Preplanned Studies

Spatial Distribution and Clustering Patterns of Cognitive Impairment Among the Older Population — 31 PLADs, China, 2024

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Summary

What is already known about this topic?

As the Chinese population ages, the prevalence of cognitive impairment among older adults continues to increase. Cognitive impairment severely restricts daily activities and creates significant social and economic burdens.

What is added by this report?

Using nationally representative data from the China Survey of Aging and Health (CAHS), this study found that the weighted prevalence of subjective cognitive decline and mild cognitive impairment among individuals aged 65 years and older in China was 38.8% and 28.4% in 2024, respectively, and both showed spatial clustering.

What are the implications for public health practice?

Through the analysis of spatial distribution patterns and identification of high-risk regions of cognitive impairment, this study provides critical information for developing targeted regional prevention and control interventions.

ABSTRACT

Introduction: Cognitive impairment poses a serious threat to the health of older adults. Understanding spatial distribution patterns and identifying high-risk areas are essential for developing targeted regional prevention and control strategies. This study examined the spatial distribution and clustering patterns of cognitive impairment in China in 2024.

Methods: This study utilized data from the 2024 China Survey of Aging and Health. Rao-Scott chi-square tests were used to compare differences in prevalence across demographic subgroups. Global and local spatial autocorrelation analyses were conducted to examine the spatial distribution patterns and clustering characteristics.

Results: In 2024, the prevalence of subjective cognitive decline (SCD) and mild cognitive impairment (MCI) among older adults ≥65 years in China was 38.8% and 28.4%, respectively. The prevalence of SCD was highest in western China (45.1%), while MCI was highest in central China (31.0%). Global spatial autocorrelation analysis revealed that SCD (P=0.025) and MCI (P=0.015) distribution exhibited spatial clustering across China.

Conclusions: The current burden of cognitive impairment in China's older population is substantial and characterized by significant regional variations. Prevention and treatment measures should prioritize support for high-prevalence areas with limited resources and promote scientifically based, precise, and efficient cognitive impairment prevention and treatment strategies throughout China.

Cognitive impairment is a cardinal manifestation of neurodegenerative disorders, including Alzheimer's disease (AD) and other dementia syndromes (*1*). Subjective cognitive decline (SCD) is a preclinical stage of AD, with progressive SCD potentially advancing to mild cognitive impairment (MCI), which carries an elevated risk of further progression to AD (*2*). Current research indicates that approximately 15.07 million individuals >60 years in China live with dementia (*3*). An epidemiological study conducted from 2018 to 2019 documented an MCI prevalence rate of 27.8% among individuals ≥65 years (*4*). This study utilized data from the China Survey of Aging and Health (CAHS) to examine the prevalence of cognitive impairment among adults aged ≥65 years throughout China. Through a systematic analysis of spatial distribution patterns and identification of high-risk geographic regions, this study aimed to inform the development of targeted regional prevention and intervention strategies.

The CAHS utilized a multistage stratified cluster sampling design across all 31 provincial-level administrative divisions (PLADs) in China. This study utilized probability proportional-to-size sampling to ensure both national and provincial representativeness. The sampling framework comprises three sequential stages. First, the required sample size for each PLAD was calculated based on the standardized age distribution and sex ratio of the older population. Second, two to three representative survey cities were selected from each PLAD based on prefecture-level city gross domestic product rankings (with municipalities required to include two urban and two suburban districts); each prefecture-level city contributed a minimum of two districts or counties representing medium development levels, with each district providing two communities for survey participation. The CAHS successfully recruited 49,193 individuals aged ≥65 years. After implementing rigorous onsite quality control measures and comprehensive data cleaning procedures, 41,859 valid questionnaires were included in the final analysis, yielding an overall response rate of 85.1%. The Beijing Hospital Ethics Committee approved the study protocol (approval number: 2021BJYEC-114-01), and informed consent was obtained from all participants.

The CAHS utilized the Subjective Cognitive Decline Nine-item Questionnaire to assess patients' subjective experience of cognitive decline, despite objective test performance remaining within normal ranges for their age and education level, without meeting the criteria for MCI or dementia (*5*). Additionally, the Ascertain Dementia Eight-item Questionnaire demonstrates high sensitivity and specificity in identifying initial cognitive changes associated with various types of dementia, including AD, vascular dementia, dementia with Lewy bodies, and frontotemporal dementia, while remaining unaffected by age, education, or cultural differences (*6*).

Statistical analyses included sampling design, non-response adjustment, and post-stratification correction weights to ensure population representativeness. We computed prevalence estimates with 95% confidence intervals (*CIs*) using survey-weighted methods and evaluated subgroup disparities through Rao-Scott χ^2 tests. All descriptive analyses were conducted using STATA (version 18.0; StataCorp LLC, College Station, Texas, USA). We used ArcGIS (version 10.8.1; Environmental Systems Research Institute, California, USA) to conduct spatial distribution and clustering pattern analyses. The spatial weights matrix was defined using the "Inverse Distance" method for conceptualizing spatial relationships, with the distance method set to the default "Euclidean_Distance" and the standardization method set to "ROW." Using PLADs as spatial analysis units, we employed global spatial autocorrelation analysis to assess the overall spatial aggregation of cognitive impairment across the 31 PLADs. We used local spatial autocorrelation analyses to identify clustering patterns, categorizing the regions into four distinct types: high-high, low-high, low-low, and high-low aggregation areas. Statistical significance was set at $P<0.05$.

In 2024, the weighted prevalence of SCD and MCI among older adults aged ≥65 years in China was 38.8% and 28.4%, respectively. SCD prevalence was highest in western China (45.1%), whereas that of MCI peaked in central China (31.0%). Females demonstrated higher prevalence rates for both conditions (39.7% and 28.4%, respectively) than males (37.8% and 28.3%, respectively). Rural areas consistently exceeded urban areas in terms of the prevalence rates (41.7% *vs.* 37.1% for SCD and 33.8% *vs.* 25.1% for MCI). Adults aged ≥80 years exhibited the highest prevalence rates for both SCD (46.3%) and MCI (40.3%). Higher educational attainment demonstrated a significant inverse association between SCD prevalence and MCI incidence rates. When body mass index fell within the normal range of 18.5–24.9 kg/m^2, the prevalence of SCD was lowest (36.9%) (Table 1).

In 2024, SCD prevalence among adults aged ≥65 years across China's 31 PLADs ranged from 23.6% (Hainan) to 72.4% (Qinghai). Global spatial autocorrelation analysis revealed that the distribution of SCD exhibits spatial clustering across China (Moran's I=0.162, Z=2.242, P=0.025). Local spatial autocorrelation analysis identified distinct clustering patterns: high-high clustering areas: Ningxia, Xizang, Sichuan, and Gansu; low-low clustering areas: Liaoning and Hebei; high-low clustering area: Heilongjiang. The geographic distribution revealed that SCD among older adults is predominantly concentrated in China's western regions (Table 2).

In 2024, MCI prevalence among individuals aged ≥65 years across China's 31 PLADs ranged from 12.3% (Tianjin) to 58.9% (Qinghai). Global spatial autocorrelation analysis revealed that the distribution of MCI exhibits spatial clustering across China (Moran's I=−0.242, Z=−2.431, P=0.015). Local spatial

TABLE 1. Demographic distribution of subjective cognitive decline and mild cognitive impairment among adults aged 65 years and older population in 31 PLADs, China, 2024.

Characteristics	Participants *N* (%)	Subjective Cognitive Decline		Mild Cognitive Impairment	
		Weighted % (95% *CI*)	*P*	Weighted % (95% *CI*)	*P*
Total	41,859 (100.0)	38.8 (35.7, 42.1)		28.4 (25.3, 31.6)	
Region			<0.001		<0.001
Eastern	16,795 (40.1)	33.5 (28.5, 39.0)		27.7 (21.7, 34.5)	
Central	11,462 (27.4)	41.5 (35.7, 47.6)		31.0 (26.3, 36.2)	
Western	10,115 (24.2)	45.1 (39.0, 51.3)		28.4 (23.8, 33.6)	
Northeastern	3,487 (8.3)	37.1 (29.1, 45.9)		24.6 (18.9, 31.4)	
Sex			<0.001		<0.001
Male	19,893 (47.5)	37.8 (33.4, 42.4)		28.3 (23.6, 33.6)	
Female	21,966 (52.5)	39.7 (35.6, 44.0)		28.4 (24.7, 32.4)	
Age (years)			<0.001		<0.001
65−69	12,518 (29.9)	33.9 (28.7, 39.6)		23.8 (19.2, 29.1)	
70−74	12,794 (30.6)	35.7 (30.2, 41.6)		23.5 (19.2, 28.4)	
75−79	8,001 (19.1)	44.3 (38.2, 50.6)		30.3 (25.0, 36.3)	
≥80	8,546 (20.4)	46.3 (39.0, 53.8)		40.3 (32.3, 48.9)	
Area type			<0.001		<0.001
Urban	25,553 (61.1)	37.1 (33.1, 41.1)		25.1 (21.8, 28.6)	
Rural	16,306 (38.9)	41.7 (36.4, 47.2)		33.8 (28.0, 40.0)	
Education			<0.001		<0.001
Primary school or less	22,475 (53.7)	42.7 (37.9, 47.6)		34.1 (29.1, 39.4)	
Secondary school	10,402 (24.8)	35.7 (30.6, 41.2)		22.7 (18.8, 27.3)	
High school and above	8,982 (21.5)	33.9 (28.6, 39.6)		21.9 (17.4, 27.2)	
BMI (kg/m^2)			0.004		0.065
<18.5	1,920 (4.6)	42.8 (30.8, 55.8)		34.7 (23.9, 47.4)	
18.5−24.9	27,769 (66.3)	36.9 (33.2, 40.7)		27.3 (23.6, 31.4)	
25.0−29.9	10,765 (25.7)	42.0 (35.6, 48.6)		29.3 (23.7, 35.6)	
≥30.0	1,405 (3.4)	45.2 (30.0, 61.3)		32.2 (19.6, 48.1)	
Monthly household income (CNY)			<0.001		<0.001
<3,000	11,437 (27.3)	42.3 (35.9, 49.0)		30.3 (25.0, 36.3)	
3,000−5,999	11,468 (27.4)	38.4 (32.9, 44.1)		26.3 (21.0, 32.4)	
6,000−9,999	7,989 (19.1)	37.2 (31.8, 42.9)		25.0 (20.2, 30.5)	
≥10,000	4,703 (11.2)	33.6 (27.1, 40.8)		25.8 (20.0, 32.6)	
Unwilling to disclose	6,262 (15.0)	41.8 (31.1, 53.4)		37.4 (24.8, 51.9)	

Abbreviation: PLADs=provincial-level administrative divisions; BMI=body mass index; CNY=Chinese Yuan; *CI*=confidence interval.

autocorrelation analysis identified Yunnan as a high-low clustering area and Hebei as a low-high clustering area (Table 3).

DISCUSSION

This study found that the prevalence of SCD and MCI among older adults ≥65 years in China in 2024 was 38.8% and 28.4%, respectively. Previous domestic research revealed an MCI prevalence rate of 27.8% among the same age group (*4*). The 28.4% prevalence of MCI among China's older population in 2024 found in this study indicates that the prevention and treatment of cognitive impairment represents a substantial public health challenge that requires urgent attention. Additionally, SCD prevalence was highest in

TABLE 2. Prevalence and clustering patterns of subjective cognitive decline among adults aged 65 years and older across 31 PLADs, China, 2024.

PLADs	Sample size, *N* (%)	Weighted prevalence (%)	*Z* Score	*P*	Clustering patterns
Hainan	199 (0.5)	23.6 (7.4, 54.3)	0.968	0.176	
Guangdong	2,063 (4.9)	24.9 (14.2, 40.0)	1.052	0.160	
Beijing	1,216 (2.9)	26.1 (19.6, 34.0)	0.844	0.208	
Tianjin	453 (1.1)	26.4 (17.4, 38.0)	1.011	0.164	
Liaoning	1,639 (3.9)	27.0 (12.8, 48.4)	1.633	0.050	LL
Zhejiang	1,775 (4.2)	28.1 (14.2, 47.8)	−0.052	0.500	
Jilin	802 (1.9)	29.0 (20.4, 39.5)	1.264	0.098	
Guangxi	1,372 (3.3)	29.8 (17.6, 45.7)	0.479	0.342	
Henan	3,342 (8.0)	35.7 (26.4, 46.1)	−0.852	0.212	
Jiangxi	1,031 (2.4)	36.7 (26.3, 48.7)	0.199	0.418	
Chongqing	1,124 (2.7)	36.9 (21.7, 55.1)	−1.625	0.058	
Inner Mongolia	661 (1.6)	38.6 (17.6, 65.0)	1.331	0.102	
Fujian	899 (2.1)	38.7 (24.2, 55.5)	1.203	0.118	
Hebei	2,394 (5.7)	38.7 (29.3, 49.1)	1.796	0.018	LL
Jiangsu	2,746 (6.6)	39.8 (26.4, 55.0)	0.221	0.418	
Hunan	2,619 (6.3)	40.2 (24.6, 58.0)	0.271	0.396	
Ningxia	150 (0.4)	40.7 (24.2, 59.6)	2.118	0.014	HH
Yunnan	1,027 (2.4)	41.5 (17.2, 70.9)	0.304	0.376	
Shanxi	903 (2.2)	42.6 (26.2, 60.8)	−0.016	0.498	
Xizang	41 (0.1)	43.1 (25.2, 63.0)	2.818	0.006	HH
Sichuan	2,672 (6.4)	43.2 (28.8, 58.9)	2.290	0.016	HH
Shandong	3,104 (7.4)	44.2 (28.1, 61.7)	−1.252	0.108	
Shanghai	1,946 (4.6)	45.1 (33.6, 57.1)	−0.909	0.192	
Anhui	1,805 (4.3)	45.6 (37.5, 53.9)	−0.666	0.254	
Heilongjiang	1,046 (2.5)	48.2 (37.6, 58.9)	−1.578	0.050	HL
Xinjiang	408 (1.0)	48.9 (40.7, 57.3)	0.256	0.370	
Hubei	1,762 (4.2)	49.8 (32.3, 67.4)	−0.240	0.404	
Gansu	624 (1.5)	51.5 (27.9, 74.5)	2.754	0.010	HH
Guizhou	866 (2.1)	55.3 (40.3, 69,3)	−0.546	0.298	
Shaanxi	1,046 (2.5)	62.6 (53.0, 71.3)	0.580	0.294	
Qinghai	124 (0.3)	72.4 (55.1, 84.9)	1.307	0.094	

Abbreviation: HH=high-high; LH=low-high; LL=low-low; HL=high-low; PLADs=provincial-level administrative divisions.

the western regions, whereas MCI prevalence peaked in the central regions, consistent with previous research findings. These significant regional disparities in prevalence likely reflect regional differences in economic development, availability of medical resources, and access to health education.

We observed significant regional differences in SCD and MCI prevalence among adults ≥65 years across 31 provinces in China. Notably, Qinghai Province exhibited the highest prevalence of both SCD and MCI compared to Xizang. Both Qinghai and Xizang are located on the Tibetan Plateau, where altitude gradients (1,500–2,500 m, 2,500–4,000 m, and ≥ 4,000 m) demonstrate significant associations with cognitive function changes. These effects are moderated by residential history (long-term/lifetime residence) and acclimatization levels, suggesting that the impact of high-altitude hypoxia on cognition may vary across individuals and environments (*7*). The hypoxic conditions in Qinghai are generally less severe than those in Xizang. Moderate hypoxia may pose greater risks than extreme hypoxia: chronic "sub-lethal"

TABLE 3. Prevalence and clustering patterns of mild cognitive impairment among adults aged 65 years and older across 31 PLADs, China, 2024.

PLADs	Sample size, *N* (%)	Weighted prevalence (%)	*Z* Score	*P*	Clustering patterns
Tianjin	453 (1.1)	12.3 (4.4, 29.8)	−0.845	0.214	
Hainan	199 (0.5)	16.1 (4.6, 43.1)	0.120	0.418	
Xizang	41 (0.1)	17.2 (8.6, 31.5)	0.637	0.290	
Ningxia	150 (0.4)	19.4 (14.4, 25.5)	0.357	0.410	
Jiangsu	2,746 (6.6)	19.4 (11.3, 31.3)	1.114	0.134	
Liaoning	1,639 (3.9)	20.1 (9.2, 38.4)	−0.566	0.264	
Jilin	802 (1.9)	20.8 (14.7, 28.6)	0.973	0.170	
Beijing	1,216 (2.9)	20.8 (12.4, 32.8)	0.264	0.384	
Zhejiang	1,775 (4.2)	21.1 (9.6, 40.2)	−0.817	0.210	
Inner Mongolia	661 (1.6)	21.9 (8.6, 45.7)	0.751	0.214	
Sichuan	2,672 (6.4)	22.5 (12.7, 36.6)	−0.990	0.170	
Chongqing	1,124 (2.7)	23.5 (11.7, 41.6)	0.757	0.238	
Henan	3,342 (8.0)	24.2 (17.2, 32.7)	−0.130	0.418	
Yunnan	1,027 (2.4)	25.2 (10.0, 50.5)	−1.429	0.050	HL
Gansu	624 (1.5)	26.4 (14.3, 43.5)	−0.968	0.164	
Fujian	899 (2.1)	27.3 (13.8, 46.7)	0.609	0.254	
Hubei	1,762 (4.2)	28.4 (15.4, 46.4)	−0.953	0.170	
Hunan	2,619 (6.3)	28.7 (18.2, 42.0)	−0.192	0.384	
Guangxi	1,372 (3.3)	28.9 (15.9, 46.8)	−0.755	0.248	
Hebei	2,394 (5.7)	29.2 (22.3, 37.1)	−3.135	0.004	LH
Jiangxi	1,031 (2.4)	29.6 (20.3, 41.0)	−0.946	0.186	
Shanghai	1,946 (4.6)	29.6 (17.3, 45.8)	−1.225	0.098	
Heilongjiang	1,046 (2.5)	29.7 (21.0, 40.3)	−0.265	0.426	
Guangdong	2,063 (4.9)	34.6 (17.3, 57.2)	−0.261	0.426	
Shaanxi	1,046 (2.5)	35.9 (28.2, 44.3)	−1.120	0.120	
Xinjiang	408 (1.0)	36.6 (29.4, 44.4)	−1.134	0.060	
Guizhou	866 (2.1)	38.9 (26.6, 52.7)	0.466	0.330	
Shanxi	903 (2.2)	40.7 (25.3, 58.3)	−1.804	0.054	
Anhui	1,805 (4.3)	41.2 (31.1, 52.2)	−0.345	0.418	
Shandong	3,104 (7.4)	42.7 (25.6, 61.7)	−0.186	0.450	
Qinghai	124 (0.3)	58.9 (38.7, 76.4)	−1.254	0.102	

Abbreviation: HL=high-low; LH=low-high; PLADs=provincial-level administrative divisions.

hypoxia can lead to sustained oxidative stress and neuroinflammation, whereas extreme hypoxia may trigger more robust protective physiological responses (*8*).

Global spatial autocorrelation analysis revealed that the distribution of SCD across China exhibited clustering patterns in which high-prevalence regions were geographically adjacent to other high-prevalence areas. In contrast, MCI demonstrated a distinct spatial pattern characterized by low-prevalence regions in neighboring high-prevalence areas. This divergence between SCD and MCI stems from a fundamental misalignment between subjective self-perception and objective cognitive assessment results. This discrepancy is primarily attributable to the substantial heterogeneity within SCD populations, where symptom reporting rates depend heavily on individual awareness of cognitive changes. Consequently, individuals may report symptoms of cognitive decline that have not yet been detected (*9*). Additionally, multiple studies have demonstrated that MCI detection rates correlate strongly with healthcare accessibility, as reduced access increases the risk of underdiagnosis (*10*).

The findings in this report are subject to three limitations. First, the cross-sectional design captured cognitive status at a single time point, preventing the examination of symptom progression trajectories over time. Second, reliance on self-reported measures introduces potential recall and social desirability biases, which may compromise response accuracy. Finally, future research should incorporate specific cognitive impairment risk factors and conduct statistical analyses to examine conversion rates among SCD, MCI, and AD.

In conclusion, spatial clustering of SCD and MCI exists in the older Chinese population. Prevention and treatment strategies should emphasize regional differentiation by prioritizing support for high-burden areas with limited resources. Implementation of cognitive health literacy campaigns should improve public awareness of modifiable risk factors for cognitive impairment (e.g., hypertension, diabetes, and physical inactivity) in areas with high-high SCD clustering. Continuous monitoring of changes in SCD and MCI distributions will enable real-time evaluation of intervention effectiveness (e.g., health education and resource allocation), facilitating evidence-based adjustments and advancing precise public health initiatives.

Conflicts of interest: No conflict of interest.

Acknowledgements: All research personnel who contributed to the data collection efforts and all study participants whose involvement made this investigation possible.

Ethical statement: The CAHS protocol approved by the Ethics Committee of Beijing Hospital (approval number: 2021BJYEC-114-01).

Funding: Supported by the National Key R&D Plan "Intergovernmental International Science and Technology Innovation Cooperation" Key Special Project (2021YFE0111800).

doi: 10.46234/ccdcw2025.219

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Submitted: July 22, 2025
Accepted: September 24, 2025
Issued: October 10, 2025

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