously choose the order of policy implementation, formulate implementation programmers, and report on their work within the limits permitted by law and policy.

4.3 Problems with attention allocation in grassroots government

4.3.1 Attention fatigue: the burden on grassroots governments

Attention fatigue is the result of an excess of attention resources, was operationally defined as decline in alerting, orienting, and executive attention performance (72). Attention resources are always limited, although governments can conserve these resources through flexible attention allocation strategies. Since the outbreak of COVID-19, urban and rural grassroots governments have become the first line of epidemic prevention and control (73). As the governance system bridging the state and society, they play a crucial role in managing the pandemic. In COVID-19 prevention and control, various routine and non-routine tasks have been refined at the grassroots level. These include mapping people's movements, conducting household health surveillance, cleaning and disinfecting public places, and disseminating knowledge about epidemic prevention and control. This has resulted in an enormous workload for grassroots governments,

with a shortage of manpower in the community and a significant burden on the grassroots governments.

4.3.2 Distraction of attention: inefficiency of grassroots governments in accomplishing their tasks

During a major public emergency, grassroots governments face a significant increase in organizational tasks. This requires them to handle multiple tasks simultaneously. To ensure the smooth implementation of each task, the attention of grassroots governments needs to be allocated in multiple threads. During the COVID-19 epidemic, grassroots governments are responsible for completing routine tasks such as sealing off epidemic areas, patrolling, and preserving supplies (74). However, the government's attention is divided among many different tasks, making it difficult to focus attention and governance resources on key tasks. The second manifestation of dispersed attention is the completion of routine tasks over a prolonged period or the gradual transformation of non-routine tasks into routine ones. This is often due to the monotony of grassroots government work or the lack of external stimuli. Attention allocation is characterized by high persistence and low intensity.

4.3.3 Attention mismatch: selective mandate implementation by grassroots governments

Attention mismatch is the allocation of attention resources in an inappropriate location. According to Simon's theory of limited rationality in decision-making, attention mismatch or imbalance can be caused by organizations' limited rationality and information overload. Under the pressure-based system, grassroots governments vary in their implementation of higher authority tasks. Driven by self-interest, they respond positively to policies that benefit them, but are passive and neglectful toward other policies. This creates a mismatch between the priorities of higher authorities and grassroots governments. This mismatch causes them to focus solely on the indicators and neglect the underlying issues, resulting in a result-oriented approach to their tasks. Although the ultimate goal of tasks and indicators is to serve the public interest, the quality of public services often fails to receive sufficient attention from the government during policy implementation. This selective approach to task implementation can result in a mismatch between the allocation of attention by grassroots governments and the public interest.

4.4 Reasons for problems with attention allocation in grassroots government

4.4.1 Insufficient resources for attention

Variations in the allocation of government attention can impact the policy agenda process, which in turn affects the formulation and implementation of public policies. As a result, government attention has become a subject of competition among different policy interest groups (75). In routine tasks, higher authorities often assess the performance of grassroots governments using informative and quantitative data and forms (76). This requires the attention resources of grassroots governments to be allocated to data and forms for a long period of time, making it difficult for them to spare time to deal with other matters. Grassroots cadres often have a range of responsibilities, including completing tasks assigned by their superiors in functional departments. This can be in addition to their essential work, and can be layered, multidisciplinary, arbitrary, and repetitive, which can increase their workload.

4.4.2 Untimely diversion in attention

To save attention resources, grassroots governments can use the mode of attention diversion in non-routine tasks. This process requires converting human and material resources, as well as related organizational structures and working modes. Campaign-style governance can often divert the central focus of governance (77), and establishing a non-essential temporary institution which drain the government's attention resources. It is important to maintain a stable and efficient governance structure. Due to the absence of standards and supervision, grassroots governments often face challenges when implementing attention diversion. These challenges include delays caused by vague systems and inconsistent requirements, as well as delays in withdrawing attention resources due to organizational interests and demands. Additionally, corruption for personal gain is not uncommon, resulting in a serious mismatch of attentional resources.

4.4.3 Differences in the degree to which higher-level tasks attract attention at the grass-roots level

In the Chinese government system, higher-level government can effectively control the lower level of government through task decomposition, indicator control, and result assessment. Grassroots governments tend to prioritize indicators with higher incentives when allocating attention and resources. During COVID-19, the number of confirmed cases has become the primary indicator of the effectiveness of the government's epidemic prevention and control. As a result, achieving zero-cases has become a priority for grassroots governments and has received increased attentional resources. These tasks can be easily quantified and endorsed by superiors, which will easily lead to an over-reliance on quantitative indicators by grassroots governments, resulting in inappropriate and excessive anti-epidemic measures and causing inconvenience to people's daily lives (78).

5 Conclusion and discussion

5.1 Key results

This paper proposes a model of attention allocation in situations where the government faces routine and non-routine tasks. Attention allocation is a crucial mediating variable that affects government behavior. The related studies have been reviewed to support this proposal. In routine tasks, the government should exhibit low-intensity attention with high persistence. It is recommended to invest in persistent and stable behavior for routine tasks while allocating fewer resources and allowing for variability in the implementation process to superiors. In non-routine tasks, the government's focus is characterized by high-intensity, low-persistence attention. The government will primarily adapt to variable and high-intensity attention allocation through campaign governance (79). This involves clustering resources to better implement superior tasks, with attention fading quickly after the goal is completed within a short period of

time. The behavior is not continuous, representing a flexible attention-diversion mode.

In this framework, task contexts are independent variables that influence the allocation of government attention. Government behavior, such as the allocation of resources, continuity, and policy implementation, are dependent variables. The study found that the intensity of grassroots governments' attention to non-routine tasks decreases after the gradual normalization of COVID-19 prevention and control. The model demonstrates that grassroots governments facing the challenge of having less power and more work, optimize their attentional resources through three modes: attentional allocation in routine tasks, attentional allocation model in non-routine tasks, and routinization model through attention diversion. This response logic can result in high efficiency but low effectiveness. Relevant research has revealed the complexity of the government's attention allocation. Excessive investment can either be the root cause of resource waste or a "manifestation" of institutional flaws. Grassroots officials may shift their attention to tasks that are "easy to quantify" or "visible to superiors," resulting in Goal Displacement (80). In order to cope with inspections by higher authorities, grassroots governments have devoted excessive energy to organizing archival materials, while neglecting the actual needs of people's livelihood (81). Phenomena such as the "attention trap" or the "paradox of excessive attention" should be taken seriously.

Therefore, it is important to study the allocation of government attention in order to understand the logic behind the behavior of grassroots governments. This includes exploring the dilemmas of attention fatigue and attention mismatch. The findings of this study can provide theoretical support for grassroots governments to conduct attention allocation more effectively and rationally, thus contributing to the modernization of grassroots governments' governance capacity and governance system.

In practice, the focus of government attention is mainly determined by the context in which it operates (82). Attention allocation usually remains stable in normal situations, but crises can disrupt the balance of the existing policy system and awaken government attention (83). The attention triggered by a crisis requires an effective response from the political system, and attention allocation is the fundamental way to respond to the crisis (84). Because in a normal state, a highly stable management system will have characteristics such as regular goals, hierarchical control, clear rights and responsibilities, and fixed control. And crisis situations can cause local officials to face more issues such as shifting attention allocation, balancing multiple goals, and conflicting rights and responsibilities (85). The attention dissemination within the Chinese system usually focuses on vertical transmission, and political and administrative affairs are often guided by superiors to subordinate actions (86). Faced with various challenges in crisis, the central government or higher-level government guides the attention allocation of grassroots governments through institutionalized mechanisms such as power authority mechanisms (such as highly valued leadership), incentive mechanisms (such as promotion and accountability), and resource allocation mechanisms, effectively promoting the transformation of the administrative system from "multitasking" in normal times to "crisis management" (87).

Of course, the framework also has shortcomings: the corresponding allocation of attention in a single task situation is only an ideal result. In reality, several tasks are intertwined and the allocation of attention is the result of the joint action of several factors. Regarding the Wuhan epidemic prevention, excessive formalism in some areas has depleted the government's attention resources and resulted in high allocation toward routine tasks (88). Therefore, the attention allocation model needs to be adapted to the actual situation.

5.2 Policy recommendations

5.2.1 Promote attention expansion

To address the limited attention resources, grassroots governments should expand their focus. To manage the excessive number of matters that consume attention resources, higher-level governments should assign tasks effectively and grassroots governments should integrate their work reasonably. To expand the attention of grassroots governments, we should first guide the participation of diverse subjects in grassroots governance (89). Secondly, higher-level governments should take the initiative to delegate power to the grassroots (90) and flexibly deal with the procedure of approving and instructing resource allocation in different situations.

To achieve effective integration of grassroots governments, it is necessary to strengthen grid-based and precise management (91), clarify the responsibilities of grassroots governments, and achieve unity of power and responsibility. It is important to regulate the scope of law enforcement and avoid unlimited departmental responsibilities that exacerbate the scarcity of attention (92). Secondly, grassroots governments should focus on their work and prioritize efficiently allocating attention and resources.

5.2.2 Establishing an institutionalized pathway for attention diversion

To tackle the issue of delayed attention diversion, it is crucial to establish a formalized process for attention diversion. During major crises, it is important to rationalize the allocation of attention resources within the government and strengthen the responsibility of grassroots governments for territorial management. This will enable grassroots governments to allocate attention resources independently, gather resources and concentrate attention when non-routine tasks arise.

To establish an institutionalized approach, grassroots governments must learn from their experiences in handling non-routine tasks. This can be achieved through institutional arrangements that reduce the feeling of helplessness when faced with unexpected challenges. Additionally, such arrangements can strengthen supervision and management, allowing for the timely withdrawal of attention resources once non-routine tasks are completed.

5.2.3 Improving incentives for higher-level assignments

To achieve an orderly allocation of attention, we stimulate the vitality of grassroots governments by scientifically determining indicators and conducting performance assessments. The government's principal-agent relationship is often hindered by the asymmetry of information (93). To address this problem, it is crucial to establish a monitoring mechanism, higher levels of government

should enhance their supervision of key matters to prevent any attention mismatches.

5.3 Limitations

This study attempted to propose attention allocation for governments facing both normal and abnormal task scenarios model. Firstly, although the attention allocation model is a perspective for interpreting grassroots government decisions and behaviors, it is not the only one. Secondly, government decisions and actions in the real world are undoubtedly very complex and never have simple explanations. Attention and its allocation are just one of these complex influencing factors. Political pressure, resource constraints, or personal leadership styles can all affect it to varying degrees, in different task contexts, or under other conditions. In addition, the same applies to psychological, emotional, and attitudinal factors. Thirdly, the allocation of attention corresponding to a single task scenario is only an ideal division. In reality, the two tasks are intertwined, and the allocation of attention is also the result of the interaction of various factors. In the theoretical test taking COVID-19 as an example, we found that the model still needs to be discussed. Formalism in some regions consumes government attention resources and shows a high distribution state in conventional tasks. Therefore, the attention distribution model needs to be adjusted according to the actual situation, and the model also needs to be improved by subsequent research. Finally, this study only focuses on the government's attention distribution in the abnormal situation, especially in a special crisis such as COVID-19. While the COVID-19 provides a unique context to study government behavior, it may not be representative of normal operating conditions. These findings may lean toward crisis management rather than daily management. Considering the above, further in-depth exploration is needed.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Author contributions

YZ: Conceptualization, Funding acquisition, Investigation, Supervision, Validation, Writing – original draft, Writing – review & editing. ZX: Funding acquisition, Project administration, Visualization, Writing – original draft, Writing – review & editing. JX: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This article was funded by the Anhui Philosophy and Social Sciences Planning Project, the grant number is AHSKQ2019D023.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 04 July 2025
DOI 10.3389/fpubh.2025.1592213

OPEN ACCESS

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RECEIVED 12 March 2025
ACCEPTED 25 June 2025
PUBLISHED 04 July 2025

CITATION
Khadka D, Xinyi Z, Mengjie Z, Bhusal R and Zhang C (2025) National Health Policy and factors predicting its implementation at the local level in Nepal: an exploratory cross-sectional study.
Front. Public Health 13:1592213.
doi: 10.3389/fpubh.2025.1592213

National Health Policy and factors predicting its implementation at the local level in Nepal: an exploratory cross-sectional study

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Introduction: Nepal's National Health Policy (NHP), periodically revised since 1991, aims to enhance citizens' health and well-being within the federal democratic framework established in line with the Constitution of Nepal 2015. This study evaluated the implementation status, challenges, and opportunities of the NHP at the local level in Nepal.

Materials and methods: A descriptive cross-sectional study was conducted in the Lumbini province among 166 health workers selected through simple random sampling. Data were collected from October 10 to November 15, 2024, using a structured questionnaire developed in Nepali through literature review and expert consultations. Field researchers administered the questionnaire. The final tool assessed awareness, challenges, and factors influencing the National Health Policy implementation. Descriptive statistics and inferential statistics using binary logistic regression were used for analysis.

Results: The study revealed moderate awareness of NHP among health workers, with 60.2% somewhat familiar with the policy. Major implementation challenges included inadequate infrastructure (62.0%), limited access to skilled healthcare professionals (56.0%), and insufficient financial resources (54.2%). Regular use of technology significantly increased the likelihood of positive NHP implementation outcomes (OR: 5.448, 95% CI: 1.988–14.926, $p = 0.001$). Age (OR: 0.919, 95% CI: 0.880–0.961, $p < 0.001$) and years of experience (OR: 0.934, 95% CI: 0.895–0.975, $p = 0.002$) were significantly associated with attitudes toward NHP implementation. While 65.7% of respondents were somewhat aware of local NHP initiatives, 86.8% expressed the need for additional training and resources.

Conclusion: The study found moderate awareness of the National Health Policy among health workers, with key challenges including inadequate infrastructure, limited skilled professionals, and insufficient funding. Regular use of technology significantly improved implementation outcomes, while younger age and less experience were linked to more positive attitudes. Despite some awareness of local initiatives, most participants stressed the need for additional training and resources to enhance policy execution.

KEYWORDS

national health, healthcare workers, health policy, Nepal, public health

10.3389/fpubh.2025.1592213

Introduction

Nepal's NHP, which was first implemented in 1991 and has been periodically revised, with the latest update in 2019, plays a pivotal role in enhancing the health and well-being of its citizens (1, 2). The adoption of Nepal's new constitution in 2015 marked a significant shift from a unitary government to a federal system, establishing Nepal as a federal democratic republic with three levels of autonomous government: the federal level, seven provinces, and 753 local governments, each with an elected assembly (3, 4). Local elections in late 2017 further solidified this transition, the first in two decades (5, 6), signaling the effective implementation of federalism in Nepal (6).

Nepal's diverse topography and socioeconomic conditions pose unique challenges for its healthcare system, yet significant strides have been made in improving healthcare access and implementing the NHP (7). The NHP is at the core of these efforts, primarily focusing on ensuring equitable access to quality healthcare for all citizens, regardless of their geographic or socioeconomic status. However, questions remain about the policy's effectiveness at the local level, which continues to be underrepresented in healthcare improvements. These issues have sparked ongoing research and debate (8).

At the same time, Nepal has been working toward implementing the Sustainable Development Goals (SDGs), coinciding with the federalization of the health sector (9). One of the key components of the NHP is developing an equity-focused health system based on the principles of Universal Health Coverage (UHC) (10). This includes health insurance programs, free basic healthcare services, transparent and accountable health services, and capacity-building initiatives outlined in the Nepal Health Sector Plan and its implementation plan (11, 12). With the support of UHC Partnership activities, some progress has been made in these areas (13).

Despite these successes, significant challenges persist in achieving equitable healthcare access, especially locally (14). Unequal service distribution, inadequate healthcare infrastructure, and limited resource allocation continue to hinder progress (15, 16). The rising burden of non-communicable diseases, mental health issues, and health concerns arising from natural disasters further complicate healthcare delivery (11). These factors have made it difficult to implement the NHP fully, underscoring the need for closer scrutiny of the policy's effectiveness and identifying opportunities for improvement (17).

The NHP, through its various revisions, has set ambitious goals to tackle the country's major health issues, including reducing maternal and child mortality, controlling communicable diseases, and preventive healthcare (18). However, the translation of these policy goals into measurable improvements at the local level has been inconsistent (19). Factors such as inadequate resource allocation, weak governance structures, and limited human capacity have impeded the full realization of the policy's potential (20). This research aims to critically assess the implementation of the NHP at the local level in Nepal, focusing on the challenges and opportunities within the federal context. By examining the relationships and coordination between the federal, provincial, and local governments, this study seeks to identify key bottlenecks hindering effective policy implementation. Additionally, the research will explore the experiences of healthcare providers and community members to understand the lived realities of the NHP at the grassroots level.

Materials and methods

Study design and setting

This research employs a quantitative descriptive cross-sectional design to evaluate the implementation of Nepal's NHP in Lumbini Province, a region encompassing around 5 million residents across 109 local administrative units. These units include four sub-metropolitan cities, 32 municipalities, and 73 rural municipalities, reflecting a socio-geographically diverse landscape ranging from urbanizing hubs to remote rural areas. This setting provides a strategic context to analyze decentralized health governance under federalism, enabling systematic comparisons of infrastructure, workforce distribution, financial allocations, and service coverage metrics across urban, semi-urban, and rural tiers. The cross-sectional approach facilitates a snapshot assessment of policy-driven outcomes and urban–rural disparities in health system performance, aligning with the province's administrative and demographic complexities.

Participants

This study employed a quantitative descriptive cross-sectional design to assess Nepal's NHP implementation in Lumbini Province. Participants were selected through simple random sampling from a comprehensive roster of health workers across all 109 local administrative units (4 sub-metropolitan cities, 32 municipalities, 73 rural municipalities) to ensure representation of urban, semi-urban, and rural contexts. The sample size ($n = 166$) was calculated using the formula $n = Z^2 \times p \times (1 - p) / d^2$, with a 95% confidence level ($Z = 1.96$), a margin of error ($d = 5\%$), and an assumed proportion ($p = 87.2\%$) (21) of health workers familiar with similar policies, derived from a prior study. Inclusion criteria targeted health professionals directly involved in policy execution, including medical doctors, nursing staff, allied health workers (e.g., Health Assistants, lab technicians), pharmacists, and Public Health Inspectors/Officers (PHI/PHOs), spanning diverse career stages (0–15 + years of experience) and employment modalities (permanent, contract, temporary, volunteer). Exclusion criteria were implicit: individuals not engaged in frontline health service delivery or those outside the province's administrative jurisdiction were excluded. The final sample achieved a 96.5% response rate, minimizing non-response bias and capturing perspectives across socio-geographically distinct tiers. Participants were recruited proportionally from urbanizing hubs and remote rural areas to reflect infrastructure, resource access, and governance disparities. This approach ensured a holistic evaluation of NHP implementation barriers and facilitators within the province's decentralized health system.

Measures

Independent variables

Likert-type questions were employed. Awareness of the NHP was measured on a 5-point scale, ranging from "not familiar at all" to "very familiar." Participants were also asked to rate their understanding of the objectives and components of the NHP on a similar scale, from "not well at all" to "very well." Additional data were gathered on the

sources of NHP information, such as training sessions, official documents, workshops, or peer interactions. Awareness of NHP initiatives at the local level was assessed using a 5-point scale from "not aware at all" to "very aware." To identify areas for improvement, participants rated their perceived need for further training or resources for NHP implementation on a scale from "strongly agree" to "strongly disagree."

Next, participants' perceptions of challenges and opportunities in implementing the NHP were explored. Challenges assessed included key factors such as healthcare access, the effectiveness of health insurance, regulation of medical products, and the profit- versus service-oriented approach in the health sector. These items were rated on scales appropriate to each challenge—for example, from "very low" to "very high" for healthcare access and from "not effective at all" to "extremely effective" for insurance effectiveness. Opportunities in NHP implementation were evaluated across areas such as responsibility sharing among different levels of government, the potential for increased public health awareness, advancements in healthcare technology and quality management, and the role of statistical data in decision-making. Each opportunity was rated using relevant scales to quantify participants' perceptions. Finally, the study assessed factors influencing NHP implementation. Participants rated elements such as the clarity of NHP goals, the adequacy of financial resources, the influence of politics, and the competency of health personnel. These factors were evaluated on a scale ranging from "strongly agree" to "strongly disagree" to provide insight into perceived facilitators or barriers to effective policy implementation.

Dependent variables

The 5-point Likert scale responses regarding factors influencing the implementation of the NHP of ordinal scale data were aggregated and transformed into an interval scale. For analysis, the interval-scale data were dichotomized into two categories: "Agree" (combining "Strongly Agree" and "Agree") and "Disagree" (combining "Neutral," "Disagree," and "Strongly Disagree") using the SPSS software (22). Descriptive statistics, including means and standard deviations, were calculated for each aggregated statement to summarize the data. The normality of the transformed interval data was assessed using the Shapiro–Wilk test. The results indicated that the data met the assumption of normal distribution (23), justifying its use in further parametric analyses. Binary logistic regression was then employed to explore the relationship between independent variables—financial resources, political influences, health personnel competence, and public health expenditures—and the dichotomized dependent variable. The dependent variable categorized perceptions as "positive" or "negative" toward the implementation of the NHP (24) based on the mean cut-off.

Data collection

The data collection took place between October 10 and November 15, 2024, using a structured questionnaire developed in Nepali. The questionnaire was designed based on a thorough review of relevant literature and consultations with subject matter experts, including national health policymakers and government advisors. A pilot test involving 10% of the sample (17 participants) from Kirtipur Municipality was conducted to assess its reliability and clarity, leading to minor revisions before its final implementation. Data collection was carried out by seven trained enumerators (four females and three males), all of whom were public health graduates with a sound understanding of Nepal's health system. These enumerators underwent 3 days of rigorous training focused on ethical considerations, using the questionnaire, and maintaining consistency during data collection. Each interview lasted approximately 30–40 min, allowing adequate time to gather detailed participant responses.

The data was initially collected using paper-based questionnaires and later transferred to an electronic format using password-protected tablets to enhance accuracy and minimize transcription errors. The digitized data was uploaded daily to a secure, centralized server, ensuring immediate backup and protection against data loss. To maintain strict privacy, access to the data was limited to authorized members of the research team, and personal identifiers were removed during the data cleaning process to ensure anonymity. Confidentiality was prioritized throughout the study, with informed consent obtained from all participants before the interviews. Participants were assured that their responses would remain anonymous and used exclusively for research. The research followed the ethical guidelines of the Nepal Health Research Council (NHRC), adhering to national and international data privacy and confidentiality standards.

Statistical analysis

The collected data were thoroughly checked for consistency and completeness before being entered into Microsoft Excel. Quantitative data were analyzed using descriptive statistics, such as means, standard deviations, frequencies, and percentages. Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 20 and Microsoft Excel. Binary logistic regression analysis was employed to identify significant associations, with variables having a p-value ≤ 0.05 considered statistically significant.

Ethical considerations

The study obtained ethical approval from the Nepal Health Research Council (Ref. No: NHRC-024-722) and written informed consent from all participants. Maintaining participant confidentiality and anonymity was crucial, given the sensitive nature of some topics covered, such as perspectives on political influences and resource allocation challenges. This ethical approach ensured the participants' protection and the data's integrity.

Results

The study participants included a diverse group in terms of age, gender, and professional background. Regarding age, 32.5% were under 30, 43.4% were between 30 and 40, 21.7% were 40–50, and 2.4% were over 50. Most participants were female (61.4%), with males making up 38.6%. Regarding professional categories, 49.4% were Allied Health Workers, 28.3% were Nursing Staff, 9.6% were Medical Doctors, 6.6% were Pharmacists, and 6.0% were Public Health Inspectors/Officers (PHI/PHO).

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Regarding work experience, 23.5% had 0–5 years, 33.1% had 5–10 years, 16.3% had 10–15 years, and 27.1% had more than 15 years. Regarding employment status, 61.4% were permanently employed, 9.6% were on contract, 17.5% worked part-time or temporarily, and 11.4% were volunteers. Technology use at work showed that 71.1% used it regularly, 16.9% occasionally, and 12.0% rarely (detailed in a Supplementary material).

Access to healthcare resources was moderate for 41.6% and insufficient for 58.4% of participants. Regarding training on the NHP, 14.5% had received training, while 85.5% had not. Local government support for NHP implementation was reported by only 9.0% of participants, with 91.0% indicating a lack of support. Finally, sources of NHP information varied, with 36.7% learning from official documents, 32.5% from training sessions, 12.7% from colleagues or superiors, 10.2% from workshops or seminars, and 7.8% from other sources (Supplementary material).

Table 1 presents the awareness and understanding of the NHP among local health workers. Regarding familiarity with the NHP, 100 (60.2%) reported being somewhat familiar, 43 (25.9%) were very familiar, 14 (8.4%) were neutral, 8 (4.8%) were not very familiar, and 1 (0.6%) were not familiar at all. In terms of comprehensive understanding of the NHP's objectives and components, 89 (53.6%) stated they understood moderately well, 30 (18.1%) understood very well, 24 (14.5%) were neutral, 21 (12.7%) did not understand very well, and 2 (1.2%) did not understand well at all. When asked about their primary source of information on the NHP, 61 (36.7%) cited official documents, 54 (32.5%) mentioned training sessions, 21 (12.7%) learned from colleagues or superiors, 17 (10.2%) referred to workshops or seminars, and 13 (7.8%) reported other sources. For awareness of NHP strategies and initiatives at the local level, 109 (65.7%) were somewhat aware, 18 (10.8%) were very aware, 20 (12.0%) were neutral, 16 (9.6%) were not very aware, and 3 (1.8%) were not aware at all. Finally, regarding the need for additional training or resources to enhance understanding of the NHP, 81 (48.8%) agreed, 63 (38.0%) strongly agreed, 19 (11.4%) were neutral, 2 (1.2%) disagreed, and 1 (0.6%) strongly disagreed.

Table 2 outlines the challenges and opportunities for implementing the NHP in local communities. Access to healthcare services among citizens was rated as moderate by 110 (66.3%) of respondents, while 22 (13.3%) rated it high, 24 (14.5%) rated it low, 9 (5.4%) rated it very low, and 1 (0.6%) rated it very high. The effectiveness of health insurance implementation was rated slightly effective by 63 (38.0%), moderately effective by 61 (36.7%), very effective by 33 (19.9%), not effective at all by 6 (3.6%), and extremely effective by 3 (1.8%). Regarding challenges related to the regulation of medicine and medical products, 90 (54.2%) agreed that there were challenges, 43 (25.9%) remained neutral, 15 (9.0%) disagreed, 9 (5.4%) strongly disagreed, and 9 (5.4%) strongly agreed. Respondents perceived the health sector as equally profit- and service-oriented by 54 (32.5%), while 34 (20.5%) viewed it as mostly service-oriented, 34 (20.5%) as mostly profit-oriented, 34 (20.5%) as completely service-oriented, and 10 (6.0%) considered it completely profit-oriented. Responsibility sharing for health services at federal, state, and local levels was rated poorly by 61 (36.7%), adequately by 39 (23.5%), well by 45 (27.1%), very poorly by 17 (10.2%), and very well by 4 (2.4%). Opportunities to increase public awareness of health-related issues were rated good by 54 (32.5%), limited by 55 (33.1%), some by 44 (26.5%), none by 9 (5.4%), and excellent by 4 (2.4%). Advancements in information technologies, drugs, and equipment were observed slightly by 67 (40.4%), moderately by 66 (39.8%), not at all by 16 (9.6%), very much by 15 (9.0%), and extremely by 2 (1.2%). Emphasis on management and quality of health in policies and programs was rated slightly by 73 (44.0%), moderately by 71 (42.8%), very much by 14 (8.4%), not at all by 8 (4.8%), and extremely by none. Finally, the use of statistics in policymaking and decision-making processes was rated poor by 78 (47.0%), fair by 38 (22.9%), good by 28 (16.9%), very poor by 21 (12.7%), and excellent by 1 (0.6%).

TABLE 1 Awareness and understanding of the NHP among health workers at the local level.

Statement	Frequency (*N*)	Percent (%)
I am familiar with the National Health Policy (NHP).		
Not familiar at all	1	0.6%
Not very familiar	8	4.8%
Neutral	14	8.4%
Somewhat familiar	100	60.2%
Very familiar	43	25.9%
I have a comprehensive understanding of the key objectives and components of the NHP.		
Not well at all	2	1.2%
Not very well	21	12.7%
Neutral	24	14.5%
Moderately well	89	53.6%
Very well	30	18.1%
I primarily receive information about the NHP through training, official documents, workshops/seminars, and colleagues.		
Training sessions	54	32.5%
Official documents	61	36.7%
Workshops or seminars	17	10.2%
Colleagues or superiors	21	12.7%
Other	13	7.8%
I am aware of the strategies and initiatives outlined in the NHP being implemented at the local level.		
Very aware	18	10.8%
Somewhat aware	109	65.7%
Neutral	20	12.0%
Not very aware	16	9.6%
Not aware at all	3	1.8%
I feel the need for additional training or resources to enhance my understanding of the NHP.		
Strongly agree	63	38.0%
Agree	81	48.8%
Neutral	19	11.4%
Disagree	2	1.2%
Strongly disagree	1	0.6%

1 (Strongly disagree) to 5 (Strongly agree).

TABLE 2 Challenges and opportunities for implementing the NHP in local communities in Nepal.

	Variables	Frequency (*N*)	Percent (%)
Challenges	Access to healthcare services among citizens		
	Very Low	9	5.4%
	Low	24	14.5%
	Moderate	110	66.3%
	High	22	13.3%
	Very High	1	0.6%
	Health insurance effectiveness in implementation		
	Not Effective at All	6	3.6%
	Slightly Effective	63	38.0%
	Moderately Effective	61	36.7%
	Very Effective	33	19.9%
	Extremely Effective	3	1.8%
	Medicine and medical products regulation challenges		
	Strongly Disagree	9	5.4%
	Disagree	15	9.0%
	Neutral	43	25.9%
	Agree	90	54.2%
	Strongly Agree	9	5.4%
	Profit-oriented health sector rather than service-oriented		
	Completely Profit-Oriented	10	6.0%
	Mostly Profit-Oriented	34	20.5%
	Equally Profit- and Service-Oriented	54	32.5%
	Mostly Service-Oriented	34	20.5%
	Completely Service-Oriented	34	20.5%

(Continued)

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TABLE 2 (Continued)

	Variables	Frequency (*N*)	Percent (%)
Opportunities	Responsibility sharing for health services at federal, state, and local levels		
	Very Poorly	17	10.2%
	Poorly	61	36.7%
	Adequately	39	23.5%
	Well	45	27.1%
	Very Well	4	2.4%
	Opportunities to increase public awareness of health-related issues		
	No Opportunities	9	5.4%
	Limited Opportunities	55	33.1%
	Some Opportunities	44	26.5%
	Good Opportunities	54	32.5%
	Excellent Opportunities	4	2.4%
	Observe advancements in new information technologies, drugs, and equipment		
	Not at All	16	9.6%
	Slightly	67	40.4%
	Moderately	66	39.8%
	Very Much	15	9.0%
	Extremely	2	1.2%
	Emphasis on health policies and programs in management and quality of health		
	Not at All	8	4.8%
	Slightly	73	44.0%
	Moderately	71	42.8%
	Very Much	14	8.4%
	Extremely	0	0.0%
	Rating of statistics use in policymaking and decision-making processes		
	Very Poor	21	12.7%
	Poor	78	47.0%
	Fair	38	22.9%
	Good	28	16.9%
	Excellent	1	0.6%

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Regarding the main obstacles to providing free, quality basic health services in the local community, financial constraints were reported by 54.2% of participants. Limited access to skilled healthcare professionals affected 56.0% of respondents, while inadequate infrastructure and facilities were highlighted by 62.0%. High out-of-pocket healthcare costs were a concern for 29.5% of participants. Inefficient health insurance policies impacted 43.4% of respondents; although 97.0% reported no awareness, only 3.0% indicated experiencing awareness issues (detailed table on a Supplementary material).

Table 3 shows respondents' perceptions of various aspects of implementing the NHP. A majority, 139 (45.8%), agreed that the objectives of the NHP are clear, while 100 (33.1%) were neutral, and 32 (10.8%) strongly agreed. A smaller portion, 30 (10.2%), disagreed or strongly disagreed with the clarity of the objectives. Regarding the understandability of the NHP goals, 170 (56.6%) found them understandable, with 78 (26.5%) remaining neutral and only 11 (3.6%) expressing disagreement. Regarding financial resources, 78 (26.5%) strongly agreed, and 114 (38.6%) agreed that insufficient financial resources exist for the NHP's implementation. A significant portion, 91 (30.7%), remained neutral on this issue. When it came to the clarity of the financial resource distribution, 144 (48.8%) agreed that it was clear, while 75 (25.3%) were neutral, and 62 (21.1%) felt it was unclear. Concerning political influence, 83 (28.3%) believed that political influence had a positive effect on NHP implementation, while 108 (36.7%) agreed with this view. However, 18 (6.0%) disagreed, and 12 (4.2%) strongly disagreed. Regarding political interference negatively affecting the implementation, 87 (29.5%) strongly agreed, 114 (38.6%) agreed, and 73 (24.7%) were neutral, indicating a concern about political interference. Regarding health personnel competence, 114 (38.6%) agreed that personnel were sufficiently competent, but 41 (13.8%) disagreed or strongly disagreed, suggesting concerns about the workforce's preparedness. A significant 136 (45.8%) felt a shortage of competent personnel to effectively implement the NHP, with 56 (18.7%) strongly agreeing. Regarding the allocation of public health expenses, 119 (40.4%) agreed that the budget was adequately allocated for healthcare needs, although 37 (12.7%) disagreed or strongly disagreed. Furthermore, 70 (23.5%) strongly agreed, and 136 (45.8%) agreed that public health expenses are insufficient, indicating dissatisfaction with the financial investment. Regarding the availability of resources for successful implementation, 136 (45.8%) agreed that sufficient resources were available, while 61 (20.5%) thought there was a shortage. Lastly, 127 (42.8%) of respondents agreed that their organization strongly supports the NHP, with 103 (34.9%) remaining neutral, and 139 (47%) felt that health workers actively contribute to its successful implementation.

Table 4 shows that the binary logistic regression analysis revealed that age was a significant predictor of the implementation of the NHP (CoR = 0.919, 95% CI [0.880–0.961], $p < 0.001$). Gender was not significantly associated, with males showing a CoR of 0.815 (95% CI [0.426–1.557], $p = 0.536$) compared to females. Profession categories showed no significant differences compared to the reference group (PHI/PHO/Pharmacists), with nursing staff (CoR = 0.667, 95% CI [0.167–2.666], $p = 0.566$), allied health workers (CoR = 0.943, 95% CI [0.303–2.932], $p = 0.919$), and medical doctors (CoR = 0.565, 95% CI [0.199–1.604], $p = 0.283$) all yielding non-significant results.

Mode of employment was not significantly associated with the Implementation of the NHP. Permanent employees had a CoR of 1.333 (95% CI [0.492–3.614], $p = 0.572$), contract employees had a CoR of 1.212 (95% CI [0.311–4.730], $p = 0.782$), and temporary/part-time employees had a CoR of 1.382 (95% CI [0.420–4.541], $p = 0.594$) compared to volunteers. Use of technology in work showed a significant association for regular use (CoR = 5.448, 95% CI [1.988–14.926], $p = 0.001$), while occasional use was not significant (CoR = 1.202, 95% CI [0.365–3.956], $p = 0.762$). Access to healthcare resources was not significantly associated with implementing the NHP, with moderate access showing a CoR of 1.376 (95% CI [0.718–2.636], $p = 0.336$). Training on NHP did not yield a significant association, with a CoR of 0.761 (95% CI [0.315–1.837], $p = 0.543$). Support from local authorities for NHP implementation was also not significant, with a CoR of 1.621 (95% CI [0.493–5.334], $p = 0.427$). Years of experience in the health sector significantly predicted the Implementation of the NHP (CoR = 0.934, 95% CI [0.895–0.975], $p = 0.002$). These results identify significant and non-significant associations among the variables examined.

Discussion

This research evaluates the implementation of Nepal's NHP locally, focusing on challenges within the federal system. It examines coordination between different government levels and explores the perspectives of healthcare providers.

Understanding the awareness and comprehension levels of the NHP among local health workers is crucial for effective policy implementation and healthcare delivery. Regarding awareness of the NHP, the current study indicates a moderate level of familiarity among health workers of policy. Moreover, the diverse sources through which health workers receive information about the policy, including training sessions, official documents, workshops, and colleagues, emphasize the importance of a multi-channel approach to disseminating information and promoting awareness. Our findings highlight the need for targeted interventions, such as enhanced training programs and communication strategies, to strengthen the NHP implementation and enhance its impact on healthcare delivery. For this, the timely and effective use of a sufficient budget is critical for successfully implementing health policy (25).

The challenges in NHP implementation are evident in Nepal, with perceived difficulties in accessing healthcare services, managing medicines, and addressing the profit orientation of the health sector. Likewise, this found obstacles to providing free, quality basic health services due to inadequate infrastructure and limited access to skilled professionals. Studies underscored similar challenges, including unequal healthcare distribution, poor infrastructure, insufficient essential drugs, unregulated private providers, inadequate health budget allocation, and rural human resource (17) retention issues also found that only 61.8% of Nepalese households have timely access to healthcare facilities, underscoring the need for urgent population-level interventions (26), as there is far less than the World Health Organization's (WHO) recommendation of 2.3 doctors, nurses, and midwives per 1,000 people in Nepal (27). Similarly, a study in China discovered that the increasing inequity in subnational public expenditure suggests that subnational-level resources and responsibilities were not well aligned with national priorities (28).

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TABLE 3 Factors influencing the implementation of the NHP.

Statement	Frequency (*N*)	Percent (%)	Mean	Std. deviation
The objectives outlined in the National Health Policy are communicated.	166	100	2.22	1.19
Strongly agree	18	10.8		
Agree	76	45.8		
Neutral	55	33.1		
Disagree	14	8.4		
Strongly disagree	3	1.8		
The goals of the National Health Policy are easily understandable.	166	100	2.22	1.14
Strongly agree	22	13.3		
Agree	94	56.6		
Neutral	44	26.5		
Disagree	3	1.8		
Strongly disagree	3	1.8		
The financial resources allocated for NHP implementation are sufficient.	166	100	2.13	1.19
Strongly agree	44	26.5		
Agree	64	38.6		
Neutral	51	30.7		
Disagree	6	3.6		
Strongly disagree	1	0.6		
There is a lack of clarity in the distribution of financial resources for the NHP.	166	100	2.20	1.15
Strongly agree	35	21.1		
Agree	81	48.8		
Neutral	42	25.3		
Disagree	6	3.6		
Strongly disagree	1	0.6		
Political influences positively contribute to the effective implementation of the NHP.	166	100	2.21	1.16
Strongly agree	47	28.3		
Agree	61	36.7		
Neutral	41	24.7		
Disagree	10	6.0		
Strongly disagree	7	4.2		
Political interference negatively impacts the successful execution of the NHP.	166	100	2.17	1.18
Strongly agree	49	29.5		
Agree	64	38.6		
Neutral	41	24.7		
Disagree	8	4.8		
Strongly disagree	3	1.8		
Health personnel are well-equipped and competent in implementing NHP strategies.	166	100	2.47	1.19
Strongly agree	28	16.9		
Agree	64	38.6		
Neutral	51	30.7		
Disagree	14	8.4		
Strongly disagree	9	5.4		

(Continued)

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TABLE 3 (Continued)

Statement	Frequency (*N*)	Percent (%)	Mean	Std. deviation
There is a shortage of competent health personnel to execute the NHP effectively.	166	100	2.33	1.18
Strongly agree	31	18.7		
Agree	76	45.8		
Neutral	34	20.5		
Disagree	23	13.9		
Strongly disagree	2	1.2		
Public health expenses for the NHP are appropriately allocated to address healthcare needs.	166	100	2.47	1.16
Strongly agree	28	16.9		
Agree	67	40.4		
Neutral	43	25.9		
Disagree	21	12.7		
Strongly disagree	7	4.2		
The current allocation of public health expenses is inadequate for the comprehensive implementation of the NHP.	166	100	2.17	1.18
Strongly agree	39	23.5		
Agree	76	45.8		
Neutral	38	22.9		
Disagree	10	6.0		
Strongly disagree	3	1.8		
There are ample human and material resources to support the successful implementation of the NHP.	166	100	2.48	1.16
Strongly agree	25	15.1		
Agree	76	45.8		
Neutral	34	20.5		
Disagree	22	13.3		
Strongly disagree	9	5.4		
Human and material resources are insufficient to meet the requirements of NHP initiatives.	166	100	2.13	1.18
Strongly agree	34	20.5		
Agree	92	55.4		
Neutral	27	16.3		
Disagree	11	6.6		
Strongly disagree	2	1.2		
The organization provides strong support for the implementation of NHP initiatives.	166	100	2.40	1.14
Strongly agree	23	13.9		
Agree	71	42.8		
Neutral	58	34.9		
Disagree	10	6.0		
Strongly disagree	4	2.4		
Individual health workers actively engage and contribute to the successful execution of the NHP.	166	100	2.34	1.18
Strongly agree	25	15.1		

(Continued)

TABLE 3 (Continued)

Statement	Frequency (*N*)	Percent (%)	Mean	Std. deviation
Agree	78	47.0		
Neutral	46	27.7		
Disagree	15	9.0		
Strongly disagree	2	1.2		

1 (Strongly disagree) to 5 (Strongly agree).

Despite challenges, the present study findings also point toward opportunities for improvement, such as increased collaboration among different levels of governance, raising public awareness, and leveraging technological advancements. Similarly, the federal environment of Nepal has facilitated direct collaboration between local governments and constituents, enabling better funding and evidence-based planning tailored to community needs, thus increasing financial support for health initiatives (4, 29). The Nepal Health Policy (NHP) provides a broad vision and framework for the healthcare system, focusing on long-term goals like equity, accessibility, and quality. In contrast, the Nepal Health Sector Strategy (NHSS) 2015–2020 was an action-oriented plan with specific objectives but faced challenges due to poor coordination among policy actors, resulting in inefficiencies and inconsistencies in service delivery (15). Similarly, Wasti et al. (17) a study conducted in Nepal, also reported that challenges like poor coordination, delayed funds, staff maldistribution, procurement issues, and inadequate monitoring underscore systemic deficiencies hampering healthcare delivery in Nepal.

This study reveals important insights into implementing the NHP. While 45.8% of respondents agreed that the NHP objectives were clear and 56.6% found the goals understandable, concerns about financial resources were prominent. The study reveals a gap in funding for the NHP, with 65.1% of respondents feeling funds are insufficient and 58.5% questioning the adequacy of public health spending. This highlights the need for sustainable financing. Studies highlight that diversifying funding sources through international aid and public-private partnerships and increasing the public health budget to support the NHP's goals effectively (30).

Political factors also showed mixed results. While 65% saw political influence as positive, 68.1% identified political interference as a hindrance, suggesting that political stability and governance reforms are essential. Political hindrance in Nepal's health policy implementation stems from political instability, frequent leadership changes, corruption, and mismanagement of resources. Political polarization and lack of consensus among parties also prevent unified action, while weak governance structures allow political interference to undermine the effectiveness of public health programs (31).

Human resources were another key concern, with 45.8% agreeing there is a shortage of competent personnel, and 13.8% disagreed that personnel were adequately prepared. This underscores the need for targeted training and capacity-building. Nepal's shortage of competent healthcare personnel is due to limited training opportunities, brain drain, insufficient professional development, low compensation, and unequal distribution, with urban areas having more healthcare workers than rural regions (32).

Regarding Factors Predicting the Implementation of the NHP in Nepal, Age was significantly associated with a positive attitude toward the implementation of the NHP in Nepal, with an odds ratio (OR) of 0.919 (95% CI, 0.880–0.961, $p < 0.001$). The association between age and a positive perception toward implementing Nepal's NHP can be attributed to several factors. Younger individuals may exhibit a more progressive mindset and greater adaptability to change, fostering positive attitudes toward new policies (33). They are often more exposed to contemporary public health information and are more likely to embrace innovations and reforms in the healthcare system (34).

The use of technology in work was significantly associated with positive outcomes in NHP implementation. Regular use of technology was associated with a significantly higher likelihood (OR: 5.448, 95% CI: 1.988–14.926, $p = 0.001$) than rare use. However, occasional use was not significantly associated (OR: 1.202, 95% CI: 0.365–3.956, $p = 0.762$). The significant association between regular use of technology and positive outcomes may be its ability to streamline workflows, enhance efficiency, and provide better access to information (35). Regular users are likely more skilled in utilizing technological tools, enabling them to adapt effectively to modern work demands and policy implementations (36).

In contrast, occasional users may lack proficiency or consistent exposure, limiting their ability to leverage technology's benefits fully. This could explain the lack of a significant association in this group. Frequent engagement with technology fosters familiarity, confidence, and a greater capacity to achieve favorable outcomes in professional settings. Years of experience in the health sector were significantly associated with the Implementation of the NHP (OR: 0.934, 95% CI: 0.895–0.975, $p = 0.002$). This indicates that for each additional year of experience, the odds of supporting the implementation of the NHP decrease. The inverse association may reflect that individuals with more years of experience tend to rely on established practices and may be less receptive to adopting new approaches or policies (34). In contrast, those with less experience may exhibit greater openness to innovation and adaptability in implementing new health sector strategies. This highlights the need for targeted interventions, such as tailored training programs and awareness campaigns, to engage experienced healthcare professionals and encourage their participation in adopting and implementing new policies effectively (37, 38).

Strengths of the study

This study is the first of its kind in Nepal, addressing a critical gap in understanding the implementation of the NHP within the federal context. It employed a robust quantitative design, incorporating 166 health workers from various health offices, including medical doctors, nursing staff, allied health professionals, pharmacists, and public health personnel. This diversity ensures a comprehensive representation of healthcare perspectives. The structured questionnaire, carefully developed through a literature review and expert consultations, enhanced the content validity and reliability of

TABLE 4 Factors predicting the implementation of the NHP in Nepal.

Variable	Sig.	Crude Odds Ratio	95% CI for CoR [Lower–Upper]
Age	**0.000**	0.919	[0.880–0.961]
Gender (Ref: Female)			
Male	0.536	0.815	[0.426–1.557]
Profession (Ref: PHI/PHO/Pharmacist)			
Nursing staffs	0.566	0.667	[0.167–2.666]
Allied Health Workers	0.919	0.943	[0.303–2.932]
Medical Doctors	0.283	0.565	[0.199–1.604]
Mode of employment (Ref: Volunteer)			
Permanent	0.572	1.333	[0.492–3.614]
Contract	0.782	1.212	[0.311–4.730]
Temporary/part-time	0.594	1.382	[0.420–4.541]
Use of the technology in work (Ref: Rare)			
Regular use	**0.001**	5.448	[1.988–14.926]
Occasional use	0.762	1.202	[0.365–3.956]
Access to healthcare resources (Ref: Insufficient)			
Moderate	0.336	1.376	[0.718–2.636]
Received training on NHP (Ref: No)			
Yes	0.543	0.761	[0.315–1.837]
Local authorities support NHP implementation. (Ref: No)			
Yes	0.427	1.621	[0.493–5.334]
Year of experience in the health sector	**0.002**	0.934	[0.895–0.975]

$p < 0.05$. Bold values indicate statistically significant associations.

the findings. Combining Likert-scale items with detailed demographic analysis offers valuable insights into the challenges, opportunities, and factors influencing NHP implementation at the local level, emphasizing the need for such research in Nepal's federal framework.

Limitations of the study

The study faced several methodological constraints that may affect the generalizability of its findings. The focus on health workers solely within the Lumbini province may not fully represent the perspectives of healthcare workers in other regions of Nepal, particularly rural areas with different healthcare challenges.

Implications of the study

The findings significantly affect policy and practice in Nepal's healthcare system. First, it highlights the critical need to strengthen health workers' awareness and understanding of the NHP through targeted training programs and enhanced communication channels. Second, the identified challenges in healthcare access, insurance efficiency, and resource allocation underscore the necessity for systemic reforms and increased investment in healthcare infrastructure, particularly in underserved areas. Finally, the mixed perceptions about resource distribution, political interference, and personnel competency emphasize the importance of developing multi-stakeholder approaches to address these challenges, potentially through improved inter-governmental coordination and sustainable funding mechanisms. These implications are particularly relevant for policymakers and healthcare administrators working to enhance the effectiveness of NHP implementation locally.

Conclusion

In conclusion, this study highlights the challenges and opportunities of implementation. Despite moderate awareness among health workers, significant barriers such as financial constraints, inadequate human resources, political interference, and infrastructure limitations persist. However, the federal system offers the potential for improved coordination and local-level collaboration, which can enhance policy effectiveness. Technology use, age, and experience influence positive attitudes toward NHP implementation, underscoring the need for targeted interventions, capacity-building, and sustainable funding. Addressing these systemic challenges, promoting greater political stability, and leveraging technological advancements while ensuring a more equitable distribution of healthcare resources across the country is crucial to achieving the policy's goals.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by the Nepal Health Research Council (Ref. No: NHRC-024-722). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

DK: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. ZX: Conceptualization, Supervision, Writing – review & editing. ZM: Conceptualization, Formal analysis, Supervision, Writing – review & editing. RB: Conceptualization, Formal analysis, Supervision, Writing – review & editing. CZ: Conceptualization, Project administration, Supervision, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This research was funded by

the National Natural Science Foundation of China under Grant (No. 72274091), the General Program of the Guangdong Philosophy and Social Science Planning (No. GD23CGL06), the Guangdong Basic and Applied Basic Research Foundation under Grant (No. 2022A1515011591).

Acknowledgments

We would like to extend our heartfelt gratitude to all the health workers, the ethical review body, the Nepal Health Research Council (NHRC), and the university staff who supported and contributed to this study. We sincerely thank the health workers who participated in this research.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that Gen AI was used in the creation of this manuscript. Only for the grammer corrections.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2025.1592213/full#supplementary-material

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 11 July 2025
DOI 10.3389/fpubh.2025.1629981

OPEN ACCESS

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RECEIVED 16 May 2025
ACCEPTED 30 June 2025
PUBLISHED 11 July 2025

CITATION
Li X, Tong P and Zhu B (2025) Strategic investment patterns of the medical industry in senior health.
Front. Public Health 13:1629981.
doi: 10.3389/fpubh.2025.1629981

Strategic investment patterns of the medical industry in senior health

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This study constructs a fuzzy-set Qualitative Comparative Analysis (fsQCA) framework based on seven supply–demand variables in the senior-health sector of Japan and South Korea (2014–2023) and the medical-industry's investment ratio in senior health, to systematically explore the multiple configurational pathways that enhance investment ratios. Four typical pathways were identified: P1 (high Government Fiscal Investment + Enterprise Technology Innovation Index + Older Adult Service Institution Capacity), P2 (Government Fiscal Investment + Social Capital Participation + high Health Insurance Reimbursement Rate + Older Adult Service Institution Capacity), P3 (Government Fiscal Investment + Enterprise Technology Innovation Index + Smart Service Platform Construction) and P4 (Social Capital Participation + Enterprise Technology Innovation Index + Smart Service Platform Construction + Older Adult Service Institution Capacity + high Health Insurance Reimbursement Rate). All paths demonstrate that "fiscal leverage + market incentives + digital empowerment + institutional safeguards" in four-dimensional linkage are pivotal to improving resource-allocation efficiency. Robustness tests confirm the stability of each pathway after threshold adjustments and outlier exclusions, bolstering the external validity of the findings. A Japan–Korea comparison reveals higher coverage in government-led and market-reform pathways in Korea, whereas Japan leads in the intelligent-care and telemedicine pilot pathway. Policy recommendations emphasize context-sensitive, flexible configuration of fiscal, market, technological and institutional elements, with priority support for Smart Service Platform Construction and public–private partnership models to meet differentiated needs under varying fiscal capacities and aging pressures. This study applies the dynamic fsQCA method to the integrated medical–older adult care domain, enriching the theoretical paradigm of strategic investment in the senior-health industry and offering transferable policy-configuration pathways for other aging societies.

KEYWORDS

senior health, strategic investment, fuzzy-set qualitative comparative analysis, medical-care integration, supply-demand coupling

1 Introduction

Strategic investment by the medical industry in the field of senior health has become a core initiative for addressing the challenges of population aging and promoting the sustainable development of public health (1). As the degree of population aging continues to rise in both South Korea and Japan, their governments and market actors have been exploring novel models of medical care integration to enhance the quality of life for older adults and optimize resource allocation (2). In South Korea, the government has introduced Social Capital

Participation into older adult care services via a public private partnership model, leveraging policy subsidies, tax incentives and land grants to foster deep collaboration between medical institutions and care homes in service processes, professional training and information systems (3). Meanwhile, Japan has led the way in community based home care and the application of Smart Service Platform Construction and wearable health monitoring devices (4). Initiatives such as "Dementia Cafés" and "Community Health Stations," together with the deployment of Internet of Things, big data and telemedicine, have established a "near at hand, accessible, continuous" service loop centered on the community (5). Although the two countries differ in institutional design and practical pathways, both demonstrate that the integration of medical industry and older adult care services not only meets increasingly diversified health needs but also drives coordinated development across the upstream and downstream of related industrial chains (6). As shown in Figure 1, this study provides an in-depth analysis of the core factors influencing the effectiveness of strategic investment. By drawing on the practical experiences of South Korea and Japan under different governance models, it offers valuable insights and practical guidance for other Asian countries entering the aging phase to develop healthcare systems tailored to their national circumstances (7).

Strategic investment in the healthcare industry for older adult well-being is directly linked to the enhancement of care quality and the long-term sustainability of public health expenditure. Against this backdrop, factors such as the degree of population aging, government fiscal input, medical insurance reimbursement rates, the bed capacity of care institutions, and the deployment of smart service platforms not only determine the scale of market demand and the intensity of policy support, but also significantly influence capital allocation and project returns (8). A systematic examination of the interplay between these critical variables and investment decisions can help clarify the underlying logic of resource distribution, providing a sound basis for optimizing and scaling integrated medical and older adult care models (9). Existing studies predominantly focus on the impact of one or two variables on strategic investment intentions in integrated older adult care, relying on qualitative approaches such as surveys and in-depth interviews, or employing quantitative techniques such as multiple linear regression, Analytic Hierarchy Process (AHP), and gray relational analysis. While a limited number of scholars have attempted to examine the issue from both the supply side of healthcare and the demand side of older adult care, most remain confined to descriptive case studies or static models, lacking the capacity to reveal the synergistic effects and path dependencies among variables (10). Moreover, key latent factors such as the degree of social capital participation and the diffusion of technological innovation remain underexplored. In response to these research gaps, this study proposes a framework encompassing seven dimensions—population aging, government fiscal input, smart service platform development, insurance reimbursement rates, institutional capacity, social capital participation, and technological innovation diffusion (11). It adopts the Qualitative Comparative Analysis (QCA) method to systematically address the core research question: "Which combinations of factors are most effective in driving higher strategic investment performance?"

FIGURE 1
Comparison of Korea and Japan.

Specifically, the study selects representative cases of integrated older adult care initiatives in South Korea and Japan, assigning fuzzy set values to the seven variables based on official statistics, policy documents, and field interviews (12). It then constructs a truth table and applies Boolean algebra to identify core and peripheral conditions (13). Through pathway analysis and robustness testing, the study distills a series of actionable and context-sensitive configurations of influencing factors. Compared to traditional static models, QCA retains the depth of qualitative insights while enabling a rigorous examination of interactive effects, substitution mechanisms, and complementary dynamics within complex socio-economic systems (14). As such, it provides clear, evidence-based investment configurations that are highly relevant to strategic decision-making across diverse governance contexts.

The theoretical contributions of this study are twofold. First, by constructing a multidimensional impact framework encompassing population aging, policy resources, market mechanisms and technological innovation, it expands the research paradigm for strategic investment in the medical industry and senior health. Second, it is the first to apply Qualitative Comparative Analysis to this field, overcoming the limitations of single model approaches, providing a novel tool for uncovering factor synergies and path dependence, and offering a transnational comparative perspective for medical care integration practices under different governance models. Methodologically, the study's case selection, condition calibration and truth table construction are grounded in empirical research, ensuring the credibility and operability of the findings; robustness checks via specialized software further enhance the scientific rigor and generalizability of the results. This paper fills a gap in the literature on the multi factor linkage perspective of strategic investment in the medical industry and provides theoretical support and practical guidance for governmental decision makers and private investors in resources allocation, institutional design and technology application.

2 Theoretical background and applied practice of investment by the medical industry in the field of senior health

2.1 Research background and theoretical foundations

As global demographic structures continue to age, strategic investment in the healthcare industry's older adult care segment has emerged as a pivotal means of alleviating public health burdens and enhancing the quality of eldercare services (15). Conventional studies have predominantly concentrated on the impact of individual variables upon investment intentions, yet they have overlooked the joint mechanisms by which institutional environments and market demand interact, rendering them unable to explain why regions with comparable policy incentives can nonetheless exhibit markedly divergent investment outcomes (16). To address this lacuna, the present study adopts a "supply–demand coupling" perspective, endeavoring to transcend single-factor frameworks by integrating institutional incentives with market pressures, thereby revealing the driving mechanisms of integrated medical–older adult care investment (17). However, absent a robust theoretical underpinning, such coupling analyses risk appearing arbitrary and lack generalizability. Accordingly, this section draws upon the dual theoretical lenses of New Institutional Economics and the Resource–Capability View to afford the coupling model a firm scholarly foundation, and to demonstrate why incorporating the seven variables—government fiscal investment, social capital participation, technological innovation, smart platform deployment, institutional capacity, insurance reimbursement rates, and population aging—into a unified analytical framework is logically coherent (18).

From the standpoint of New Institutional Economics (NIE), institutional settings decisively influence resource allocation and transaction costs (19). Government fiscal investment signifies official support for the older adult healthcare sector, encompassing budget allocations, tax relief and land grants, thus directly reducing project transaction costs; social capital participation reflects non-governmental entities' risk preferences and resource-integration capabilities in public service projects, with its scale and structure exerting a profound impact on financing pathways and project feasibility; and the enterprise technology innovation index, as a manifestation of firm competitiveness within prevailing institutional frameworks, not only shapes the development and dissemination of medical devices and smart eldercare solutions but also determines service efficiency and quality control (20). Consequently, treating government fiscal investment, social capital participation and technological innovation as supply-side variables allows for a comprehensive grasp of how institutional incentives mold the sector's supply capacity (21). Meanwhile, under the Resource–Capability View, strategic decision-making hinges upon the alignment of an organization's internal resource endowments with external market demands. On the demand side, smart service platform construction showcases the extent to which digital technologies—such as teleconsultation, big-data health analytics and interoperable electronic health records—reengineer care delivery processes, reducing coordination costs and enhancing service accessibility; older adult service institution capacity gages the physical resource base of the market through indicators such as available beds and day-care center numbers, directly correlating to service scale and marginal returns; health insurance reimbursement rates, as a core payment-protection metric, determine elders' out-of-pocket costs and willingness to utilize services; and the degree of population aging, measured by the proportion of those aged 65 and over, reflects potential demand scale and market expansion (22). By regarding these four metrics as demand-side variables, one can accurately capture market pressures driving strategic investment and reveal the dynamic matching between supply incentives and demand forces.

Within our analytical framework, the supply- and demand-side variables collectively constitute the multidimensional drivers of integrated care investment. The supply side comprises three key elements—government fiscal investment, social capital participation and the technology innovation index—each quantifiable by budgetary outlays, PPP project counts, private capital inflows, R&D intensity, patent filings and technology adoption rates (23). The demand side involves four factors—smart platform coverage (measured via user numbers or module counts), institutional capacity (beds and facility counts), insurance reimbursement ratios and population aging degree—each capturing distinct aspects of market need and service uptake (24). These seven variables, when modeled together, not only elucidate how institutional incentives influence funding and technological progress drives service

evolution, but also how digital platforms, facility resources and payment assurances shape demand, with population aging providing long-term trend forecasts, thereby enabling a systematic supply–demand coupling analysis of investment performance (25).

Analysing these seven variables within a single model stems from the complementary nature of the two theoretical perspectives and the inherent systemic attributes of integrated care. NIE emphasizes the efficacy of institutional constraints and incentive designs, while the Resource–Capability View focuses on resource utilization and capability transformation (26). In the healthcare–eldercare nexus, government and social capital furnish institutional and financial backing, technological innovation and smart platforms spur service innovation, institutional capacity and reimbursement rates jointly determine market absorptive capacity, and population aging offers the longitudinal context. Incorporating all seven variables into a unified Qualitative Comparative Analysis framework allows us to discern their relative importance across diverse institutional and market settings, to distinguish their combinatory and substitution effects, and to furnish policymakers and investors with practical configuration pathways—ultimately providing both theoretical and empirical support for strategic investment in integrated older adult healthcare across Asia and beyond.

2.2 Investment practice by the medical industry in the field of senior health

With the intensification of population aging, investment practice by the medical industry in senior health in Japan has undergone a profound transformation from single-product supply to the provision of comprehensive solutions (27). Japanese corporations such as Panasonic Healthcare and Fujitsu have not only increased their stakes in high-end medical diagnostic devices and wearable health-monitoring terminals but have also formed strategic alliances with municipal retirement communities and hospital networks to construct data-driven, end to end health management service systems. Panasonic Healthcare, leveraging its expertise in sensor manufacturing and home appliance miniaturization, has launched a smart wristband capable of real time monitoring of blood pressure, blood glucose and activity levels (28). In collaboration with local governments, it is piloting a dual track "home + remote" care model for older adult patients with severe chronic illnesses in over 20 communities, thereby forming an integrated "device platform service" loop (29). Fujitsu, on the other hand, has capitalized on its strengths in cloud computing and artificial intelligence to partner with leading Japanese universities and multiple hospitals in the development of a "Smart Senior Health Platform." By applying large scale machine learning to vital, behavioral and environmental data from tens of thousands of older users, it has developed early warning models that predict fall risk and acute heart failure episodes (30). In conjunction with insurance providers, these models have been embedded into chronic disease management insurance products, delivering precise interventions for high risk groups. These initiatives have markedly reduced emergency visits and readmission rates at community hospitals while providing service based, recurring revenue streams unequivocally demonstrating the decisive role of deep technological integration and multi stakeholder collaboration in creating value within the senior health industry (31).

In South Korea, leading medical industry firms have similarly integrated themselves deeply into senior health service systems through cross sector mergers and acquisitions, equity investments and platform co development, rapidly enhancing their competitiveness in the older adult care market. Samsung Life, for instance, utilizes its capital and risk management capabilities in financial services to invest heavily in domestic Medical Care Integration operators, taking part in the establishment of multiple medical rehabilitation long term care communities (32). By underwriting a portion of operational risk with proprietary insurance products, Samsung Life has created a dual revenue model of "service income + insurance premium income." For data interoperability, it has connected its investments to its financial risk control systems, enabling real time health monitoring and dynamic risk assessment of residents, so that insurance payouts and health interventions are synchronously triggered substantially lowering long term care premium costs (33).

LG CNS, renowned for its IT and system integration prowess, has teamed with a national university hospital and regional older adult care centers to develop an "Intelligent Senior Care Cloud Platform." This platform integrates electronic medical records, cloud based medical imaging, virtual consultation suites and social rehabilitation features for older adults. It not only achieves a full process data loop but also provides standardized interfaces for third party service providers such as domestic help, meal subscription services and psychological counseling thereby accelerating ecosystem expansion. By the end of 2024, this platform had reached over 50 municipal districts, serving more than 100,000 senior users and generating stable cloud service subscription revenues for LG CNS (34).

Although Japanese and South Korean enterprises emphasize different facets, their investment practice in senior health collectively reflects three strategic pillars: "Technology Empowerment + Ecosystem Collaboration + Risk Sharing." In terms of Technology Empowerment, firms in both countries have upgraded single-point medical devices into sustainable health management terminals via IoT, artificial intelligence and big data analytics, consolidating disparate data onto unified platforms to deliver personalized, preventive and continuous interventions (35). In Ecosystem Collaboration, partnerships such as Panasonic Healthcare with municipal retirement communities and Samsung Life with Medical Care Integration operators demonstrate that companies are no longer operating in isolation but are building symbiotic networks across the value chain and industries to share costs and jointly reap benefits (36). In Risk Sharing, by organically combining insurance capital, governmental subsidies and user fees, enterprises can distribute operational risk while guaranteeing service quality, and offer predictable returns to both public and private investors thereby fostering a virtuous cycle driven by policy incentives and market orientation (37). From a supply demand theoretical perspective, these successful practices not only balance strong demand among older adults for high quality health services with their payment capacity but also enhance overall supply efficiency through the organic allocation of public and private resources. They provide replicable experience models for innovation in the Medical Care Integration industrial paradigm (38).

3 Methodology and analysis

3.1 Data sample framework construction

With the acceleration of population aging, senior health has become a central concern for both governments and market actors

worldwide. High income nations particularly Asian exemplars South Korea and Japan, each endowed with mature public health systems and information based regulatory mechanisms began systematic strategic investment in the senior health sector as early as 2014 (39). As shown in Figure 2, This study constructs its data sample framework from a dual supply demand perspective, selecting three supply side factors Government Fiscal Investment (GFI), Social Capital Participation (SCP) and Enterprise Technology Innovation Index (ETII) and four demand side factors Smart Service Platform Construction (SSPC), Older Adult Service Institution Capacity (ESIC), Health Insurance Reimbursement Rate (HIRR) and Degree of Population Aging (DPA). We compile annual panel data for both countries over the period 2014 2023 to undertake a horizontal, country level comparison (40, 41).

Firstly, South Korea leverages the multidimensional data resources of the National Health Insurance Service (NHIS) and the Health Insurance Review & Assessment Service (HIRA) to monitor in real time each year's Government Fiscal Investment, service utilization and reimbursement patterns. Japan, in turn, relies on the Ministry of Health, Labor and Welfare and the mandatory annual surveys under the Long Term Care Insurance (LTCI) system to assemble a comprehensive database encompassing fiscal allocations, social donations, institutional capacity and digital platform metrics (42). Secondly, to ensure national representativeness and comparability of indicators, all data sources are verified against official statistical releases from each country and OECD databases (43). This guarantees that flow based metrics such as GFI and SCP, technological and platform development indices such as ETII and SSPC, service capacity and payment security indicators such as ESIC and HIRR, and demographic structure measures such as DPA, are all drawn from transparent, traceable official documents and international reports (44). On this basis, comparative analysis of the two countries' funding intensity trajectories, market participation rates and innovation vigor enables a deep dissection of the interaction mechanisms among government policy orientation, private sector incentives and industrial technological advancement (45). It also permits exploration of the co evolutionary pathways of senior health service supply and demand under different institutional frameworks, thereby offering transferable

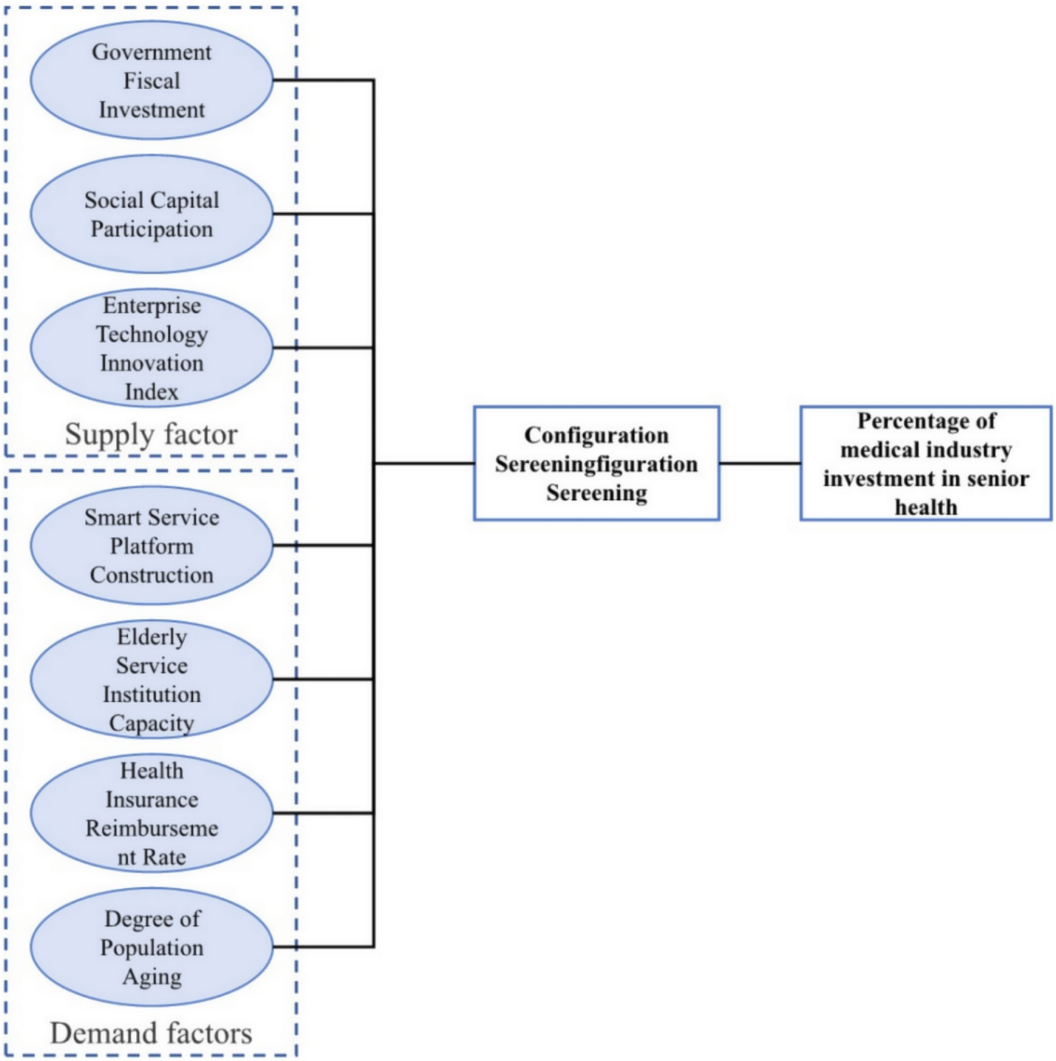

FIGURE 2
Data framework construction diagram.

lessons and policy recommendations to other nations confronting rapid population aging (46).

For the seven core indicators, rigorous quantitative methods and standardization procedures are applied. Government Fiscal Investment (GFI) is measured by each country's annual "Health and Aging Services Special Budget" expenditure, with nominal values converted to current year US dollars via purchasing power parity (PPP) to neutralize the effects of inflation and exchange rate fluctuations. Year on year growth rates of these expenditures are then calculated to reveal the temporal dynamics of policy support intensity. Social Capital Participation (SCP) is defined as the proportion of each special budget sourced from private capital, charitable foundations and venture funds, directly reflecting market actors' willingness to enter and the depth of their engagement; numerator and denominator data for SCP are obtained from annual reports published by finance ministries, relevant foundations and industry associations (47). The Enterprise Technology Innovation Index (ETII) integrates R\&D expenditure ratios and targeted R\&D investments in smart medical devices, rehabilitation robotics and digital diagnostics. On the demand side, Smart Service Platform Construction (SSPC) is indexed by the installed base of IoT enabled monitoring devices, the number of AI driven health management platforms serving hospitals and communities, and the proportion of telemedicine systems integrated into medical consortiums; these components are standardized and aggregated. Older adult Service Institution Capacity (ESIC) is expressed as the number of beds or service slots per 1,000 individuals aged 65 and over, indicating physical service capacity. Health Insurance Reimbursement Rate (HIRR) takes each year's average reimbursement percentage of senior citizen medical expenditure under national health insurance, representing institutional payment security. Degree of Population Aging (DPA) is the share of the population aged 65 + in the total population (48).

To mitigate confounding macro environmental influences, this study employs a dynamic QCA (Qualitative Comparative Analysis) approach on the constructed panel data framework, systematically analysing the interactive effects of supply side conditions (GFI, SCP, ETII), demand side provisions (SSPC, ESIC, HIRR) and demographic pressure (DPA). This facilitates an investigation of each nation's systematic investment strategy in senior health at the country level (49).

3.2 Data calibration

As shown in Table 1, In dynamic fuzzy-set qualitative comparative analysis (fsQCA), direct calibration is pivotal for mapping raw variables onto the [0, 1] membership-degree scale in a manner that is both rigorous and robust, thereby accommodating sample heterogeneity and ensuring model comparability. Accordingly, this study adheres to established methodological practice by designating each variable's 95th, 50th, and 5th percentiles as its "full membership," "crossover point" and "full non-membership" anchors (50). On the one hand, the 95th and 5th percentiles effectively eschew distortions from extreme maxima and minima, enhancing calibration stability; on the other hand, the 50th percentile serves as the fuzzy-set midpoint—neither fully in nor fully out—ensuring a smooth transition in the membership function that faithfully reflects typical regional and variable-level distinctions across both supply and demand dimensions. Employing the anchor criteria proposed by Liu and Yi (51), we directly calibrated seven condition variables—government fiscal investment (A), social capital participation (B), enterprise technology innovation index (C), smart service platform construction (D), older adult service institution capacity (E), health insurance reimbursement rate (F) and degree of population aging (G)—together with the outcome variable, the proportion of medical-industry investment in older adult healthcare (Y). The procedure entailed first extracting the 95th/50th/5th percentile values from each variable's raw data as the critical thresholds for the membership function; subsequently, we applied a standard fuzzy-set transformation to map these thresholds into the [0, 1] interval, thereby ensuring comparability across differing units and data sources.

Calibration results are as follows: Supply-side: A's three anchors are 0.143/0.024/0.017, indicating a generally low and tightly clustered distribution; B's are 0.437/0.153/0.253, showing high discriminative power; C's are 0.427/0.156/0.273—similar to B—revealing pronounced regional variation in market-driven and

TABLE 1 Calibration of variables.

Variables	Variable name	Fully affiliated	Intersection	Completely unaffiliated
Outcome variables	The medical industry's investment ratio in senior health	0.135	0.043	0.014
Condition variable	Government fiscal investment	0.143	0.024	0.017
	Social capital participation	0.437	0.153	0.253
	Enterprise technology innovation index	0.427	0.156	0.273
	Smart service platform construction	1214.134	512.18	183.960
	Older adult service institution capacity	2143.221	137.135	121.793
	Health insurance reimbursement rate	0.713	0.485	0.264
	Degree of population aging	14.682	11.231	8.256

innovation-driven factors: Demand-side: D's anchors (1214.134/512.180/183.960) and E's (2143.221/137.135/121.793) exhibit vast spans, reflecting considerable regional divergence in technological platforms and service-supply infrastructure; F's (0.713/0.485/0.264) reveal stratified policy-protection intensity; G's (14.682/11.231/8.256) capture differences in demographic pressure. Outcome variable: Y's anchors are 0.135/0.043/0.014. Although overall low, Y possesses sufficient variance for use in subsequent causal-path analysis.

This calibration not only underscores the background-setting and reinforcing roles of the supply-side core elements (A, B, C), but also illustrates how demand-side factors (D, E, F, G) jointly shape investment behavior via technological platforms, institutional capacity, policy-based protection and demographic pressure. Building on this calibrated foundation, the forthcoming dynamic fsQCA will investigate multiple causal pathways to furnish robust empirical support for precision policy design and resource allocation (52).

3.3 Necessity analysis of the data sample

Within the panel data framework of Qualitative Comparative Analysis (QCA), necessity analysis seeks to ascertain whether a given condition (or its absence) is consistently present across all cases exhibiting the target outcome. Its principal metric is consistency, for which a threshold of 0.90 is typically adopted to designate a necessary condition; coverage then gages the substantive explanatory power of that condition for the outcome (53). As shown in Table 2, According to configurational theory grounded in Boolean algebra and set theory, reducing calibration distance can enhance the precision of consistency estimates, thereby more accurately identifying necessary conditions. Should a condition meet the consistency threshold with moderate coverage, it may be provisionally deemed a necessary precursor to the outcome.

For the necessity test of "high medical industry investment ratio in senior health (Y)," no single condition or negation thereof achieves a consistency above 0.90. The highest consistencies are observed for "\ ~ A (low Government Fiscal Investment)" and "\ ~ E (low Older Adult Service Institution Capacity)," each at 0.84 with coverages of 0.62 and 0.67 respectively; "F (high Health Insurance Reimbursement Rate)" records a consistency of 0.82 and a coverage of 0.62. Although these conditions frequently appear in high Y cases, none satisfies the threshold for necessity, indicating that a high investment ratio is not driven by any solitary factor but rather by the synergistic action of multiple conditions (54).

Similarly, for the necessity test of "low medical industry investment ratio in senior health (\ ~ Y)," no condition or its negation exceeds a consistency of 0.90. The negations "\ ~ B (low Social Capital Participation)" and "\ ~ D (low Smart Service Platform Construction)" exhibit consistencies of 0.80 and 0.77 with coverages of 0.62 and 0.64 respectively; other indicators display consistencies predominantly in the 0.65 0.75 range. Thus, low investment ratios are likewise not determined by any single necessary condition. Overall, the sample warrants close attention to those conditions with relatively high consistency (>0.80) yet falling short of the threshold, as these will inform the empirical basis for multi condition configurational testing in the subsequent fsQCA pathway analysis (55).

3.4 Configurational analysis

As shown in Table 3, prototypical high-income nations in Asia, South Korea and Japan, leveraging their robust public-health systems and digital governance mechanisms, initiated systematic strategic investment in the older adult-healthcare sector as early as 2014 under their respective National Health Insurance Service (NHIS/HIRA) and Long-Term Care Insurance (LTCI) schemes. This study adopts a dual supply–demand perspective, selecting three supply-side variables—Government Fiscal Investment (GFI), Social Capital Participation (SCP) and Enterprise Technology Innovation Index (ETII)—and four demand-side variables—Smart Service Platform Construction (SSPC), Older Adult Service Institution Capacity (ESIC), Health Insurance Reimbursement Rate (HIRR) and Degree of Population Aging (DPA)—to construct an annual panel dataset for both countries covering 2014–2023. Employing dynamic fuzzy-set qualitative comparative analysis (fsQCA), we distill four prototypical configurational pathways (Parameterizations 1–4) and quantitatively evaluate each pathway's consistency, original coverage, PRI score, and adjusted within- and between-case distances, thereby elucidating diverse combination patterns for achieving a high proportion of medical-industry investment in older adult healthcare under varying policy imperatives and demographic pressures.

Across the four prototypical configurational pathways identified in this study (P1–P4), each exemplifies the interactive mechanisms and policy implications of supply- and demand-side factors under varying developmental stages and institutional contexts. Firstly, Pathway 1 (P1) is driven primarily by high Government Fiscal Investment (GFI), high Enterprise Technology Innovation Index (ETII) and high Older Adult Service Institution Capacity (ESIC); despite low Social Capital Participation (SCP), Smart Service Platform Construction (SSPC) and Health Insurance Reimbursement Rate (HIRR), a pronounced Degree of Population Aging (DPA) still delivers a high investment ratio (Consistency = 0.850, Coverage = 0.302). This configuration typifies the early reform phase, wherein the government leads by deploying special budgetary measures to support technology firms and rapidly expanding offline beds and care slots to fill the gaps left by nascent private capital and digital services. Secondly, Pathway 2 (P2) combines high GFI with high SCP alongside elevated ESIC and HIRR; even with ETII and SSPC at nascent levels, the "capital + institution" dual-engine model maximizes investment efficiency (Consistency = 0.821, Coverage = 0.339). This configuration illustrates the 'amplifier' effect of robust institutional safeguards on private capital participation—underpinned by mature public insurance and regulatory frameworks in South Korea and Japan—whereby social capital secures more reliable return expectations and, through compliant operation, drives simultaneous growth in project scale and service quality. Pathway 3 (P3) emphasizes the triad of "government-led + corporate innovation + smart platforms": in the context of significant aging pressure, high GFI, ETII and SSPC synergise to sustain high investment ratios via intelligent care and telemedicine pilots, even when ESIC and HIRR are relatively weak (Consistency = 0.912, Coverage = 0.219). This configuration, exemplified by Japan's community-based, Internet + healthcare models, demonstrates the transformative potential of digital technologies on traditional care paradigms. Finally, Pathway 4 (P4) highlights the substitutive and complementary roles of market mechanisms and insurance capital: with comparatively limited GFI, a coalition of high SCP, advanced

10.3389/fpubh.2025.1629981

TABLE 2 Data necessity test.

Variant	Aggregate consistency	Aggregate coverage	Inter-group consistency	Intra-group consistency
The medical industry's investment ratio in senior health (Y)				
A	0.65	0.71	0.05	0.05
~A	0.84	0.62	0.02	0.04
B	0.75	0.60	0.03	0.03
~B	0.67	0.62	0.04	0.05
C	0.74	0.73	0.03	0.06
~C	0.72	0.68	0.02	0.07
D	0.74	0.67	0.04	0.06
~D	0.69	0.62	0.05	0.07
E	0.73	0.62	0.03	0.04
~E	0.84	0.67	0.04	0.04
F	0.82	0.62	0.03	0.03
~F	0.81	0.63	0.05	0.04
G	0.76	0.68	0.04	0.03
~G	0.68	0.61	0.03	0.04
The medical industry's investment ratio in senior health (~Y)				
A	0.78	0.43	0.01	0.05
~A	0.72	0.66	0.03	0.03
B	0.70	0.35	0.02	0.06
~B	0.80	0.62	0.04	0.04
C	0.72	0.62	0.02	0.02
~C	0.75	0.64	0.03	0.05
D	0.73	0.61	0.04	0.06
~D	0.77	0.64	0.06	0.07
E	0.64	0.62	0.02	0.05
~E	0.78	0.60	0.07	0.04
F	0.82	0.53	0.05	0.07
~F	0.71	0.65	0.04	0.06
G	0.72	0.61	0.07	0.06
~G	0.65	0.71	0.05	0.04

technology (ETII), mature SSPC, ample ESIC and high HIRR collectively compensates for fiscal shortfalls, sustaining elevated investment ratios (Consistency = 0.815, Coverage = 0.264). This pathway indicates that, when public resources are constrained, diversified market actors and comprehensive payment-protection schemes can collaboratively construct a 'community-oriented' eldercare ecosystem, integrating private capital with public services. Collectively, these configurations reveal that under different policy stimuli and demographic pressures, government funding, market dynamism and technological innovation achieve dynamic equilibrium through multiple combinations, with smart platforms, institutional capacity and protection mechanisms forming the cornerstones of sustainable investment growth. For policymakers, it is advisable to adapt and refine these configurational elements in accordance with national or regional fiscal capacity, social-capital market maturity and digital infrastructure readiness to attain optimal and enduring allocations of medical-industry investment in older adult healthcare.

Comparative analysis of these four pathways yields the following policy implications: first, governments should fully leverage fiscal levers in synergy with social capital and technological innovation, avoiding "isolation" of single policy tools; second, under high aging pressure, priority support for SSPC via digital means can enhance resource utilization in medical and long term care; third, when aging pressure is lower or fiscal space is constrained, raising HIRR and ESIC alongside diversified private capital incentives can achieve "market + institution" complementarity; finally, policy packages should be tailored flexibly to different institutional frameworks and developmental stages to meet heterogeneous regional needs.

3.5 Configuration robustness analysis

To verify the reliability and robustness of the principal model's configurational results, As shown in Table 4 this study conducted

10.3389/fpubh.2025.1629981

TABLE 3 Configuration analysis results.

Conditional variables	Parameterization 1	Parameterization 2	Parameterization 3	Parameterization 4
(A) Government fiscal investment	●	●	●	●
(B) Social capital participation		●	⊗	●
(C) Enterprise technology innovation index	●		●	●
(D) Smart service platform construction	⊗	●	⊗	
(E) Older adult service institution capacity	●		●	●
(F) Health insurance reimbursement rate		●		
(G) Degree of population aging	●	●	●	●
Consistency	0.850	0.821	0.912	0.815
Original coverage	0.302	0.339	0.219	0.264
Unique coverage	0.056	0.127	0.032	0.032
PRI	0.624	0.577	0.631	0.641
Inter-group consistency adjusted distance	0.052	0.024	0.021	0.017
Intra-group consistency-adjusted distance	0.034	0.025	0.037	0.024
Overall PRI	0.613			
Overall consistency	0.832			

multiple sensitivity tests on key parameters namely the consistency threshold, calibration anchor points and case inclusion beyond the original four typical pathways (Parameterization 1 4). Post-testing, the consistency values for the four configurations remained stable between 0.773 and 0.853, closely aligning with the main model's range of 0.815 0.912. The original coverage fluctuated only modestly between 0.211 and 0.254, versus 0.219 0.339 in the primary analysis, indicating that the breadth of each pathway's explanatory reach was not materially reduced by parameter tweaks. PRI values also held steady at 0.475 0.547, comparable to the initial 0.577 0.641, demonstrating that the discriminative power and directional clarity of each pathway remained intact. Furthermore, the maximum adjusted between-set distance stayed at a mere 0.031, and the highest within-set distance was only 0.024 figures akin to the original model's between 0.017 0.052 and within 0.025 0.037 ranges underscoring that the granularity and consistency characteristics of the causal configurations were preserved despite anchor repositioning and outlier exclusion.

These robustness checks confirm that all four identified pathways "Government Fiscal Investment + Enterprise Technology Innovation Index + Older Adult Service Institution Capacity," "Government Fiscal Investment + Social Capital Participation + Health Insurance Reimbursement Rate," "Government Fiscal Investment + Enterprise Technology Innovation Index + Smart Service Platform Construction" and "Social Capital Participation + Enterprise Technology Innovation Index + Health Insurance Reimbursement Rate + Smart Service Platform Construction" exhibit high consistency and replicability, remaining resilient to parameter adjustments and sample variations. This consistency across theoretical thresholds and data-quality controls affirms the empirical support for our causal-configurational analysis of systematic strategic investment in senior health in Japan and South Korea, and further enhances the external validity and policy relevance of our findings.

3.6 Country coverage analysis

Based on the 2014 2023 fsQCA analysis for senior health in South Korea and Japan, the four typical configurations (P1 P4) exhibit marked national differences in coverage. As shown in Table 4 South Korea outperforms Japan in Configurations 1, 2 and 4, with Configuration 4 (market + high end technology + digitalization + capacity + reimbursement) achieving the highest coverage of 0.478. This indicates that when Government Fiscal Investment is constrained, Korea swiftly fills public service gaps by liberalizing insurance capital and pursuing market reforms. By contrast, Japan's coverage distribution is more balanced, with no single pathway dominating. This divergence not only reveals diversified policy combinations employed by the two countries in response to rapid aging but also underscores the crucial role of institutional design and implementation pace in raising the medical industry investment ratio in senior health.

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TABLE 4 Configuration robustness analysis results.

Conditional variables	Parameterization 1	Parameterization 2	Parameterization 3	Parameterization 4
(A) Government fiscal investment	●	●	●	
(B) Social capital participation			⊗	●
(C) Enterprise technology innovation index	●	●	●	●
(D) Smart service platform construction	⊗	●	⊗	⊗
(E) Older adult service institution capacity	●		●	●
(F) Health insurance reimbursement rate		●		
(G) Degree of population aging	●	●		●
Consistency	0.817	0.792	0.853	0.773
Original coverage	0.242	0.234	0.211	0.254
Unique coverage	0.031	0.116	0.028	0.027
PRI	0.526	0.475	0.547	0.516
Inter-group consistency adjusted distance	0.031	0.016	0.020	0.015
Intra-group consistency-adjusted distance	0.021	0.019	0.024	0.021
Overall PRI	0.506			
Overall consistency	0.812			

As shown in Table 5, a comparison of configurations shows that P1 ("Government Fiscal Investment + Enterprise Technology Innovation Index + Older Adult Service Institution Capacity") has a coverage of 0.317 for Korea versus 0.233 for Japan: Korea's earlier use of special budgets to expand beds and care slots significantly boosted initial investment efficiency, whereas Japan relied more on subsequent intelligent retrofitting. P2 ("Government Fiscal Investment + Social Capital Participation + Health Insurance Reimbursement Rate + Older Adult Service Institution Capacity") scores 0.421 for Korea and 0.377 for Japan: Korea's active attraction of private capital and service expansion drove a "funding + institution" dual engine, whereas Japan's regional reimbursement discrepancies and cautious capital admission slightly dampened private-sector incentives. P3 ("Government Fiscal Investment + Enterprise Technology Innovation Index + Smart Service Platform Construction") is higher in Japan (0.325) than Korea (0.273): Japan's large-scale pilots in telemonitoring and AI diagnostics since 2017 have made smart services central to addressing deep aging; Korea, although accelerating digitalization, remains limited by institutional capacity and reimbursement. The most pronounced gap appears in P4 ("Social Capital Participation + Enterprise Technology Innovation Index + Smart Service Platform Construction + Older Adult Service Institution Capacity + Health Insurance Reimbursement Rate"), at 0.478 for Korea versus 0.327 for Japan: Korea's market reforms and insurance-capital openness have yielded a richer diversity of service provision, whereas Japan's reform has proceeded more cautiously due to institutional inertia and decentralization.

In light of these coverage disparities, policy design should first implement differentiated support: regions experiencing deep aging may emulate Japan's mature Smart Service Platform Construction and telecare pilots by increasing investment in AI assisted diagnosis and digital health management; areas under fiscal strain but with strong market vigor could follow Korea's market reform path by relaxing insurance and private capital entry thresholds to leverage diverse funding for service provision. Simultaneously, coordination between Older Adult Service Institution Capacity development and Health Insurance Reimbursement Rate policies must be strengthened by modestly raising bed and care slot standards and streamlining reimbursement procedures to ensure service supply matches demand. Building a closed loop mechanism encompassing Government Fiscal Investment, Social Capital Participation, Health Insurance Reimbursement Rate and digital services is essential to drive cross-departmental regulatory collaboration. For configurations with lower coverage, emphasis should be placed on bolstering Enterprise Technology Innovation Index support and enhancing public private partnership (PPP) management capabilities. Finally, under a dynamic evaluation and localized framework, fsQCA and other mixed quantitative qualitative methods should be continuously applied to monitor each pathway's fit at different development stages and flexibly optimize factor combinations according to local institutional

TABLE 5 Configuration country coverage analysis.

Configuration 1	Configuration 2	Configuration 3	Configuration 4
0.317	0.421	0.273	0.478
0.233	0.377	0.325	0.327

foundations, demographic profiles and fiscal capacity thereby achieving the optimal balance between resource efficiency and service quality in senior health.

4 Discussion

This study utilizes a dynamic fuzzy-set qualitative comparative analysis (fsQCA) to systematically uncover the multifaceted synergistic mechanisms among seven dimensions: government fiscal investment, social capital participation, enterprise technology innovation index, smart service platform construction, older adult service institution capacity, health insurance reimbursement rate, and degree of population aging. Our findings demonstrate that no single factor can independently drive high levels of medical-industry investment in senior health; only the four-dimensional linkage of "fiscal leverage + market incentives + digital empowerment + institutional safeguards" can markedly enhance resource allocation efficiency and policy effectiveness. Comparative analysis between Japan and South Korea reveals that South Korea achieves greater configurational coverage in the government-led (P1), capital-institution dual-engine (P2) and multi-compensation (P4) pathways, reflecting its advantage in rapidly expanding care resources and mobilizing insurance capital via subsidies and tax incentives, yet still requires improvements in smart-platform deployment and digitalized reimbursement. Conversely, Japan excels in the "innovation + platform-led" (P3) pathway, having accrued substantial expertise in telemedicine and smart eldercare—particularly in AI-assisted diagnostics, chronic-disease management and insurance payment reform.

For South Korea, while continuing to leverage fiscal support and private investment, priority should be given to integrating smart platforms within the national insurance scheme by introducing differentiated reimbursement schedules and performance-based bonuses, thereby incentivizing remote monitoring, AI-enabled diagnostics and big-data analytics. Simultaneously, a "Government–Social Capital Elder-Care Fund" and risk-sharing mechanisms should be established to lower barriers for private investors and encourage the construction of high-standard care hubs in under-served areas, ensuring a balanced expansion of institutional capacity and digital services. For Japan, to capitalize on its smart-care and telemedicine lead, regulatory barriers to social and insurance capital entry should be eased: the national insurance system ought to broaden coverage to include smart-care devices and remote-service fees, while regulatory sandboxes could be introduced to pilot novel service models and commercial insurance products. Furthermore, Japan should adopt South Korea's model of fiscal subsidies and tax breaks for capacity expansion, promoting public–private partnerships to augment bed capacity in response to rising care demand. Both nations should harness data interoperability and policy coordination to forge a sustainable integrated care system anchored on "fiscal leverage + market incentives + digital empowerment + institutional safeguards."

5 Conclusion and implication

5.1 Conclusion

Through dynamic fsQCA analysis of seven supply demand variables and investment ratios in the senior health sector of South Korea and Japan (2014, 2023), this study uncovers the driving mechanisms by which combinations of Government Fiscal Investment, Social Capital Participation, Enterprise Technology Innovation Index, Smart Service Platform Construction, Older Adult Service Institution Capacity, Health Insurance Reimbursement Rate and Degree of Population Aging yield a high medical industry investment ratio in senior health.

First, configurational pathways demonstrate that single policy instruments cannot independently achieve a high investment ratio; coordinated action across the four dimensions of "fiscal leverage + market incentives + digitalization + institutional safeguards" is indispensable. P1 and P2 reveal the complementary effect of concurrent Government Fiscal Investment and Social Capital Participation: the former lays groundwork during early institutional reform through special budgets and bed capacity expansion, while the latter magnifies investment efficiency in mature phases with high reimbursement rates and private engagement. P3 underscores the critical role of Smart Service Platform Construction, indicating that under intense aging pressure, traditional supply side expansion alone is insufficient to meet diverse care needs and must be supplemented by digital services such as remote monitoring and AI assisted diagnosis. P4 illustrates the substitutive function of market mechanisms and insurance capital where fiscal support is limited, diversified capital and technological platforms can still sustain a high investment ratio.

Second, differences in policy pacing and institutional frameworks between Japan and South Korea explain coverage variations. South Korea's higher coverage in P1, P2, and P4 reflects its more aggressive market reforms and insurance capital liberalization; Japan's lead in the P3 Smart Service Platform Construction pathway stems from continuous investment in telecare pilots and AI technology demonstrations since 2017. Accordingly, countries or regions should dynamically adjust policy mixes: areas with robust fiscal capacity but weak market activity should prioritize incentives for social capital and technological innovation; fiscally constrained regions with solid private provision should ease capital entry and strengthen public private partnerships; and amid deep aging, Smart Service Platform Construction ought to be elevated in policy priority to enhance resource utilization efficiency through digital means.

Finally, despite advantages in data completeness and methodological innovation, this study has limitations. The panel

dataset is confined to Japan and South Korea, and its external validity warrants testing through broader comparative research. Moreover, fsQCA excels at revealing causal path combinations but does not quantify the elasticity or marginal effects of individual factors. Future work could integrate in depth case interviews and randomized controlled trials to refine understanding of Smart Service Platform Construction and Social Capital Participation mechanisms, and extend analysis to provinces or additional countries to improve generalizability and policy operability.

5.2 Theoretical implication

Utilizing dynamic fsQCA, this research highlights the interactive and composite effects of five elements fiscal investment, social capital, technological innovation, digital platforms and institutional safeguards. Contrary to traditional single factor analyses, it finds that a high investment ratio is not driven by any solitary factor but by their mutual supplementation across multiple pathways. This conclusion resonates with the "synergy" concept in complexity governance theory, suggesting that scholars and policymakers should eschew isolated, tool based interventions in favor of a holistic, multi dimensional linkage framework that concurrently addresses fiscal levers, market mechanisms, technological support and social protection.

The results also demonstrate the prevalence of "equifinality" in eldercare investment: whether through government leadership plus capacity expansion, market driven high end technology, or digital empowerment with insurance capital engagement, each combination can yield high investment levels within its respective institutional environment. This aligns with integrated governance theory's emphasis on accepting diverse pathways, underscoring the context dependency of policy outcomes and the need for evaluative models that categorize scenarios by institutional arrangements, demographic structures and fiscal capacity thereby improving replicability and adaptability of policy measures.

By comparing Japan and South Korea's configurational coverage and pathway differences, the study validates the profound influence of institutional embeddedness and path dependence in public service reform. South Korea's rapid market reforms and insurance capital openness, alongside Japan's gradual evolution of smart platform pilots, both illustrate how institutional inertia and technological experimental fields shape policy development. Future theoretical research should integrate institutional embeddedness and technological innovation into dynamic evolution models, examine mechanisms for adjusting factor weights across development stages, and explore policy feedback pathways within multi level governance networks, thus constructing a more comprehensive theoretical framework for senior health public service reform.

5.3 Limitation and future research

Although based on annual panel data from 2014 to 2023 covering key supply demand variables in Japan and South Korea's senior health sectors, this study has limitations. First, the annual frequency may obscure policy adjustments and short term fluctuations at quarterly or monthly intervals, potentially masking the effects of time sensitive innovation pilots. The seven condition variables exclude micro level factors such as family support and community mutual assistance, slightly reducing the model's capacity to identify impacts of individual and social network behaviors. Dynamic fsQCA highlights configurational diversity and parallel pathways, yet regional heterogeneity in fiscal policy, demographic structure and digital development within each country is not fully captured at the national level, limiting the precision of cross regional policy recommendations.

To deepen understanding of diverse eldercare investment pathways, future research could: (1) incorporate quarterly or monthly data to capture dynamic policy implementation rhythms and short term shocks; (2) extend the analysis to other high and middle income countries to test external validity and institutional fit of configurational pathways; (3) include micro level factors such as family support, community mutual assistance and individual health behaviors to enrich the demand side perspective; (4) combine cost effectiveness and quality feedback indicators in mixed methods research to explore the trade off between resource allocation efficiency and service quality across different configurations; and (5) focus on institutional adjustments and long term effects following public health crises (e.g., the COVID 19 pandemic) to provide empirical support for building more resilient eldercare systems.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found at: https://www.korea.go.kr/ https://www.kantei.go.jp.

Author contributions

XL: Software, Funding acquisition, Conceptualization, Writing – review & editing, Formal analysis, Writing – original draft, Resources, Project administration, Methodology. PT: Investigation, Writing – original draft, Software, Formal analysis, Funding acquisition, Data curation, Project administration, Conceptualization, Validation, Writing – review & editing, Methodology, Supervision. BZ: Writing – original draft, Methodology, Software, Funding acquisition, Data curation, Visualization, Resources, Supervision, Project administration, Writing – review & editing, Validation.

Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2025.1629981/full#supplementary-material

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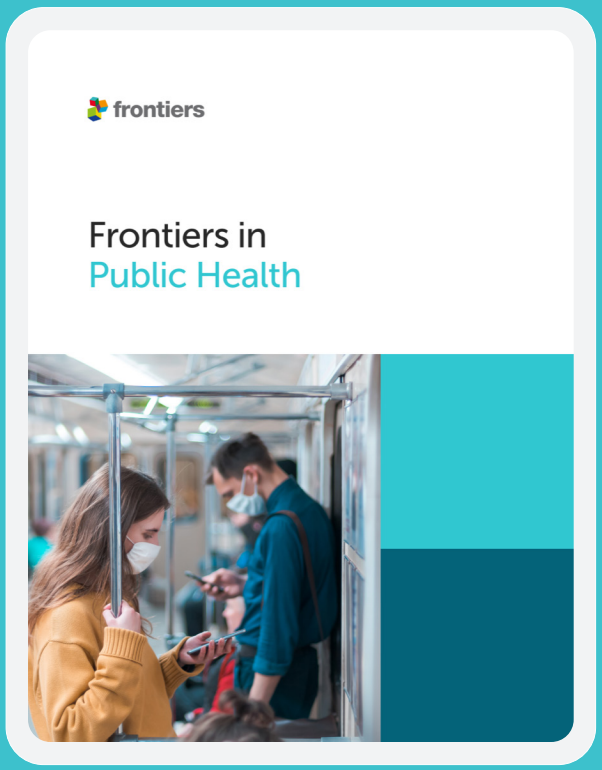

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