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ABSTRACT

Geographic Variation in Inpatient Care Utilization, Outcomes and Costs for Dementia Patients in China

Dementia leads public health issue worldwide. China has the largest population of adults living with dementia in the world, imposing increasing burdens on the public health and healthcare systems. Despite improved access to health services, inadequate and uneven dementia management remains common. We document the provincial-level geographic patterns in healthcare utilization, outcomes, and costs for patients hospitalized for dementia in China. Regional patterns demonstrate gaps in equity and efficiency of dementia care and management for dementia patients. Health policy and practices should consider geographic disparities in disease burden and healthcare provision to promote equitable allocation of resources for dementia care throughout China.

JEL Classification: J14, I11, I14, I18, H75

Keywords: dementia, health care, hospitalization, inpatient costs, in-hospital mortality, geographic variation

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1. Introduction

Globally over 55 million people live with dementia, and the aggregate financial burden of the disease is over 1 trillion US dollars annually.^{1,2} This burden has been growing rapidly in China, which habitates almost one-fourth of the total dementia cases worldwide.^{3,4} Prior research shows that the prevalence of dementia in China is high and differs geographically.^{3,4} However, no previous study has revealed the geographic patterns of dementia care and cost in China.

To bridge that gap, we used administrative data from an extensive national database to characterize the geographic patterns in healthcare utilization, outcomes, and costs for patients hospitalized for dementia in China. We obtained novel estimates at both the provincial and national levels to enrich the understanding of the disease burden nationwide and facilitate the effective allocation of resources for dementia care.

Our results demonstrated significant geographic disparities in inpatient care utilization, outcomes, and costs for patients hospitalized for dementia in China across provinces. Specifically, we found notable geographic clusters in inpatient care costs and length of stay. These regional patterns imply gaps in equity and efficiency of dementia care and management for this rapidly growing population of dementia patients. Future policies and practices should consider these geographical disparities and promote a more equitable system for dementia care.

The paper was organized as follows. Section 2 described our data, measures and methods; Section 3 presented results on geographic variation in inpatient care utilization, outcomes and costs for dementia patients in China; Section 4 concluded and discussed potential implications for health policy and practices.

2. Data and Methods

Hospital service data were obtained through the Data Center for High-Quality Hospital Management at Peking University Institute for Global Health and Development. The Center integrates data on healthcare services and management of representative hospitals in China for health policy and management research. The national sample covers 30 provinces except for Tibet (Xizang), Taiwan, Hong Kong, and Macau, making it a representative sample for understanding geographic variations. The dataset spanning from June 2017 to June 2019 provides information on inpatient records, including admission type, dates of admission and discharge, primary and secondary diagnoses, comorbidities, and costs. To ensure that the care utilization and costs were related directly to dementia, we extracted inpatient records with primary diagnosis as dementia based on the International Classification of Disease (ICD) codes (see the list in Table S1).

Since dementia is an age-related condition, we restricted samples to patients aged 65 years or older at admission. Samples with a respective 2% of the highest and lowest total inpatient care costs were excluded from the analysis to mitigate the influence of extreme values; and the results were

similar if we excluded extreme values based on other criteria (e.g., excluding 1% of the highest and lowest). Overall, 1,917 hospitals in the database had valid dementia cases (51,530 total cases), with 960 (50.1%) tertiary hospitals and 957 (49.9%) secondary hospitals or below. The distribution of hospitals and cases by province is further illustrated in Supplementary Figure S1, where the total number of hospitals (and cases) and the proportion of types of hospitals are presented for each province.

In this study, the inpatient care utilization, i.e., the number of hospital admissions due to dementia per 100,000 person-years, was first assessed for each province. This assessment utilized our medical records data and data from China Statistical Yearbook for hospital admission and provincial population.⁵ Specifically, we scaled our total number of dementia admissions by the ratio of hospital admissions included in our database to the total hospital admissions from the Yearbook. The provincial population aged 65 or older and the observed periods were used as the denominator. Second, we evaluated the disease severity/urgency and outcomes of hospital admissions for dementia patients. Specifically, we used the percentage of emergency room (ER) admission and the number of comorbidities to reflect the disease severity/urgency of admission; and we used the percentage of in-hospital mortality as an indicator for care outcomes. The number of comorbidities was calculated as the sum of all coexisting diagnosed conditions documented at the time of admission using ICD codes. The in-hospital mortality was calculated as the proportion of patients who died during hospitalization among all dementia inpatient admissions. Third, we estimated the average total costs per admission based on the total hospital expenditure reported for each admission (including out-of-pocket and insurance-covered expenses), the average length of stay (LOS), and the average daily cost per admission to assess the care intensity during the hospitalization.

The quality of data was highly reliable, with limited missing records and extreme cases. Specifically, we found no missing data for all measures except for mortality outcome (with only <0.01% missing records). No extreme cases with values outside valid/possible ranges were found in our data. For each outcome, we calculated the national average, by averaging the provincial estimates of the outcome. Furthermore, using Moran's I statistic, we examined spatial autocorrelation and clustering using the distance decay parameter of 2. STATA (release 16.0, Stata Corp) and R (version 4.0.2, R Core Team) were used to perform the analyses.

3. Results

Figure 1 displays the geographic patterns of inpatient care utilization, severity/urgency, and outcomes. Panel A presents the number of dementia-related hospital admission per 100,000 person-years for each province. The national average number of dementia admissions was 111 (95% CI: 72, 149) per 100,000 person-years. The utilization rate of care was higher in western provinces and some central and southern provinces, such as Xinjiang (579), Yunnan (218), Guizhou (181), and Guangdong (273), but lower in northeastern provinces. Panel B presents the percentage of ER

admissions among all dementia admissions. The national average across provinces was 19.5% (95% CI: 15.8%, 23.2%). At the province level, the percentage of ER admissions ranged from 3.2% in Nei Mongol to 40.5% in Shanghai. Some provinces with high percentages of ER admission included Beijing (38.2%), Jilin (37.0%), Guizhou (33.4%), Qinghai (31.7%), Henan (31.3%), and Heilongjiang (30.3%). Panel C presents the average number of comorbidities per admission. Hospitalized dementia patients generally had multiple comorbidities. The national average across provinces was 5.5 (95% CI, 4.9, 6.1) comorbidities; and at the province level, the average number of comorbidities ranged from 3.1 in Liaoning to 9.5 in Yunnan. The average number of comorbidities in patients was higher in western provinces and some eastern or northern provinces, such as Xinjiang (7.6), Qinghai (7.5), Fujian (8.9), Zhejiang (7.0), and Beijing (7.5), as compared to others. Lastly, for care outcomes, Panel D displays the percentage of in-hospital mortality among all dementia-related admissions. The national average across provinces was 1.0% (95% CI, 0.5%, 1.4%). Northern provinces had the highest percentage of in-hospital mortality, including Nei Mongol (6.5%), Heilongjiang (2.5%), Jilin (1.8%), and Liaoning (1.3%). The Moran's I statistics were all very small and no significant spatial autocorrelation was found for these measures except for the utilization rate.

Figure 2 further illustrates the geographic variation in average total costs, daily costs, and LOS per admission, as measures of care intensity and disease burden. Panel A presents the average total costs per admission. The national average total cost across provinces was 14,755 (95% CI, 12738, 16772) CNY per admission which presented clear geographic patterns at the province level. Notably, the average total costs per admission were highest among Jing-Jin-Ji metropolitan area (i.e., Tianjin: 35,357; Beijing: 28,660; and Hebei: 15,618) and were consistently higher among eastern or southern coastal provinces (e.g., Fujian: 22,072; Shanghai: 19,624; and Zhejiang: 17,406) than others. Panels B and C, present the average daily costs and LOS per admission. At the national level, the average daily costs were 1,171 (95% CI: 965, 1,377) CNY, and the average LOS was 15.5 (95% CI: 13.7, 17.4) days per admission. At the province level, the average daily costs were higher among Jing-Jin-Ji metropolitan area and some northern provinces than others, including Beijing (3,491), Tianjin (2,818), Hebei (1,385), Nei Mongol (1,442), and Jilin (1,175). The average daily costs were also relatively high in some coastal provinces, such as Shanghai (1,385) and Guangdong (1,126). By contrast, the LOS was highest among coastal areas and some western provinces, such as Fujian (23.0), Zhejiang (23.0), Jiangsu (20.7), Shanghai (18.4), Sichuan (22.5), and Guizhou (21.0). The Moran's I statistics for average total costs, daily costs, and LOS were large and significant at 0.1% ($p < 0.001$), indicating strong spatial correlation and clustering across provinces.

4. Conclusions and Discussion

The study demonstrates geographic variation in inpatient care utilization, disease severity/urgency, care outcomes, and costs for dementia patients in China. Several findings in the study warrant further discussion.

First, the geographical patterns of inpatient care utilization and costs overall were not entirely consistent with the patterns of disease prevalence, which may reflect the underlying disparities in dementia care and management.⁴ While some western provinces with higher dementia prevalence showed greater utilization and disease burden, the patterns of other regions and provinces differed in many other aspects. Such differences between utilization and prevalence could be partially explained by the regional variations in the proportion of older adults, economic development, healthcare infrastructure, disease awareness, and management. Varying levels of financial burden and coverage for dementia care may contribute to regional patterns.⁴

Second, we showed that the regional patterns might vary across utilization measures, disease urgency/severity, outcomes, and costs, which deserves investigation in future research. For instance, while we observed greater utilization rates in western provinces, the severity/urgency of the admissions (e.g., percentage of ER admissions) seemed to be higher in some other provinces. Both demand and supply-side factors might explain these patterns. On the demand side, the utilization rate is mainly determined by disease prevalence and patients' care-seeking behaviors. Many demand-side factors, such as economic difficulties, low awareness, and social stigma, may impede dementia patients from seeking care and treatment at an early stage, which will consequently lead to greater severity/urgency of the diseases and higher rates of ER admissions.^{1,2,4} On the supply side, inpatient care utilization largely depends on timely access and quality of care. The varying availability of well-trained specialists and dementia care facilities across provinces may result in the differential capacity of clinical management and control, thereby shaping the patterns of utilization, disease outcomes, and costs. Additionally, the criteria for dementia admissions may vary across areas due to the uneven distribution of dementia care resources, leading to diverse patient compositions and care outcomes.⁴ Our initial evidence on the geographic patterns highlight the potential differences in various aspects of dementia care. Future studies should consider this and further disentangle the underlying causes of the patterns.

Third, we found strong geographic clustering of costs, daily costs, and LOS. The costs and the care intensity were consistently higher among more developed areas, such as Jingjing-Ji metropolitan area and eastern coastal provinces, which reemphasized the regional disparities in dementia care and utilization across provinces. As the demand for healthcare and nursing are intertwined, lack of access to primary and long-term care, especially in less developed areas, has limited the care for people with dementia and enlarged their health inequities. Demographic shifts to a greater proportion of older adults and the rising burden of dementia suggest a need to establish and strengthen primary care and long-term care systems and affordable and equitable dementia caring models.^{6,7}

This study was subject to some limitations. First, only hospital admissions with dementia as the primary diagnosis were included. Yet restrictions by medical technology, dementia misdiagnosis

and misclassifications may affect some provinces more than others, leading to certain levels of geographic differences. The ubiquitous underdiagnosis of dementia may also apply to our study context for all provinces. Moreover, dementia could have been a secondary diagnosis for admission, which were not examined in this study. Second, the underlying mechanisms for the geographic variations were not fully illuminated. Data on local policies and practices needs to be linked to the medical records to understand the mechanisms of the regional patterns.

Acknowledgements

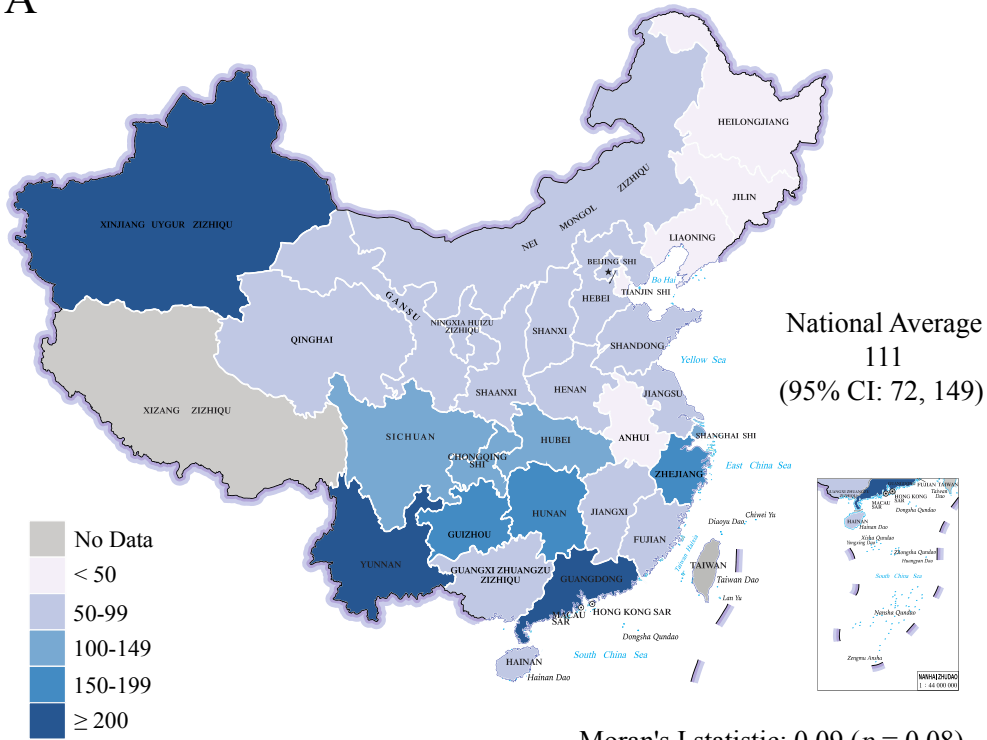
This manuscript is prepared for a special issue of the Alzheimer's Disease and Alzheimer's Disease Related Dementias (AD/ADRD), to be published by the *China CDC Weekly* during the Alzheimer's Awareness Month, November 2022. The IZA Discussion Paper Series serves as a preprint server to deposit latest research for feedback. This work was supported by the Career Development Award (K01AG053408) and a major research grant (R01AG077529) from the National Institute on Aging; Claude D. Pepper Older Americans Independence Center at Yale School of Medicine, funded by the National Institute on Aging (P30AG021342); and Yale Alzheimer's Disease Research Center (P30AG066508); James Tobin Research Fund at Yale Economics Department; and Yale Macmillan Center Faculty Research Award. The funders had no role in the study design; data collection, analysis, or interpretation; in the writing of the report; or in the decision to submit the article for publication.

Conflict of interest: The authors have no conflict of interest.

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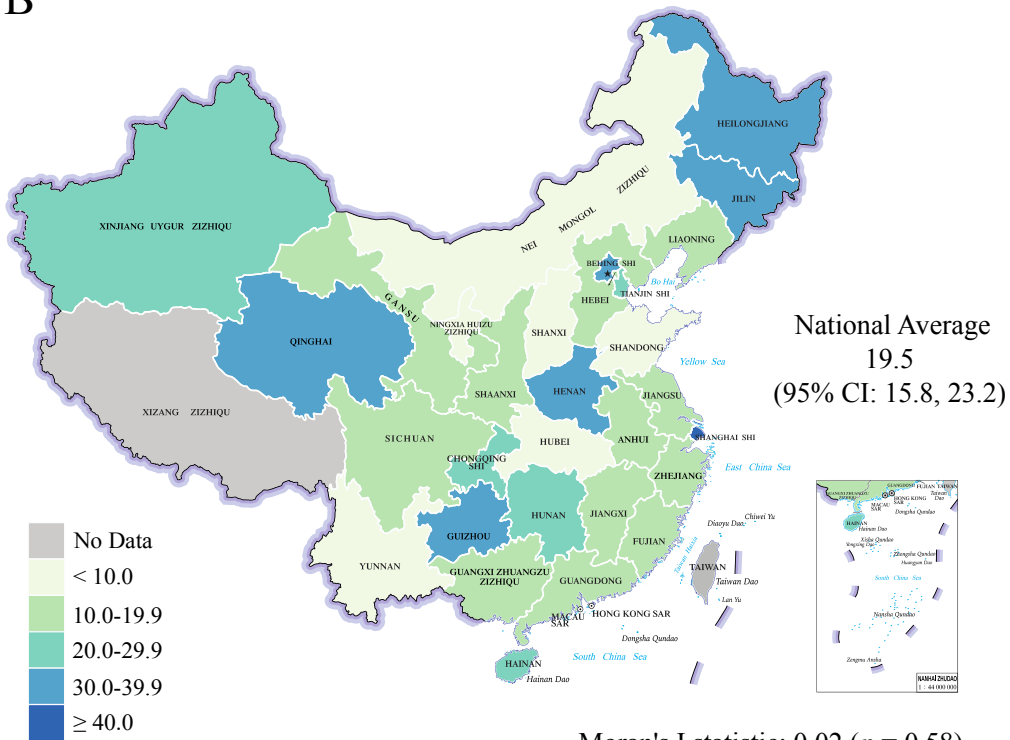
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A



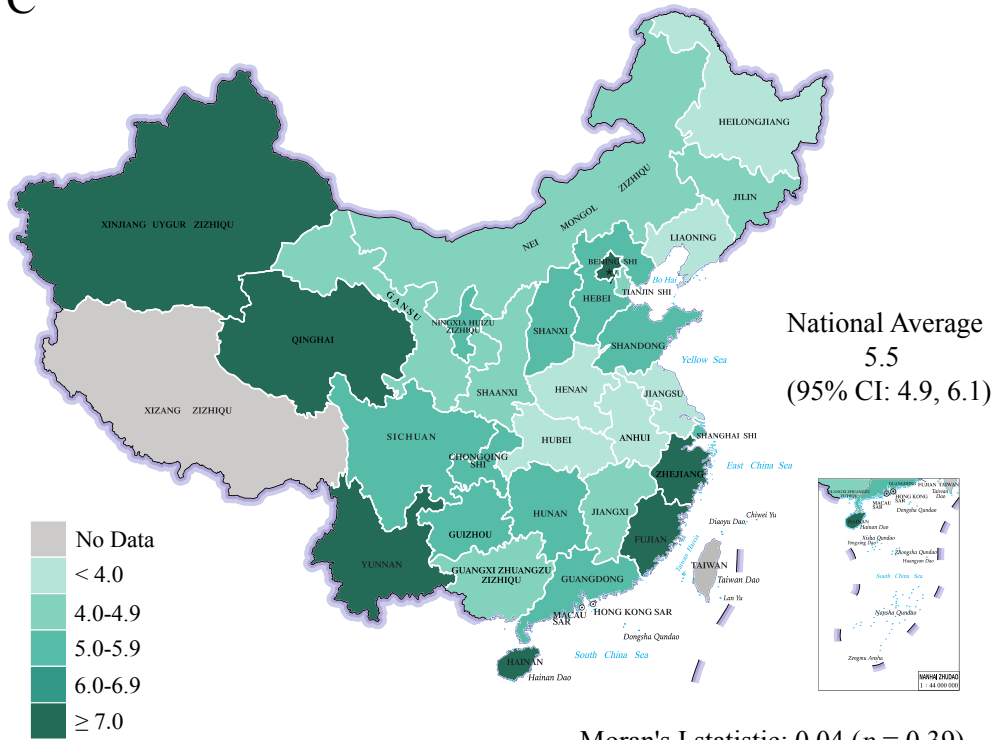
Moran's I statistic: 0.09 ($p = 0.08$)

B



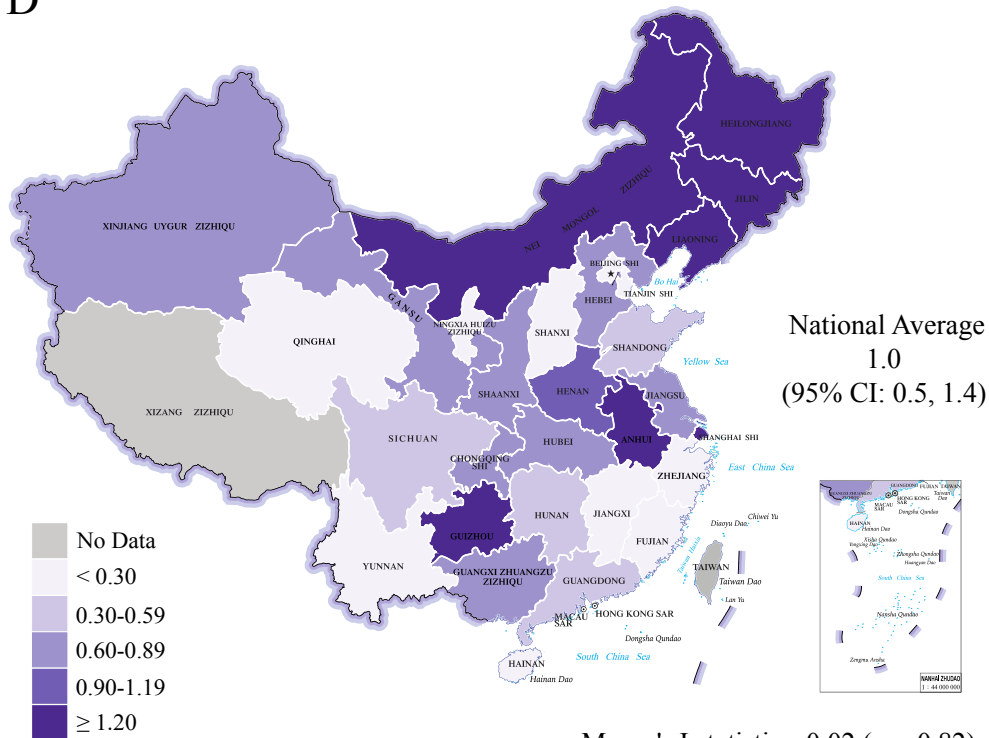
Moran's I statistic: 0.02 ($p = 0.58$)

C



Moran's I statistic: 0.04 ($p = 0.39$)

D



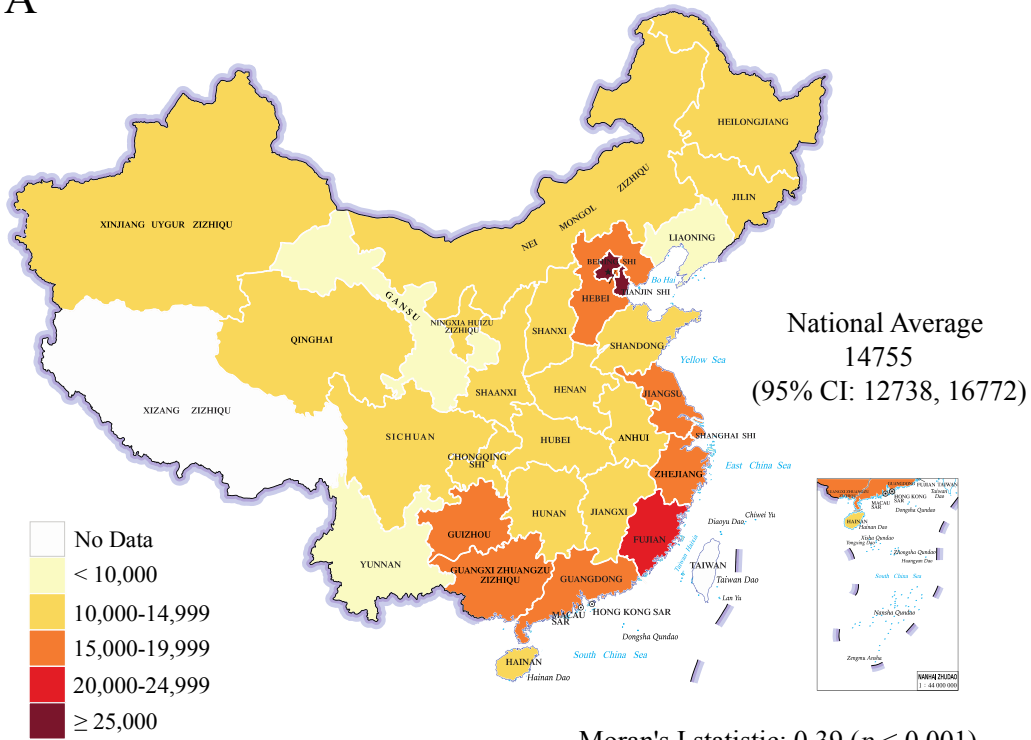
Moran's I statistic: -0.02 ($p = 0.82$)

Figure 1. Geographical variation in health care utilization and outcomes for hospitalized dementia patients in China. (A) Number of hospital admissions due to dementia per 100,000 person-years;

(B) percentage of emergency room admissions; (C) average number of comorbidities; (D) percentage of in-hospital mortality.

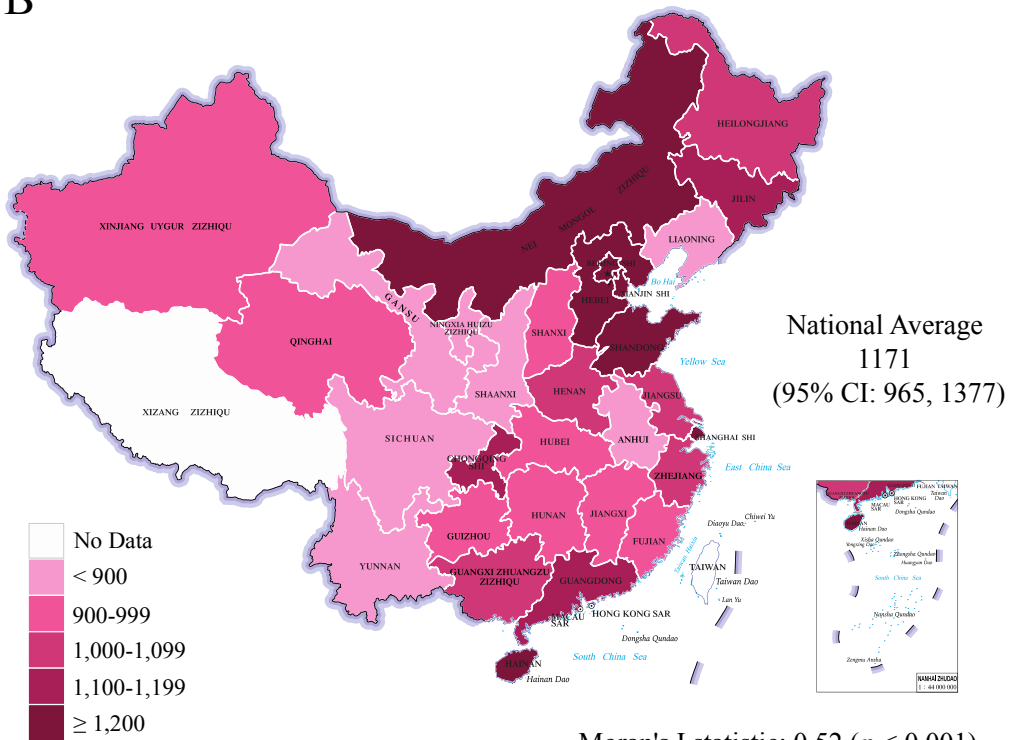
Notes: In each panel, the sample period was from June 2017 to June 2019; and data were available for all provinces except for Tibet (Xizang), Taiwan, Hong Kong, and Macau. Moran's I statistic for spatial autocorrelation is displayed at the bottom; and the national average across provinces is displayed on the right with 95% confidence interval (95% CI) presented in the parentheses. The following terms were used interchangeably: Xizang=Tibet; Nei Mongol=Inner Mongolia; Zizhiqu=Autonomous Region; SAR=Special Administrative Region.

A



Moran's I statistic: 0.39 ($p < 0.001$)

B



Moran's I statistic: 0.52 ($p < 0.001$)

C

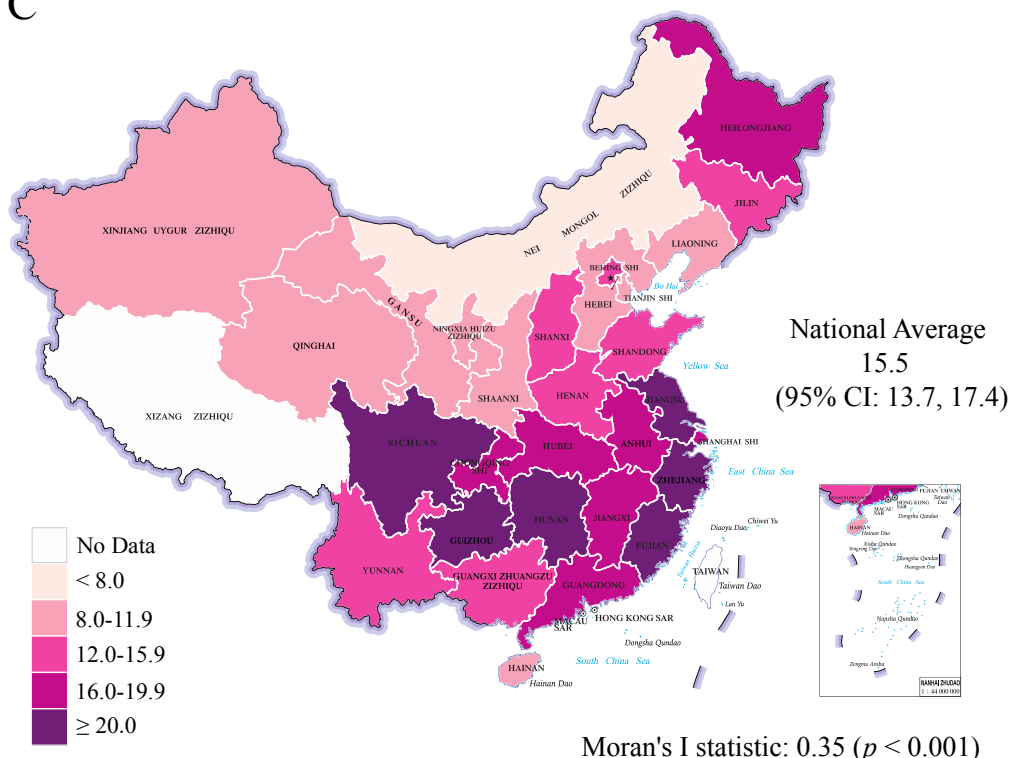
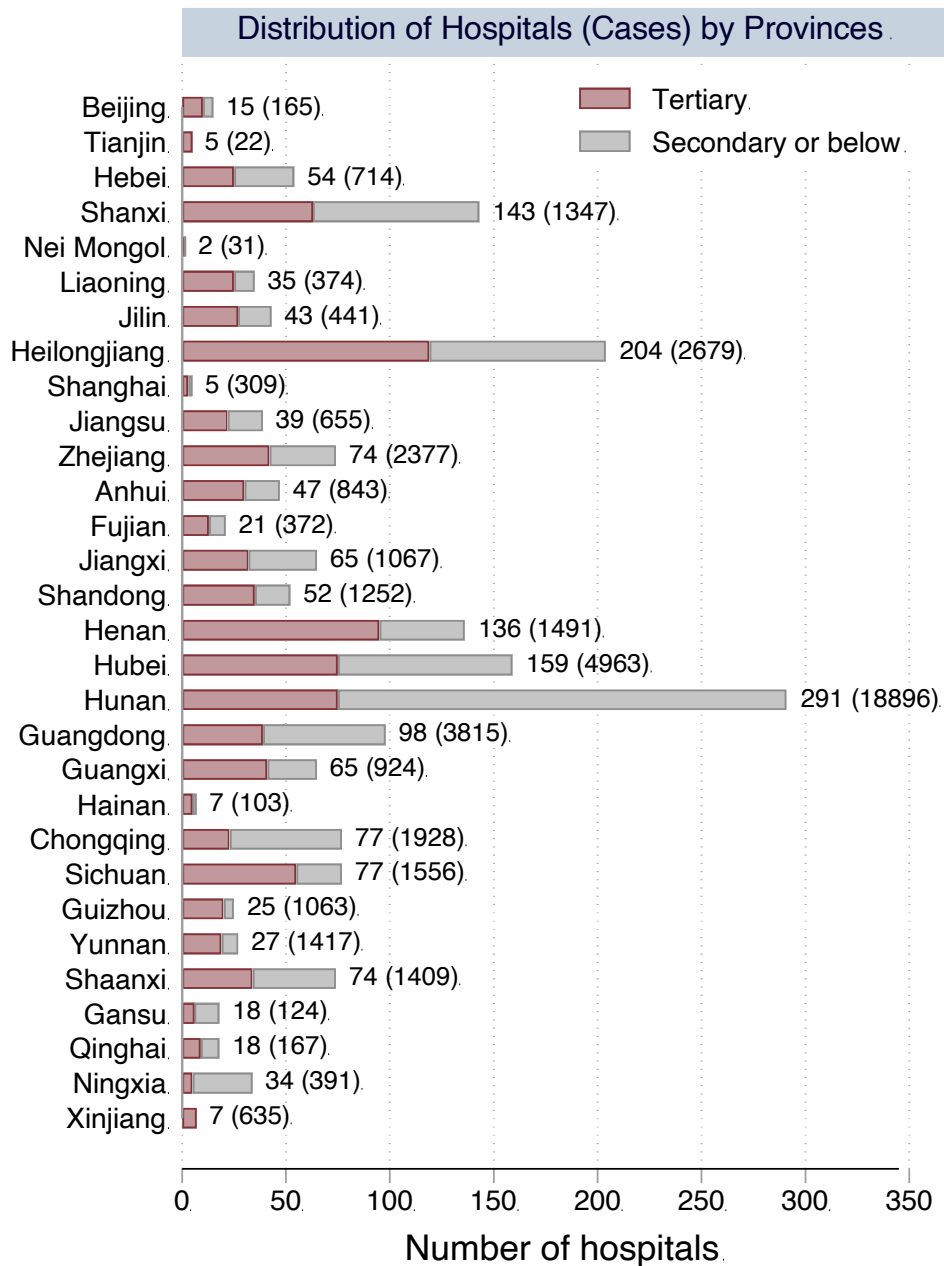


Figure 2. Geographical variation in health care costs, daily costs, and length of stay for hospitalized dementia patients in China. (A) Average total inpatient cost per admission (in CNY); (B) average daily cost per admission (in CNY); (C) average length of stay per admission (in days).

Notes: In each panel, the sample period was from June 2017 to June 2019; and data were available for all provinces except for Tibet (Xizang), Taiwan, Hong Kong, and Macau. Moran's I statistic for spatial autocorrelation is displayed at the bottom; and the national average across provinces is displayed on the right with 95% confidence interval (95% CI) presented in the parentheses. The following terms were used interchangeably: Xizang=Tibet; Nei Mongol=Inner Mongolia; Zizhiqu=Autonomous Region; SAR=Special Administrative Region; CNY=Chinese Yuan.

Supplementary Materials



The number of dementia cases are shown in parantheses .

Figure S1. Distribution of hospitals and admitted dementia cases by provinces

Notes: The figure displays the distribution of hospitals (and admitted dementia cases) by provinces in our data. The horizontal bar represents the number of hospitals, where red color represents tertiary hospitals and gray color represents secondary hospitals or below. For each province, the total number of hospitals is displayed next to the corresponding bar; and the number of dementia cases identified in the hospitals is shown in parentheses.

Table S1. ICD codes for dementia diagnosis and classification

	ICD-10 Codes	ICD-9 Codes
Alzheimer's Disease and Related Dementias	G30, F01, G31, G91, G93.7, G94, G23.8, F02, F03, F04, F05, F06, R41	331.0, 290.4, 290.0, 290.1, 290.2, 290.3, 290.8, 290.9, 294.x, 331.1-331.9, 333.0, 797

Abbreviations: ICD-10, International Classification of Diseases, 10th Revision; ICD-9, International Classification of Diseases, 9th Revision.