ORIGINAL RESEARCH

Sanming Model of Medical Service Integration: Impact on Medical Expenditures, Service Provision, and Resource Allocation in China

Kunhe Lin [1],*, Xiao Liu[2],*, Li Xiang[1], Fei Luo[3]

[1]Department of Health Management, School of Medicine and Health Management, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, People's Republic of China; [2]Department of Medical Affairs, Wuhan No. 1 Hospital, Wuhan, People's Republic of China; [3]Department of Research, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, People's Republic of China

*These authors contributed equally to this work

Correspondence: Fei Luo, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, No. 1277 Jiefang Avenue, Wuhan, People's Republic of China, Email 267115670@qq.com

Background: Fragmentation of healthcare services has been a central issue, contributing to escalating medical expenditures and service provision, thereby exacerbating the waste of limited medical resources. In response, China has introduced the Sanming Mode, a medical service integration model designed to address these challenges. This study evaluates the model's impact on medical expenditures, service provision, and resource allocation.

Methods: We conducted an interrupted time series analysis on outcome variables related to medical expenditures, service provision, and resource allocation in Sanming City. The dataset encompassed operational data from all public hospitals and community health service institutions in Sanming from January 2016 to November 2019.

Results: Post-reform, the monthly medical expenditures, outpatient visits, and inpatient admissions in Sanming City shifted from a rapid growth trend to a slower growth trend, with slopes decreasing by 0.1%, 1.4%, and 0.5%, respectively. Heterogeneity analysis between hospitals and community health service institutions revealed a more pronounced slowdown in the growth rate of monthly medical expenses in community health service institutions. However, the growth rates for outpatient and inpatient visits in hospitals significantly decreased post-reform, while there was no significant change observed in community health service institutions.

Conclusion: The Sanming Model represents a significant localized attempt to integrate hospital and community health services in China. It effectively curbs the rapid growth of medical expenditures and service provision, thereby reducing the consumption of basic medical insurance funds. The Model enhances the efficiency of medical resource utilization and promotes a shift in service provision from hospitals to community health service institutions, reflecting a trend in resource allocation that concentrates serious illnesses in hospitals while directing minor health issues to community health service institutions. This positive impact promotes the effective integration and rational allocation of medical resources.

Keywords: medical service integration, Sanming model, health expenditures, resource allocation, healthcare efficiency, Community Health Service Institutions

Introduction

The integration of medical services aims to create a convenient, sustainable, and efficient health system that better meets the health needs of the population. In 2007, the Director-General of the World Health Organization (WHO) emphasized the need for a comprehensive, integrated approach to service delivery, stating, "We need to fight fragmentation".[1] In 2016, WHO reiterated this call, highlighting the need for integrated health services that coordinate medical institutions at all levels to provide lifelong, coherent care tailored to health needs.[2] Research has shown that collaboration between hospitals and community health service institutions is increasingly recognized as a crucial strategy for enhancing

healthcare coordination and integrating health services.[3,4] For instance, the integrated delivery network in the USA, managed by a parent company and comprising several hospitals and community health service institutions, collaboratively provide a range of services. This model improves service accessibility, optimizes resource utilization, and reduces medical expenses.[5] Similarly, Singapore has restructured its regional medical system to integrate hospitals with community health service institutions, transferring care to local communities and achieving sustainable universal healthcare coverage.[6]

Globally, health resources are relatively scarce, particularly in low- and middle-income countries (LMICs), where many hospitals face significant challenges, such as low efficiency and resource wastage.[7] Institutional integration may serve as a vital approach to enhance resource utilization in these settings. However, LMICs typically have more limited financial investment in healthcare compared to high-income countries, which can hinder integrated organizations from avoiding competition. Hospitals often operate in a competitive environment and require substantial revenue to support their development, potentially exacerbating issues of resource allocation among community health service institutions. Therefore, the institutional integration of healthcare in LMICs necessitates a systematic and thoughtful approach.

China, like many other LMICs, is characterized by a predominance of public hospitals, which grapple with challenges related to waste and inefficiency. These public hospitals operate independently, undermining community health service institutions and leading to notable fragmentation of health services. Consequently, effectively controlling unreasonable services and reducing waste in hospitals, as well as promoting continuous health services, have emerged as two pressing issues in China's medical reform. Despite China's active implementation of comprehensive medical reform since 2009, the outcomes have not been as significant as expected.[8,9] In 2016, China issued the "Outline of the Healthy China 2030 Plan", emphasizing the importance and urgency of integrating medical services.[10] In response, the Chinese government has promoted multitype medical alliances (MAs), which aim to integrate vertical and horizontal medical institutions within specific regions to enhance medical service integration and resource sharing.[11] However, challenges persist within these regions. For example, the rising volume of patients remains hard to control, and medical expenditures show an imbalance between different institutions.[12,13] A survey indicated that 62.6% of respondents believe that MAs in China have yet to fulfill their intended role.[14]

China's MAs primarily achieve the vertical integration of medical resources across administrative hierarchies and asset ownership through asset restructuring, trusteeship arrangements, contracts, or partnerships among hospitals and community health service institutions, creating varying degrees of integration. The core goals of this reform are to reduce transaction costs and control expense growth by internalizing external markets and allocate hospital and community health resources more effectively, guiding patients to seek care in a hierarchical and orderly manner, thus providing integrated medical services.[15,16] Since the policy's release in 2017, 94.7% of Chinese cities have implemented MAs. However, many cities' MAs prioritize form over substance and quantity over quality, leading to limited reform outcomes.[9,17] Furthermore, several significant challenges confront MA reforms across various cities.

The first issue is the chaotic governance structure of China's MAs. In terms of the external governance structure, MAs are managed by various government departments, such as the health administration department, medical insurance department, financial department, personnel department, and the Organization Department. For example, the health administration department is responsible for the establishment and daily supervision of medical institutions; the medical insurance department oversees patient cost compensation; the finance department handles the annual government appropriation for MAs; the personnel department manages staffing for MAs; and the organization department is in charge of the appointment, removal, and promotion of personnel. Moreover, the objectives of these departments are often inconsistent.[18] For instance, the medical insurance department aims to achieve good medical outcomes with minimal expenses, while the finance department seeks to minimize government funding; the personnel department aims to control staff numbers. The limited autonomy of MAs and the poor coordination among external government management departments inevitably lead to ineffective self-regulation within MAs. Regarding the internal governance structure, most medical institutions within MAs are independent legal entities, making it difficult to achieve coordinated planning for the distribution of interests, personnel allocation, and so on.[12] Furthermore, hospitals within MAs hold a comparatively dominant position, and the resulting conflicts of interest can undermine the survival of community health services.

Meanwhile, the economic incentive mechanism of MAs is inadequate. Externally, the government finance department provides only a small amount of differential funding to hospitals based on staffing, and hospitals have long operated under the "independent operation and responsible for their own profits and losses" model. As a result, hospitals establish MAs to compete for patient resources and expand their market share, which deviates from the policy goals of medical alliance construction. In recent years, studies have shown that bundled payment systems for individual hospitals can help control costs.[19,20] However, the independent settlement of MAs' internal institutions by medical insurance impedes the overall financial planning and cost control of MAs. Furthermore, given their own interests, it is difficult for medical institutions to align with the goals of the MAs. In terms of the internal economic incentive mechanism, many hospitals within MAs still implement a salary system where medical staff earn higher salaries based on higher business income. To maximize their personal benefits, medical staff have little incentive to control costs, and they are not motivated to refer patients to community health services. As a result, the goal of integrating health services is difficult to achieve.

Among the various models of reform, the Sanming model has gained prominence. Sanming City has restructured its internal and external governance methods, integrating all medical institutions across its 12 administrative regions into 12 MAs. The systematic reform approaches and positive outcomes of Sanming have captured the attention of China's top leaders. In 2021, the National Health Commission recognized the Sanming model as a national benchmark and issued promotion policies to support its implementation.[18]

The Sanming model serves as a prominent example of integrated healthcare services that is being emulated nationwide in China. We conduct a descriptive analysis of the impact of the Sanming model on healthcare expenditures, service provision, and resource allocation, followed by further statistical analysis using Interrupted Time Series Analysis (ITSA). By examining the reform measures of the Sanming model, we aim to identify the underlying factors contributing to its effects. This study provides insights for promoting medical service integration in LMIC. We seek to address two key questions: First, has the Sanming model effectively reduced healthcare expenditures and unnecessary service provision while enhancing the efficiency of medical resource utilization? Second, have hospitals and community health service institutions improved the allocation of medical resources and facilitated the integration of healthcare services? Through our analysis of the Sanming model, we aim to gain a clearer understanding of its effects on healthcare costs, service provision, and resource allocation.

Materials and Methods
Study Setting

Sanming, located in Fujian Province, China, is an economically disadvantaged city with a large population of retired workers, while also facing a noticeable outflow of middle-aged and young residents. The limitations and unsustainability of its previous health system have also become increasingly apparent.[19,20] The contradiction between the sustainability of the medical insurance fund and the rapidly growing demand for medical services became a key opportunity for Sanming to initiate the reform. With the encouragement of the central government, Sanming achieved full systematic MA reform citywide by October 2017. Unlike the fragmented approaches taken in other cities, Sanming established a comprehensive MA construction plan centered on two key areas: governance structure and economic incentives. Table S1 provides detailed descriptions of these measures (Supplementary Material 1).

First, Sanming City restructured its governance model to address the decentralized and inconsistent leadership of MAs. Externally, Sanming City established unified oversight by centralizing relevant medical department authorities under a vice mayor. Additionally, a leading group for MA development was created, led by the vice mayor and including regional government heads as members, thereby resolving interdepartmental conflicts and clarifying government objectives for external MA governance. Internally, the city's 12 MAs integrated all public hospitals and community health service institutions within each region, forming unified organizations with a single legal representative. MA directors oversee these organizations, reducing fragmentation among internal medical institutions. Directors are granted expanded powers in management, personnel, and finances, fostering greater initiative and accountability.

Second, Sanming City implemented incentive-based reforms to optimize the economic incentives and reduce inappropriate behaviors within MAs. Externally, MAs qualify for an annual surplus reward if they meet government

 207

objectives through a global budget and performance-based payment system. Conversely, non-compliance requires compensation for associated deficits. For example, hospitalization expenses are paid according to DRGs, with limits on patient out-of-pocket costs, and any excess costs are borne by the hospital. Directors' salaries, funded by the government, are performance-based and tied to objectives such as cost control effectiveness and the utilization rate of community health service institutions, thus aligning director incentives with government goals. Internally, MAs reformed employee compensation to link annual salaries with director assessments, medical revenue, and the annual surplus of bundled insurance payments. Medical revenue includes income from treatments, surgeries, and care but excludes income from drugs, materials, tests, and inspections. Employee annual salaries are calculated based on work points derived from specific indicators, including medical revenue, outpatient visits, discharged patients, and risk control, with cost control accounting for 25% of the total assessment. This structure aligns employee behavior with MA performance goals, which in turn reflect government priorities. If MAs face salary shortfalls, the government provides financial support to ensure stable income levels, reducing profit-driven behaviors and securing staff income through government funding.

Study Design and Data Sources

The research design is based on retrospective comparative analysis. This study used official data from the Sanming Health Commission from 2016 to 2019 for analysis. The data sources include the "Annual Health Development Report of Sanming" and the "Monthly Report on the Operation of Medical Institutions in Sanming." The "Annual Health Development Report of Sanming" provides information on medical insurance funds, medical expenditures, and service provision for hospitals and community health service institutions in Sanming from 2016 to 2019. The "Monthly Report on the Operation of Medical Institutions in Sanming" includes data on medical expenditures and service provision for all hospitals and community health service institutions in Sanming during the same period. Due to the focus of the Sanming Model on public healthcare institutions, all private medical facilities were excluded from this study. In total, Sanming comprises 12 MAs, which include 31 public hospitals and 143 community health service institutions. The decision to limit the data collection to 2019 was made due to the outbreak of the COVID-19 pandemic in 2020, which introduced significant bias into the data; therefore, data from December 2019 onwards were excluded from the ITSA.

The emergence of the Sanming model aims to promote the integration of medical services, facilitate effective collaboration between hospitals and community health service institutions, and enhance the efficiency of medical resource utilization. Consequently, our study design includes a comparative analysis of changes in service provision, medical expenditures, and medical insurance fund expenditures before and after the implementation of the Sanming model. Additionally, we conducted a stratified analysis based on institutional type—hospitals and community health service institutions—to examine the impact of the Sanming model on resource allocation. This analysis reflects the distribution of medical expenditures and service provision, thereby illustrating the effects of medical service integration.

Outcome Variables

This study aims to analyze the impact of the Sanming model on medical expenditures, service provision, and the allocation of medical resources. Consequently, the outcome variables include two dimensions: medical expenditures and service provision. The medical expenditure variable uses the total amount of medical expenditure (including outpatient and inpatient medical expenditures) to measure the overall consumption of medical resources. Since the expenditure level of medical insurance funds can also indicate the consumption of healthcare resources, supplementary analysis will be conducted on this dimension. The service provision variables include the number of outpatient visits and inpatient admissions, which reflect the demand for outpatient and inpatient services. To elucidate the impact of the reform on resource allocation between hospitals and community health service institutions and to explore the effects of integrated healthcare services, a stratified analysis of the aforementioned dimensions will be performed based on institution types (hospital and community health service institution).

Statistical Analysis

This study utilizes the aforementioned outcome indicators to conduct descriptive analyses through annual comparisons before and after the reform, covering the period from 2016 to 2019. The ITSA will be employed to analyze monthly data

and determine the effects of the reform. The reform implementation date is set as October 2017, marking the intervention point for the reform. The time series for pre-reform data spans from January 2016 to September 2017, while the post-reform series covers October 2017 to November 2019, allowing for an examination of the changes in monthly data trends before and after policy implementation. The ITSA regression model is specified as follows:

$$Y_t = \beta_0 + \beta_1 \times T + \beta_2 \times X_t + \beta_3 \times T \times X_t + \varepsilon_t$$

Where Y_t represents the value of the outcome indicator at time point t; β_0 is the baseline level of the outcome indicator when t = 0; β_1 is the trend estimate of the independent variable prior to the Sanming global capitation reform as it varies with the time variable t; β_2 indicates the instantaneous change at the policy implementation point; and β_3 reflects the change in slope following the reform, such that $\beta_1 + \beta_3$ represents the post-intervention slope. T denotes the continuous monthly time variable ranging from 1 to 47, corresponding to the study duration. X_t is coded as 0 prior to the Sanming reform and 1 during the reform period; $T \times X_t$ is an interaction term, taking the value of 0 before the reform and T afterwards. The error term ε_t accounts for random errors.

Using the reform initiation as the cutoff point, the model will be fitted using piecewise ordinary least squares (OLS) regression to test for significant differences in regression coefficients before and after the intervention. Seasonal factors will be removed using the moving average ratio method. If the Breusch-Godfrey test indicates significant autocorrelation in the indicator variables, the Newey-West estimator will be applied to adjust the treatment variable model, controlling for the effects of autocorrelation on parameter estimates in the regression model. All statistical analyses will be conducted using Stata 17.0, with statistical significance determined at the 1%, 5%, and 10% levels.

Results

Descriptive Statistics

Table 1 presents the composition of medical expenditures for all institutions, including hospitals and community health service institutions, in Sanming City. From 2016 to 2019, medical expenditures showed an upward trend in both hospitals and community health service institutions. The proportion of expenditures in hospitals decreased from 91.1% to 89.8%. Conversely, the proportion for community health service institutions increased from 8.9% to 10.1%, demonstrating a steady annual rise.

Table 2 compares the balances of the basic medical insurance fund before and after the reform. With the aging population and a slowdown in the growth of the working-age population, the old-age dependency ratio in Sanming City declined from 1.64:1 to 1.47:1. Consequently, the sustainability risk of the basic medical insurance fund gradually increased. However, from 2016 to 2019, both employee medical insurance and resident medical insurance maintained a balanced fund, indicating relative stability in fund operations. Meanwhile, the fund surplus rate rose from 7.53% in 2016 to 19.98% in 2019. Since the implementation of the Sanming model reform in October 2017, the fund balance rate has increased by 4 to 6 percentage points.

Table 3 reflects the changes in service provision before and after the reform. From 2016 to 2019, the outpatient volume in Sanming City increased from 9,209,821 to 11,361,033, indicating a positive trend. The inpatient volume also

Table 1 Distribution of Medical Expenditures in Medical Institutions from 2016 to 2019

Year	Medical Expenditure (10k CN¥)	Hospitals		Community Health Service Institutions	
		Medical Expenditure (10k CN¥)	Rate (%)	Medical Expenditure (10k CN¥)	Rate (%)
2016	284,512.2	259,257.8	91.1	25,254.4	8.9
2017	302,548.8	274,349.2	90.7	28,199.6	9.3
2018	333,749.6	302,237.1	90.6	31,512.5	9.4
2019	365,280.6	327,952.0	89.9	37,328.6	10.1

Table 2 The Basic Medical Insurance Fund Information from 2016 to 2019

Year	Old-Age Dependency Ratio[a]	Employee Medical Insurance			Resident Medical Insurance			Balance Reward (100 Million CN¥)	Balance Rate (%)
		Number of Insured Persons (10k)	Total Amount (100 Million CN¥)	Balance (100 Million CN¥)	Number of Insured Persons (10k)	Total Amount (100 Million CN¥)	Balance (100 Million CN¥)		
2016	1.64:1	40.29	7.81	0.86	221.21	11.98	0.63	/	7.53
2017	1.56:1	40.46	13.61	1.69	221.19	13.36	0.74	/	9.01
2018	1.51:1	41.05	14.13	2.40	221.25	14.26	0.54	1.36	15.15
2019	1.47:1	41.44	14.56	3.23	221.29	16.26	0.12	2.81	19.98

Note: [a] The proportion of the working age population aged 20–64 supporting the elderly population over 65.

Table 3 Distribution of Service Provision in Medical Institutions from 2016 to 2019

Variables	2016	2017	2018	2019
Overall				
Outpatient volume (person)	9,209,821	10,168,915	10,473,609	11,361,033
Inpatient volume (person)	413,073	417,411	409,136	419,712
Hospital				
Outpatient volume (person)	5,831,787	6,098,557	6,221,613	6,604,957
Proportion of outpatient volume (%)	63.3	60.0	59.4	58.1
Inpatient volume (person)	312,957	317,181	311,150	316,912
Proportion of Inpatient volume (%)	75.8	76.0	76.1	75.5
Community health service institution				
Outpatient volume (person)	3,378,034	4,070,358	4,251,996	4,756,076
Proportion of outpatient volume (%)	36.7	40.0	40.6	41.9
Inpatient volume (person)	100,116	100,230	97,986	102,800
Proportion of inpatient volume (%)	24.2	24.0	23.9	24.5

rose slightly, from 413,073 to 419,712. Specifically, between 2016 and 2019, the outpatient visits at hospitals and community health service institutions rose from 5,831,787 and 3,378,034, respectively, to 6,604,957 and 4,756,076, both showing an upward trend. The proportion of outpatient visits at hospitals decreased from 63.3% to 58.1%, while the proportion at community health service institutions increased from 36.7% to 41.9%. Regarding inpatient visits, from 2016 to 2019, the numbers at hospitals and community health service institutions rose from 312,957 and 100,116 to 316,912 and 102,800, respectively, both showing an upward trend. Notably, the proportion of inpatient visits at hospitals decreased from 75.8% in 2016 to 75.5% in 2019, while the proportion at community health service institutions increased from 24.2% to 24.5%.

The ITSA results of Outcome Variables

The results of the ITSA for the outcome variables are presented in Table 4 and Figure 1, illustrating the impact of the Sanming model on the trends in medical expenditures and service provision in the region. Prior to the reform, Sanming City experienced a notable increase in monthly medical expenditures, with a growth rate of 0.8% ($\beta_1 = 0.008$, P < 0.001). However, following the reform, the growth trend in monthly medical expenditures slowed, decreasing by 0.1% ($\beta_3 = -0.001$, P = 0.095). Similar trends were observed in the monthly outpatient and inpatient volumes. Before the reform, outpatient and inpatient volumes showed monthly growth rates of 1.6% and 0.5%, respectively ($\beta_1 = 0.016$, P < 0.001; $\beta_1 = 0.005$, P = 0.041). After the reform, outpatient and inpatient volumes exhibited monthly decreases of 1.4% and 0.5% from their original growth trends ($\beta_3 = -0.014$, P < 0.001; $\beta_3 = 0.005$, P = 0.098).

Additionally, Table 4 and Figure 1 display the ITSA results for hospitals and community health service institutions separately. Prior to the reform, the monthly medical expenditures in hospitals showed a growth trend of 0.7% ($\beta_1 = 0.007$,

Table 4 The ITSA Results of Outcome Variables

Variables	Before Reform (2016.1–2017.9)		Reform Instantaneous (2017.10)		After Reform (2017.10–2019.11)	
	β1	P	β2	P	β3	P
Overall						
Ln (medical expenditure+1)	0.008 (0.001)	**0.001**	−0.029 (0.019)	0.575	−0.001 (0.001)	**0.095**
Ln (outpatient volume+1)	0.016 (0.002)	**0.001**	−0.035 (0.063)	0.572	−0.014 (0.004)	**0.001**
Ln (inpatient volume+1)	0.005 (0.002)	**0.041**	−0.062 (0.030)	**0.042**	−0.005 (0.003)	**0.098**
Hospital						
Ln (medical expenditure+1)	0.007 (0.002)	**0.001**	−0.007 (0.031)	0.802	−0.001 (0.003)	0.663
Ln (outpatient volume+1)	0.007 (0.002)	**0.001**	−0.037 (0.020)	**0.068**	−0.004 (0.002)	**0.060**
Ln (inpatient volume+1)	0.004 (0.001)	**0.014**	−0.042 (0.020)	**0.034**	−0.004 (0.002)	**0.033**
Community health service institution						
Ln (medical expenditure+1)	0.018 (0.003)	**0.001**	−0.035 (0.068)	0.604	−0.009 (0.004)	**0.039**
Ln (outpatient volume+1)	0.021 (0.004)	**0.001**	0.153 (0.129)	0.236	−0.008 (0.008)	0.288
Ln (inpatient volume+1)	0.007 (0.002)	0.227	−0.154 (0.097)	0.114	−0.004 (0.007)	0.595

Notes: Data are presented as coefficients (Standard Errors). The results displayed in bold text indicate statistical significance in the statistical analysis.

$P = 0.001$). Post-reform, there was some evidence of a suppressive effect on medical expenditures, although this result was not statistically significant ($\beta_3 = -0.001$, $P = 0.663$). Before the reform, outpatient and inpatient volumes in hospitals increased by 0.7%/month and 0.4%/month, respectively ($\beta_1 = 0.007$, $P < 0.001$; $\beta_1 = 0.004$, $P = 0.014$). After the reform,
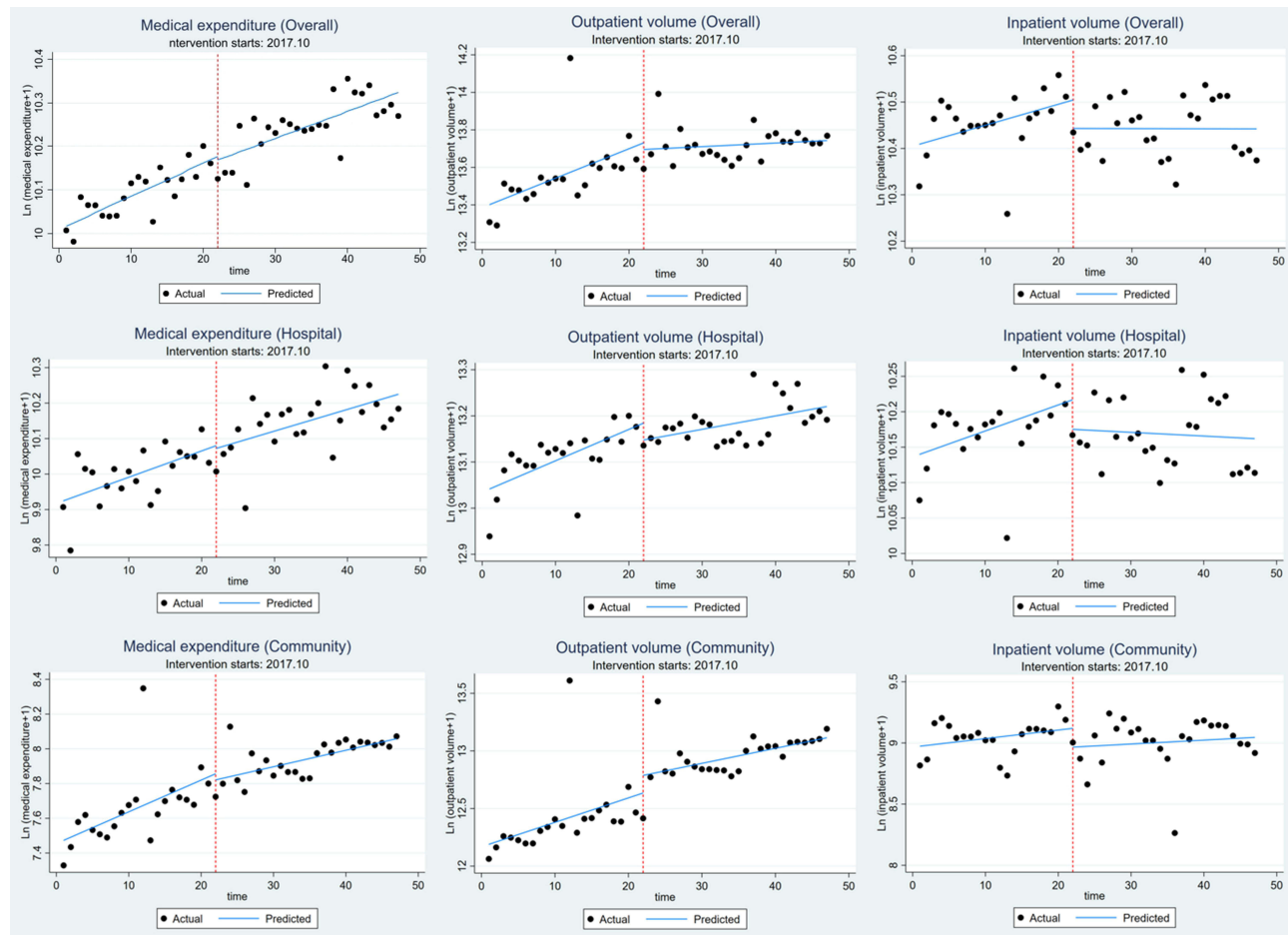
Figure 1 Changes in outcome variables before and after the reform using ITSA.

these volumes declined by 0.4%/month ($\beta_3 = -0.004$, P = 0.060; $\beta_3 = -0.004$, P = 0.033). For community health service institutions, the monthly medical expenditures prior to the reform demonstrated a growth trend of 1.8% ($\beta_1 = 0.018$, P < 0.001). Post-reform, this trend decreased by 0.9%/month ($\beta_3 = -0.009$, P = 0.039). Outpatient volume for community health service institutions showed a growth rate of 2.1%/month before the reform ($\beta_1 = 0.021$, P < 0.001). After the reform, outpatient volume continued to rise, albeit at a non-significant rate ($\beta_3 = -0.008$, P = 0.288). No significant changes were observed in the inpatient volume of community health service institutions before and after the reform ($\beta_1 = 0.007$, P = 0.227; $\beta_3 = -0.114$, P = 0.595).

Discussion

We analyzed medical expenditures, service provision, and resource allocation in Sanming City, focusing on the impact of the Sanming model on improving resource efficiency and promoting the integration of healthcare services. The results indicate that, post-reform, Sanming's monthly medical expenditures, outpatient volume, and inpatient volume shifted from a rapid growth trend to a slower growth trend, with slopes decreasing by 0.1%, 1.4%, and 0.5%, respectively. Notably, the trend for monthly inpatient volume transitioned from growth to decline. Since the implementation of the Sanming model reform in October 2017, the medical insurance fund balance rate has increased by 4 to 6 percentage points. Heterogeneity analysis revealed that the slowdown in monthly medical expenditure growth was more pronounced in community health service institutions. In contrast, hospitals experienced significant declines in the growth rates of both outpatient volume and inpatient volume post-reform, while community health service institutions showed no significant changes.

Encouragingly, the efficiency of medical resource utilization in Sanming City has significantly improved following the implementation of the Sanming Model.[21,22] This outcome is consistent with the anticipated effects of integrated healthcare services. From 2005 to 2020, China's medical expenditures increased more than tenfold, outpacing the growth of national income. Additionally, medical institutions historically exhibited a tendency toward over-treatment, increasing their revenue by accommodating more patients, which led to a wasteful overutilization of limited medical resources.[23] However, after the implementation of the Sanming Model, there has been effective restraint on medical expenditures, inpatient admissions, and outpatient visits in Sanming city.

The achievements of the Sanming Model can be primarily attributed to the collaborative efforts of government departments and the unified governance of MAs as legal entities. A significant reason for the slow progress of healthcare reform in China has been the bureaucratic infighting among various government sectors.[24] The Sanming government established a leadership group to standardize the tasks of all departments involved in the development of the Sanming Model, directly facilitating the integration of public medical institutions across the twelve counties in the region and fostering a sense of shared interests. Moreover, the Sanming Model introduced global budgets and a performance-based payment system, shifting the revenue structure of medical institutions away from dependence solely on the volume of services provided, linking it instead to the overall quality and efficiency of healthcare services. This transition encourages hospitals and community health service institutions to focus more on controlling medical expenditures and reducing unnecessary services. Each MA operates under an independent global budget with unified performance assessment goals, compelling them to meet government targets while managing costs effectively and minimizing unnecessary outpatient and inpatient visits to ensure sufficient surpluses. These results align with previous research indicating that global budgets effectively curb rapid increases in medical expenditures.[25,26] Performance-based payments enhance medical institutions' adherence to performance objectives.[27] For instance, the Merit-based Incentive Payment System (MIPS) in the United States has successfully curtailed excessive service provision.[23] Similarly, the performance payment system for safety-net hospitals in Minnesota has led to a significant reduction in inpatient services.[28]

At the MA level, the strongest hospital leader acts as the sole legal entity for unified governance, with other institution managers serving as board members for collaborative decision-making. MA managers possess control over all internal medical institutions, enabling them to make decisions aligned with government performance goals. Additionally, MA managers must weigh the interests of all medical institutions rather than focusing solely on those of individual entities. Considering the principal-agent relationship between physicians and medical institutions, MAs have also reformed the

performance distribution system for doctors, ensuring that their performance objectives are aligned with those of the MA and government.

The results are similar to the Primary Care Physician (PCP) model and the Maryland Reform. The PCP model and the Maryland Reform have both demonstrated effective results in curbing overall healthcare costs and improving the efficiency of healthcare services.[29–31] Although the PCP model primarily focuses on primary care providers and small-scale units like primary care practices, and the Sanming Model and Maryland Reform work on a larger scale involving hospital systems and broader healthcare alliances, all three share a common goal of aligning financial incentives with health outcomes. These models highlight the importance of coordinated care and cost control in achieving more efficient and sustainable healthcare systems. By focusing on both the quality of services and the efficiency of resource use, these models contribute to a more balanced healthcare system that is better able to meet the needs of populations while managing costs effectively. For example, the Sanming Model and the PCP model, both models encourage healthcare providers to focus on patient outcomes rather than service volume, with financial incentives linked to the overall efficiency and quality of care. The Sanming Model bears a strong resemblance to the Maryland Reform, especially in its approach to managing healthcare costs through global budgets. Maryland's All-Payer System sets a fixed payment amount for services, regardless of the type or volume of services rendered, which is similar to the global budget system used in Sanming. Both systems seek to control healthcare spending while ensuring high-quality care by providing fixed payments that incentivize hospitals to focus on efficiency and reduce unnecessary services. Additionally, the performance-based payment systems introduced in both the Sanming Model and the Maryland Reform further incentivize healthcare institutions to achieve quality care objectives while managing costs. In Maryland, hospitals are rewarded for meeting specific performance goals, similar to how Sanming's MAs are evaluated based on performance metrics aligned with government targets.

However, a key difference from Maryland's system is that Maryland operates a global budget for individual hospitals, without the involvement of competition among other institutions. This could potentially lead to issues where hospitals might shift patients to avoid exceeding their global budget. In contrast, the Sanming Model employs a global budget for each MA, which involves multiple healthcare institutions. Despite the unified budget, there is still competition among these institutions, leading to issues where institutions may vie for patients due to the conflicting interests within the alliance. The heterogeneous analysis of hospitals and community health service institutions reveals that an increasing number of patients are receiving appropriate medical services at community health service institutions, thereby reducing their reliance on hospitals. Following the implementation of the Sanming Model, the rapid growth in outpatient and inpatient volumes at hospitals has been significantly curtailed, while there has been no notable change in community health service institutions. Hospitals are now prioritizing referral services to the community when managing patients, which has enhanced the utilization of community health services. This indicates that the performance evaluation within the Sanming Model plays a crucial role in promoting cooperation among medical institutions. By strengthening collaboration between hospitals and community health service institutions and facilitating reasonable resource allocation, outpatient services are gradually shifting toward community health service institutions, thus demonstrating the initial effectiveness of medical service integration.

The principal-agent theory highlights the goal divergence and information asymmetry between principals and agents. Due to opportunism and a sense of entitlement, agents often act in ways that prioritize their personal interests over those of the principals.[32] When the public welfare and economic objectives of medical service integration are misaligned, the actions of healthcare institution boards and employees may deviate from the public welfare of health services. Management economics also indicates that both external and internal management must be effectively coordinated.[24] Therefore, a systems thinking approach is necessary to ensure alignment of interests and goals among multiple stakeholders, which is achieved through the Sanming model.

However, it is noteworthy that, despite the trend of service provision shifting from hospitals to community health service institutions, hospital medical expenditures did not show a significant decline. Instead, there was a deceleration in the growth rate of expenditures at community health service institutions. This may be attributed to the unified management of MAs, which has facilitated a resource allocation trend where major illnesses concentrate in hospitals while minor illnesses are directed to community health service institutions, thereby enhancing the quality of medical services to meet

government standards for patient care. Nonetheless, concerns remain that MAs are often dominated by influential hospital managers, who may still operate under self-interested incentives. In addition to their roles as MA managers, these hospital administrators must also consider their hospital's performance evaluations on a national level, as well as independent assessments and grading requirements. Given their significant size and central position within MAs, there is a risk that they may prioritize controlling medical expenditures at community health service institutions to ensure the stability of their own cash flow. However, this study is unable to validate this.

This study has several strengths. First, the analysis is based on official data from the reform area, ensuring high data quality. Second, outcome Variables are effectively analyzed using ITSA, which highlights differences before and after the reform. Third, the study includes a heterogeneity analysis of hospitals and community health service institutions, further examining the reform's impact on resource allocation and reflecting the results of integrated healthcare services.

This study has several limitations. First, the unique case of the Sanming model restricts the generalizability of the conclusions. Second, the onset of the COVID-19 pandemic in December 2019 limited the availability of long-term comparisons. Third, the study lacks an analysis of quality indicators, making it difficult to ascertain the true impact of the Sanming model on healthcare quality. Third, the absence of a control group affects the credibility of the research findings. Fourth, the study lacks a thorough discussion of the potential impact of confounding factors, such as the effects of other overlapping policies and specific socioeconomic characteristics. However, fortunately, ITSA can, to some extent, effectively capture the trend effects of the reform on the outcome variables.

Conclusion

The Sanming model represents an important localized attempt in China to integrate hospitals and community health service institutions. This article outlines the implementation characteristics of the Sanming model and its impact on medical expenditures, service provision, and resource allocation. The study finds that the Sanming model effectively aligns the objectives of stakeholders, leading to a successful curtailment of the rapid growth in medical expenditures and service provision, thereby reducing the consumption of basic medical insurance funds. Clearly, the Sanming model enhances the efficiency of medical resource utilization. Furthermore, our analysis indicates a shift in service provision from hospitals to community health service institutions, facilitating a resource allocation trend where major illnesses are concentrated in hospitals while minor ailments are addressed at community health service facilities. This promotes the effective integration and rational allocation of medical resources. However, there is a risk that MAs manager may prioritize controlling medical expenditures at community health service institutions to ensure the stability of hospital's cash flow.

Based on the findings from the Sanming model, we observe that effective organizational structures and economic incentive reforms can promote proactive collaboration between healthcare institutions. However, there are still several aspects of the policy that require attention. On one hand, it is crucial to strengthen medical supervision to prevent cost reduction from negatively impacting the quality of care. On the other hand, careful consideration is needed regarding the collaboration between hospitals and community health service institutions, ensuring that hospitals do not exploit community health services in order to secure their own financial stability, but rather work toward a mutually coordinated partnership. Additionally, while the Sanming model offers valuable lessons for other regions and countries, it is a localized experience with certain geographical limitations. Therefore, any attempt to replicate or adapt this model must take into account local conditions and be tailored to the specific needs of the region.

Data Sharing Statement

The datasets used and analyzed during the present study are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

The study design was approved by the ethics institutional review board of Huazhong University of Science and Technology, Wuhan, China (approval number: 20210630-S170). All the methods were carried out in accordance with relevant guidelines and regulations. This study utilized retrospective statistical data from medical institutions in Sanming

City collected between 2016 and 2019. The data did not involve individual human participants or identifiable personal information. The need for informed consent was waived by the ethics institutional review board of Huazhong University of Science and Technology. The research process complies with the Declaration of Helsinki. The dataset was provided by the Sanming Health Commission.

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Disclosure

The authors declare that they have no competing interests.

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     215

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