



## Avoidable hospitalizations for type 2 diabetes and hypertension in rural areas of central and western China



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### ABSTRACT

**Background:** High-quality primary health care (PHC) can reduce complications from chronic diseases by providing timely, effective, and continuous interventions, thereby preventing hospitalizations due to disease progression. However, there has been limited evidence on avoidable hospitalizations in rural areas of central and western China.

**Objective:** This study aims to localize the measurement of avoidable hospitalizations tailored to China's context and assess the quality and efficiency of PHC in rural areas of central and western China among patients with type 2 diabetes or hypertension.

**Methods:** Data from 61,450 hospitalizations related to hypertension and diabetes were extracted from the medical records of three county-level hospitals in two provinces between 2017 and 2021, using ICD-10 diagnostic codes. Two types of avoidable hospitalizations were defined: (type I) PHC preventable but not avoidable hospitalization; (type II) PHC preventable and avoidable hospitalization. A multilevel logistic regression model was used to identify the factors influencing avoidable hospitalizations.

**Results:** Between 2017 and 2021, 18.1 % of diabetes-related hospitalizations and 49.6 % of hypertension-related hospitalizations were preventable by PHC but not avoidable (type I). Meanwhile, 8.1 % of diabetes-related hospitalizations and 2.4 % of hypertension-related hospitalizations were preventable by PHC and avoidable (type II). Avoidable hospitalizations for these two chronic conditions at the three hospitals resulted in an estimated financial loss of approximately 2.37 million yuan per year. Factors influencing avoidable hospitalizations for diabetes included demographic characteristics and health status, while for hypertension, additional factors included medical insurance coverage and distance to the hospital.

**Conclusion:** The quality of PHC for chronic diseases in rural counties of central and western China remains suboptimal, with inefficiencies and significant resource waste. Strengthening PHC quality should be a key strategy for future chronic disease management in rural China.

By 2018, the prevalence of diabetes among adults in China had reached 12.4%,<sup>1</sup> while the prevalence of hypertension among adults aged 18 and above was as high as 27.5%.<sup>2</sup> This large patient population imposes a substantial burden on individuals, families, and society. In the context of disease spectrum shifting, primary health care (PHC), the cornerstone of healthcare systems, has emerged as a key approach to mitigating this burden.<sup>3</sup> In theory, high-quality PHC helps prevent disease onset, slow progression, reduce complications, and stop minor ailments from worsening, thereby reducing the hospitalizations.<sup>4</sup> The reduction in hospitalizations due to effective PHC is referred to as avoidable hos-

pitalizations (also known as potentially preventable hospitalizations). Diseases that can be prevented through early intervention, timely treatment, and management services in primary care facilities are summarized as ambulatory care sensitive conditions (ACSCs). Hospitalization is significantly more expensive and consumes greater health insurance resources. As a result, avoidable hospitalizations often reflects the overall quality of PHC in a given country or region, as well as the efficiency of medical resource utilization.<sup>5-7</sup>

Reducing avoidable hospitalizations is crucial for improving patient health and achieving cost-effective healthcare system performance. De-

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veloped countries, such as the United States has widely adopted avoidable hospitalizations as a metric to evaluate the quality of PHC.<sup>8</sup> However, its application in China remains in the early stages,<sup>6,9</sup> and there remains inconsistency in its definition.<sup>10,11</sup> Diabetes and hypertension are internationally recognized as key ACSCs.<sup>5-7,12,13</sup> These chronic conditions have long disease courses, complex etiologies, and are strongly linked to lifestyle factors. As such, they represent critical focus areas for PHC in China and are among the top priorities of China’s public health initiatives.

Therefore, based on a localized definition for avoidable hospitalizations and using hospital discharge data of patients with hypertension or diabetes in rural areas of central and western China, this study aims to explore the overall quality of PHC in responding chronic disease, assess the efficiency of medical resource allocation, and examine the factors influencing these outcomes in rural China.

**Data and methods**

*Data source*

This study utilized de-identified hospital discharge data from three county-level hospitals in two provinces (Hubei and Henan) in central and western China, spanning the period from January 2017 to December 2021. A total of 146,077 hospital admission records were collected. The records include basic patient information (e.g., gender, age, occupation, home address), ICD-10 diagnosis codes, surgical procedure codes, medical costs, and admission/discharge dates.

The sample consists of rural inpatients diagnosed with “hypertension” or “type 2 diabetes” (in Chinese) or with related ICD-10 codes. These diagnoses were found in four key fields: outpatient diagnosis, primary admission diagnosis, primary discharge diagnosis, and other secondary discharge diagnosis (top three). This yielded 88,269 records, with rural patients identified as either those whose occupation was registered as farmer/agricultural worker, or unemployed individuals with a registered rural address.

Exclusions were made for records with missing key data (such as primary admission diagnosis, primary discharge diagnosis, or total hospitalization costs) (412 records), patients transferred from other hospitals (18 records), patients who died during hospitalization (2325 records), pregnancy-related hospitalizations (1879 records), planned readmissions (14,233 records), patients under 15 years old (18 records), and hospitalizations due to external causes like injury or poisoning (7934 records). A total of 26,819 records were excluded, leaving 61,450 hospital admission records related to hypertension or diabetes for analysis.

*Variable definition*

The composition of admitted patients in China differs significantly from that of other countries, making it inappropriate to directly apply international concepts of avoidable hospitalizations. Hospitalizations in China are notably high: in 2009, the hospitalization rate was 9.95 %, and by 2019, it had nearly doubled to 19.03 %, surpassing the 2021 average hospitalization rate of 13.0 % for members of the Organization for Economic Cooperation and Development (OECD).<sup>14,15</sup> In addition to patients with legitimate hospitalization indications, China also sees instances of over-hospitalization or induced hospitalizations.<sup>16</sup> These cases are not linked to the quality of PHC but are rather a consequence of inefficient resource allocation and systemic problems in the health-care system, such as hospitals inducing hospitalizations for insurance fraud or patients with poor health literacy seeking unnecessary hospital admissions.<sup>17</sup>

In this study, hospitalizations are categorized based on two factors: whether complications related to diabetes or hypertension could have been prevented through high-quality PHC, and the severity of the patient’s condition at the time of hospitalization. Based on these factors, hospitalizations are divided into four categories: (1)PHC-preventable but unavoidable; (2)PHC-unpreventable and unavoidable;

(1) PHC preventable & Unavoidable	(2) PHC unpreventable & Unavoidable
(3) PHC preventable & Avoidable	(4) PHC unpreventable & Avoidable

**Fig. 1.** Four categories of hospitalizations.

(3)PHC-preventable and avoidable,; (4)PHC-unpreventable but avoidable (Figure 1).

In an ideal healthcare system, characterized by high-quality PHC and efficient resource allocation (e.g., effective tiered care and patient triage), all hospitalizations should ideally fall under category (2). When the quality of PHC is insufficient but resource allocation remains efficient, hospitalizations classified as category (1) will occur. For example, consider a patient hospitalized due to diabetic ketoacidosis (DKA). High-quality PHC could reduce the likelihood of complications like DKA through timely outpatient services, proper medication management, and lifestyle interventions. However, once the patient develops DKA, it qualifies as an acute complication of diabetes, requiring hospitalization, potentially in an intensive care unit (ICU), making the hospitalization unavoidable. This would be classified as a category (1) hospitalization. On the other hand, take the example of a patient admitted and discharged with a diagnosis of hypertension without any complications. This type of hospitalization lacks clear medical indications and may have occurred due to induced hospitalization by healthcare providers, patient distrust of primary care services, or the financial incentive of higher inpatient reimbursement. Such cases would be classified as category (3) hospitalizations. In summary, complications of hypertension or diabetes that are preventable by PHC fall into the PHC-preventable category. Hospitalizations for uncomplicated hypertension or diabetes, which could have been avoided under optimal conditions, are categorized as avoidable in this instance.

This study primarily focuses on the quality of PHC and, therefore, with particular attention to categories (1) and (3) hospitalizations, which are preventable by PHC. Drawing from well-established definitions of avoidable hospitalizations provided by the U.S. Agency for Healthcare Research and Quality (AHRQ) and the OECD,<sup>18,19</sup> this study defines avoidable hospitalizations as outlined in Table 1. Hospitalizations involving death, cases related to pregnancy, childbirth, postpartum, or newborns, as well as records with missing primary diagnoses or total hospitalization costs, are excluded from the avoidable hospitalization analysis.

Since avoidable hospitalizations are directly related to the utilization of inpatient services, we included factors influencing service utilization as control variables. These were identified based on prior studies on avoidable hospitalizations<sup>20,21</sup> and Andersen’s Health Services Utilization Model.<sup>22</sup> The control variables include sociodemographic factors (such as gender, marital status, age, and ethnicity), health-related variables (Charlson Comorbidity Index,<sup>23</sup> whether surgery was performed, department of hospitalization), medical insurance, and distance to the county-level hospital. The year of hospitalization was also controlled.

*Data analysis*

Descriptive analysis was conducted to report the basic characteristics of the sample, the incidence of avoidable hospitalizations, and the associated medical costs. Categorical data were expressed as relative

**Table 1**  
Inclusion and exclusion criteria for hypertensive and diabetic avoidable hospitalizations.

	(Type I) PHC-preventable but unavoidable hospitalization	(Type II) PHC-preventable and avoidable hospitalization
Diabetes	Age $\geq 15$ years; Primary admission diagnosis includes type 2 diabetes complications, such as diabetes with coma, diabetes with ketoacidosis, diabetes with renal complications, diabetes with eye complications, diabetes with neurological complications, diabetes with peripheral circulatory complications, or diabetes with multiple complications.	Age $\geq 15$ years; Both the primary admission and discharge diagnoses are type 2 diabetes; No diabetes complications as mentioned above.
Hypertension	Age $\geq 15$ years; Primary admission diagnosis includes hypertension-related complications, such as hypertensive heart disease, hypertensive kidney disease, hypertensive heart and kidney disease, hypertensive encephalopathy; Primary admission diagnosis includes malignant hypertension, grade 3 hypertension, hypertensive crisis, refractory hypertension, or hypertensive urgency.	Age $\geq 15$ years; Both the primary admission and discharge diagnoses are grade 1 hypertension, grade 2 hypertension, isolated systolic hypertension, or primary hypertension; No hypertension complications as mentioned above.

frequencies, while non-normally distributed continuous data were presented as medians (interquartile range). The numerator for calculating the incidence of avoidable hospitalizations was the number of cases classified as avoidable hospitalizations (as defined in Table 1), while the denominator was the total number of hospitalizations involving a diagnosis of hypertension or diabetes, identified through diagnostic criteria and ICD-10 codes. Univariate analysis was used to report avoidable hospitalizations and medical costs across different patient characteristics, with Chi-square tests used for group comparisons. Since patients treated in the same hospital and by the same attending physician may exhibit intragroup correlation, a multilevel logistic regression model was used to analyze the factors influencing avoidable hospitalizations. The data structure comprised three levels: admitted patients, attending physicians, and hospitals. Data cleaning and analysis were conducted using Stata/MP 17.0 software. P-value of less than 0.05 was considered statistically significant.

## Results

### Basic characteristics of patients

This study included 61,450 hospitalizations, with a relatively even distribution across the years. Of the patients, 53.3 % were female, and 81.4 % were married, with an average age of 66 years. Those aged 65 and above accounted for 58.6 %. Furthermore, 81.3 % were covered by the Urban-Rural Resident Medical Insurance or the New Rural Cooperative Medical Scheme, and 24.8 % of hospitalizations involved surgery (see Table 2).

### Levels and distribution of avoidable hospitalizations

Among diabetic inpatients, 26.2 % of hospitalizations were classified avoidable. Of these, 18.1 % were preventable through PHC but unavoidable for the current hospitalization, while 8.1 % were both preventable and avoidable. Between 2017 and 2021, the incidence of PHC-preventable but unavoidable hospitalizations among diabetic patients increased from 13.7 % in 2017 to 22.2 % in 2021. In contrast, the incidence of PHC-preventable and avoidable hospitalizations decreased from 9.1 % in 2017 to 3.8 % in 2021 (see Table 3).

Among hypertensive inpatients, 52.0 % of hospitalizations were classified as PHC-avoidable (49.55 % + 2.40 % = 51.95 %). Specifically, 49.6 % of hospitalizations were PHC-preventable but unavoidable for the current hospitalization, while 2.4 % were both PHC-preventable and avoidable for this hospitalization. Between 2018 and 2021, the rate of PHC-preventable but unavoidable. Similarly, the rate of PHC-preventable and avoidable hospitalizations showed little variation, remaining around 2 % (see Table 3).

The incidence of PHC-preventable but unavoidable hospitalizations was higher among males (diabetes: 19.1 % vs. 17.5 %, hypertension: 50.4 % vs. 48.8 %) and in non-surgical hospitalizations (diabetes: 19.1 % vs. 14.5 %, hypertension: 54.8 % vs. 33.7 %). Conversely, the incidence of PHC-preventable and avoidable hospitalizations was notably higher among married individuals (diabetes: 8.4 % vs. 6.4 %, hypertension: 2.6 % vs. 1.7 %), younger patients (diabetes  $\leq 44$  years: 16.0 %, hypertension  $\leq 44$  years: 4.2 %), non-surgical hospitalizations (diabetes: 9.4 % vs. 3.1 %, hypertension: 2.8 % vs. 1.2 %), and those covered by Urban-Rural Resident Medical Insurance (diabetes: 8.3 %, hypertension: 2.7 %) (see Table 3).

### Costs of avoidable hospitalizations

On average, 8.1 % of diabetes hospitalizations and 2.4 % of hypertension hospitalizations between 2017 and 2021 were both PHC-preventable and avoidable (see Table 3).

Despite the relatively low incidence, the large number of hospitalizations still leads to significant financial waste. In the three county-level hospitals in central and western China analyzed in this study, avoidable hospitalizations for hypertension led to an estimated financial waste of 4.55 million Yuan(CNY), while those for diabetes resulted in approximately 7.29 million yuan in wasted funds during the 2017–2021 period (see Table 4).

### Analysis of factors influencing avoidable hospitalizations in diabetes patients

Sociodemographic characteristics and patient health status were strongly associated with both PHC-preventable but unavoidable hospitalizations and PHC-preventable and avoidable hospitalizations. The department of hospitalization was the most significant factor for PHC-preventable but unavoidable hospitalizations in diabetes patients. Patients hospitalized in the internal medicine department were 55 % more likely to experience PHC-preventable but unavoidable hospitalizations compared to those in the Traditional Chinese Medicine (TCM) department (OR = 1.551, 95 % CI = 1.193 - 2.016). Surgery was the most significant factor for PHC-preventable but unavoidable hospitalizations. Patients who did not undergo surgery during this hospitalization were 76 % more likely to experience PHC-preventable but unavoidable hospitalizations compared to those who had surgery (OR = 1.762, 95 % CI = 1.415 - 2.195). Moreover, the trends in avoidable hospitalizations for diabetes varied over time: compared to 2017, PHC-preventable but unavoidable hospitalizations significantly increased from 2019 to 2021, while PHC-preventable and avoidable hospitalizations significantly decreased in 2021 (see Table 5).

**Table 2**  
Basic characteristics of rural patients with hypertension or type 2 diabetes<sup>a</sup>.

Patient characteristics	Hypertension only	Diabetes only	Comorbidity (both diseases)	Total	P value
	Cases (%)	Cases (%)	Cases (%)	Cases (%)	
<b>Gender</b>					
Female	21,017 (50.60 %)	4297 (52.31 %)	7438 (63.57 %)	32,752 (53.30 %)	<0.001
Male	20,518 (49.40 %)	3917 (47.69 %)	4263 (36.43 %)	28,698 (46.70 %)	
<b>Marital status</b>					
Unmarried, divorced, widowed	8053 (19.39 %)	1313 (15.98 %)	2082 (17.79 %)	11,448 (18.63 %)	<0.001
Married	33,482 (80.61 %)	6901 (84.02 %)	9619 (82.21 %)	50,002 (81.37 %)	
<b>Age Group</b>					
≤44	1517 (3.65 %)	929 (11.31 %)	343 (2.93 %)	2789 (4.54 %)	<0.001
45–54	5400 (13.00 %)	1817 (22.12 %)	1623 (13.87 %)	8840 (14.39 %)	
55–64	8471 (20.39 %)	2204 (26.83 %)	3113 (26.60 %)	13,788 (22.44 %)	
65–74	13,704 (32.99 %)	2183 (26.58 %)	4166 (35.60 %)	20,053 (32.63 %)	
≥75	12,443 (29.96 %)	1081 (13.16 %)	2456 (20.99 %)	15,980 (26.00 %)	
<b>Ethnicity</b>					
Minority	16,224 (39.06 %)	2649 (32.25 %)	3049 (26.06 %)	21,922 (35.67 %)	<0.001
Han	25,311 (60.94 %)	5565 (67.75 %)	8652 (73.94 %)	39,528 (64.33 %)	
<b>Insurance type<sup>b</sup></b>					
UEBMI	2778 (6.69 %)	479 (5.83 %)	697 (5.96 %)	3954 (6.43 %)	<0.001
URBMI/NCMS	33,675 (81.08 %)	6844 (83.32 %)	9429 (80.58 %)	49,948 (81.28 %)	
Medical Assistance	4105 (9.88 %)	738 (8.98 %)	1313 (11.22 %)	6156 (10.02 %)	
Other	977 (2.35 %)	153 (1.86 %)	262 (2.24 %)	1392 (2.27 %)	
<b>Surgical procedure</b>					
No	30,566 (73.59 %)	6360 (77.43 %)	9287 (79.37 %)	46,213 (75.20 %)	<0.001
Yes	10,969 (26.41 %)	1854 (22.57 %)	2414 (20.63 %)	15,237 (24.80 %)	
<b>Year of admission</b>					
2017	6000 (14.45 %)	1218 (14.83 %)	1302 (11.13 %)	8520 (13.86 %)	<0.001
2018	8324 (20.04 %)	1473 (17.93 %)	2027 (17.32 %)	11,824 (19.24 %)	
2019	9954 (23.97 %)	1871 (22.78 %)	2716 (23.21 %)	14,541 (23.66 %)	
2020	8634 (20.79 %)	1823 (22.19 %)	2772 (23.69 %)	13,229 (21.53 %)	
2021	8623 (20.76 %)	1829 (22.27 %)	2884 (24.65 %)	13,336 (21.70 %)	
<b>Charlson comorbidity index</b>					
0	15,010 (36.14 %)	181 (2.20 %)	347 (2.97 %)	15,538 (25.29 %)	<0.001
1	19,137 (46.07 %)	4389 (53.43 %)	4453 (38.06 %)	27,979 (45.53 %)	
2–3	5742 (13.82 %)	2907 (35.39 %)	6048 (51.69 %)	14,697 (23.92 %)	
>3	1646 (3.96 %)	737 (8.97 %)	853 (7.29 %)	3236 (5.27 %)	
<b>Department of admission<sup>c</sup></b>					
Internal medicine	22,075 (53.15 %)	4832 (58.83 %)	7586 (64.83 %)	34,493 (56.13 %)	<0.001
Other departments	9642 (23.21 %)	1666 (20.28 %)	2164 (18.49 %)	13,472 (21.92 %)	
TCM department	9818 (23.64 %)	1716 (20.89 %)	1951 (16.67 %)	13,485 (21.94 %)	

<sup>a</sup> Due to rounding, the sum of some proportions may not equal 100%.

<sup>b</sup> UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance; NCMS, New Cooperative Medical Scheme.

<sup>c</sup> According to the "Performance Assessment and Medical Quality Management Inpatient Medical Record Front Page Data Collection Quality and Interface Standards (2020 Edition)" issued by the Medical Administration Bureau of the National Health Commission, the internal medicine specialty in the front page data of the medical records of secondary hospitals includes respiratory medicine, gastroenterology, neurology, cardiology, hematology, nephrology, endocrinology, immunology, allergy, geriatrics, and others.<sup>24</sup>

*Analysis of factors influencing avoidable hospitalizations in hypertension patients*

Avoidable hospitalizations for hypertensive patients were significantly associated with sociodemographic characteristics, health status, medical insurance, and distance to the hospital. The department of hospitalization was the most significant factor for PHC-preventable but unavoidable hospitalizations. Patients in the internal medicine department had an 87 % higher likelihood of experiencing PHC-preventable but unavoidable hospitalizations compared to those in the TCM department (OR = 1.868, 95 % CI = 1.635 - 2.134). From 2019 to 2021, the likelihood of PHC-preventable but unavoidable hospitalizations significantly decreased compared to 2017. For PHC-preventable and avoidable hospitalizations among hypertensive patients, surgery was the most important influencing factor (OR = 2.060, 95 % CI = 1.690 - 2.511), followed by the department of hospitalization (internal medicine: OR = 1.813, 95 % CI = 1.380 - 2.384). Medical insurance also played a significant role in avoidable hospitalizations. Compared to patients covered by Urban Employee Medical Insurance, patients receiving poverty assistance had a significantly higher likelihood of experiencing PHC-preventable but unavoidable hospitalizations (OR = 1.150, 95 % CI = 1.017 - 1.300), but a significantly lower likelihood of PHC-preventable and avoidable hos-

pitalizations (OR = 0.485, 95 % CI = 0.281 - 0.838). Between 2018 and 2021, the likelihood of PHC-preventable and avoidable hospitalizations among hypertensive patients significantly increased (see Table 6).

**Discussion**

This study localized avoidable hospitalizations, building upon international research while considering China’s context of high hospitalization rates and varying reasons for hospitalization. We distinguished two types of avoidable hospitalizations related to PHC and analyzed five years of hospital discharge data from three county-level hospitals in two provinces, to assess the quality of chronic disease management in rural areas of central and western China.

The main findings of this study can be summarized in three points: First, the quality of chronic disease management and prevention for hypertension and diabetes under PHC in rural counties of central and western China is low, with significant room for improvement. Between 2017 and 2021, 18.1 % of diabetes-related hospitalizations and 49.6 % of hypertension-related hospitalizations could have been prevented with higher-quality PHC. Second, the allocation of healthcare resources in these rural counties is inefficient, leading to significant waste. Specifically, 8.1 % of diabetes-related hospitalizations and 2.4 %

**Table 3**  
The distribution of avoidable hospitalizations for diabetic and hypertensive patients<sup>a</sup>.

Patient characteristics	Diabetes		Hypertension	
	(Type I) PHC-preventable but unavoidable	(Type II) PHC-preventable and avoidable	(Type I) PHC-preventable but unavoidable	(Type II) PHC-preventable and avoidable
<b>Year</b>				
2017	344/2520 (13.65 %)	228/2520 (9.05 %)	3724/7302 (51.00 %)	64/7302 (0.88 %)
2018	420/3500 (12.00 %)	334/3500 (9.54 %)	5072/10,332 (49.09 %)	236/10,332 (2.28 %)
2019	862/4586 (18.80 %)	460/4586 (10.03 %)	6236/12,667 (49.23 %)	407/12,667 (3.21 %)
2020	937/4594 (20.40 %)	407/4594 (8.86 %)	5552/11,358 (48.88 %)	305/11,358 (2.69 %)
2021	1045/4713 (22.17 %)	177/4713 (3.76 %)	5708/11,400 (50.07 %)	262/11,400 (2.30 %)
<b>Gender</b>				
Female	2050/11,734 (17.47 %)	940/11,734 (8.01 %)	13,846/28,374 (48.80 %)	688/28,374 (2.42 %)
Male	1558/8179 (19.05 %)	666/8179 (8.14 %)	12,446/24,685 (50.42 %)	586/24,685 (2.37 %)
<b>Marital Status</b>				
Unmarried/Divorced/Widowed	469/3394 (13.82 %)	217/3394 (6.39 %)	5616/10,099 (55.61 %)	171/10,099 (1.69 %)
Married	3139/16,519 (19.00 %)	1389/16,519 (8.41 %)	20,676/42,960 (48.13 %)	1103/42,960 (2.57 %)
<b>Age Group</b>				
≤44	371/1272 (29.17 %)	203/1272 (15.96 %)	698/1852 (37.69 %)	77/1852 (4.16 %)
45–54	827/3440 (24.04 %)	446/3440 (12.97 %)	2959/6988 (42.34 %)	192/6988 (2.75 %)
55–64	1099/5317 (20.67 %)	446/5317 (8.39 %)	5431/11,525 (47.12 %)	287/11,525 (2.49 %)
65–74	965/6348 (15.20 %)	390/6348 (6.14 %)	8895/17,819 (49.92 %)	447/17,819 (2.51 %)
≥75	346/3536 (9.79 %)	121/3536 (3.42 %)	8309/14,875 (55.86 %)	271/14,875 (1.82 %)
<b>Ethnicity</b>				
Minority	1627/5698 (28.55 %)	492/5698 (8.63 %)	6974/19,267 (36.20 %)	848/19,267 (4.40 %)
Han	1981/14,215 (13.94 %)	1114/14,215 (7.84 %)	19,318/33,792 (57.17 %)	426/33,792 (1.26 %)
<b>Charlson Comorbidity Index</b>				
0	0/528 (0.00 %)	0/528 (0.00 %)	1689/15,303 (11.04 %)	415/15,303 (2.71 %)
1	1929/8841 (21.82 %)	1130/8841 (12.78 %)	15,697/23,533 (66.70 %)	613/23,533 (2.60 %)
2–3	1430/8954 (15.97 %)	409/8954 (4.57 %)	8092/11,732 (68.97 %)	230/11,732 (1.96 %)
>3	249/1590 (15.66 %)	67/1590 (4.21 %)	814/2491 (32.68 %)	16/2491 (0.64 %)
<b>Surgery</b>				
No	2990/15,647 (19.11 %)	1473/15,647 (9.41 %)	21,838/39,853 (54.80 %)	1114/39,853 (2.80 %)
Yes	618/4266 (14.49 %)	133/4266 (3.12 %)	4454/13,206 (33.73 %)	160/13,206 (1.21 %)
<b>Department</b>				
Internal Medicine	2726/12,418 (21.95 %)	1163/12,418 (9.37 %)	18,779/29,496 (63.67 %)	890/29,496 (3.02 %)
Other Departments	87/3828 (2.27 %)	41/3828 (1.07 %)	4428/11,796 (37.54 %)	42/11,796 (0.36 %)
TCM Department	795/3667 (21.68 %)	402/3667 (10.96 %)	3085/11,767 (26.22 %)	342/11,767 (2.91 %)
<b>Insurance Type</b>				
UEBMI	163/1176 (13.86 %)	68/1176 (5.78 %)	1349/3470 (38.88 %)	78/3470 (2.25 %)
URBMI/NCMS	3129/16,272 (19.23 %)	1354/16,272 (8.32 %)	21,227/42,948 (49.42 %)	1144/42,948 (2.66 %)
Medical Assistance	234/2050 (11.41 %)	163/2050 (7.95 %)	3119/5403 (57.73 %)	20/5403 (0.37 %)
Other	82/415 (19.76 %)	21/415 (5.06 %)	597/1238 (48.22 %)	32/1238 (2.58 %)
<b>Distance to County Hospital</b>				
1st Quintile (Closest)	775/4542 (17.06 %)	337/4542 (7.42 %)	5249/10,486 (50.06 %)	253/10,486 (2.41 %)
2nd Quintile	790/4131 (19.12 %)	362/4131 (8.76 %)	5106/10,675 (47.83 %)	247/10,675 (2.31 %)
3rd Quintile	752/3887 (19.35 %)	326/3887 (8.39 %)	5304/10,680 (49.66 %)	217/10,680 (2.03 %)
4th Quintile	635/3701 (17.16 %)	301/3701 (8.13 %)	5289/10,636 (49.73 %)	259/10,636 (2.44 %)
5th Quintile (Furthest)	656/3652 (17.96 %)	280/3652 (7.67 %)	5344/10,582 (50.50 %)	298/10,582 (2.82 %)

<sup>a</sup> Taking the reported figures "344/2520 (13.65%)" in the table of preventable by PHC preventable & unavoidable this hospitalization for diabetes in 2017 as an example, the denominator represents the total number of hospital records for diabetes in 2017, and the numerator represents the number of hospital records defined as preventable by PHC preventable and unavoidable this hospitalization.

**Table 4**  
Avoidable inpatient expenditures for diabetic and hypertensive patients (2017–2021).

Condition	(Type I) PHC-preventable but unavoidable		(Type II) PHC-preventable and avoidable	
	Median Cost per Hospitalization (CNY)	Total Cost (CNY)	Median Cost per Hospitalization (CNY)	Total Cost (CNY)
<b>Diabetes</b>				
Total	4575.7 (3465.6–5784.9)	17,903,577	4534.9 (3321.5–5748.6)	7,292,841
2017	4633 (3332–5964)	1,703,276	5006 (3101–6626)	1,637,803
2018	4500 (3323–5680)	1,983,531	4698 (3423–5921)	2,163,577
2019	4404 (3384–5598)	4,114,255	4416 (3286–5600)	1,940,108
2020	4638 (3546–5848)	4,651,231	4523 (3471–5682)	775,676
2021	4694 (3582–5826)	5,451,285	4098 (2983–5271)	775,676
<b>Hypertension</b>				
Total	5312.1 (3717.1–7440.1)	195,644,398	3386.0 (1892.4–4944.8)	4,545,087
2017	5614 (3835–7190)	27,882,314	4040 (2416–5886)	347,058
2018	5504 (3826–6926)	34,882,540	3640 (2893–4623)	931,494
2019	5198 (3753–7387)	47,962,858	2904 (2033–4041)	1,292,504
2020	5089 (3599–7356)	40,810,803	3023 (2446–3779)	1,051,785
2021	5103 (3583–7850)	44,105,881	3272 (2509–4237)	922,246

**Table 5**  
Multilevel Logistic regression models of avoidable hospitalizations for type 2 diabetes.

	(Type I) PHC-preventable but unavoidable			(Type II) PHC-preventable and avoidable		
	OR	95 % CI	P value	OR	95 % CI	P value
Gender (ref=Male)	1.023	[0.926 - 1.130]	0.657	1.149	[1.014 - 1.301]	0.029
Age	0.982	[0.978 - 0.986]	<0.001	0.969	[0.964 - 0.974]	<0.001
Marital Status (ref=Unmarried/Other)	1.283	[1.117 - 1.474]	<0.001	1.231	[1.036 - 1.462]	0.018
Ethnicity (ref=Minority)	1.471	[1.233 - 1.756]	<0.001	0.586	[0.452 - 0.760]	<0.001
Health Status						
Charlson Comorbidity Index	1.069	[1.031 - 1.108]	<0.001	0.748	[0.701 - 0.797]	<0.001
Condition Type (ref=Comorbidity of Both)						
Diabetes	1.528	[1.382 - 1.690]	<0.001	1.516	[1.337 - 1.717]	<0.001
Surgery (ref=Yes)	1.159	[1.001 - 1.343]	0.049	1.762	[1.415 - 2.195]	<0.001
Department of Admission (ref=TCM Department)						
Internal Medicine	1.551	[1.193 - 2.016]	0.001	0.549	[0.397 - 0.760]	<0.001
Other Departments	0.456	[0.302 - 0.690]	<0.001	0.188	[0.109 - 0.325]	<0.001
Other Factors						
Health Insurance (ref=UEBMI)						
URBMI/NCMS	0.927	[0.735 - 1.169]	0.521	1.079	[0.804 - 1.447]	0.614
Medical Assistance	0.959	[0.714 - 1.289]	0.781	1.078	[0.756 - 1.538]	0.678
Other Insurance	0.957	[0.643 - 1.425]	0.828	0.731	[0.409 - 1.306]	0.289
Distance to County Hospital (ref=5th Quintile, Furthest)						
4th Quintile	0.899	[0.767 - 1.054]	0.191	0.994	[0.816 - 1.211]	0.955
3rd Quintile	1.067	[0.914 - 1.245]	0.415	1.008	[0.831 - 1.223]	0.935
2nd Quintile	1.045	[0.897 - 1.217]	0.575	0.989	[0.818 - 1.196]	0.911
1st Quintile (Closest)	1.031	[0.884 - 1.203]	0.697	0.954	[0.786 - 1.158]	0.636
Year (ref=2017)						
2018	1.090	[0.902 - 1.317]	0.372	1.179	[0.955 - 1.455]	0.126
2019	1.864	[1.562 - 2.225]	<0.001	1.023	[0.834 - 1.253]	0.830
2020	1.940	[1.609 - 2.338]	<0.001	0.996	[0.801 - 1.238]	0.968
2021	1.837	[1.493 - 2.259]	<0.001	0.374	[0.282 - 0.496]	<0.001

**Table 6**  
Multilevel Logistic regression models of avoidable hospitalizations for hypertension.

	(Type I) PHC-preventable but unavoidable			(Type II) PHC-preventable and avoidable		
	OR	95 % CI	P value	OR	95 % CI	P value
Gender (ref=Male)	0.925	[0.884 - 0.968]	0.001	1.229	[1.084 - 1.394]	0.001
Age	1.018	[1.016 - 1.020]	<0.001	0.963	[0.958 - 0.969]	<0.001
Marital Status (ref=Unmarried/Other)	1.007	[0.950 - 1.068]	0.814	1.037	[0.864 - 1.244]	0.698
Ethnicity (ref=Minority)	0.890	[0.820 - 0.965]	0.005	0.986	[0.840 - 1.158]	0.868
Charlson Comorbidity Index	1.250	[1.231 - 1.270]	<0.001	0.794	[0.736 - 0.857]	<0.001
Condition Type (ref=Comorbidity of Both)						
Hypertension	1.859	[1.756 - 1.969]	<0.001	1.816	[1.504 - 2.193]	<0.001
Surgery (ref=Yes)	1.169	[1.097 - 1.247]	<0.001	2.060	[1.690 - 2.511]	<0.001
Department of Admission (ref=TCM Department)						
Internal Medicine	1.868	[1.635 - 2.134]	<0.001	1.813	[1.380 - 2.384]	<0.001
Other Departments	1.615	[1.364 - 1.912]	<0.001	0.560	[0.302 - 1.041]	0.067
Other Factors						
Health Insurance (ref=UEBMI)						
URBMI/NCMS	1.041	[0.942 - 1.150]	0.430	1.015	[0.770 - 1.336]	0.918
Medical Assistance	1.150	[1.017 - 1.300]	0.026	0.485	[0.281 - 0.838]	0.009
Other Insurance	1.203	[1.007 - 1.436]	0.041	0.874	[0.544 - 1.406]	0.580
Distance to County Hospital (ref=5th Quintile, Furthest)						
1st Quintile (Closest)	0.917	[0.855 - 0.984]	0.017	0.800	[0.660 - 0.969]	0.022
2nd Quintile	0.893	[0.833 - 0.957]	0.001	0.921	[0.760 - 1.116]	0.399
3rd Quintile	0.947	[0.883 - 1.016]	0.128	0.735	[0.604 - 0.895]	0.002
4th Quintile	0.915	[0.854 - 0.981]	0.013	0.935	[0.774 - 1.130]	0.487
Year (ref=2017)						
2018	0.925	[0.854 - 1.001]	0.054	3.514	[2.610 - 4.731]	<0.001
2019	0.889	[0.820 - 0.964]	0.004	5.456	[4.081 - 7.294]	<0.001
2020	0.822	[0.755 - 0.895]	<0.001	4.698	[3.458 - 6.382]	<0.001
2021	0.770	[0.703 - 0.843]	<0.001	3.774	[2.736 - 5.207]	<0.001

of hypertension-related hospitalizations could have been preventable by PHC and avoidable for the current hospitalizations. Given the large number of hospitalizations, these preventable cases resulted in an estimated financial waste of approximately 2.37 million yuan annually across just the three hospitals for these two chronic conditions. Third, avoidable hospitalizations in rural areas of central and western China are influenced by patient demographic characteristics, health status, medical insurance, and the distance to the hospital.

The findings of this study, which highlight the low quality of chronic disease prevention and management in rural areas based on avoidable hospitalizations, are consistent with broader research evidence. National epidemiological surveys reveal that the prevalence of diabetes and hypertension in rural China has been steadily increasing, even surpassing that of urban residents. However, the rates of awareness, treatment, and control of chronic diseases remain significantly lower in rural areas compared to urban counterparts.<sup>1,24</sup>

Sun et al.<sup>25</sup> used diabetes hospitalization rates as an outcome indicator to evaluate the quality of China's PHC using data from the CHARLS database. They found that diabetes-related hospitalizations increased from 4.01 % in 2011 to 6.08 % in 2013, without any improvement in the proportion of patients receiving diabetes screening and treatment during this period. Wu et al.<sup>26</sup> examined the quality of PHC for diabetes in rural western China using standardized patients, finding that only 20 % of doctors adhered to clinical guidelines, and only half provided lifestyle advice. Similarly, Zhang et al.<sup>27</sup> used standardized patients to investigate hypertension screening and blood pressure measurement practices by general practitioners (GPs) across seven provinces of China, discovering that only 26.9 % of migraine patients and 15.4 % of diabetes patients had their blood pressure measured. Despite numerous calls for strengthening the role of PHC in chronic disease prevention and control,<sup>28</sup> the current low-quality PHC in rural areas of central and western China remains inadequate to meet this demand.

In this study, 8.1 % of diabetes hospitalizations and 2.4 % of hypertension hospitalizations were classified as PHC-preventable and avoidable, with most patients concentrated in the TCM and internal medicine departments. These hospitalizations represent an overutilization of healthcare services, resulting in wasted resources and decreased efficiency in the healthcare system. The poor quality of PHC is a key factor driving rural residents to bypass primary care facilities and overuse inpatient services at county-level hospitals,<sup>29</sup> particularly by relying on the internal medicine and TCM departments as their primary source of healthcare.

Inappropriate incentive mechanisms that encourage providers to induce demand are also a key cause of avoidable hospitalizations. Chen et al.<sup>30</sup>, using the OECD definition of avoidable hospitalizations, found a continuous rise in diabetes-related avoidable hospitalizations from 2015 to 2018. In 2018, one developed city in eastern China reported over 40,000 diabetes-related avoidable hospitalizations, with an avoidable hospitalization rate of 2.17 %, far lower than the 22 % observed in central and western China in this study. Although there are methodological differences between the two studies, the contrast in data highlights the disparity in PHC quality between developed eastern regions and underdeveloped central and western regions, as well as differences in hospitalization practices at county-level hospitals.

This issue is not unique to China. In transitioning health systems, it is common for hospitals to provide primary care services. A study using data from 56 countries found that around 20 % of the population received hospital-based care for services that should have been provided by PHC, such as contraception, routine prenatal care, treatment for common childhood conditions like diarrhea, fever, and cough. Urban residents, particularly those with higher education levels and better economic conditions, are more likely to use hospitals as their primary healthcare provider.<sup>31</sup>

Therefore, improving the service capacity of PHC is essential for achieving tiered diagnosis and treatment while reducing healthcare system costs. At the same time, healthcare payment reforms that address the financial incentives driving hospitals to overprovide inpatient services—particularly economic incentives—are crucial in reducing avoidable hospitalizations. Strengthening trust in PHC among patients will gradually increase its utilization. However, if PHC lacks a highly qualified workforce and sufficient medical resources, incentive mechanisms alone will not lead to effective tiered healthcare.

This study also found that medical insurance plays a role in influencing avoidable hospitalizations among hypertensive patients. Improving the medical insurance system could complement efforts to enhance PHC capacity, ensuring that minor illnesses can be treated in primary care facilities, thus achieving the goals of tiered healthcare. Addressing the imbalance between outpatient and inpatient reimbursement rates and improving chronic disease management in PHC are also essential. Furthermore, it is important to improve GPs' skills, service quality, and continuity, with a particular focus on promoting healthy behaviors for chronic disease management at the family level.<sup>32</sup>

The ongoing promotion of county-level medical alliance may help integrate county hospitals and primary care facilities, strengthening PHC capacity.<sup>33</sup> This initiative aligns with the international concept of "system-focused hospitals," which advocates for the reallocation of hospital resources to enhance PHC.<sup>34</sup> However, the development of county-level medical alliance in China remains in the exploratory phase and faces several challenges. One risk is that county hospitals may replicate specialized service structures and philosophies in managing primary care facilities, evaluating PHC using county hospital metrics. This could lead to a shift in PHC's focus toward specialized services, thereby undermining its strengths in continuous, coordinated, and family-oriented health management. The long-term impact of county-level medical alliance development on PHC will require further time and evidence to validate.<sup>35</sup>

Moreover, the methods used to measure avoidable hospitalizations still require further exploration. Currently, most studies in China adopt the OECD or AHRQ definitions for avoidable hospitalizations, allowing for international comparisons.<sup>36</sup> Additionally, Chinese scholars have started exploring the development of an ACSC list better suited to the Chinese context.<sup>37</sup> Chen et al.<sup>38</sup>, using the OECD definition, analyzed avoidable hospitalizations due to chronic diseases in rural areas of central China. They found that the avoidable hospitalization rate was 3.04 % for diabetes patients and 3.53 % for hypertension patients in 2017–2018, lower than in the U.S. (7.16 % in 2011) and Austria (7 % in 2013). Although the rates were not high, the large patient population in China results in a much higher number of avoidable hospitalizations, leading to greater resource waste.<sup>38</sup> Chen et al. also used the OECD definition to analyze avoidable hospitalizations in both rural areas of central and western China, as well as in eastern China.<sup>30,38</sup>

When comparing avoidable hospitalizations across different studies, it is crucial to consider the definition of the denominator. For national or regional avoidable hospitalizations, the numerator is the total number of avoidable hospitalizations in the area, while the denominator is the population of the country or region. However, if complete hospitalization data are not available, the denominator may consist of the total or partial number of hospitalizations. This study focuses on two of the most common chronic diseases in rural areas, and thus the denominator used is the number of hospitalizations for these chronic diseases, rather than all hospitalizations.

Using avoidable hospitalizations as a measure of PHC quality has its limitations. Although the concept of avoidable hospitalizations has a theoretical and conceptual basis, there is ongoing international debate regarding which hospitalizations should be classified as avoidable.<sup>9</sup> The relationship between hospitalizations and the quality of PHC is not simply causal. Avoidable hospitalizations are influenced by three key factors: (1) Patient characteristics, including disease severity, health literacy, and self-management abilities.<sup>21</sup> However, due to the limited information available in the medical record databases, which lack detailed data, it is difficult to fully control for individual patient factors when analyzing avoidable hospitalizations. This is a significant limitation in current research. (2) The quality of PHC, including the accessibility, timeliness, effectiveness, and coordination of primary care services. High-quality PHC can prevent complications and reduce the need for hospitalizations. (3) Hospital characteristics, such as proximity to the hospital, health insurance policies, and the doctor-patient relationships.<sup>20</sup> Additionally, avoidable hospitalizations vary in different culture and ethical contexts. For instance, there is ongoing debate about whether hospitalizations that provide no medical benefit should be classified as avoidable.<sup>9</sup> Future research could further refine the concept of avoidable hospitalizations for chronic diseases, collect more comprehensive data, and use these hospitalizations as a means to track the effectiveness of chronic disease prevention and management efforts in county-level PHC systems across China.

This study has the following limitations: First, the data were limited to three county-level hospitals in two provinces, which may not

represent the broader situation in rural areas of central and western China. Second, the study focused only on patients with hypertension and diabetes, excluding those with other diseases, meaning the avoidable hospitalizations reported here may not reflect the overall situation in these hospitals. Third, due to the limited information in the hospital discharge data, this study was unable to control for important factors such as socioeconomic status, which can significantly influence health-care utilization. Future research should consider linking hospital discharge data with data that include socioeconomic information to better control for confounding factors.

## Conclusion

This study identified two types of avoidable hospitalizations related to PHC and found that chronic disease management and prevention for hypertension and diabetes in rural counties of central and western China remain inadequate. There are also issues of inefficiency and resource waste. Strengthening the capacity of primary care and improving service quality should be key priorities for future efforts in chronic disease prevention and control.

## Declarations

Not applicable.

## Authors' contributions

Conceptualization, L.M. and L.X.; Methodology, L.M. and L.X.; Data curation, Z.X., L.M., C.X., Z.B., C.H., T.H., Z.H.,; Formal analysis, L.M.; Funding acquisition, not applicable; Project administration, not applicable; Resources, not applicable; Supervision, L.X.; Validation, L.X.; Writing—original draft, L.M.; Writing—review and editing, Z.H., L.X., Z.X., T.H. and Z.H. All authors have read and agreed to the published version of the manuscript.

## Ethics approval and consent to participate

The study received approval from Peking University Health Science Center Biomedical Ethics Committee (IRB00001052–22155).

## Consent for publication

Not applicable.

## Availability of data and materials

Not applicable.

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## Authors' other information

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## Competing interests

All authors declare that there are no competing interests.

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