Prevalence, risk factors, and management of dementia and mild cognitive impairment in adults aged 60 years or older in China: a cross-sectional study

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Summary

Background

Findings

Interpretation

Funding

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For the Chinese translation of the abstract see Online for appendix 1

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Introduction

China has 249·49 million people aged 60 years or older, representing 17·9% of the total population of 1·40 billion people,[1] suggesting a high prevalence of dementia or mild cognitive impairment (MCI). Over the past three decades, more than 100 epidemiological studies have been done

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Research in context

Evidence before this study

We searched PubMed and the China National Knowledge Infrastructure database for articles published up to May 31, 2020, using the terms "prevalence", "dementia", "Alzheimer's disease", "vascular dementia", "other dementia", "mild cognitive impairment", "risk factor", "management", "epidemiology", and "China". We screened papers by reviewing abstracts to identify full-text reports that were relevant to the study aims and found more than 100 epidemiological studies on dementia prevalence in China. However, most studies were done with relatively small samples in a single area, city, or province. These studies reported that the prevalence estimates have been highly inconsistent, varying from 2% to 13% for individuals aged 60 or 65 years or older, making it difficult to know which data are more accurate. Although we identified a survey in a large sample (32 552 adults aged 65 years or older between 2013 and 2015) that explored the prevalence of mental health disorders (eg, mood disorders, anxiety disorders, alcohol-use and drug-use disorders, schizophrenia and other psychotic disorders, eating disorders, impulse-control disorder) as well as dementia, the main topic of that study was not dementia and did not address dementia risk factors. Since mild cognitive impairment (MCI) is thought to be a transitional stage between being cognitively unimpaired and dementia, consensus has been reached to focus primary interventions in this population to prevent dementia. Of the few studies that have investigated MCI prevalence in China, the results have been inconsistent, with estimates ranging from 9·7% to 23·3%. Additionally, most of these studies were done in single regions and did not represent the prevalence of MCI on a national scale. Furthermore, most previous studies reported either dementia or MCI prevalence only, thus ignoring the continuity of cognitive impairment from mild to severe, as well as common, shared risk factors. Clarification of these factors would inform specific control measures because most suspected risk factors are modifiable. Additionally, few reports have focused on the management of dementia and MCI, making this a poorly understood, yet critically important, topic. To our knowledge, no previous study has covered prevalence, risk factors, and management of both dementia and MCI in China or worldwide.

Added value of this study

We report what is, to our knowledge, the largest and most comprehensive dementia and MCI survey to date from a nationally representative sample of 46 011 Chinese adults aged 60 years or older. Our results show that the overall prevalence of dementia was 6·0% and of MCI was 15·5%, representing 15·07 million individuals with dementia and 38·77 million individuals with MCI. We found that MCI and dementia shared similar, modifiable risk factors including rural residence, fewer years of education, living alone, smoking, hypertension, hyperlipidaemia, diabetes, and heart and cerebrovascular disease. Unfortunately, most people with dementia were undiagnosed, inadequately treated, and not cared for by people with professional training as caregivers for patients with dementia. Most patients with MCI did not know what MCI was, and did not realise that it could progress into dementia.

Implications of all the available evidence

The large dementia and MCI population has become a heavy health and economic burden, not only in China but around the world, which calls for authorities to take stronger anti-dementia measures so as to control this disease. Based on the risk factors we found in this study that are shared by both dementia and MCI, it is crucial to develop a prevention strategy targeting the MCI population to thwart or slow down disease progression to postpone dementia onset and reduce prevalence. In addition, establishing a feasible dementia and MCI management system should be a government priority, in which all people with MCI should be monitored and their risk factors controlled, and people with dementia can receive a timely diagnosis and be well treated and properly cared for. We believe these strategies would effectively reduce the prevalence of dementia

in China. While contributing to the understanding regarding dementia prevalence, the prevalence estimates from these studies have been highly inconsistent, varying from 2% to 13% for older individuals (ie, ≥60 years or ≥65 years of age),[2,3] making it difficult to know which data are more accurate. Because MCI is thought to be a transitional stage between being cognitively unimpaired and dementia, consensus has been reached to focus primary interventions on this population to prevent dementia. However, the few studies that have investigated MCI prevalence in China also have had inconsistent results, with estimates ranging from 9·7% to 23·3%.[4,5] These inconsistencies necessitate further study to yield a more accurate estimate. Additionally, the prevalence of dementia has been thought to double at 5-year intervals,[6] meaning an updated report is necessary. In the past few decades, China has experienced considerable changes to people's lifestyle and lifespan, urbanisation, and environment, which are likely to affect exposure to risk factors for Alzheimer's disease and thus the prevalence of dementia. For example, higher fat intake among Chinese individuals in recent years has led to increases in hypertension and hyperlipidaemia, and therefore cardiocerebrovascular disease, which can cause vascular dementia and even Alzheimer's disease.[7] However, previous studies have not assessed systematic risk factors for dementia or MCI. Clarification of these factors would inform specific control measures as many risk factors are modifiable. Additionally, few reports have focused on the management of dementia and MCI, making this a poorly understood, yet crucially important, topic.

We speculated that there has been a substantial increase in the prevalence of dementia and MCI in China over the past decade, as the population has aged.

Therefore, we did this study in a large, nationally representative sample of adults aged 60 years or older, based on the China Cognition and Aging Study, to investigate the prevalence, risk factors, and management of dementia and MCI in China.

Methods

Study design and participants

We used a multistage, stratified, cluster-sampling procedure, which considered geographical region, degree of urbanisation, economic development status, and sex and age distribution, derived from the 2010 China census data.[8] In stage 1, we chose 12 provinces, metropolises, and autonomous areas that were representative of the socioeconomic status and lifestyles of three major geographical regions in China (north, south, and west). In stage 2, we randomly selected two cities (classified as urban, with >500 000 residents) and two counties (classified as rural, with ≤500 000 residents) from each of the 12 provinces or autonomous areas, such that one city and county were considered economically developed (at or above the median provincial gross domestic product [GDP]) and the other two were considered underdeveloped (below the median provincial GDP). In stage 3, we randomly selected two districts from each city and two townships from each county. In stage 4, we randomly selected four communities from each district and four villages from each township; communities or villages usually have 800–1200 households. In brief, there were four levels of sampling units: the primary sampling unit was province or autonomous area, secondary was city (urban) or county (rural), tertiary was district (urban) or township (rural), and quaternary was community (urban) or village (rural). Finally, we screened all eligible individuals aged 60 years or older who were of Han Chinese ethnicity, were listed in the census of the community or village registry, and had lived there for at least 1 year preceding the survey date. Those listed in the census but who were institutionalised (eg, people in nursing homes) were excluded. Additionally, participants with life-threatening disease or hearing or vision loss were excluded after screening. In total, 96 study sites (48 urban and 48 rural) participated in the study. The study protocol was approved by the Ethics Review Board of the Xuanwu Hospital, Beijing Capital Medical University and all other participating institutes or hospitals. Written informed consent was obtained from all participants.

Procedures

First, in-person interviews were done to obtain data on sociodemographic characteristics, lifestyle, medical history, current medications, and family history. Participants then completed a neuropsychological testing battery administered by a psychological evaluator. Cognition was assessed with the Mini-Mental State Examination,[9] Montreal Cognitive Assessment for global cognition,[10] and the WHO University of California-Los Angeles Auditory Verbal Learning Test for memory assessment.[11] Social functioning was assessed with activities of daily living[12] and the Hachinski Ischemic Score[13] was used for differentiating degeneration from vascular causes. A physician blinded to the results of the neuropsychological tests then took a detailed medical history and determined participants' Clinical Dementia Rating (CDR)[14] score. For dementia diagnosis, MRI or CT was compulsory. All information was

For the **study protocol** see http://jiajpneuro.org/gczx/2020/10/10/study-protocol-and-crf-for-prevalence-risk-factors-and-management-of-dementia-and-mild-cognitive-impairment-in-china

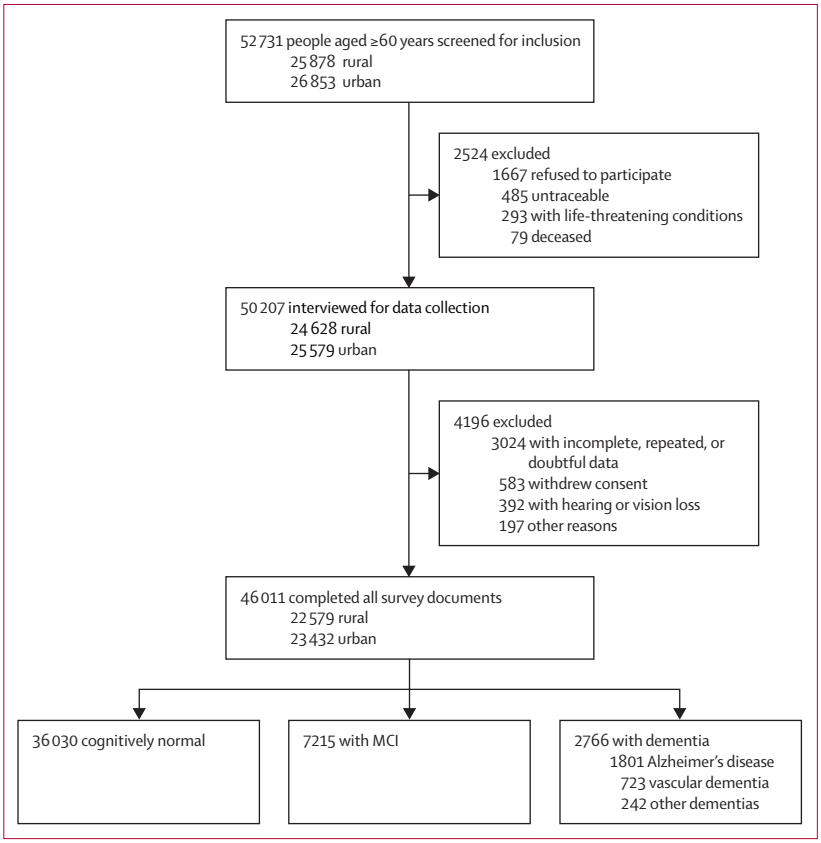

Figure 1: **Study flowchart**
MCI=mild cognitive impairment.

	All study participants (n=46 011)	Male (n=22 866)	Female (n=23 145)
Sex distribution	..	49·7%	50·3%
Age, years	70·26 (7·51)	70·10 (7·41)	70·42 (7·60)
60–69	27 630 (60·1%)	13 977 (61·1%)	13 653 (59·0%)
70–79	12 837 (27·9%)	6265 (27·4%)	6572 (28·4%)
80–89	4974 (10·8%)	2374 (10·4%)	2600 (11·2%)
≥90	570 (1·2%)	250 (1·1%)	320 (1·4%)
Parental history of dementia			
Yes	510 (1·1%)	249 (1·1%)	261 (1·1%)
No	45 501 (98·9%)	22 617 (98·9%)	22 884 (98·9%)
Residence location			
Rural	22 579 (49·1%)	11 244 (49·2%)	11 335 (49·0%)
Urban	23 432 (50·9%)	11 622 (50·8%)	11 810 (51·0%)

(Table 1 contiues on next page)

	All study participants (n=46 011)	Male (n=22 866)	Female (n=23 145)
(Continued from pervious page)			
National region			
West	11 549 (25·1%)	5773 (25·2%)	5776 (25·0%)
South	16 242 (35·3%)	8163 (35·7%)	8079 (34·9%)
North	18 220 (39·6%)	8930 (39·1%)	9290 (40·1%)
Education level, years			
All participants			
<1	7967 (17·3%)	3799 (16·6%)	4168 (18·0%)
1–6	15 177 (33·0%)	7503 (32·8%)	7674 (33·2%)
>6	22 867 (49·7%)	11 564 (50·6%)	11 303 (48·8%)
Rural			
<1	5027/22 579 (22·3%)	2414/11 244 (21·5%)	2613/11 335 (23·1%)
1–6	8727/22 579 (38·7%)	4334/11 244 (38·5%)	4393/11 335 (38·8%)
>6	8825/22 579 (39·1%)	4496/11 244 (40·0%)	4329/11 335 (38·2%)
Urban			
<1	2940/23 432 (12·5%)	1385/11 622 (11·9%)	1555/11 810 (13·2%)
1–6	6450/23 432 (27·5%)	3169/11 622 (27·3%)	3281/11 810 (27·8%)
>6	14 042/23 432 (59·9%)	7068/11 622 (60·8%)	6974/11 810 (59·1%)
Marital status			
Widowed	3676 (8·0%)	1762 (7·7%)	1914 (8·3%)
Divorced or living alone	2397 (5·2%)	1157 (5·1%)	1240 (5·4%)
Married	39 938 (86·8%)	19 947 (87·2%)	19 991 (86·4%)
Occupation			
White collar	10 114 (22·0%)	5024 (22·0%)	5090 (22·0%)
Blue collar	24 585 (53·4%)	12 215 (53·4%)	12 370 (53·4%)
House working	8034 (17·5%)	3981 (17·4%)	4053 (17·5%)
Other	3278 (7·1%)	1646 (7·2%)	1632 (7·1%)
Current smoker			
Yes	9624 (20·9%)	4795 (21·0%)	4829 (20·9%)
No	36 387 (79·1%)	18 071 (79·0%)	18 316 (79·1%)
Hypertension			
Yes	21 244 (46·2%)	10 482 (45·8%)	10 762 (46·5%)
No	24 767 (53·8%)	12 384 (54·2%)	12 383 (53·5%)
Hyperlipidaemia			
Yes	11 105 (24·1%)	5418 (23·7%)	5687 (24·6%)
No	34 906 (75·9%)	17 448 (76·3%)	17 458 (75·4%)
Diabetes			
Yes	10 026 (21·8%)	4926 (21·5%)	5100 (22·0%)
No	35 985 (78·2%)	17 940 (78·5%)	18 045 (78·0%)
Heart disease			
Yes	3283 (7·1%)	1544 (6·8%)	1739 (7·5%)
No	42 728 (92·9%)	21 322 (93·2%)	21 406 (92·5%)
Cerebrovascular disease			
Yes	5021 (10·9%)	2450 (10·7%)	2571 (11·1%)
No	40 990 (89·1%)	20 416 (89·3%)	20 574 (88·9%)
MMSE score	26·95 (3·96)	27·19 (3·70)	26·71 (4·19)

Data are n (%) or mean (SD) unless specified otherwise. MMSE=Mini-Mental State Examination. CDR=Clinical Dementia Rating.

Table 1: **Demographics of the study population**

reviewed by an expert panel that was established in each province, who made a final diagnosis when consensus was not reached.

Eight to ten teams of interviewers were formed for each community or village, each consisting of one junior neurologist, one medical student, and one social worker. Each province's expert panel consisted of two neurologists and two neuropsychologists with expertise in dementia. To minimise inconsistencies, interviewers and experts received the same week-long training on all necessary knowledge and skills, and a retraining course every 6 months. Inter-rater reliability for assessment of videos of or questionnaires from individuals with cognitive decline was required to exceed 0·90.

Data were stored on a secured server that only allowed authorised personnel access. For quality control, monitors did daily computer-based logic checks for item non-response and survey data outliers. Additionally, as part of a random spot check, telephone calls were made to more than 25% of respondents to identify improper behaviour of the interviewers, such as inaccurate reading of questions, insufficient probing, or falsified answers.

Diagnostic criteria

Participants were categorised as cognitively normal, MCI, or dementia according to cognitive level. Cognitively normal was assigned when participants scored 0 on global CDR. Dementia was diagnosed according to the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, Text Revision criteria.[15] Alzheimer's disease was diagnosed according to criteria of the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association[16] or the National Institute on Aging and the Alzheimer's Association (NIA-AA) workgroup,[17] and vascular dementia on the National Institute of Neurological Disorders and Stroke-Association Internationale pour la Recherché et l'Enseignement en Neurosciences criteria.[18] Other dementias included mixed dementia,[19] frontotemporal dementia, dementia with Lewy bodies, Parkinson's disease with dementia, alcoholic dementia, hydrocephalus dementia, and post-traumatic dementia, according to various globally accepted criteria. Participants who were neither cognitively normal nor categorised as having dementia were classified as MCI according to the clinical criteria recommended by the NIA-AA workgroup.[20]

Statistical analysis

All calculations were weighted to represent the general adult population aged 60 years or older in China, according to the 2010 population census.[8] We calculated weights using data from the census and study sample, and adjusted for refused participation and other demographic differences between the sample and total population. Based on available data from previous studies,[21] we assumed the lowest prevalence of dementia for individuals aged 60 years or older would be 5%, and applied a design effect of 2 to account for the multistage cluster sampling design. To achieve a relative error of 15%, we calculated

	Cognitively normal			MCI			Dementia			p value*
	Male (n=18 756)	Female (n=17 364)	Both sexes (n=36 120)	Male (n=2974)	Female (n=4151)	Both sexes (n=7125)	Male (n=1136)	Female (n=1630)	Both sexes (n=2766)	
Sex distribution	51·9%	48·1%	..	41·7%	58·3%	..	41·1%	58·9%	..	<0·0001
Age, years	69·42 (6·91)	69·46 (6·95)	69·44 (6·93)	72·32 (8·49)	72·38 (8·29)	72·35 (8·37)	75·49 (8·90)	75·65 (9·08)	75·58 (9·01)	<0·0001
60–69	12 270 (65·4%)	11 292 (65·0%)	23 562 (65·2%)	1379 (46·4%)	1891 (45·6%)	3270 (45·9%)	328 (28·9%)	470 (28·8%)	798 (28·9%)	<0·0001
70–79	4804 (25·6%)	4488 (25·8%)	9292 (25·7%)	1005 (33·8%)	1464 (35·3%)	2469 (34·7%)	456 (40·1%)	620 (38·0%)	1076 (38·9%)	<0·0001
80–89	1577 (8·4%)	1482 (8·5%)	3059 (8·5%)	516 (17·4%)	685 (16·5%)	1201 (16·9%)	281 (24·7%)	433 (26·6%)	714 (25·8%)	<0·0001
≥90	105 (0·6%)	102 (0·6%)	207 (0·6%)	74 (2·5%)	111 (2·7%)	185 (2·6%)	71 (6·3%)	107 (6·6%)	178 (6·4%)	<0·0001
Parental history of dementia										
Yes	144 (0·8%)	114 (0·7%)	258 (0·7%)	41 (1·4%)	55 (1·3%)	96 (1·3%)	64 (5·6%)	92 (5·6%)	156 (5·6%)	<0·0001
No	18 612 (99·2%)	17 250 (99·3%)	35 862 (99·3%)	2933 (98·6%)	4096 (98·7%)	7029 (98·7%)	1072 (94·4%)	1538 (94·4%)	2610 (94·4%)	<0·0001
Residence location										
Rural	8853 (47·2%)	8001 (46·1%)	16 854 (46·7%)	1765 (59·3%)	2453 (59·1%)	4218 (59·2%)	626 (55·1%)	881 (54·0%)	1507 (54·5%)	<0·0001
Urban	9903 (52·8%)	9363 (53·9%)	19 266 (53·3%)	1209 (40·7%)	1698 (40·9%)	2907 (40·8%)	510 (44·9%)	749 (46·0%)	1259 (45·5%)	<0·0001
National region										
West	4682 (25·0%)	4316 (24·9%)	8998 (24·9%%)	721 (24·2%)	969 (23·3%)	1690 (23·7%)	370 (32·6%)	491 (30·1%)	861 (31·1%)	<0·0001
South	6777 (36·1%)	6112 (35·2%)	12 889 (35·7%)	1063 (35·7%)	1523 (36·7%)	2586 (36·3%)	323 (28·4%)	444 (27·2%)	767 (27·7%)	<0·0001
North	7297 (38·9%)	6936 (39·9%)	14 233 (39·4%)	1190 (40·0%)	1659 (40·0%)	2849 (40·0%)	443 (39·0%)	695 (42·6%)	1138 (41·1%)	<0·0001
Education level, years										
All participants										
<1	2546 (13·6%)	2380 (13·7%)	4926 (13·6%)	952 (32·0%)	1378 (33·2%)	2330 (32·7%)	301 (26·5%)	410 (25·2%)	711 (25·7%)	<0·0001
1–6	6116 (32·6%)	5760 (33·2%)	11 876 (32·9%)	993 (33·4%)	1380 (33·2%)	2373 (33·3%)	394 (34·7%)	534 (32·8%)	928 (33·6%)	<0·0001
>6	10 094 (53·8%)	9224 (53·1%)	19 318 (53·5%)	1029 (34·6%)	1393 (33·6%)	2422 (34·0%)	441 (38·8%)	686 (42·1%)	1127 (40·7%)	<0·0001
Rural										
<1	1560/8853 (17·6%)	1425/8001 (17·8%)	2985/16 854 (17·7%)	650/1765 (36·8%)	904/2453 (36·9%)	1554/4218 (36·8%)	204/626 (32·6%)	284/881 (32·2%)	488/1507 (32·4%)	<0·0001
1–6	3479/8853 (39·3%)	3198/8001 (40·0%)	6677/16 854 (39·6%)	621/1765 (35·2%)	870/2453 (35·5%)	1491/4218 (35·3%)	234/626 (37·4%)	325/881 (36·9%)	559/1507 (37·1%)	<0·0001
>6	3814/8853 (43·1%)	3378/8001 (42·2%)	7192/16 854 (42·7%)	494/1765 (28·0%)	679/2453 (27·7%)	1173/4218 (27·8%)	188/626 (30·0%)	272/881 (30·9%)	460/1507 (30·5%)	<0·0001
Urban										
<1	986/9903 (10·0%)	955/9363 (10·2%)	1941/19 266 (10·1%)	302/1209 (25·0%)	474/1698 (27·9%%)	776/2907 (26·7%)	97/510 (19·0%)	126/749 (16·8%)	223/1259 (17·7%)	<0·0001
1–6	2637/9903 (26·6%)	2562/9363 (27·4%)	5199/19 266 (27·0%)	372/1209 (30·8%)	510/1698 (30·0%)	882/2907 (30·3%)	160/510 (31·4%)	209/749 (27·9%)	369/1259 (29·3%)	<0·0001
>6	6280/9903 (63·4%)	5846/9363 (62·4%)	12 126/19 266 (62·9%)	535/1209 (44·3%)	714/1698 (42·0%)	1249/2907 (43·0%)	253/510 (49·6%)	414/749 (55·3%)	667/1259 (53·0%)	<0·0001
Marital status										
Widowed	1151 (6·1%)	992 (5·7%)	2143 (5·9%)	344 (11·6%)	519 (12·5%)	863 (12·1%)	267 (23·5%)	403 (24·7%)	670 (24·2%)	<0·0001
Divorced or living alone	847 (4·5%)	788 (4·5%)	1635 (4·5%)	203 (6·8%)	291 (7·0%)	494 (6·9%)	107 (9·4%)	161 (9·9%)	268 (9·7%)	<0·0001
Married	16 758 (89·3%)	15 584 (89·7%)	32 342 (89·5%)	2427 (81·6%)	3341 (80·5%)	5768 (81·0%)	762 (67·1%)	1066 (65·4%)	1828 (66·1%)	<0·0001
Occupation										
White collar	4158 (22·2%)	3956 (22·8%)	8114 (22·5%)	619 (20·8%)	804 (19·4%)	1423 (20·0%)	247 (21·7%)	330 (20·2%)	577 (20·9%)	<0·0001
Blue collar	9961 (53·1%)	9181 (52·9%)	19 142 (53·0%)	1635 (54·98%)	2302 (55·5%)	3937 (55·3%)	619 (54·5%)	887 (54·4%)	1506 (54·4%)	<0·0001
House working	3257 (17·4%)	3011 (17·3%)	6268 (17·35%)	527 (17·7%)	749 (18·0%)	1276 (17·9%)	197 (17·3%)	293 (18·0%)	490 (17·7%)	<0·0001
Other	1380 (7·4%)	1216 (7·0%)	2596 (7·2%)	193 (6·5%)	296 (7·1%)	489 (6·9%)	73 (6·4%)	120 (7·4%)	193 (7·0%)	<0·0001

(Table 2 continues on next page)

	Cognitively normal			MCI			Dementia			p value*
	Male (n=18 756)	Female (n=17 364)	Both sexes (n=36 120)	Male (n=2974)	Female (n=4151)	Both sexes (n=7125)	Male (n=1136)	Female (n=1630)	Both sexes (n=2766)	
(Continued from previous page)										
Current smoker										
Yes	3787 (20·2%)	3505 (20·2%)	7292 (20·2%)	656 (22·1%)	921 (22·2%)	1577 (22·1%)	352 (31·0%)	403 (24·7%)	755 (27·3%)	<0·0001
No	14 969 (79·8%)	13 859 (79·8%)	28 828 (79·8%)	2318 (77·9%)	3230 (77·8%)	5548 (77·9%)	784 (69·0%)	1227 (75·3%)	2011 (72·7%)	<0·0001
Hypertension										
Yes	8140 (43·4%)	7442 (42·9%)	15 582 (43·1%)	1628 (54·7%)	2302 (55·5%)	3930 (55·2%)	714 (62·9%)	1018 (62·5%)	1732 (62·6%)	<0·0001
No	10 616 (56·6%)	9922 (57·1%)	20 538 (56·9%)	1346 (45·3%)	1849 (44·5%)	3195 (44·8%)	422 (37·1%)	612 (37·5%)	1034 (37·4%)	<0·0001
Hyperlipidaemia										
Yes	4184 (22·3%)	3922 (22·6%)	8106 (22·4%)	804 (27·0%)	1160 (27·9%)	1964 (27·6%)	430 (37·9%)	605 (37·1%)	1035 (37·4%)	<0·0001
No	14 572 (77·7%)	13 442 (77·4%)	28 014 (77·6%)	2170 (73·0%)	2991 (72·1%)	5161 (72·4%)	706 (62·1%)	1025 (62·9%)	1731 (62·6%)	<0·0001
Diabetes										
Yes	3734 (19·9%)	3419 (19·7%)	7153 (19·8%)	782 (26·3%)	1069 (25·8%)	1851 (26·0%)	410 (36·1%)	612 (37·5%)	1022 (36·9%)	<0·0001
No	15 022 (80·1%)	13 945 (80·3%)	28 967 (80·2%)	2192 (73·7%)	3082 (74·2%)	5274 (74·0%)	726 (63·9%)	1018 (62·5%)	1744 (63·1%)	<0·0001
Heart disease										
Yes	1177 (6·3%)	1187 (6·8%)	2364 (6·5%)	213 (7·2%)	341 (8·2%)	554 (7·8%)	154 (13·6%)	211 (12·9%)	365 (13·2%)	<0·0001
No	17 579 (93·7%)	16 177 (93·2%)	33 756 (93·5%)	2761 (92·8%)	3810 (91·8%)	6571 (92·2%)	982 (86·4%)	1419 (87·1%)	2401 (86·8%)	<0·0001
Cerebrovascular disease										
Yes	1616 (8·6%)	1506 (8·7%)	3122 (8·6%)	391 (13·1%)	490 (11·8%)	881 (12·4%)	443 (39·0%)	575 (35·3%)	1018 (36·8%)	<0·0001
No	17 140 (91·4%)	15 858 (91·3%)	32 998 (91·4%)	2583 (86·9%)	3661 (88·2%)	6244 (87·6%)	693 (61·0%)	1055 (64·7%)	1748 (63·2%)	<0·0001
MMSE score	28·37 (1·06)	28·34 (1·06)	28·36 (1·06)	25·00 (0·82)	24·99 (0·81)	24·99 (0·81)	13·47 (5·55)	13·69 (5·54)	13·6 (5·54)	<0·0001
CDR score†	0	0	0	0·5	0·5	0·5	2·13 (0·83)	2·12 (0·83)	2·12 (0·83)	<0·0001

Data are n (%) or mean (SD) unless specified otherwise. MCI=mild cognitive impairment. MMSE=Mini-Mental State Examination. CDR=Clinical Dementia Rating. *p value for difference between cognitively normal, MCI, and dementia. †By definition, participants who are cognitively normal score zero and participants with MCI score 0·5.

Table 2: **Demographics of the study population by cognitive status**

sample sizes using the formula in Huang,[22] which led to a sample size of roughly 7000. Therefore, our sample of more than 50 000 participants in this study is sufficient.

Estimates of the prevalence of MCI, dementia, Alzheimer's disease, and vascular dementia in urban and rural populations with different sex and education compositions were calculated separately for the overall population and for subgroups stratified by age, sex, and education. Age-standardised and sex-standardised prevalence were calculated using China's population distribution in 2018.[1] Rural and urban prevalence ratios with 95% CIs adjusted for age and sex were calculated to compare the prevalence between urban and rural populations. We did not impute missing data.

Significant differences were assessed using one-way analysis of variance or Student's *t* test for continuous variables and χ^2 test for categorical variables. The prevalence trend by covariables was tested using the Cochran-Armitage test. Logistic regression models ascertained the risk factors associated with dementia and its subtypes or MCI, including age group (60–69, 70–79, 80–89, and ≥90 years), sex, parental history of dementia, residence location (rural *vs* urban), education level (<1, 1–6, and >6 years), marital status (widowed, divorced or living alone, and married), current smoker, and presence of hypertension, hyperlipidaemia, diabetes, heart disease, or cerebrovascular disease. All analyses were done in SAS 9.1 or SPSS 22.0. Differences between groups were considered statistically significant for p<0·05.

Role of the funding source

The funder had no role in the study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all data in the study and had final responsibility for the decision to submit for publication.

Results

Between March 10, 2015, and Dec 26, 2018, 52 731 adults were invited to participate in the survey, of whom 6720 were excluded (figure 1). 46 011 individuals completed all survey documents (table 1), of whom 2766 (6·0%) were classified as having dementia: 1801 (3·9%) with Alzheimer's disease, 723 (1·6%) with vascular dementia, and 242 (0·5%) with other dementias (table 2). The overall age-adjusted and sex-adjusted prevalence was estimated to be 6·0% (95% CI 5·8–6·3) for dementia, 3·9% (3·8–4·1) for Alzheimer's disease, 1·6% (1·5–1·7) for vascular dementia, and 0·5% (0·5–0·6) for other dementias. Out of the 249·49 million people aged 60 years or older in China,[1] we estimated that 15·07 million (95% CI 14·53–15·62) people have dementia, among

whom 9·83 million (9·39–10·29) have Alzheimer's disease, 3·92 million (3·64–4·22) have vascular dementia, and 1·32 million (1·16–1·50) have other dementias (figure 2A). Dementia prevalence varied across the three major regions in China, with a prevalence of 6·3% (5·9–6·6) in the north, 4·7% (4·4–5·1) in the south, and 7·5% (7·0–7·9) in the west (appendix 2 p 1).

We classified age, sex, and family history as unmodifiable risk factors. The prevalence of dementia increased with age, from 2·9% in 27 630 individuals aged 60–69 years to 31·9% in 570 aged 90 years or older (table 2; figure 2B), with odds significantly increasing with age (table 3). The estimated number of people with dementia for each age group, nationwide, was 4·34 million (95% CI 4·05–4·65) in 149·72 million people aged 60–69 years, 5·90 million (5·57–6·24) in 70·19 million people aged 70–79 years, 3·87 million (3·61–4·14) in 26·51 million aged 80–89 years, and 0·98 million (0·86–1·10) in 3·07 million aged 90 years or older (figure 2A). Among our 35 382 participants aged 65 years or older, the prevalence of dementia was 6·9% (n=2450), leading to an estimated 10·39 million (9·98–10·79) people nationwide aged 65 years or older with dementia. Dementia prevalence was significantly higher in women than in men (tables 1, 2), with significantly higher prevalence and percentage distribution in all female age groups (figure 3A; appendix 2 p 2). The percentage of participants with parental dementia history was significantly higher in 2766 participants with dementia than in the 43 245 participants without dementia (156 [5·6%] *vs* 354 [0·8%]; table 3).

Modifiable risk factors for dementia were found to be rural residence, fewer years of education, and marital status (table 3). Specifically, the prevalence of dementia in rural areas was significantly higher than in urban areas (figure 4A). Percentage distribution of dementia in these areas is shown in the appendix 2 (p 3). Other risk factors for dementia were smoking, hypertension, hyperlipidaemia, diabetes, heart disease, and cerebrovascular disease (table 3).

7125 (15·5%) of 46 011 participants were diagnosed with MCI. The overall prevalence of MCI in China was estimated at 15·5% (95% CI 15·2–15·9), representing 38·77 million (37·95–39·62) people nationwide. The prevalence of MCI increased with age, from 11·9% (11·5–12·3; representing 17·77 million people) in people aged 60–69 years, 19·3% (18·6–20·0; 13·53 million people) in those aged 70–79 years, 24·4% (23·2–25·6; 6·46 million people) in those aged 80–89 years, and 33·1% (29·2–37·2; 1·01 million people) in those aged 90 years or older (table 3; figure 2C). The increasing prevalence of MCI was also correlated with female sex, rural residence, fewer years of education, and factors such as smoking, hypertension, hyperlipidaemia, diabetes, and cerebrovascular disease (table 3). Moreover, in all age groups, prevalence of MCI was significantly higher among women than men (figure 3B; appendix 2 p 2) and in rural areas than in urban ones (figure 4B; appendix 2 p 3). The percentage distribution of MCI by sex and residence location is shown in the appendix 2 (pp 2–3).

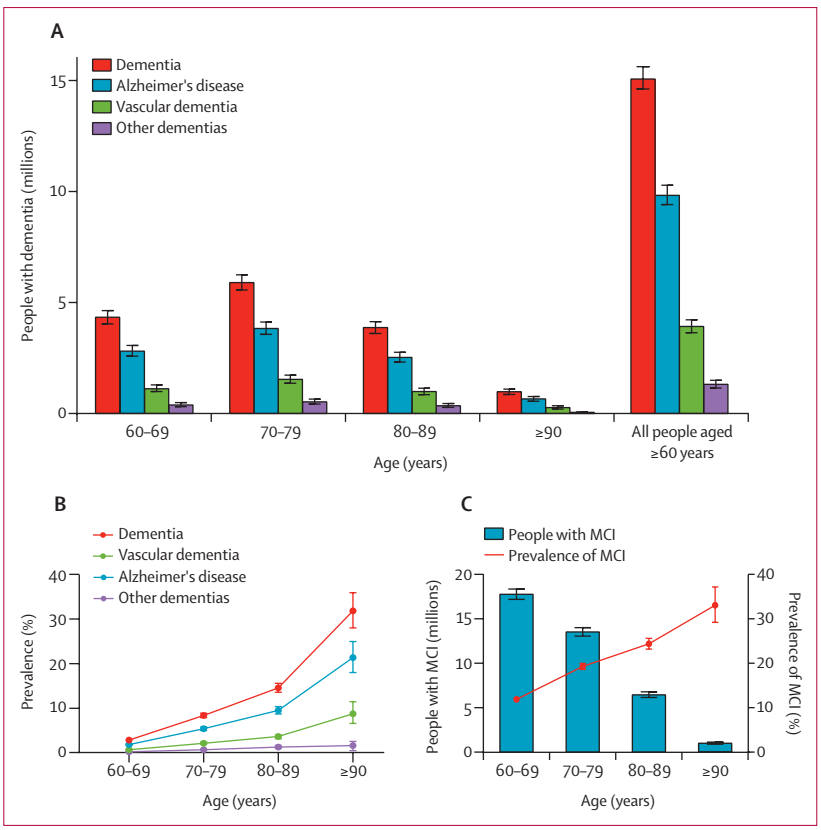

Figure 2: **Estimated prevalence and number of people with dementia and MCI, by age group**
(A) Estimated number of people with dementia, Alzheimer's disease, vascular dementia, and other dementias, by age group. (B) Prevalence of dementia, Alzheimer's disease, vascular dementia, and other dementias, by age group. (C) Prevalence and estimated number of people with MCI, by age group. Error bars represent 95% CIs. MCI=mild cognitive impairment.

See Online for appendix 2

In the 2766 participants with dementia and their family, 1974 (71·4%) had never seen a doctor about their dementia, the reasons for which included the sentiment that "old people tend to be forgetful but it is not a disease", shared by 1285 (65·1%) participants; financial difficulties (389 [19·7%] participants); and shame related to dementia or other reasons (300 [15·2%] participants). With respect to medication, 397 (14·4%) participants with dementia had taken cholinesterase inhibitors, memantine, or nootropics and 187 (6·8%) had received Chinese medicine, indicating that 2182 (78·9%) participants had not received any drug therapy for their dementia. With regard to care, 2321 (83·9%) were cared for by their spouse, 296 (10·7%) by their children, and 149 (5·4%) by a nanny or nurse. 2680 (96·9%) participants lived at home, whereas 86 (3·1%) were in a nursing home. 2083 (75·31%) caregivers of participants with dementia did not know what dementia was or how to manage it. With regard to MCI, 6926 (97·2%) of 7125 individuals had never seen a doctor about their condition nor taken any drugs for it, and

	Dementia (n=2766)		MCI (n=7125)	
	OR (95% CI)	p value	OR (95% CI)	p value
Age, years				
≥90	6·60 (5·24–8·32)	<0·0001	4·70 (3·77–5·87)	<0·0001
80–89	3·90 (3·45–4·40)	<0·0001	2·54 (2·33–2·76)	<0·0001
70–79	2·69 (2·43–2·98)	<0·0001	1·89 (1·77–2·00)	<0·0001
60–69	1 (ref)	..	1 (ref)	..
Sex				
Female	1·43 (1·31–1·56)	<0·0001	1·51 (1·43–1·59)	<0·0001
Male	1 (ref)	..	1 (ref)	..
Parental history of dementia				
Yes	7·20 (5·68–9·12)	<0·0001	1·91 (1·48–2·46)	<0·0001
No	1 (ref)	..	1 (ref)	..
Residence location				
Rural	1·16 (1·06–1·27)	0·0010	1·45 (1·38–1·54)	<0·0001
Urban	1 (ref)	..	1 (ref)	..
Education level, years				
<1	1·55 (1·38–1·73)	<0·0001	3·48 (3·25–3·73)	<0·0001
1–6	1·17 (1·06–1·29)	0·0021	1·48 (1·39–1·58)	<0·0001
>6	1 (ref)	..	1 (ref)	..
Marital status				
Widow	2·59 (2·30–2·90)	<0·0001	1·58 (1·44–1·73)	<0·0001
Divorced or living alone	2·66 (2·29–3·10)	<0·0001	1·74 (1·56–1·95)	<0·0001
Married	1 (ref)	..	1 (ref)	..
Smoker				
Yes	1·85 (1·67–2·04)	<0·0001	1·27 (1·19–1·36)	<0·0001
No	1 (ref)	..	1 (ref)	..
Hypertension				
Yes	1·86 (1·70–2·03)	<0·0001	1·62 (1·54–1·71)	<0·0001
No	1 (ref)	..	1 (ref)	..
Hyperlipidaemia				
Yes	1·87 (1·71–2·05)	<0·0001	1·29 (1·21–1·37)	<0·0001
No	1 (ref)	..	1 (ref)	..
Diabetes				
Yes	2·14 (1·96–2·34)	<0·0001	1·44 (1·35–1·53)	<0·0001
No	1 (ref)	..	1 (ref)	..
Heart disease				
Yes	1·98 (1·73–2·26)	<0·0001	1·17 (1·06–1·30)	0·0023
No	1 (ref)	..	1 (ref)	..
Cerebrovascular disease				
Yes	5·44 (4·95–5·97)	<0·0001	1·49 (1·36–1·62)	<0·0001
No	1 (ref)	..	1 (ref)	..

MCI=mild cognitive impairment. OR=odds ratio.

Table 3: **Adjusted ORs for dementia and MCI**

7070 (99·2%) did not know what MCI was or its relation to dementia.

Discussion

This cross-sectional study included a larger sample than previous studies in China, and used a stringent sampling design and standard methods to guarantee the quality of the survey. As a result, we have provided an accurate report of the prevalence, risk factors, and management of dementia and MCI in China.

Our results showed that the overall prevalence of dementia was 6·0%, representing 15·07 million adults aged 60 years or older with dementia in China, higher than most previous estimates. Two relatively large-sample studies in 2014[23] (10 276 participants) and 2019[24] (32 552 participants) showed that the prevalence of dementia was 5·14% and 5·60%, respectively, for individuals aged 65 years or older. A meta-analysis of 96 observational studies, published in 2018, reported that the overall prevalence of dementia was 5·30% in Chinese people aged 60 years or older.[25] Our results of prevalence distribution showed the lowest prevalence in the south of China and the highest in the west, which is consistent with previous findings.[25] When compared with other countries, our reported prevalence is similar to that in most parts of the world (5·5–7·0%), but is higher than the prevalence in sub-Saharan Africa (5·47%) and central Europe (5·18%), and lower than that reported in Latin America (8·41%) and southeast Asia (7·64%) for adults aged 60 years or older.[26] In east Asian countries, prevalence has been reported as 11·30% in Japan[27] and 9·20% in South Korea[28] for adults aged 65 years or older; however, no data are available for those aged 60 years or older. The differences in global prevalence might be explained by different dementia survival times, environmental risk and genetic factors, and mortality rates preceding the onset of dementia. Moreover, heterogeneity in research methods, including the use of different diagnostic criteria, can affect results. However, our stringent sampling design and larger sample size than most previous domestic and international studies suggests our results might be more accurate. The 2016 Global Burden of Disease study estimated that dementia prevalence in China increased by 5·6% from 1990 to 2016, while global prevalence increased by 1·7%,[29] indicating a faster increase in China and supporting our estimates.

Our results showed 12 risk factors for dementia, three of which are unmodifiable—increasing age, female sex, and parental family history—similar to other previously published studies.[30] Ageing is accompanied by changes in the brain, including general atrophy particularly in the hippocampus, an imbalance of amyloid-β production and degradation, activation of inflammation, and frailty of neurons in areas related to memory.[31] Increased prevalence in women might be due to a reduction of oestrogen and related hormones after menopause, as well as a difference in brain structure.[32] Parental dementia history could add a genetic predisposition for the disease. Importantly, we found nine risk factors that are modifiable, including living in a rural setting, fewer years of education, and living alone. Education duration was shorter in rural than in urban areas, which might explain differences in the prevalence of dementia, supporting the view that longer education might increase the brain's cognition reserve.[33]

Poorer medical support, unhealthy diet, and higher comorbidity rates in rural areas might also contribute to the differences.[23,34] Marital status was also associated with dementia; a terminated marriage or loss of a spouse might result in loneliness and less communication or mutual assistance, which are factors that impair cognition in older adults.[35] Risk factors and comorbidities such as smoking, hypertension, hyperlipidaemia, and heart and cerebrovascular disease were closely related to dementia.[36] Stroke can induce vascular dementia directly and can also trigger Alzheimer's disease pathogenic mechanisms to promote disease onset.[37] We speculate that controlling these modifiable risk factors will allow for better control of dementia.

Notably, we found that 7125 individuals had MCI, accounting for 15·5% of adults in our sample and representing an estimated 38·77 million such patients in China. Most previous studies have reported either dementia or MCI prevalence only. This separation does not represent clinical practice given the spectrum of normal functioning to dementia, and ignores the continuity of cognitive impairment from mild to severe, as well as common shared risk factors. This disease spectrum is important to consider for the development of effective interventions. Knowing common risk factors is also crucial for disease prevention. With respect to MCI prognosis over the course of 3–5 years, a previous study found a third of individuals remained as they were, a third reversed diagnosis to cognitively normal, and a third progressed to dementia,[38] thereby providing a large time window to intervene. The different MCI prognoses also suggest there are protective factors halting disease progression and risk factors facilitating it. We found that MCI and dementia shared similar, modifiable risk factors including rural residence, lower education, living alone, smoking, hypertension, hyperlipidaemia, diabetes, and heart and cerebrovascular disease.[39] At present, there is no medication for the treatment of MCI approved by the US Food and Drug Administration. Designing a primary intervention to halt or slow down MCI progression is key to reducing the overall prevalence of dementia.

Based on the high estimated prevalence of dementia found in this study and its resulting economic burden, establishment of a comprehensive public health system to control and manage dementia is encouraged in China. Under this system, we recommend an anti-dementia national surveillance network[40] that does regular cognitive evaluations of people aged 60 years or older and monitors disease progression and dementia mortality to determine the developmental trajectory of dementia. The first priority should be given to primary prevention strategies[41] that include targeting modifiable risk factors we have identified, particularly for people with MCI. Cognitive training and regular monitoring are equally important for MCI. Furthermore, public awareness of dementia as a disease, and not an inevitable aspect of ageing, should be increased: this can be done through so-called patient clubs—where groups of patients and their family members can discuss experiences with pharmacological and non-pharmacological treatments, and where doctors regularly give lectures on disease education to enhance public awareness—as well as on social media and internet forums. Secondary prevention strategies are also crucial, as most people with dementia remain undiagnosed, inappropriately treated, and cared for by people without training as caregivers for people with dementia. Specific strategies include early diagnosis by trained dementia professionals, pharmacological therapy, and control of comorbidities to enhance patient's quality of life and delay disease progression. We also found geographical differences in dementia prevalence, with a higher prevalence in west China, likely due to underdevelopment. Policies to develop education, economics, and medical care in west China can help to lower dementia prevalence. Greater efforts should be made to delay dementia onset in women, which should include exploring the potential causes, improving female health conditions particularly during pregnancy and menopause, and increasing educational opportunities. Additionally, a dementia nursing system should be integrated to alleviate the burden of care on family and improve patient prognosis. In sum, these public health

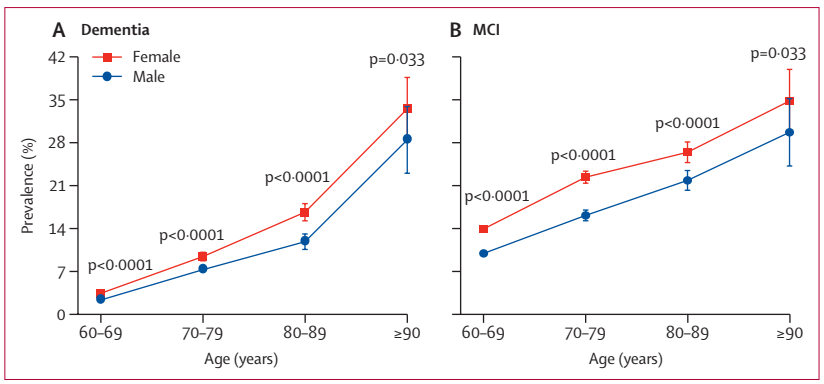

Figure 3: **Prevalence of dementia and MCI by sex and age group**
Error bars represent 95% CIs. MCI=mild cognitive impairment.

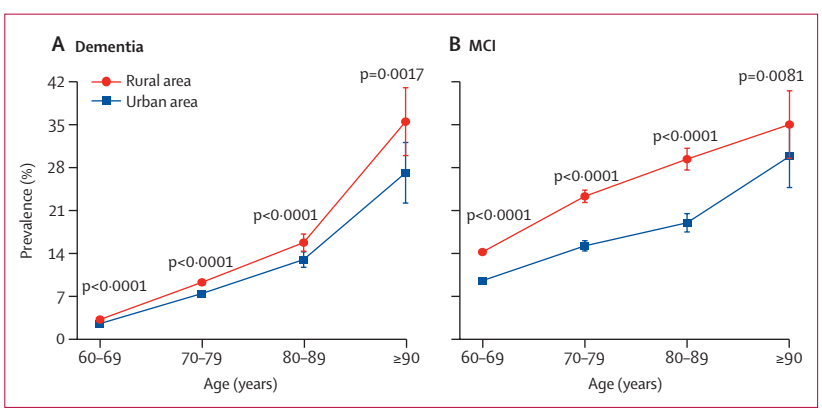

Figure 4: **Prevalence of dementia and MCI by residence and age group**
Error bars represent 95% CIs. MCI=mild cognitive impairment.

strategies form the infrastructure for controlling the prevalence of dementia in China.

This study has some limitations. First, we did not classify MCI according to its aetiology, such as amnestic or vascular origin, due to the vast amount of data that could not be described or analysed in detail. Second, we used modifiable and unmodifiable categories for risk factors, which might be arbitrary and should be tested in future studies. Third, since this is a cross-sectional study, a causal relationship of the identified associated factors could not be established. Fourth, comorbidity classification was based on combinations of conditions (for example, transient ischaemic attack, brain infarction, and brain haemorrhage were combined into a single category of cerebrovascular disease), which might conceal the correlation of specific conditions with dementia. Fifth, it was difficult to make a singular diagnosis when Alzheimer's disease presented with cerebrovascular disease or vice versa. We diagnosed participants with either Alzheimer's disease or vascular dementia diagnosis on the basis of time of onset and number of features associated with the disease. As such, some patients who should have been diagnosed as mixed dementia were missed.[19] However, we had expert panels to discuss these cases. Once individuals with mixed dementia were identified, we incorporated them into the other dementias category. Sixth, the results of the study might be biased as a result of inaccurate past information collected (such as parental dementia history) due to recall problems or low recognition of dementia, misclassification due to subjectivity of certain questions, and exclusion of participants with hearing and vision loss. Finally, despite being a large-scale, multicentre, national study, people from minority ethnic groups might still have been insufficiently represented as most inhabit or reside in specific local regions. This is why we restricted our participants to Han Chinese. However, we do agree that it is of interest for future studies to explore the similarities and differences between Han Chinese and ethnic minorities.

The increasing prevalence of dementia and MCI is becoming an important public health issue in China, as we estimate the overall population of individuals with dementia and MCI exceeds a fifth of all adults aged 60 years or older. We therefore call for authorities to establish stronger anti-dementia strategies to control this disease, which should include setting up a national surveillance network to monitor cognitive changes in older people, controlling MCI risk factors to attenuate dementia onset, improving management of patients with dementia, optimising a dementia nursing system, and increasing public awareness of dementia and MCI. We believe such strategies would effectively reduce the prevalence of dementia in China.

Contributors

JJ, LJ, YD, LC, ZZ, and FangyuL designed the study. JJ supervised the study. LJ, FangyuL, DL, YL*, YL†, MZ, HeZ, and MG did the statistical analysis. JJ, LJ, YD, LC, ZZ, FL, DL, YL*, YL†, MZ, HJ, YSo, YSh, HeZ, MG, CW, YT, BF, DG, FW, AZ, CC, XZ, YY, QY, WW, FangL, SS, HY, CZ, ZLia, YLv, YangL, MK, HuZ, SW, SY, HL, ZLiu, QW, and WQ contributed to the collection, analysis, and interpretation of data and drafted the manuscript. JJ, LJ, FangyuL, DL, YL*, YL†, MZ, HJ, YSo, YSh, and HZ critically revised the manuscript. JJ obtained funding for the study. All authors approved the final version of the manuscript.

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Declaration of interests

We declare no competing interests.

Data sharing

The data analysed during the current study are available from the corresponding author on reasonable request.

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