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Featured Articles

The prevalence of dementia in urban and rural areas of China

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Abstract

Objective: The Chinese population has been aging rapidly and the country's economy has experienced exponential growth during the past three decades. The goal of this study was to estimate the changes in the prevalence of dementia, Alzheimer's disease (AD), and vascular dementia (VaD) among elderly Chinese individuals and to analyze differences between urban and rural areas.

Methods: For the years 2008 to 2009, we performed a population-based cross-sectional survey with a multistage cluster sampling design. Residents aged 65 years and older were drawn from 30 urban (n = 6096) and 45 rural (n = 4180) communities across China. Participants were assessed with a series of clinical examinations and neuropsychological measures. Dementia, AD, and VaD were diagnosed according to established criteria via standard diagnostic procedures.

Results: The prevalence of dementia, AD, and VaD among individuals aged 65 years and older were 5.14% (95% CI, 4.71–5.57), 3.21% (95% CI, 2.87–3.55), and 1.50% (95% CI, 1.26–1.74), respectively. The prevalence of dementia was significantly higher in rural areas than in urban ones (6.05% vs. 4.40%, $P < .001$). The same regional difference was also seen for AD (4.25% vs. 2.44%, $P < .001$) but not for VaD (1.28% vs. 1.61%, $P = .166$). The difference in AD was not evident when the sample was stratified by educational level. Moreover, the risk factors for AD and VaD differed for urban and rural populations.

Conclusions: A notably higher prevalence of dementia and AD was found in rural areas than in urban ones, and education might be an important reason for the urban–rural differences.

Keywords: Dementia; Alzheimer's disease; Vascular dementia; Prevalence; Risk factors

1. Introduction

Dementia is one of the main disorders associated with disability, institutionalization, and mortality among elderly individuals. The prevalence of dementia in western developed countries has been reported to be approximately 4%

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to 8% among people aged 65 years and older [1–3], and studies conducted from 1980 to 2000 estimated this figure as 3% to 7% in China [4–8]. In 1995, Wang and colleagues [4] conducted a door-to-door survey in an urban community of Beijing of 3728 individuals aged 65 years and older and found the prevalence rates were 3.49% for dementia, 1.85% for Alzheimer's disease (AD), and 0.27% for vascular dementia (VaD). Dong and colleagues [5] and Kalaria and colleagues [6] reviewed systematically 25 epidemiologic studies in China for 1980 to 2004 and found that the pooled prevalence rate was 3.1% for dementia, 2.0% for AD, and 0.9% for VaD in a population aged 65 years and older. Most studies conducted in China during the past 30 years have been limited to one region and have included only a few communities. Only one large cross-sectional study, conducted in 1997, included four regional centers and 170 communities, and found a prevalence rate of 5.0% for dementia, 3.5% for AD, and 1.1% for VaD in a population aged 65 years and older [6,8].

However, the rate at which the Chinese population is aging has accelerated, and the country's economy has experienced exponential growth during the past three decades. Thus, we need to determine the current prevalence of and risk factors for dementia in China. In addition, few extant epidemiologic investigations of dementia have focused specifically on urban–rural differences in China, even though more than half of the total Chinese population lives in rural areas [9]. Residents of rural areas are significantly different from those of urban areas in many domains (education, lifestyle, and so forth), and these difference may affect the prevalence and pattern of dementia. Therefore, we conducted this survey to estimate the prevalence of and risk factors for dementia and its main subtypes—AD and VaD, in elderly individuals. We also wished to analyze differences between urban and rural areas in China in this regard.

2. Methods

2.1. Study design and samples

This study, a population-based cross-sectional survey conducted from October 2008 to October 2009, constitutes the baseline data of the China Cognition and Aging Study (China Coast), a longitudinal national study of mild cognitive impairment (MCI) and dementia in hospital and community populations. Using a multistage cluster sampling design, we recruited separate samples from urban and rural areas. First, we selected five representative regional centers (Changchun, Beijing, Zhengzhou, Guiyang, and Guangzhou) across China. Second, 10 urban districts and 12 rural counties were selected randomly. Last, 30 urban communities and 45 rural villages within the selected districts and counties were sampled at random.

All eligible individuals included in our study were 65 years or older, of Han Chinese in ethnicity, were listed in the census of the community registry office, and had lived in the target community for at least 1 year preceding the survey date. Those listed in the census but institutionalized were not included in the study. All residents aged 65 and older were drawn from 30 urban (n = 8414) and 45 rural (n = 5392) communities. Subjects who refused to participate, were untraceable, had a life-threatening illness, were deceased, or were unable to participate in the assessment because of conditions such as inadequate hearing or vision were excluded. Thus, 10,276 residents (6096 from urban areas and 4180 from rural areas) participated in the survey (Fig. 1). The protocol for this study was reviewed and approved by the ethics committee at each center. Informed consent was obtained from each subject either directly or from his or her guardian.

2.2. Assessment and diagnosis

2.2.1. Training

The investigators in our study included interviewers and experts. Eight to 10 pairs of interviewers consisting of one junior neurologist and one senior neurology graduate student were recruited in each region. An expert panel consisting of two neurologists and two neuropsychologists with special expertise in cognitive impairment was also established in each region. All interviewers and experts received the same weeklong training on neuropsychological assessment and diagnosis, and also participated in a retraining course every 3 months. The interrater reliability for videotapes of cognitive tests and diagnostic procedures was required to exceed 0.90.

2.2.2. Diagnostic procedures

First, each interviewer pair conducted individual, semi-structured interviews with participants and their close informants at the residence of respondents. Interviews lasted about 1.5 to 2 hours. Detailed data on sociodemographic characteristics, lifestyle, medical history, current medications, and family history were collected. Participants then completed a battery of neuropsychological tests administered by one of the interviewers. The neuropsychological tests covered three domains. First, cognition was assessed with the Mini-Mental State Examination [10], the Montreal Cognitive Assessment [11], and the World Health Organization University of California-Los Angeles Auditory Verbal Learning Test [12]. Second, social functioning was assessed with the Functional Activities Questionnaire (FAQ) [13]. And third, differentiation was assessed by the Hachinski Ischemic Score [14]. After one interviewer completed these tests, the other determined participants' Clinical Dementia Rating (CDR) score [15,16] and took a detailed history of all cognitive impairments, including time and mode of onset, possible triggers, affected domains, course of

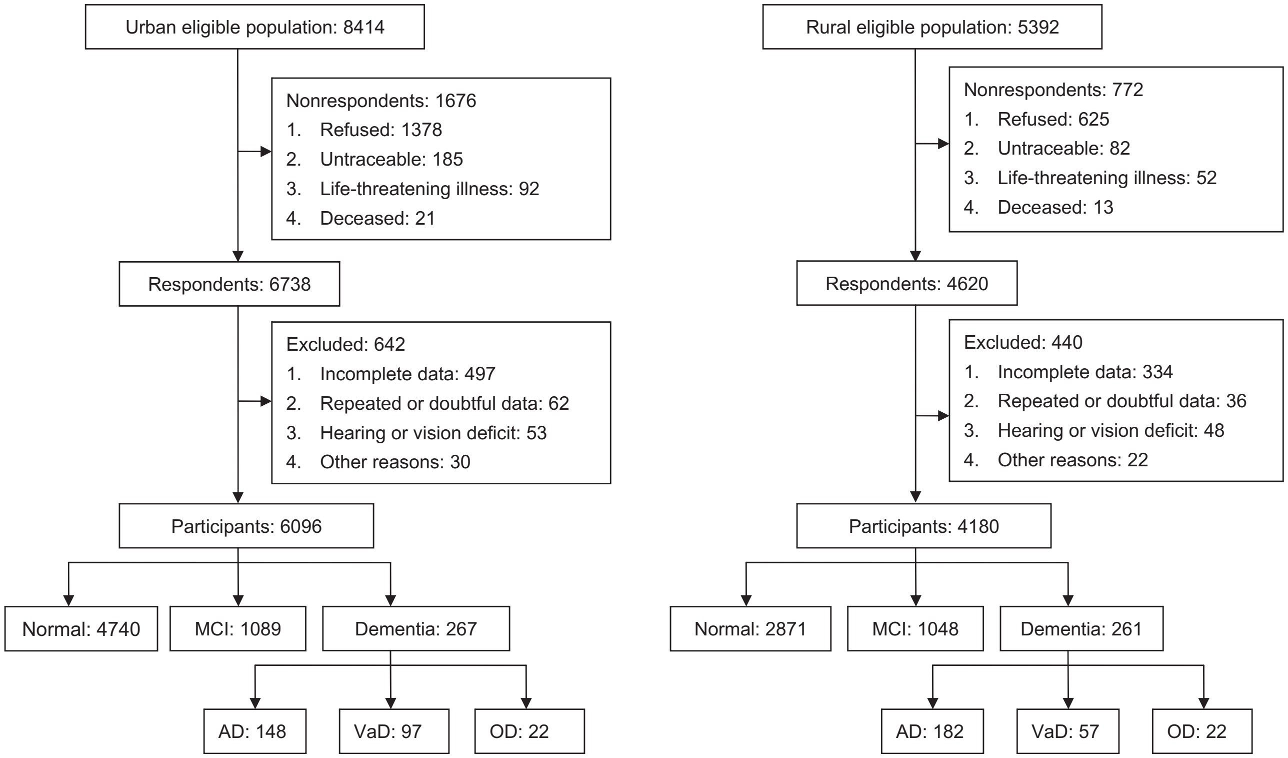

Fig. 1. Study flow chart. MCI, mild cognitive impairment; AD, Alzheimer's disease; VaD, vascular dementia; OD, other types of dementia.

condition, impact on daily activities, changes in mood or behavior, results of computed tomographic scans or magnetic resonance images, and treatment and its effects. Last, standardized general and neurological examinations were performed.

All information collected was reviewed by the expert panel and interviewers, and diagnoses were made at the end of each workday. When consensus was not reached, an expert returned to the residence the following day to reexamine the participant for a further evaluation and final diagnosis.

2.2.3. Diagnostic criteria

Participants were classified into three general categories: normal cognitive functioning, MCI, and dementia. They were considered to have normal cognitive functioning when they scored 0 point on all six domains assessed using the CDR. Criteria for MCI in our study were established on published criteria [17,18] and included all the following elements: one or more domains in CDR scored $\geq$ 0.5 point, global CDR score $\leq$ 0.5 point, essentially preserved daily and social functioning, and no dementia. Diagnostic criteria for dementia were based on the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* [19]. After a diagnosis of dementia was made, participants were divided into three subtypes: AD, VaD, and other types of dementia (ODs). Diagnostic criteria for AD were based on the criteria issued by the National Institute of Neurological and Communicative Disorders and Stroke–Alzheimer's Disease and Related Disorders Association [20]. Diagnostic criteria for VaD were based on the criteria of the National Institute of Neurological Disorders and Stroke–Association Internationale pour la Recherché et l'Enseignement en Neurosciences [21]. ODs included mixed dementia, frontotemporal dementia, dementia with Lewy bodies, Parkinson's disease with dementia, alcoholic dementia, hydrocephalus dementia, posttraumatic dementia, and so on, according to various globally accepted criteria. Because of the small sample size, ODs were not considered further in the analyses.

2.3. Statistical analysis

We compared the characteristics of urban and rural populations with Student's *t* tests and χ^2 tests. Estimates of the prevalence of dementia, AD, and VaD in urban and rural populations were calculated separately for the overall population and for subgroups stratified by age, sex, and education. Age- and sex-standardized prevalence rates were calculated based on the population distribution of China in 2005 [9]. Rural and urban prevalence ratios (PRs) with 95% confidence intervals (CIs) adjusted for age and sex were calculated to compare the prevalence in urban with that in rural populations. Logistic regression models were used to ascertain the risk factors associated with AD and VaD considering the main effects of sociodemographic characteristics, lifestyle, and comorbidity simultaneously. All analyses were performed using SAS 9.1 (SAS Institute Inc., Cary, NC, USA) or SPSS 16.0 (SPSS Inc., Chicago, IL, USA). Differences between the groups were considered statistically significant when the P value was less than .05.

3. Results

3.1. Characteristics of the sampled populations

A total of 10,276 residents (6096 from urban areas and 4180 from rural areas) completed the survey. The participation rate in rural villages was higher than that in urban communities (77.5% vs. 72.5%; $\chi^2 = 44.413$, $P < .001$), and more eligible people refused to participate or were untraceable in urban populations. We found no significant age or sex differences between participants and nonparticipants in either urban or rural communities.

The characteristics of the urban and rural samples are presented in Table 1. Women accounted for 56.8% of urban and 58.2% of rural communities, and we found no statistically significant difference between urban and rural communities with respect to sex. Elderly aged 70 to 74 years were more common in urban than in rural areas (34.3% vs. 27.3%, $P < .001$), and elderly aged 65 to 69 years were more common in rural areas than in urban ones (34.7% vs. 29.0%, $P < .001$). Elderly urban individuals were better educated than elderly rural participants ($P < .001$). Elderly individuals in rural areas were more likely to smoke and drink than their urban counterparts ($P < .001$). According to self-reports of comorbid conditions, the proportions of individuals with hypertension, hyperlipidemia, heart disease, or stroke were higher in urban areas than in rural areas; the exception to this trend was diabetes mellitus ($P < .001$).

3.2. Prevalence of dementia, AD, and VaD

The prevalence of dementia, AD, and VaD among people aged 65 years and older was 5.14% (95% CI, 4.71–5.57), 3.21% (95% CI, 2.87–3.55), and 1.50% (95% CI, 1.26–1.74), respectively. As shown in Table 2, the prevalence rates were 4.38% (95% CI, 3.87–4.89) for dementia, 2.43% (95% CI, 2.04–2.81) for AD, and 1.59% (95% CI, 1.28–1.91) for VaD in the urban population. The corresponding figures for the rural population were 6.24% (95% CI, 5.51–6.98), 4.35% (95% CI, 3.74–4.97), and 1.36% (95% CI, 1.01–1.72). AD was the most common type of dementia (urban, 55.4%; rural, 69.7%), and VaD was the second most common (urban, 36.3%; rural, 21.8%). The prevalence rates for subgroups stratified by age and sex are presented in Fig. 2. In both urban and rural areas, the prevalence of dementia was higher in women than in men, and it increased significantly with age, reaching 22.87% to 23.66% among individuals aged 85 years and

Table 1
Characteristics of the samples in the urban and rural communities

Characteristics	Urban, n (%)	Rural, n (%)	*P* value
Overall	6096 (100)	4180 (100)	
Sex			
Male	2633 (43.2)	1746 (41.8)	.152
Female	3463 (56.8)	2434 (58.2)	
Age, years			
65–69	1767 (29.0)	1450 (34.7)	<.001
70–74	2088 (34.3)	1141 (27.3)	
75–79	1399 (22.9)	950 (22.7)	
80–84	618 (10.1)	451 (10.8)	
≥85	224 (3.7)	188 (4.5)	
Education level, years			
<1	1076 (17.7)	2015 (48.2)	<.001
1–6	1993 (32.7)	1621 (38.8)	
7–9	1161 (19.0)	409 (9.8)	
10–12	895 (14.7)	112 (2.7)	
>12	927 (15.2)	17 (0.4)	
Unknown	44 (0.7)	6 (0.1)	
Occupation			
Labor worker	3595 (59.0)	3893 (91.3)	<.001
Office worker	2103 (34.5)	218 (5.2)	
Others	67 (1.1)	0 (0.0)	
Unknown	331 (5.4)	69 (1.7)	
Region*			
North	4696 (77.0)	2205 (52.8)	<.001
South	1400 (23.0)	1975 (47.2)	
Cigarette smoking†			
Yes	1617 (26.5)	1524 (36.5)	<.001
No	4479 (73.5)	2656 (63.5)	
Alcohol consumption‡			<.001
Yes	524 (8.6)	717 (17.2)	
No	5430 (89.1)	3418 (81.8)	
Unknown	142 (2.3)	45 (1.1)	
Comorbidity			
Hypertension			
Yes	2870 (47.1)	1431 (34.2)	<.001
No	3191 (52.3)	2707 (64.8)	
Unknown	35 (0.6)	42 (1.0)	
Hyperlipidemia			
Yes	1454 (23.9)	464 (11.1)	<.001
No	4484 (73.6)	3687 (88.2)	
Unknown	158 (2.6)	29 (0.7)	
Diabetes mellitus			
Yes	964 (15.8)	829 (19.8)	<.001
No	5078 (83.3)	3338 (79.9)	
Unknown	54 (0.9)	13 (0.3)	
Heart disease			
Yes	1599 (26.2)	437 (10.5)	<.001
No	4265 (70.0)	3554 (85.0)	
Unknown	232 (3.8)	189 (4.5)	
Stroke			
Yes	979 (16.1)	434 (10.4)	<.001
No	4382 (71.9)	3313 (79.3)	
Unknown	735 (12.1)	433 (10.4)	

*North (Beijing, Changchun, Zhengzhou), South (Guangzhou, Guiyang).
†Cigarette smoking was defined as having smoked at least 100 cigarettes in one's lifetime.
‡Alcohol consumption was defined as drinking at least 0.1 drink per day for 1 year or more, with one drink equal to 10 g pure alcohol.

Table 2
Prevalence of dementia, AD and VaD, in urban and rural populations

	Urban*	Rural*	PR of rural–urban†
Dementia			
Crude	4.38 (3.87–4.89)	6.24 (5.51–6.98)	
Standardized	4.40 (3.89–4.92)	6.05 (5.32–6.77)	1.37 (1.16–1.62)‡
AD			
Crude	2.43 (2.04–2.81)	4.35 (3.74–4.97)	
Standardized	2.44 (2.05–2.83)	4.25 (3.64–4.86)	1.74 (1.41–2.16)‡
VaD			
Crude	1.59 (1.28–1.91)	1.36 (1.01–1.72)	
Standardized	1.61 (1.30–1.93)	1.28 (0.94–1.62)	0.79 (0.57–1.10)

Abbreviations: AD, Alzheimer's disease; VaD, vascular dementia; PR, standardized prevalence ratio.

*Prevalence (percent) and 95% confidence intervals (in parentheses) provided.

†PR and 95% confidence intervals (in parentheses) provided.

‡$P < .001$. The P value was calculated by comparing the age- and sex-standardized prevalence rates between the urban and rural populations.

older. This trend was also seen for AD. However, the prevalence of VaD displayed a weak age trend and did not differ significantly by sex among those younger than 75 years of age. Moreover, we found that dementia and AD were more prevalent in rural than in urban populations, but VaD showed an opposite trend.

To determine the difference in prevalence between urban and rural populations, we standardized our data according to age and sex using data about the Chinese population in 2005 and calculated the rural and urban PR (Table 2). We found that the prevalence of dementia in rural populations was significantly higher than that in urban populations (6.05% vs. 4.40%; $\chi^2 = 13.965$; $P < .001$; PR, 1.37, 95% CI, 1.16–1.62). AD was the only subtype with significantly different prevalence rates in urban and rural areas (4.25% vs. 2.44%; $\chi^2 = 26.432$; $P < .001$; PR, 1.74, 95% CI, 1.41–2.16; VaD: 1.28% vs. 1.61%, $\chi^2 = 1.920$, $P = .166$).

We calculated the standardized prevalence rates and the rural and urban PRs of AD and VaD stratified by age, sex, and education (Table 3). We found that the prevalence of AD was higher in rural than in urban areas among women (ratio of rural to urban, 1.78) and people aged 70-79 or over 80 years (ratio of rural to urban, 1.58 or 2.01). However, the urban–rural difference for AD was not evident when the data were stratified by education. On the contrary, after stratification, the prevalence of VaD was less in rural areas than in urban ones among individuals aged 65 to 69 years (ratio of rural to urban, 0.35).

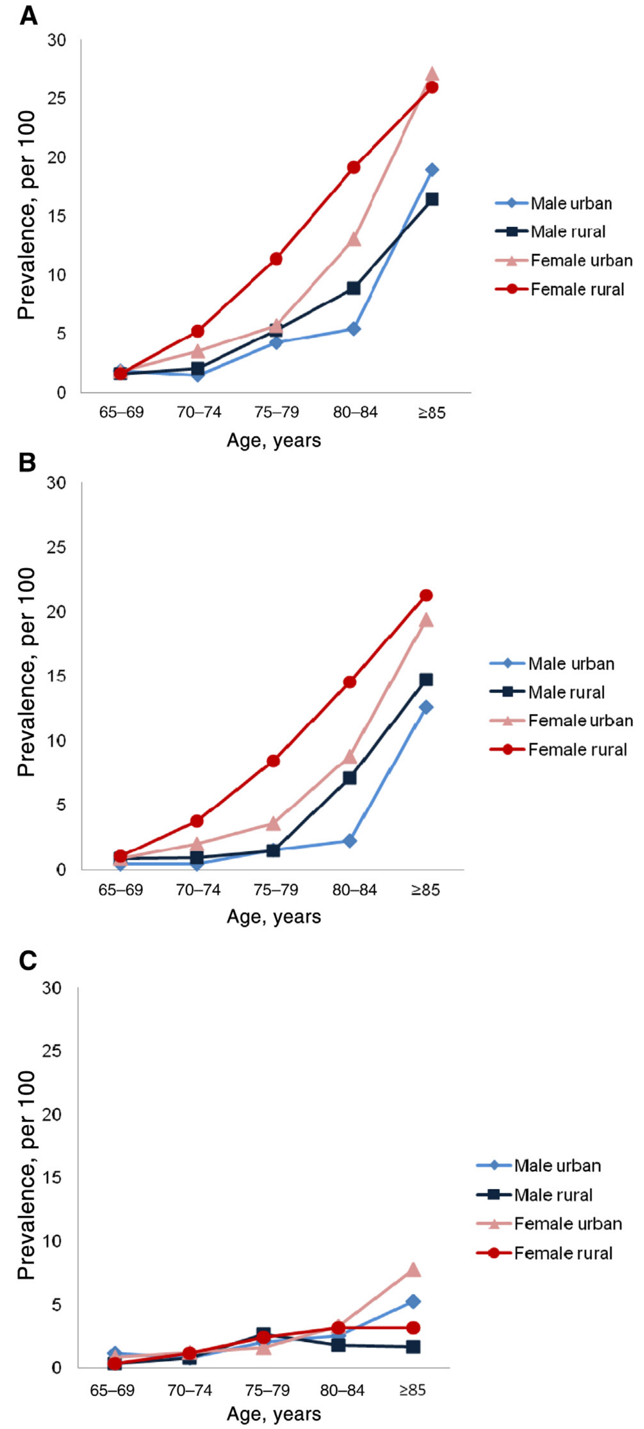

Fig. 2. Prevalence of dementia, Alzheimer's disease (AD), and vascular dementia (VaD) by age and sex categories in urban and rural populations. (A) Prevalence rates for dementia. (B) Prevalence rates for AD. (C) Prevalence rates for VaD.

3.3. Logistic analysis

To identify possible risk factors, we compared respondents with AD or VaD with control subjects using multivariate logistic regression based on the samples of patients (AD or VaD) and cognitively normal individuals (Table 4). We found that older age was a common risk factor for AD and VaD regardless of urban or rural residence ($P < .001$). However, the risk for AD was greater among manual laborers (odds ratio [OR], 2.89; 95% CI, 1.33–6.30) and nonsmokers (OR, 2.04; 95% CI, 1.08–3.85) in urban populations, whereas it was greater among

Table 3
Standardized prevalence of AD and VaD in rural and urban populations by sociodemographic characteristics

	AD			VaD		
Characteristics	Urban*	Rural*	PR of rural–urban†	Urban*	Rural*	PR of rural–urban†
Total	2.44 (2.05–2.83)	4.25 (3.64–4.86)	1.74 (1.41–2.16)	1.61 (1.30–1.93)	1.28 (0.94–1.62)	0.79 (0.57–1.10)
Sex						
Male	1.27 (0.84–1.70)	1.95 (1.30–2.60)	1.54 (0.99–2.41)	1.49 (1.02–1.95)	1.03 (0.55–1.50)	0.69 (0.41–1.17)
Female	3.54 (2.92–4.15)	6.30 (5.33–7.27)	1.78 (1.40–2.27)	1.73 (1.30–2.17)	1.50 (1.02–1.98)	0.87 (0.57–1.33)
Age, years						
65–69	0.63 (0.26–1.00)	0.95 (0.45–1.45)	1.50 (0.72–3.10)	1.00 (0.53–1.46)	0.35 (0.04–0.65)	0.35 (0.14–0.87)
70–74	1.26 (0.78–1.74)	2.30 (1.43–3.18)	1.83 (1.05–3.18)	1.03 (0.60–1.46)	0.94 (0.38–1.51)	0.92 (0.43–1.94)
75–79	2.61 (1.77–3.44)	5.24 (3.82–6.66)	2.01 (1.27–3.19)	1.80 (1.10–2.49)	2.53 (1.53–3.53)	1.41 (0.77–2.59)
≥80	9.15 (7.20–11.10)	14.49 (11.75–17.23)	1.58 (1.20–2.09)	4.14 (2.79–5.49)	2.70 (1.44–3.96)	0.65 (0.37–1.14)
Education, years						
<1	7.29 (5.73–8.84)	8.01 (6.82–9.20)	1.10 (0.84–1.44)	3.25 (2.19–4.31)	2.03 (1.41–2.64)	0.62 (0.39–0.99)
1–6	2.14 (1.50–2.77)	1.35 (0.71–1.80)	0.63 (0.35–1.19)	1.47 (0.94–1.99)	0.74 (0.33–1.16)	0.51 (0.26–0.98)
7–9	1.02 (0.44–1.60)	0.79 (0.07–1.64)	0.77 (0.24–2.43)	1.56 (0.84–2.27)	0.59 (0.16–1.33)	0.38 (0.11–1.31)
>9	0.82 (0.41–1.24)	1.22 (0.70–3.14)	1.49 (0.33–6.65)	0.75 (0.36–1.15)	0.00 (0.00–0.00)	NA

Abbreviations: AD, Alzheimer's disease; VaD, vascular dementia; PR, standardized prevalence ratio; NA, not applicable.
NOTE. Age- and sex-standardized prevalence rates were calculated based on the data of the population distribution of China in 2005.
*Prevalence (percent) and 95% confidence intervals (in parentheses) provided.
†PR and 95% confidence intervals (in parentheses) provided.

women (OR, 1.91; 95% CI, 1.11–3.29), those who were illiterate (received education for <1 year; OR, 4.55; 95% CI = 2.56–7.69; reference: the group educated 1–6 years), and those living in southern areas (OR, 1.81; 95% CI, 1.23–2.67) in rural populations. The risk for VaD was greater among individuals with hypertension (OR, 2.68; 95% CI, 1.41–5.10), diabetes mellitus (OR, 2.21; 95% CI, 1.22–4.01), or stroke (OR, 24.03; 95% CI, 12.99–44.47) in urban populations, whereas it was greater among individuals who were illiterate (OR, 5.26; 95% CI, 2.38–12.50; reference: the group educated 1–6 years), who consumed alcohol (OR, 2.73; 95% CI, 1.17–6.36), and who had a history of stroke (OR, 36.49; 95% CI, 18.36–72.51) in the rural population.

4. Discussion

This study is the only large-scale, multicenter, population-based cross-sectional investigation conducted among Chinese elderly during the past decade [7,22,23]. Our study included two important regions—Changchun and Guiyang (northeast and southwest, respectively)—that have not been included in previous studies. Thus, the current study is representative of a relatively broader spectrum of people than previous studies. Moreover, this study focused on comparing urban and rural communities regarding the prevalence of and risk factors for dementia, an approach that has been relatively rare in previous reports. It should be noted that this study used a standardized procedure of cognitive screening to provide sufficient evidence to diagnose dementia and MCI simultaneously, which thus included more cognitive assessments than only the Mini-Mental State Examination used in previous screenings. We think this change may have reduced false-negative results and produced relatively accurate and reliable data.

Our data show that the prevalence rates of dementia, AD, and VaD among Chinese elderly individuals aged 65 years and older were 5.14%, 3.21%, and 1.50%, respectively. These prevalence figures seem to represent significant increases compared with the corresponding rates reported in a systematic analysis of studies conducted from 1980 to 2004 in China, which noted rates of 3.1%, 2.0%, and 0.9% for dementia, AD, and VaD, respectively [5,6]. Two reasons may explain this increase. First, the relatively smaller sample size, different diagnostic criteria, and different methodology used in Chinese surveys conducted 20 to 30 years ago may have led to results that show a relatively lower prevalence of dementia. Second, and perhaps more likely, the prevalence of dementia has actually increased as a function of the aging population, increased life expectancy, and changes in lifestyle. Compared with a more recent study that was conducted by Zhang and colleagues in 1997, which found that the prevalence of dementia was 5.0% among elderly individuals aged 65 years and older and the results were published in 2005 and 2008. [6,8], the prevalence of dementia we report is slightly increased, supporting the view that the increased prevalence of dementia is correlated with an aging population. In addition, our study found that AD remains the most common type of dementia and that VaD is the second most common, which is similar to the pattern of dementia observed in western countries [2].

During the past few decades, only a few reports of urban–rural differences in the prevalence of dementia have been published, and their results have been inconsistent [5,23–29]. Our results show that the prevalence of

Table 4
Logistic regression models for AD and VaD in urban and rural populations

	AD		VaD	
Characteristics	Urban	Rural	Urban	Rural
Sex				
Male	Ref.	Ref.	Ref.	Ref.
Female	1.37 (0.80–2.34)	1.91 (1.11–3.29)	0.87 (0.47–1.61)	1.00 (0.40–2.47)
Age, years				
65–69	Ref.	Ref.	Ref.	Ref.
70–74	2.00 (0.90–4.44)	3.50 (1.72–7.12)	1.43 (0.62–3.28)	2.21 (0.70–6.97)
75–79	3.61 (1.61–8.10)	6.70 (3.38–13.25)	2.55 (1.08–6.03)	6.09 (2.13–17.42)
80–84	7.17 (3.05–16.89)	16.84 (8.40–33.78)	4.04 (1.58–10.35)	5.33 (1.64–17.30)
≥85	40.79 (16.99–82.06)	34.70 (16.11–74.71)	10.05 (3.25–31.06)	9.68 (1.90–49.21)
Education, years				
<1	Ref.	Ref.	Ref.	Ref.
1–6	0.48 (0.29–0.83)	0.22 (0.13–0.39)	0.56 (0.28–1.11)	0.19 (0.08–0.42)
7–9	0.52 (0.25–1.08)	0.38 (0.13–0.94)	0.79 (0.34–1.83)	0.12 (0.02–0.70)
10–12	0.38 (0.14–1.04)	0.60 (0.12–1.65)	0.31 (0.09–1.23)	NA
>12	0.40 (0.13–1.26)	NA	0.31 (0.08–1.16)	NA
Occupation				
Labor worker	2.89 (1.33–6.30)	4.35 (0.53–36.02)	2.19 (0.99–4.82)	0.49 (0.11–2.21)
Office worker	Ref.	Ref.	Ref.	Ref.
Region				
North	Ref.	Ref.	Ref.	Ref.
South	1.10 (0.66–1.86)	1.81 (1.23–2.67)	1.42 (0.77–2.60)	2.02 (0.96–4.25)
Cigarette smoking				
Yes	Ref.	Ref.	Ref.	Ref.
No	2.04 (1.08–3.85)	1.15 (0.69–1.90)	1.66 (0.84–3.32)	1.23 (0.52–2.88)
Alcohol consumption				
Yes	1.08 (0.42–2.75)	1.73 (0.99–2.98)	1.37 (0.53–3.57)	2.73 (1.17–6.36)
No	Ref.	Ref.	Ref.	Ref.
Comorbidity				
Hypertension	0.97 (0.63–1.50)	0.95 (0.64–1.41)	2.68 (1.41–5.10)	0.95 (0.49–1.85)
Hyperlipidemia	0.64 (0.35–1.19)	1.97 (0.75–5.17)	0.51 (0.25–1.03)	1.00 (0.37–2.67)
Diabetes mellitus	1.55 (0.87–2.76)	1.17 (0.72–1.91)	2.21 (1.22–4.01)	1.13 (0.53–2.37)
Heart disease	1.03 (0.62–1.70)	1.12 (0.60–2.09)	0.66 (0.37–1.19)	0.83 (0.37–2.07)
Stroke	1.18 (0.64–2.18)	0.93 (0.44–1.95)	24.03 (12.99–44.47)	36.49 (18.36–72.51)

Abbreviations: AD, Alzheimer's disease; VaD, vascular dementia; Ref., reference; NA, not applicable.

NOTE. Logistic regression models were used to ascertain the risk factors associated with AD or VaD considering the main effects of sex, age, educational level, occupation, region, cigarette smoking, alcohol consumption, and comorbidities (hypertension, hyperlipidemia, diabetes mellitus, heart disease, and stroke) concomitantly by entering the variables using forward stepwise methods. Logistic models for AD are based on a sample size of 7941, including AD patients and cognitively normal individuals. Logistic models for VaD are based on a sample size of 7765, including patients with VaD and cognitively normal individuals. Values provided are odds ratio (95% confidence interval).

dementia and AD in rural populations is significantly higher than that in urban populations in China. Moreover, the difference in AD is not evident when the sample was stratified by educational level, suggesting that education may be an important reason for urban–rural differences in the prevalence of AD. The clearly higher proportion of illiterate individuals in rural areas (48.2%) than in urban ones (17.7%), and the notably higher prevalence of AD among those who are illiterate, support this view. Urban–rural differences in the prevalence of VaD are not statistically significant. After stratification, an opposite trend was noted; the prevalence of VaD was lower in rural areas than in urban ones among individuals aged 65 to 69 years. We hypothesize that one reason for this finding is the difference in economic status and lifestyles between these two areas, which may cause earlier onset of hypertension, hyperlipidemia, and stroke, and so forth, in urban areas rather than rural ones, but further research is needed. Recently, a review published by the World Federation of Neurology Dementia Research Group indicated that urban–rural differences existed in Latin America but not in Africa, and that the situation remained unclear in developed regions and Asia [6]. Our results suggest that urban–rural difference may also exist in China, the largest country in Asia and in the world.

Many factors have been associated with a risk for dementia. Consistent with previous investigations in China and other countries [2,5,30], our study confirms that older age is the strongest risk factor for AD and VaD in both urban and rural populations. However, we did find different risk factors for AD and VaD in urban and rural populations. Data on rural populations show that illiteracy and lower education are important risk factors for AD and VaD, which supports the view that more education can protect against the consequence of dementia [5,6,31–34]. In addition, being female and living in southern areas were independent risk factors for AD, and drinking and stroke were risk factors for VaD in rural areas. However, unlike our results in rural areas, our results in urban areas confirm the results of previous studies that show increased risk for AD among manual laborers and increased risk for VaD among those with a history of stroke, hypertension, or diabetes [6,33,35,36]. It should be mentioned that the CIs for education and stroke were very large, which might be a result of the small sample size of subjects with VaD; these results need to be confirmed. Interestingly, we found a decreased risk for AD in residents of urban areas who smoked, which is inconsistent with results of prospective studies [37–39]. We think this may be attributable to the limitations of cross-sectional surveys and to the relatively higher mortality rates among those who smoke.

Our study had certain limitations that may have affected the accuracy of our results. First, the results cannot be generalized to the whole Han population in China because the sample was small compared with size of the elderly population of China (100 million), although the sample size was not small relative to many other studies. Second, the prevalence of dementia found by our study may be lower than its actual prevalence because our study did not include elderly individuals who were institutionalized. However, only 0.1% to 0.2% of the elderly in China live in nursing homes [8], so the number of people with dementia institutionalized is relatively small, although there are no accurate data reported so far. Third, the participation rates in this study were relatively low, which may have affected the results. However, we compared the age and sex distributions of participants with those of nonparticipants to attempt to reduce bias. Fourth, factors related to depression, marital status, social functioning, and so on, were not analyzed in this study, which may have influenced the results.

In conclusion, our study found that the prevalence of dementia has increased significantly during the past 30 years. Moreover, the prevalence rates of dementia and AD were notably higher in rural than in urban areas, and the risk factors for AD and VaD differed in urban and rural populations. We suggest that data on urban–rural differences can prove helpful in efforts to develop rational public health plans.

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RESEARCH IN CONTEXT

1. Systematic review: The prevalence of dementia in China was estimated to be 3% to 7% among people aged 65 years and older according to the studies conducted from 1980 to 2000. Most of these studies were limited to one region and included only a few communities, and few extant epidemiologic investigations of dementia have focused specifically on urban–rural differences in China.
2. Interpretation: We performed a population-based cross-sectional survey with a multistage cluster sampling design among elderly individuals aged 65 and older across China from 2008 to 2009. Our data show that the prevalence rates of dementia, Alzheimer's disease (AD), and vascular dementia are 5.14%, 3.21%, and 1.50%, respectively. These figures have increased significantly compared with the results reported in previous studies. The prevalence rates of dementia and AD were notably higher in rural areas than in urban ones, and education might be an important reason for the urban–rural differences. The risk factors for AD and vascular dementia also differed for urban and rural populations.
3. Future directions: Moving forward, we will explore the reasons and mechanisms for the increasing prevalence of dementia for the entire population, and for the differences between urban and rural areas with regard to prevalence and risk factors of dementia.

References

[1] Berr C, Wancata J, Ritchie K. Prevalence of dementia in the elderly in Europe. Eur Neuropsychopharmacol 2005;15:463–71.

[2] Lobo A, Launer LJ, Fratiglioni L, Andersen K, Di Carlo A, Breteler MM, et al. Prevalence of dementia and major subtypes in Europe: a collaborative study of population-based cohorts: Neurologic Diseases in the Elderly Research Group. Neurology 2000; 54:S4–9.

[3] Hofman A, Rocca WA, Brayne C, Breteler MM, Clarke M, Cooper B, et al. The prevalence of dementia in Europe: a collaborative study of 1980–1990 findings: Eurodem Prevalence Research Group. Int J Epidemiol 1991;20:736–48.

[4] Wang W, Wu S, Cheng X, Dai H, Ross K, Du X, et al. Prevalence of Alzheimer's disease and other dementing disorders in an urban community of Beijing, China. Neuroepidemiology 2000; 19:194–200.

[5] Dong MJ, Peng B, Lin XT, Zhao J, Zhou YR, Wang RH. The prevalence of dementia in the People's Republic of China: a systematic analysis of 1980–2004 studies. Age Ageing 2007; 36:619–24.

[6] Kalaria RN, Maestre GE, Arizaga R, Friedland RP, Galasko D, Hall K, et al. Alzheimer's disease and vascular dementia in developing countries: prevalence, management, and risk factors. Lancet Neurol 2008; 7:812–26.

[7] Llibre Rodriguez JJ, Ferri CP, Acosta D, Guerra M, Huang Y, Jacob KS, et al. Prevalence of dementia in Latin America, India, and China: a population-based cross-sectional survey. Lancet 2008; 372:464–74.

[8] Zhang ZX, Zahner GE, Roman GC, Liu J, Hong Z, Qu QM, et al. Dementia subtypes in China: prevalence in Beijing, Xian, Shanghai, and Chengdu. Arch Neurol 2005;62:447–53.

[9] National Bureau of Statistics of China. China statistical yearbook: 2006. Beijing: China Statistics Press; 2006.

[10] Folstein MF, Folstein SE, McHugh PR. "Mini-mental state:" a practical method for grading the cognitive state of patients for the clinician. J Psychiatry Res 1975;12:189–98.

[11] Nasreddine ZS, Phillips NA, Bedirian V, Charbonneau S, Whitehead V, Collin I, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriatr Soc 2005;53:695–9.

[12] Maj M, Satz P, Janssen R, Zaudig M, Starace F, D'Elia L, et al. WHO Neuropsychiatric AIDS Study, cross-sectional phase II: neuropsychological and neurological findings. Arch Gen Psychiatry 1994; 51:51–61.

[13] Pfeffer RI, Kurosaki TT, Harrah CH Jr., Chance JM, Filos S. Measurement of functional activities in older adults in the community. J Gerontol 1982;37:323–9.

[14] Moroney JT, Bagiella E, Desmond DW, Hachinski VC, Molsa PK, Gustafson L, et al. Meta-analysis of the Hachinski Ischemic Score in pathologically verified dementias. Neurology 1997;49:1096–105.

[15] Morris JC. The Clinical Dementia Rating (CDR): current version and scoring rules. Neurology 1993;43:2412–4.

[16] Hughes CP, Berg L, Danziger WL, Coben LA, Martin RL. A new clinical scale for the staging of dementia. Br J Psychiatry 1982; 140:566–72.

[17] Petersen RC. Mild cognitive impairment as a diagnostic entity. J Intern Med 2004;256:183–94.

[18] Roberts RO, Geda YE, Knopman DS, Cha RH, Pankratz VS, Boeve BF, et al. The Mayo Clinic Study of Aging: design and sampling, participation, baseline measures and sample characteristics. Neuroepidemiology 2008;30:58–69.

[19] American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 4th ed. Washington, DC: American Psychiatric Association; 1994.

[20] McKhann G, Drachman D, Folstein M, Katzman R, Price D, Stadlan EM. Clinical diagnosis of Alzheimer's disease: report of the NINCDS-ADRDA Work Group under the auspices of Department of Health and Human Services Task Force on Alzheimer's Disease. Neurology 1984;34:939–44.

[21] Roman GC, Tatemichi TK, Erkinjuntti T, Cummings JL, Masdeu JC, Garcia JH, et al. Vascular dementia: diagnostic criteria for research studies: report of the NINDS-AIREN International Workshop. Neurology 1993;43:250–60.

[22] Li S, Yan F, Li G, Chen C, Zhang W, Liu J, et al. Is the dementia rate increasing in Beijing? Prevalence and incidence of dementia 10 years later in an urban elderly population. Acta Psychiatr Scand 2007; 115:73–9.

[23] Zhao Q, Zhou B, Ding D, Guo Q, Hong Z. Prevalence, mortality, and predictive factors on survival of dementia in Shanghai, China. Alzheimer Dis Assoc Disord 2010;24:151–8.

[24] Zhang ZX, Zahner GE, Roman GC, Liu XH, Wu CB, Hong Z, et al. Socio-demographic variation of dementia subtypes in China: methodology and results of a prevalence study in Beijing, Chengdu, Shanghai, and Xian. Neuroepidemiology 2006;27:177–87.

[25] Ogura C, Nakamoto H, Uema T, Yamamoto K, Yonemori T, Yoshimura T. Prevalence of senile dementia in Okinawa, Japan: COSEPO Group: study group of epidemiology for psychiatry in Okinawa. Int J Epidemiol 1995;24:373–80.

[26] Arslantas D, Ozbabalik D, Metintas S, Ozkan S, Kalyoncu C, Ozdemir G, et al. Prevalence of dementia and associated risk factors in middle Anatolia, Turkey. J Clin Neurosci 2009;16:1455–9.

[27] Nunes B, Silva RD, Cruz VT, Roriz JM, Pais J, Silva MC. Prevalence and pattern of cognitive impairment in rural and urban populations from northern Portugal. BMC Neurol 2010;10:42.

[28] Rocca WA, Bonaiuto S, Lippi A, Luciani P, Turtu F, Cavarzeran F, et al. Prevalence of clinically diagnosed Alzheimer's disease and other dementing disorders: a door-to-door survey in Appignano, Macerata Province, Italy. Neurology 1990;40:626–31.

[29] Lee DY, Lee JH, Ju YS, Lee KU, Kim KW, Jhoo JH, et al. The prevalence of dementia in older people in an urban population of Korea: the Seoul Study. J Am Geriatr Soc 2002;50:1233–9.

[30] Plassman BL, Langa KM, Fisher GG, Heeringa SG, Weir DR, Ofstedal MB, et al. Prevalence of dementia in the United States: the Aging, Demographics, and Memory Study. Neuroepidemiology 2007;29:125–32.

[31] Obadia Y, Rotily M, Degrand-Guillaud A, Guelain J, Ceccaldi M, Severo C, et al. The PREMAP Study: prevalence and risk factors of dementia and clinically diagnosed Alzheimer's disease in Provence, France: prevalence of Alzheimer's disease in Provence. Eur J Epidemiol 1997;13:247–53.

[32] Ott A, Breteler MM, van Harskamp F, Claus JJ, van der Cammen TJ, Grobbee DE, et al. Prevalence of Alzheimer's disease and vascular dementia: association with education: the Rotterdam Study. BMJ 1995; 310:970–3.

[33] Bickel H, Kurz A. Education, occupation, and dementia: the Bavarian School Sisters Study. Dement Geriatr Cogn Disord 2009;27:548–56.

[34] Brayne C, Ince PG, Keage HA, McKeith IG, Matthews FE, Polvikoski T, et al. Education, the brain and dementia: neuroprotection or compensation? Brain 2010;133:2210–6.

[35] Qiu C, Karp A, von Strauss E, Winblad B, Fratiglioni L, Bellander T. Lifetime principal occupation and risk of Alzheimer's disease in the Kungsholmen project. Am J Ind Med 2003;43:204–11.

[36] Ravaglia G, Forti P, Maioli F, Sacchetti L, Mariani E, Nativio V, et al. Education, occupation, and prevalence of dementia: findings from the Conselice Study. Dement Geriatr Cogn Disord 2002;14:90–100.

[37] Juan D, Zhou DH, Li J, Wang JY, Gao C, Chen M. A 2-year follow-up study of cigarette smoking and risk of dementia. Eur J Neurol 2004; 11:277–82.

[38] Letenneur L, Larrieu S, Barberger-Gateau P. Alcohol and tobacco consumption as risk factors of dementia: a review of epidemiological studies. Biomed Pharmacother 2004;58:95–9.

[39] Reitz C, den Heijer T, van Duijn C, Hofman A, Breteler MM. Relation between smoking and risk of dementia and Alzheimer disease: the Rotterdam Study. Neurology 2007;69:998–1005.