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Hospitalization and cost trends during Iranian health system reforms over two decades: a time series analysis

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Abstract

Background Health Sector Reform (HSR) in Iran was implemented in two phases, in 2005 and 2014, financed through a governmental health insurance model managed by the Iranian Health Insurance Organization (IHIO). This study mainly aimed to evaluate the outcomes of HSR by analyzing trends in hospitalization rates and associated expenditures among the insured population covered by the IHIO over the past 20 years as well as forecasting for future based on the observed time series trend.

Methods This observational longitudinal study assessed key indicators, including hospitalization rates, average per capita inpatient costs, and the inflation rate of inpatient expenditures, from 2001 to 2021, for populations covered by both rural and non-rural insurance funds of the IHIO. Data were analyzed across three distinct periods: pre-HSR, between the two HSR phases, and post-second-phase implementation. Time series analyses were conducted using autoregressive integrated moving average (ARIMA) and exponential smoothing models to forecast trends through 2027.

Results Projections suggest that by 2027, the hospitalization rate for citizens covered by both rural and non-rural funds will likely reach 101 per 1,000 insured individuals. Over the study period, per capita hospitalization costs remained stable across both funds with no significant differences. However, the mean annual increase in per capita hospitalization costs is expected to continue rising between 2021 and 2027, reaching 54.90% in non-rural funds and 48.67% in rural funds.

Conclusions HSR appears to have achieved health equity in hospitalization rates between rural and urban populations. While per capita inpatient costs have shown parity between rural and non-rural funds.

Keywords Health care reform, Health equity, Health expenditures, Healthcare disparities, Health policy

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Background

Health sector reform (HSR) has been a global strategy for improving access to healthcare, particularly in low- and middle-income countries, where inequities in health service utilization are pronounced. Universal health coverage (UHC), as endorsed by the World Health Organization, emphasizes equitable access to healthcare services, including costly inpatient care, as a core component of achieving health equity. Despite this emphasis, evidence from various countries highlights significant challenges in implementing effective HSR policies, including financial barriers, inefficiencies in service delivery, and persistent inequities in health outcomes [1, 2].

Before the introduction of the HSR in 2004 and 2013, access to inpatient care in Iran was characterized by significant financial barriers, especially for rural populations. Prior to 2004, individuals living in rural and nomadic areas had limited access to hospital services. In 2002, the bed occupancy rate of government hospitals was 52.5%. The waiting time for receiving inpatient services in the same province where citizens lived was 2.3 days.

The rural and nomadic population that needed inpatient services, a significant portion—nearly 27% and 48%, respectively—suffered from catastrophic health expenditures, the number of out-of-pocket payments incurred by Iranian households was exceeding than 56.5%. This financial burden deterred many individuals from seeking care altogether, contributing to delayed diagnoses and poorer health outcomes in rural areas. This is despite the fact that in 2002, according to findings from national survey, the insurance coverage for rural inhabitants in a province like Isfahan has been diverse but included high co-payments and catastrophic payments, which led to one of the main concerns of rural people regarding health issues. Approximately 59.3% of rural residents were insured by the IHIO's Rural Residents Fund, while 15.4% were covered by the Social Security Organization (SSO), 1.4% by the Armed Forces Health Insurance Organization, and 4.2% by the Imam Khomeini Relief Foundation (IKRF). Although 19.7% of rural inhabitants had no any insurance coverage, the insured inhabitants should pay at least 30% of hospital bills at discharge [3].

IHIO includes five sub-funds: (1) Governmental Employees Fund; (2) Iranian Fund for self-employed; (3) Rural Residents Fund (i.e., residents in rural areas and cities less than 20000 population); (4) Universal Insurance Coverage Fund, covered uninsured persons in cities with more than 20,000 inhabitants; and (5) Other Sectors Fund (i.e., such as the poor, students, disables, families with injured persons during the war, and some professional associations). The SSO is a non-governmental organization covering employees of the formal private sectors, self-employed and voluntary contributors. IKRF support the very poor and disabled peoples [4].

Before 2004, urban residents were typically covered by either private insurance or employer-provided insurance, but many still faced substantial financial barriers. The insured individuals in urban areas often had to pay co-payments that could amount to 30% or more of the total hospitalization costs [5].

The first phase of the HSR, launched in 2004, sought to address these disparities by expanding the insurance system to include rural and nomadic populations through the Rural Insurance Fund. This reform aimed to provide financial protection against the high costs of inpatient care, with rural residents paying a maximum of 7% of their hospitalization costs in public hospitals [6]. The introduction of this new insurance scheme was transformative, as it reduced financial barriers for many rural residents, who had previously paid the full cost of care. The increase in insurance coverage was also accompanied by efforts to improve the healthcare infrastructure in rural areas, including the expansion of family physician services. This policy change led to a marked increase in the utilization of inpatient services by rural inhabitants, as more individuals sought hospital care due to the reduced financial burden [7].

In 2013, the second phase of the HSR, known as the Health Transformation Plan (HTP), expanded insurance coverage to urban populations, particularly those living in cities with populations greater than 20,000. The HTP aimed to further reduce the financial burden of inpatient care by reducing co-payments for urban residents to below 10% in public hospitals [8]. In addition to the increase in insurance coverage, the reform included a significant overhaul of medical tariffs (an average increase of 120%), as well as the addition of approximately 1,700 health services to the basic health insurance package. This phase also saw substantial investments in healthcare infrastructure, particularly in underserved and deprived urban areas [4]. Despite these efforts, however, the implementation of the HTP was not without challenges, particularly in terms of financial sustainability and capacity in the healthcare system [9].

Prior to the reforms, insurance coverage was limited, and the vast majority of both rural and non-rural populations either paid for services out-of-pocket or had minimal insurance coverage, which often did not cover the full costs of hospitalization. With the introduction of the 2004 and 2013 reforms, insurance coverage expanded significantly. By 2021, nearly 95% of the Iranian population was covered by some form of insurance, with most individuals covered by the rural or non-rural insurance funds provided by the IHIO [10, 11]. In Isfahan province, the total number of inhabitants insured by the IHIO in the province increased from 1,551,168 in 2001 to

1,715,175 in 2021. Among the rural population in 2021, 87.22% were covered by the rural insurance fund, with the remainder insured by other organizations, such as the SSO, IKRF, and other insurance organizations [3]. However, it is important to note that insurance uptake was not universal. Despite the government's efforts to increase coverage, some individuals, particularly in urban areas, remained uninsured, either due to affordability issues or lack of awareness. Insurance uptake has been high among rural populations, where the financial barriers to care were previously more pronounced, but remained somewhat lower in urban areas [4].

While much of the existing literature and policy discussion has focused on the demand-side effects of HSR—such as increased access to care through expanded insurance coverage—it is crucial to consider the supply-side dynamics. As a result, the rapid increase in demand for inpatient care in rural areas post-reform may have outpaced the supply of healthcare services, leading to potential crowding in hospitals and a strain on existing healthcare providers [12].

Studies from developed countries, particularly those within the Organization for Economic Cooperation and Development (OECD), provide robust evidence on the impact of health sector reforms on inpatient service utilization. For instance, countries implementing universal insurance schemes have reported gradual increases in hospitalization rates, improved access to inpatient care, and reductions in catastrophic health expenditures among socioeconomically disadvantaged populations. However, evidence from these settings often emphasizes long-term impacts, with limited relevance to low- and middle-income countries where resource constraints are more pronounced [1, 2, 13].

In contrast, studies from countries like Thailand, Mexico, and India—each of which has implemented ambitious HSR initiatives—highlight the challenges of ensuring equitable access to inpatient care. While hospitalization rates increased in these contexts, issues related to cost containment, inefficiencies in resource allocation, and persistent out-of-pocket (OOP) expenditures remain significant concerns [14–16].

In Iran, the implementation of HSR in two distinct phases—the Family Physician Plan (2004) and the Health Transformation Plan (2014)—represents a significant policy effort to reduce inequities in healthcare access. The first phase primarily targeted rural populations, providing insurance coverage and reducing OOP payments for inpatient services. The second phase extended these reforms to urban populations, introducing measures such as revised medical tariffs, expanded insurance benefit packages, and increased public sector investments in healthcare infrastructure [6, 8].

While several studies have evaluated the immediate impacts of these reforms, the majority focus on specific populations or geographic areas, with limited longitudinal analyses. For example, studies to date have demonstrated significant differences in hospitalization rates between the two reform phases, with a pronounced increase following the second phase, while the length of staying in public hospitals ranged between 3.4 and 3.7 with the mean of 3.51 that didn't differ before and after the second phase of HSR implementation insignificantly [17, 18]. However, these studies often lack temporal depth and fail to examine long-term trends in hospitalization rates, and costs across different phases of the HSR. Also, previous studies often examine rural and urban populations separately, without comparing outcomes across these groups from the perspective of health equity.

This study addresses these gaps by conducting a 20-year longitudinal analysis of hospitalization rates and costs among populations insured under both rural and non-rural funds of the IHIO. By encompassing three distinct periods—pre-HSR, inter-HSR, and post-HSR—this research provides a comprehensive assessment of long-term trends in inpatient service utilization and inpatient costs. Moreover, the use of time series analysis, including ARIMA and exponential smoothing models, offers valuable projections of hospitalization rates and costs through 2027, enabling evidence-based policymaking.

Methods

Study design and setting

This observational longitudinal study was conducted to examines the trend of hospitalization rates, inpatient costs reimbursed by the IHIO, and the inflation rate of inpatient expenditures in Isfahan province. Isfahan, located in central Iran with a territory of about 106,786 square kilometers, is the most populous province. This province is often considered representative due to its large population size, which provides a comprehensive view of healthcare utilization patterns in both rural and urban settings [19].

Isfahan consists of 24 districts, including both rural and urban areas. Geographic access to inpatient services is facilitated by a general public hospital in each district, serving populations of 50,000–100,000, and 8 sub-specialized educational hospitals in the provincial capital. Each public hospital offers essential inpatient services, including specialties such as internal medicine, general surgery, pediatrics, and obstetrics/gynecology [20].

Data collection and sources

Data on hospitalization rates and IHIO-reimbursed inpatient service costs were collected from the Health Costs Database at the IHIO, spanning public, private,

charitable, and non-profit hospitals in Isfahan province. The study included insured individuals covered by either the rural or non-rural IHIO funds from 2001 to 2021. Only hospital admissions for Inpatient care with a minimum stay of 24 h at hospital were considered, while Outpatient/observation care that patient discharged within 24 h were excluded. Additionally, co-payments made directly by patients for inpatient services were not considered in this study.

Statistical analysis

Numerical variables were reported as means ± standard error (SE), and the normality of the data was assessed using the Shapiro-Wilk test.

To assess the trends in hospitalization rates, inpatient costs, and inflation-adjusted expenditures, the study used two analytical approaches.

In the first approach, repeated measures analysis of variance (ANOVA) and covariance (ANCOVA) were used to compare three variables: hospitalization rate, average per capita inpatient costs, and the annual increase in health expenditures between the rural and non-rural insurance funds by adjusting inflation rate as confounder. Additionally, these variables were compared between the rural and non-rural insurance funds in each three time periods: pre-HSR Phase 1 (2001–2004), between HSR Phases 1 and 2 (2004–2014), and post-HSR Phase 2 (2014–2021). A p-value of <0.05 was considered statistically significant.

The second approach involved time series analysis to evaluate trends and forecast the three variables examined in this study. Two time series modeling techniques were employed: exponential smoothing (Brown models) and ARIMA models based on the Box-Jenkins methodology [21]. The ARIMA model incorporates three components: autoregression (p: AR), differencing or integrating (d: I), and moving average (q: MA). If a significant seasonal trend was detected, additional seasonal components for p, d, and q were calculated. The AR component reflects the correlation between current and previous observations, allowing for time-series forecasting, while the MA component addresses the correlation between errors and the weighted average of white noise [22].

The Expert Modeler option in SPSS version 27 (SPSS Inc., Chicago, IL, USA) was employed for time series modeling and forecasting. The Expert Modeler automatically determines optimal model parameters. To enhance the accuracy of estimates and forecasts, the inflation rate was controlled for as a confounding factor. Both exponential smoothing and ARIMA models were fitted separately for each variable and the best fitted model was selected based on model fit or adequacy criteria. Model adequacy was determined using the Ljung-Box test for residual independence with non-significant Ljung-Box test results [23], along with stationary indicators such as higher R^2 and adjusted R^2 values, and minimal mean absolute percentage error (MAPE), and the normalized Bayesian information criterion (BIC) scores [24]. Forecasting was conducted for a six-year horizon, from 2022 to 2027.

Results

Population distribution

In 2021, Isfahan province was inhabited by 4,800,000 individuals in urban areas and 600,000 individuals in rural areas [19]. The total number of insured inhabitants by IHIO increased from 1,551,168 in 2001 to 1,715,175 in 2021.

Over the past two decades, despite an increase in the number of insured individuals under the non-rural fund of IHIO, the proportion of the population covered by the rural fund decreased from 55.26% in 2001 to 30.51% in 2021, largely due to rural-to-urban migration. In such a way that, from 857,214 inhabitants who covered by the rural fund (55.26% of all insured inhabitants by IHIO) in 2001, it reduced to 523,307 (30.51%) in 2021. Hence, 87.22% of the rural inhabitants in 2021 were covered by rural insurance and the remainder being covered by other organizations such as the SSO.

Hospitalization trends

In 2001, the hospitalization rate among rural inhabitants was at its lowest, with 31.21 hospitalizations per 1,000 insured persons. After the implementation of the first phase of the HSR in 2004, this rate began to increase, peaking at 87.45 per 1,000 insured individuals in 2010. However, the hospitalization rate declined gradually after this peak, reaching 69.96 per 1,000 insured individuals by 2013, just before the start of the second phase of the HSR in 2013. After the second phase, the hospitalization rate for rural insured individuals began to rise again, reaching 99.49 per 1,000 insured individuals in 2018. The trend reversed once more in 2019, dropping to 65.44 per 1,000 insured persons, coinciding with the onset of the COVID-19 pandemic. While there appears to be a notable increase post-2013, the data shows some fluctuations, which we believe are influenced by multiple factors, including changes in health insurance policies and social impacts during this period.

In contrast, individuals covered by the non-rural insurance fund had a hospitalization rate of 130.21 per 1,000 insured individuals in 2001, nearly four times higher than the rural rate. The hospitalization rate for non-rural insured individuals declined from 2001 to 2008, reaching a low of 84.75 per 1,000 insured individuals. However, the rate began to rise again, peaking at 175.10 per 1,000 insured individuals in 2012. This peak occurred just before the second phase of the HSR, which aimed

to make urban healthcare more accessible. Following the launch of Phase II in 2013, the hospitalization rate for non-rural insured individuals began to decline steadily, reaching 120.82 per 1,000 insured individuals in 2020, and 108.42 per 1,000 insured individuals in 2021. The smallest gap between rural and non-rural insured populations occurred in 2017, when hospitalization rates were 77.5 and 84.75 per 1,000 insured individuals, respectively (Table 1) (Fig. 1).

Results of comparing hospitalization rate between individuals covered by non-rural and rural insurance showed that the mean hospitalization rate of individuals covered by non-rural insurance was significantly higher than rural insurance (114.12 ± 5.48 vs. 71.54 ± 5.47) ($P < 0.001$). This significant difference persisted across all three phases: before the first stage of HSR from 2001 to 2003 (130.19 ± 6.15 vs. 37.82 ± 6.15), between the 2005 to 2012 (141.18 ± 7.79 vs.76.89 ± 7.79), and after the second stage of HSR from 2014 to 2021 (148.31 ± 7.34 vs. 85.1 ± 7.34), ($P < 0.001$ for all phases).

Among the statistical models evaluated, the ARIMA model (0,1,1) for non-rural insurance and (1,1,1) for rural insurance was identified as the best fit, with the lowest mean square error of 15.740 and a Ljung-Box test p-value of 0.164. A Ljung-Box test p-value greater than 0.05 suggested no significant autocorrelation between residuals at different lag times, indicating that the residuals were white noise (Table 2). This conclusion was further supported by the autocorrelation function (ACF) and partial autocorrelation function (PACF) plots of the residuals for all three variables (Supplementary Figs. 1, 2, 3). The fitted ARIMA model was used to predict hospitalization rates till 2027, hospitalization rates would reach 101.88 per 1,000 (95%CI 0-222.39) insured individuals for non-rural populations and 100.53 per 1,000 (95%CI 37.74-163.32) insured individuals for rural populations (Table 3; Fig. 2).

Hospitalization costs

In 2021, the average per capita inpatient costs for individuals covered by the rural and non-rural funds were 9,574,717 Rials (median = 10,519,947.67 Rials) and 9,686,937.33 Rials (median = 10,818,596.98 Rials), equivalent to $1,180.90 and $1,194.74, respectively. At the commencement of the study, the exchange rate was 1 USD = 8,108 Iranian Rials [25]. Statistically, there was no significant difference in the average per capita hospitalization costs between the rural and non-rural funds in the three stages of HSR ($P > 0.05$) (Table 1).

The trend in average per capita hospitalization costs showed sharp increases during three distinct periods: in 2009, 2014 (coinciding with Phase II of HSR), and 2020 (during the COVID-19 pandemic). The most significant cost surges were 43.33%, 55.54%, and 40.45%, respectively, compared to the previous year. (Fig. 3). The multifold increase in tariffs, particularly during the second phase of HSR, as well as longer hospital stays, especially in intensive care units during the COVID-19 epidemic, contributed to the sharp rise in costs during these years.

The ARIMA model (0,2,1) for non-rural insurance and (1,2,0) for rural insurance was identified as the best fit for predicting future trends, with the lowest mean square error of 984,284.657175 Rials and a Ljung-Box test p-value of 0.809 (Table 2). The model projects that per capita inpatient costs will rise significantly by 2027, although no significant difference between rural and non-rural funds is anticipated ($P > 0.05$) (Table 3; Fig. 4).

The mean annual increase in per capita hospitalization costs was 24.94 ± 17.56% for the rural fund and 23.514 ± 12.9% for the non-rural fund over the past 20 years. There was no significant difference between the mean annual increase in costs for the rural and non-rural funds compared to the annual inflation rate in health services ($P = 0.463$ for rural, $P = 0.606$ for non-rural) (Table 1; Fig. 5).

Among the statistical models, ARIMA model (0,0,0) for non-rural insurance and (1,2,1) for rural insurance was identified as the best fit, with the lowest mean square error of 7.995 and a Ljung-Box test p-value of 0.869 (Table 2). The model predicts that the mean annual increase in per capita hospitalization costs will continue to rise significantly in both the non-rural and rural funds from 2021 to 2027 ($P < 0.001$), reaching 54.90% (95%CI 33.15–76.66) and 48.67% (95%CI 32.23–65.12), respectively (Table 3; Fig. 6).

Discussion

The hospitalization rate

During the first stage of the HSR, the utilization of inpatient services among individuals covered by rural insurance funds increased from 31.21 per 1,000 insured individuals in 2001 to 77.5 per 1,000 insured individuals in 2008. This increase aligns with expectations that expanding insurance coverage and financial risk protection, particularly for rural and underprivileged areas, would lead to increased hospital service utilization in the early years following HSR implementation. Similar trends have been observed in other studies; for instance, one reported that after the implementation of the first stage of HSR, the hospitalization rate among the insured population rose from 44.3 to 65.6 per thousand people. However, by 2011, the hospitalization rate had declined for both rural and urban residents, reaching 62.5 and 78.8 per 1,000 people, respectively [26].

Thailand had a similar experience: after the introduction of UHC in 2001, the hospitalization rate rose from 8% in 2001 to 12% in 2005 [27]. In China, following the introduction of HSR in 2009, which aimed to improve

Table 1 Distribution of the per capita hospitalization rate (per 1000 insured population), the average inpatient costs and the mean annual cost Raising for receiving inpatient services incurred by the rural and the Non-rural funds from 2001 to 2021

Stage	Year	The per capita hospitalization rate in non-rural fund	The per capita hospitalization rate in the rural fund	The average inpatient costs incurred by non-rural fund (Rials)	The average inpatient costs incurred by rural fund (Rials)	The mean cost raising for hospitalization in non-rural insurance fund (%)	The mean cost raising for hospitalization in rural insurance fund (%)	The inflation rate in health services (%)
I[1]	2001	130.21	31.21	641,567.11	528,372.76	-	-	-
	2002	137.33	33.06	798,634.04	792,460.40	24.48	49.98	16.3
	2003	143.58	32.78	914,782.57	971,629.87	14.54	22.61	16.9
II[2]	2004	122.37	32.50	1,011,342.24	1,088,666.51	10.5	12.05	17.4
III[3]	2005	117.49	52.94	1,274,129.65	1,279,953.51	25.98	17.57	19.3
	2006	108.15	79.63	1,587,507.68	1,530,184.72	24.59	19.55	13.8
	2007	103.20	80.73	1,781,957.33	1,844,347.91	12.25	20.53	17
	2008	84.75	77.50	2,121,990.42	2,271,834.67	19.1	23.18	23.3
	2009	145.97	87.22	3,041,436.27	3,060,036.25	43.33	34.69	18.9
	2010	169.79	87.45	3,731,263.14	3,564,086.71	22.68	16.47	19.9
	2011	174.16	74.28	4,413,308.83	4,130,525.89	18.28	15.89	17.2
	2012	173.36	67.79	5,633,711.50	5,356,648.73	27.65	29.68	24.7
IV[4]	2013	175.10	67.60	7,417,310.35	6,815,853.72	31.66	27.24	38.4
V[5]	2014	129.58	69.96	11,536,701.52	12,311,687.37	55.54	80.63	31.7
	2015	147.69	76.78	14,684,747.53	15,471,672.81	27.29	25.67	23.8
	2016	159.28	82.92	16,463,422.26	17,049,728.48	12.11	10.20	16.7
	2017	164.21	84.19	17,393,549.52	18,043,880.08	5.65	5.83	10.1
	2018	166.94	99.49	18,366,892.87	18,079,598.96	5.6	0.20	17.0
	2019	170.19	94.02	21,190,793.45	20,636,854.29	15.37	14.14	26.0
	2020	120.82	65.44	29,762,858.22	27,886,259.82	40.45	35.13	26.3
	2021	108.42	84.53	39,657,777.32	38,354,773.45	33.24	37.54	45.5
	The averages	140.60	69.62	9,686,937.32	9,574,717.00	23.514 ± 12.9	24.94 ± 17.56	

[1]Stage I: Before the first stage of the Health Sector Reform

[2]Stage II: Initiating the first stage of the Health Sector Reform

[3]Stage III: Between the first and second stages of the Health Sector Reform

[4]Stage IV: Initiating the second stage of the Health Sector Reform

[5]Stage V: Between the second stages of the Health Sector Reform so far

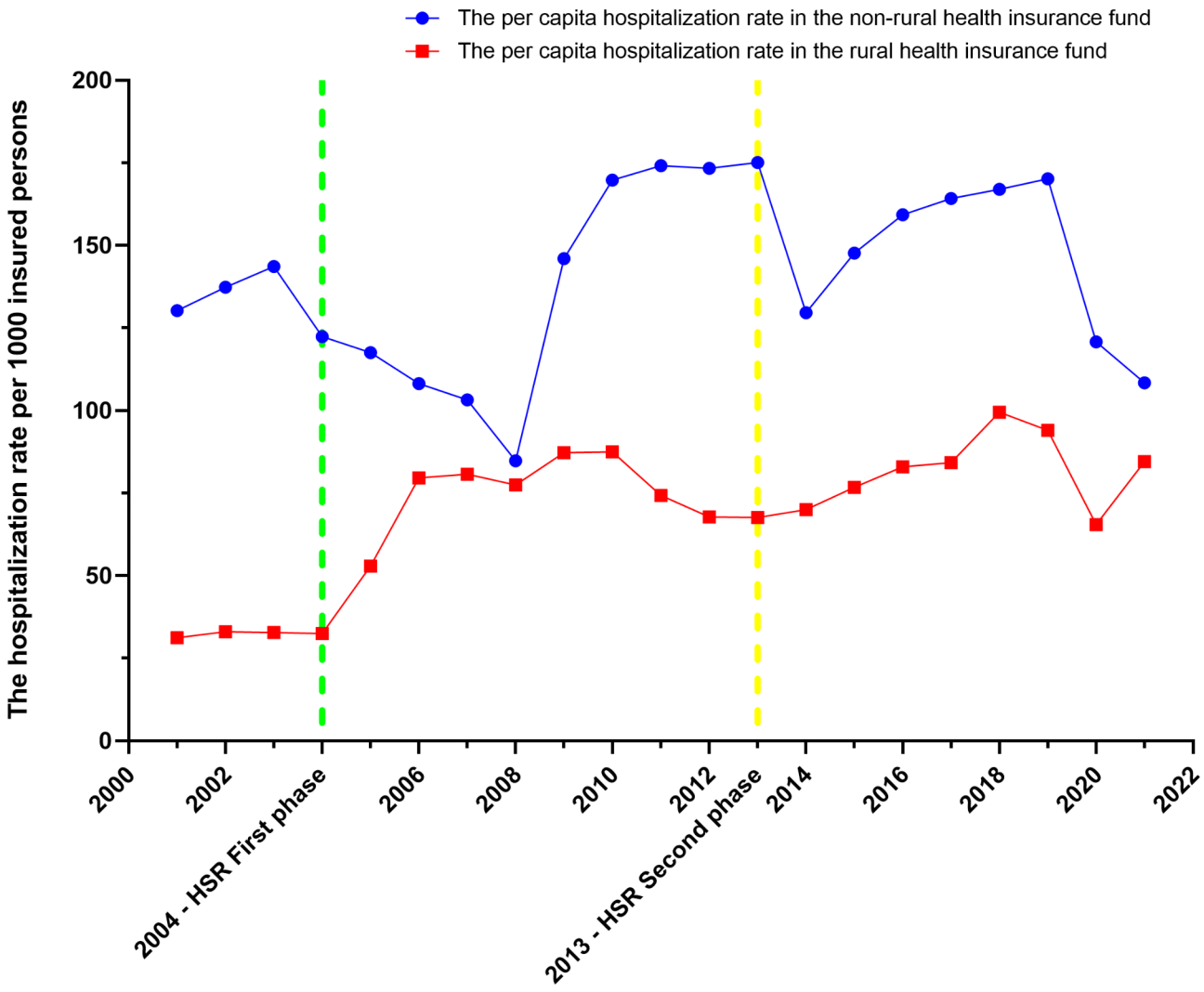

Fig. 1 Comparison of hospitalization rates among citizens covered by the rural and non-rural funds of the Iranian Health Insurance Organization from 2001 to 2021 (per 1,000 population)

Table 2 Characteristics of the fitted ARIMA models

Variable	ARIMA Models	MAE	Max APE	Max AE	Normalized BIC	Ljung-Box Q (18)		
						Statistics	DF	Sig.
The hospitalization rate per 1000 persons insured by non-rural health insurance	0,1,1	15.740	42.687	62.310	6.464	23.735	18	0.164
The hospitalization rate per 1000 persons insured by rural health insurance	1,1,1	8.554	47.748	31.246	5.160	20.136	18	0.325
The per capita inpatient costs incurred by non-rural health insurance	0,2,1	807146.634	20.247	5748170.553	28.657	12.720	17	0.755
The per capita inpatient costs incurred by rural health insurance	1,2,0	1047005.623	32.787	4692168.634	28.955	11.629	17	0.822
The annual cost raising for per capita hospitalization expenditures in the non-rural health insurance	0,0,0	7.995	217.157	23.584	4.834	11.565	18	0.869
The annual cost raising for per capita hospitalization expenditures in the rural health insurance	1,2,1	5.554	7773.043	17.184	4.550	20.015	18	0.332

ARIMA: autoregressive integrated moving average; BIC: normalized Bayesian information criterion; MAE: mean absolute error; Max AE: Maximum Absolute Error; Max APE: maximum absolute percentage error

Table 3 Forecasted hospitalization rates, per capita inpatient costs, and annual cost increases in rural and non-rural health insurance funds from 2022 to 2027

Variable		2022	2023	2024	2025	2026	2027
The hospitalization rate per 1000 persons insured by non-rural health insurance	Forecast	107.33	106.24	105.15	104.06	102.97	101.88
	UCL	156.53	175.82	190.36	202.46	212.98	222.39
	LCL	58.13	36.66	19.94	5.67	0	0
The hospitalization rate per 1000 persons insured by rural health insurance	Forecast	87.20	89.86	92.53	95.19	97.86	100.53
	UCL	112.83	126.11	136.93	146.46	155.18	163.32
	LCL	61.56	53.61	48.13	43.93	40.54	37.74
The per capita inpatient costs incurred by non-rural health insurance	Forecast	5.01E+7	6.10E+7	7.24E+7	8.44E+7	9.68E+7	1.10E+8
	UCL	5.33E+7	6.83E+7	8.46E+7	1.02E+8	1.21E+8	1.41E+8
	LCL	4.68E+7	5.37E+7	6.02E+7	6.65E+7	7.27E+7	7.87E+7
The per capita inpatient costs incurred by rural health insurance	Forecast	4.94E+7	6.09E+7	7.30E+7	8.56E+7	9.88E+7	1.12E+8
	UCL	5.32E+7	6.94E+7	8.73E+7	1.07E+8	1.27E+8	1.49E+8
	LCL	4.55E+7	5.24E+7	5.87E+7	6.47E+7	7.04E+7	7.60E+7
The annual cost raising for per capita hospitalization expenditures in the non-rural health insurance	Forecast	48.76	49.99	51.21	52.45	53.67	54.90
	UCL	70.51	71.75	72.97	74.20	75.42	76.66
	LCL	27.00	28.24	29.46	30.69	31.91	33.15
The annual cost raising for per capita hospitalization expenditures in the rural health insurance	Forecast	43.23	44.32	45.40	46.50	47.58	48.67
	UCL	59.67	60.77	61.85	62.94	64.03	65.12
	LCL	26.78	27.88	28.96	30.05	31.14	32.23

LCL: lower control limit; UCL: upper control limit

access to health services and provide financial protection, social health insurance was expanded, and public hospitals shifted from a drug-driven revenue model to one focused on price control. This reform led to a significant increase in hospital admissions, with the hospitalization rate nearly doubling from 7.41% in 2010 to 13.52% in 2016 [28].

When comparing the utilization of inpatient services during Iran's two stages of HSR with the experiences of other countries that implemented similar reforms, it appears that Iran experienced a substantial increase in hospitalization rates, but this increase was not as dramatic as those observed in China and Thailand. The maximum hospitalization rate among rural and underprivileged citizens reached 6.56%, which is less than half the rate observed in deprived areas of Thailand and China.

This distinction highlights the importance of differentiating between the rate of increase in hospitalizations and the proportion of the insured population hospitalized. While Iran experienced a substantial rise in hospitalization rates relative to its baseline, the overall proportion of the population hospitalized remains significantly lower than in countries like China and Thailand, where broader access and more comprehensive reforms led to higher hospitalization proportions.

In addition, hospitalization rates in Iran remain well below those in OECD countries, where the average hospitalization rate was 150.3 per 1,000 people in 2013. Canada had the lowest rate (82 per 1,000), while Germany had the highest (244 per 1,000) [29].

Conversely, among individuals covered by non-rural health insurance funds in Iran, the hospitalization rate declined from 130.21 per 1,000 insured individuals in 2001 to 84.75 per 1,000 in 2008, representing a 35% reduction. This reduction led to the smallest disparity in inpatient care access between rural and non-rural insurance funds over the past two decades.

However, the lower utilization rate of inpatient services in Iran compared to other nations raises questions about additional factors contributing to this discrepancy. These may include differences in the need for inpatient care, barriers to accessing hospital services beyond physical and financial constraints, or the availability of expanded outpatient services. For instance, in Canada, a study found that financial incentives introduced for primary care physicians in 2003 did not significantly reduce hospital admissions. However, hospitalization rates for diabetes mellitus did decline between 1996 and 2010, likely due to improved adherence to clinical guidelines for diabetes and hypertension management [30].

After the implementation of HSR in Massachusetts, U.S., which aimed to expand insurance coverage without racial bias, a study found that the rate of re-hospitalization among Black patients decreased within 30 days post-discharge. The authors attributed this reduction to improved access to outpatient services among the newly insured population, which in turn helped reduce hospitalization rates [31]. Another study on Massachusetts' HSR indicated a 36% increase in insurance coverage, alongside significant reductions in length of stay and hospitalizations from emergency departments (a 5.2% decrease). Preventive care measures contributed to fewer hospitalizations for avoidable conditions, as insured individuals were more likely to receive necessary follow-up

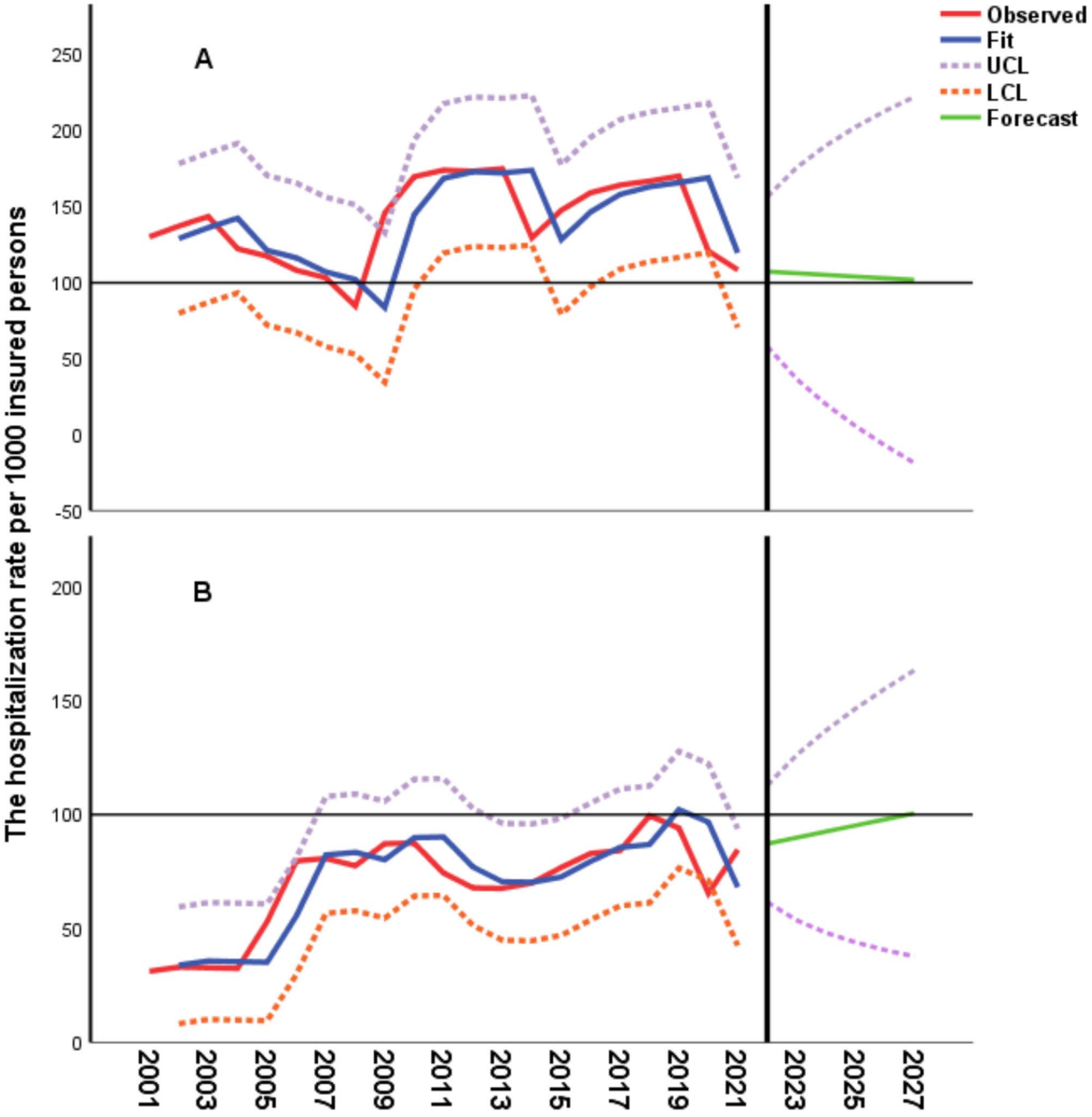

Fig. 2 Forecast of hospitalization rates for non-rural (**A**) and rural (**B**) insured populations of the Iranian Health Insurance Organization, 2001–2027 (per 1000 population). LCL: lower control limit; UCL: upper control limit

care, which was more cost-effective and reduced the likelihood of re-hospitalization [32].

Research in China supports these findings. Long-term care insurance (LTCI) implementation significantly reduced length of stay, hospitalization costs, and health insurance expenditures in tertiary hospitals by 41.0%, 17.7%, and 11.4%, respectively. The impact was particularly pronounced among individuals over the age of 80. In addition, outpatient visits to tertiary hospitals decreased by 8.1% per month following LTCI implementation. A cost-effectiveness analysis showed that every additional 1 yuan spent on LTCI saved 8.6 yuan in health insurance costs [33].

The hospitalization costs

Our findings indicate no significant difference in per capita inpatient costs between citizens covered by rural and non-rural health insurance funds over the past two decades. Hospitals in Isfahan province (largely located in urban areas) appear to have provided a standardized

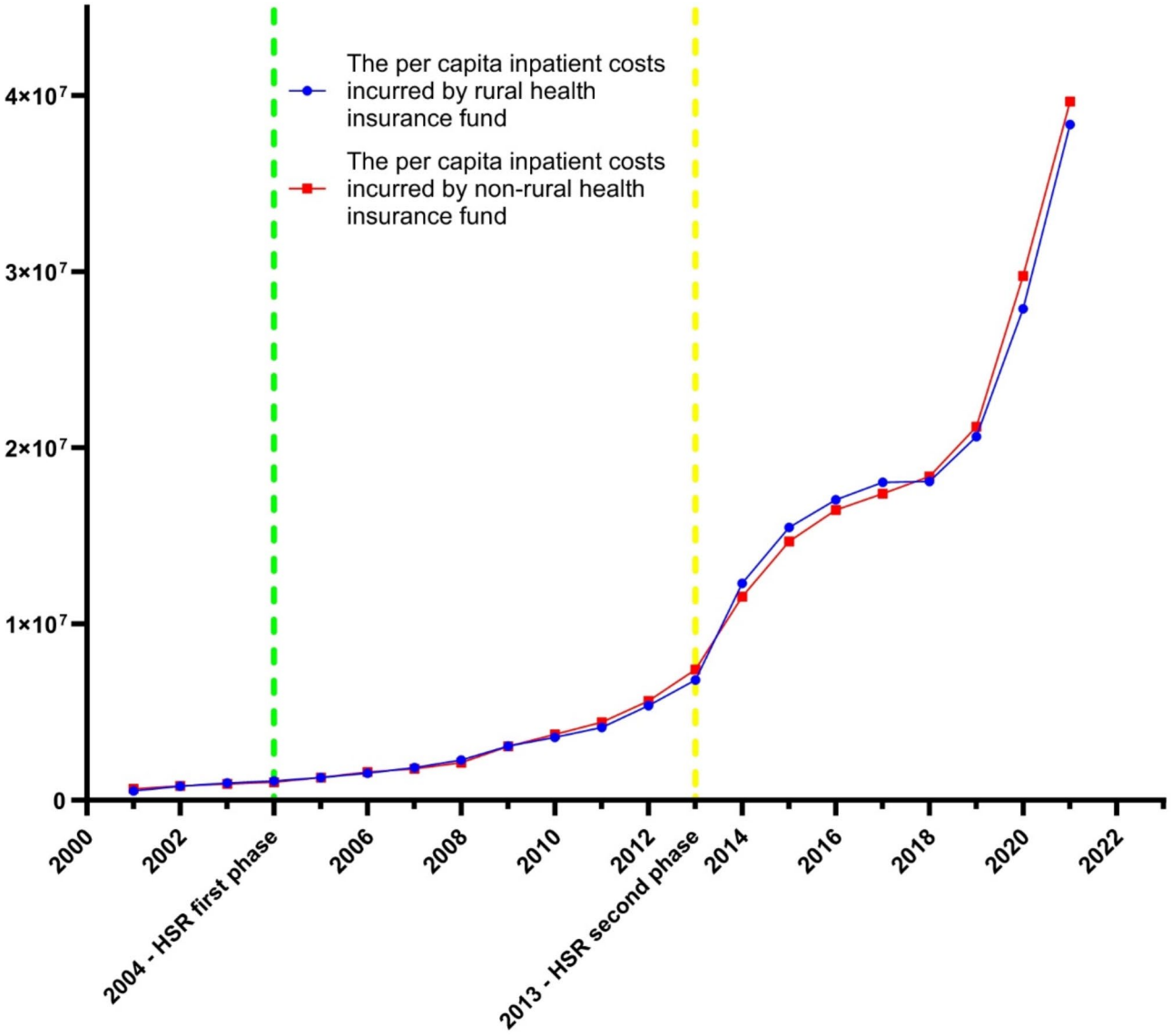

Fig. 3 Comparison of the per capita inpatient costs in the rural and the non-rural funds of the Iranian Health Insurance Organization, 2001–2021

inpatient service package to all insured individuals, irrespective of their rural or urban residence. This uniform approach reflects an egalitarian policy in inpatient service reimbursement [34], which is expected to persist until 2027.

In the current research, the per capita inpatient costs for citizens were 792,460.40 Rials ($97.74) for rural residents and 798,634.04 Rials ($98.50) for urban residents, with an average of 795,547.22 Rials ($98.12). In contrast, prior to the first stage of HSR, national survey data indicated per capita inpatient costs for insured citizens covered by the IHIO were much higher, at 1,975,950 Rials ($243.70) [35]. Hence, the per capita inpatient costs incurred for each citizen covered by rural and the non-rural funds of IHIO in Isfahan province was as likely as 40.26% of per capita inpatient costs reimbursed in the national survey, which reflects better technical efficiency and improved resource management within the IHIO in Isfahan province.

The average annual increase in per capita inpatient costs was 24.94% for rural funds and 23.52% for non-rural funds over the past two decades. During the same period, the National Health Research Institute reported an average inflation rate for health services of 22.01% ± 8.5% [36]. This indicates that much of the increase in per capita inpatient costs can be attributed to inflation in hospital services. However, the stabilization of per capita costs in urban areas over the past seven years, coinciding with a decline in inpatient utilization rates, may indicate more efficient resource allocation.

Despite these efficiencies, the ARIMA model forecasts that per capita hospitalization costs will continue to rise

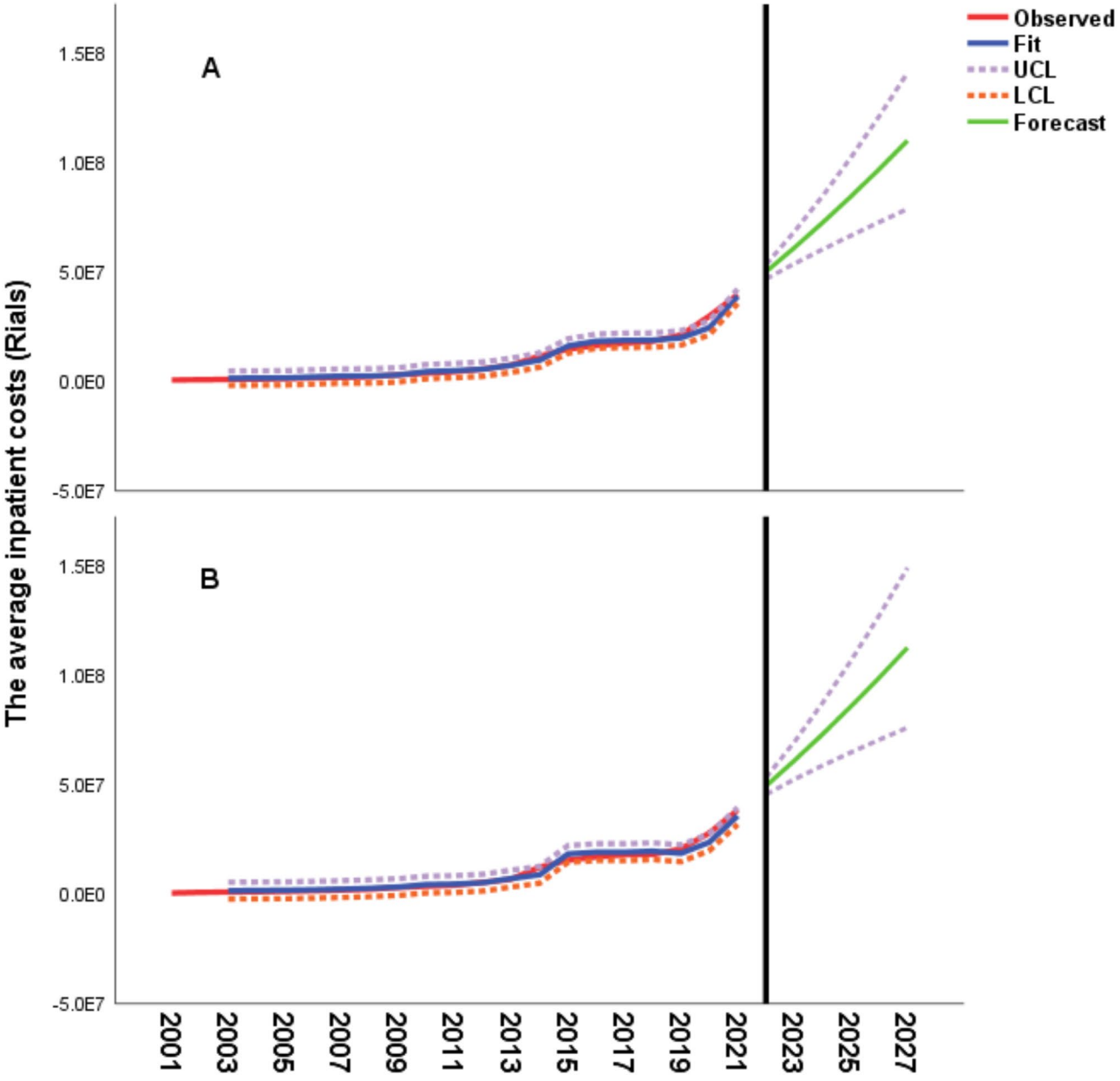

Fig. 4 Forecast of per capita inpatient costs for non-rural (**A**) and rural (**B**) insured populations of the Iranian Health Insurance Organization, 2001–2027. LCL: lower control limit; UCL: upper control limit

significantly from 2021 to 2027, by 54.90% for non-rural funds and 48.67% for rural funds. This projected rise in costs poses a significant challenge for health policymakers and hospital authorities, as the rate of budget increases for health expenditures may not keep pace with the rise in per capita hospitalization costs. Without adequate intervention, this mismatch could lead to growing financial deficits for public hospitals, potentially undermining the gains of HSR and threatening the sustainability of financial risk protection for the poor.

This study utilized time series analysis with a limited dataset, which poses some challenges in the reliability and accuracy of future predictions. The small sample size undermines the robustness of the results, making it difficult to draw definitive conclusions. Furthermore, the *p*-values obtained from the statistical tests may not provide a true reflection of the underlying relationships due to the constrained data. Caution should be exercised when interpreting these findings and considering their applicability to broader contexts.

However, we acknowledge that Isfahan's urban population is large, and the rural population is more diverse than in smaller provinces. While Isfahan's data offer valuable insights, future analyses could compare these results

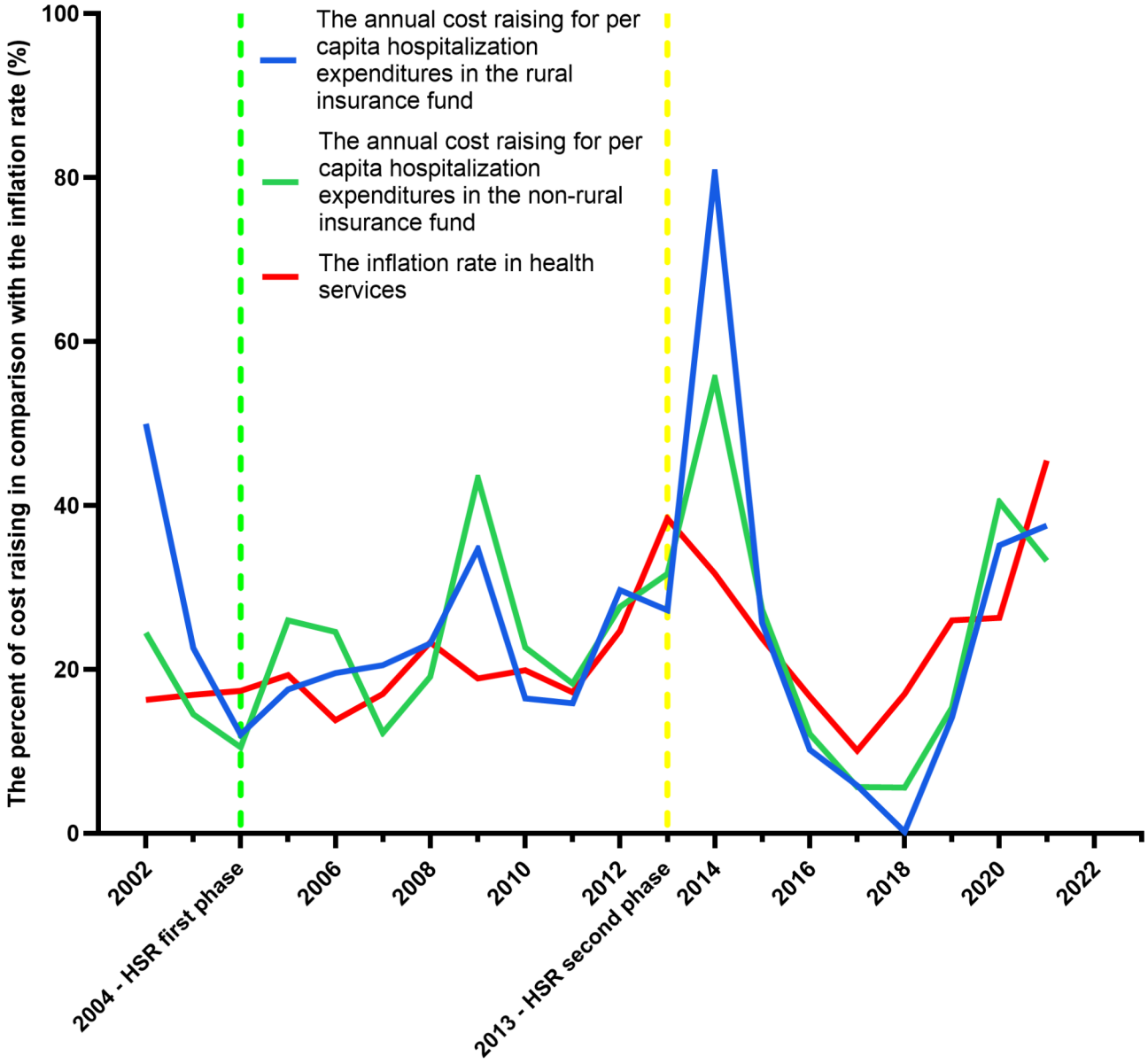

Fig. 5 Trends in the annual cost increases for per capital in inpatient costs for rural and non-rural funds of the Iranian Health Insurance Organization, 2001–2021, compared to annual inflation in the health sector

with other provinces, particularly those with less urbanized populations, to assess robustness.

Owing to the unavailability of hospital stay data throughout the study period, it was not feasible to simultaneously analyze trends in length of stay alongside differences in inpatient costs between rural and non-rural populations. This limitation restricted the capacity to assess the impact of variations in length of stay on changes in inpatient costs.

This study is limited in its ability to isolate the specific effects of Phase II reforms on hospitalization rates, as other factors such as population dynamics, evolving healthcare infrastructure, and changes in health-seeking behavior may also have contributed to these trends. Further research is needed to disentangle the direct impact of Phase II reforms from these broader influences.

Conclusions

The implementation of the first phase of HSR resulted in a 2.8-fold increase in the hospitalization rate among citizens in deprived areas. Meanwhile, the highest hospitalization rate among those covered by the non-rural health insurance fund reached 175.10 per 1,000 insured individuals in 2012, just before the second phase of HSR. Following the second phase, the hospitalization rate for the non-rural insured population declined by approximately

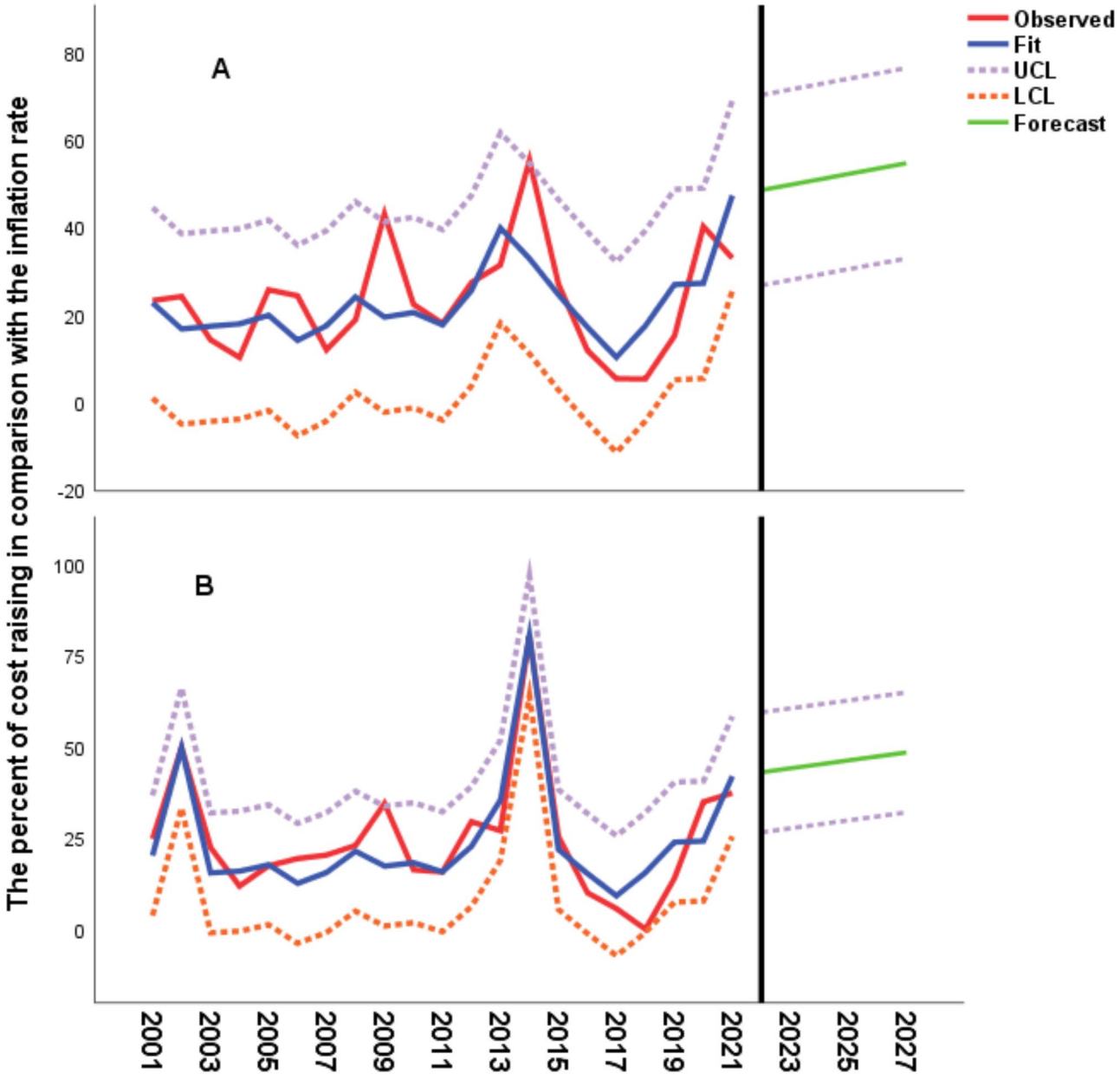

Fig. 6 Projected increase in annual per capita inpatient costs for non-rural (**A**) and rural (**B**) insured populations of the Iranian Health Insurance Organization, 2021–2027. LCL: lower control limit; UCL: upper control limit

30%, reaching 120.82 per 1,000 insured individuals in 2019 and 108.42 per 1,000 insured individuals in 2021. The ARIMA model projects that by 2027, hospitalization rates will converge, reaching 101.88 per 1,000 insured individuals for non-rural populations and 100.53 per 1,000 insured individuals for rural populations. While individuals in remote areas tend to have more essential inpatient care needs, these findings suggest that the HSR has succeeded in promoting health equity between rural and urban populations.

Over the past two decades, the average per capita hospitalization costs for insured individuals in both rural and non-rural health insurance funds were nearly identical. Although per capita inpatient costs are expected to rise significantly by 2027, no significant difference is anticipated between rural and non-rural funds. This suggests that the egalitarian approach to inpatient service reimbursement will likely persist.

Moreover, the average annual increase in hospitalization costs closely mirrored the national inflation rate. However, the ARIMA model forecasts that per capita hospitalization costs will continue to rise significantly from 2021 to 2027, reaching 54.90% and 48.67% for non-rural and rural funds, respectively. This underscores the

need for Iranian health policymakers and hospital administrators to advocate for increased inpatient budgets for both rural and non-rural funds under the governmental health insurance system. Otherwise, public hospitals risk accruing substantial debt, which could erode the financial risk protection achievements of the HSR and negatively impact the quality of clinical services provided by public hospitals.

Abbreviations

ACF	Autocorrelation function
ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
ARIMA	Autoregressive integrated moving average
BIC	Bayesian information criterion
HSR	Health sector reforms
HTP	Health Transformation Plan
IHIO	Iranian Health Insurance Organization
LCL	Lower control limit
LTCI	Long-term care insurance
MAPE	Mean absolute percentage error
OECD	Organization for Economic Cooperation and Development
PACF	Partial autocorrelation function
SDGs	Sustainable Development Goals
UCL	Upper control limit
UHC	Universal health coverage

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12939-025-02440-3.

Supplementary Material 1

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Author contributions

R.K. contributed to the design of the work. M.B and R.K. contributed to design methodology of this study. M.B. and Y.K. contributed to data collection. Y.K. and R.K. contributed to data analysis. R.K. supervised the project. Y.K. and R.K. contributed to Validation and Visualization this study. Y.K. and R.K. writing the original draft. All authors reviewed the manuscript and approved the submitted version of manuscript.

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Data availability

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This research was conducted based on the license of the Research Ethics Committee of Isfahan University of Medical Sciences with the code number: IR.ARI.MUI.REC.1401.192. The committee confirmed that the research adhered to the ethical principles outlined in the 1964 Declaration of Helsinki and its subsequent amendments.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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