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Research article

Study on the relationship between hypertension and its comorbidities and dementia in community dwelling older adults in China

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ABSTRACT

Background: China is experiencing an accelerated aging process, with an increasing number of elderly individuals suffering from chronic diseases. The association between hypertension, its comorbidities, and dementia in the elderly requires further investigation.

Objective: To explore the prevalence of hypertension and its comorbidities in community dwelling older adults and their correlation with dementia, providing a reference for dementia prevention.

Methods: This study utilized cross-sectional data from the 2018–2023 China Multicenter Dementia Survey (CMDS), which included demographic, chronic disease, and cognitive function assessments of 14,732 elderly individuals aged 65 and above. A multivariate logistic regression model was applied to analyze the correlation between hypertension, its comorbidities, and dementia.

Results: Among the 14,732 elderly participants, 8,293 (56.3 %) had two or more comorbidities, and 7,786 (52.9 %) had hypertension with comorbidities. Of these, 2,569 (17.4 %) had one comorbidity, 2,064 (14.0 %) had two, 1,018 (6.9 %) had three, and 443 (3.0 %) had four. Dementia was present in 1,111 (7.5 %) participants. After adjusting for confounding factors, multivariate logistic regression revealed that the risk of dementia in individuals with hypertension was 1.516 times higher (95 % CI: 1.014–2.267) compared to those without hypertension. The risks of dementia for individuals with 1–4 comorbidities were 1.879 times (95 % CI: 1.312–2.692), 2.071 times (95 % CI: 1.428–3.004), 2.338 times (95 % CI: 1.612–3.392), and 2.591 times (95 % CI: 1.634–4.108), respectively. The highest risk (2.550 times, 95 % CI: 1.384–4.700) was observed in those with hypertension and cerebrovascular dementia. Stratified by gender and age, dementia risk increased significantly with the number of comorbidities, with statistical significance ($P<0.05$). The highest risks for males and females with hypertension and cerebrovascular dementia were 2.842 (95 % CI: 1.095–7.375) and 2.348 (95 % CI: 1.060–5.203), respectively. For individuals aged under 75 years, the highest risk was associated with hypertension and diabetes (*OR*=2.833, 95 % CI: 1.046–7.675), while for those aged 75 and above, hypertension combined with cerebrovascular disease showed the highest risk (*OR*=2.707, 95 % CI: 1.168–6.273). Among individuals with two comorbidities, hypertension with heart disease and cerebrovascular disease had the highest dementia prevalence (*OR*=3.559, 95 % CI: 1.338–9.468). In those with three comorbidities, hypertension combined with heart disease, cerebrovascular disease, and autonomic dysfunction had the highest dementia prevalence (*OR*=3.881, 95 % CI: 1.736–8.677).

Conclusion: The prevalence of hypertension and its comorbidities is high among the elderly in China, and the risk of dementia is significantly increased in those with hypertension and its comorbidities. This risk shows variations based on age and gender.

Dementia refers to a group of symptoms marked by a severe decline in multiple cognitive domains, which significantly impair an individual's daily functioning.[1] It is estimated that the global number of dementia cases will increase from approximately 57 million in 2019 to 153 million by 2050.[2] Recent data indicate that, in China, there are currently 15.07 million dementia patients aged 60 and above, accounting for a quarter of the global total.[3] This situation places a heavy economic and caregiving burden on both families and society. As a result, the prevention of dementia has become a critical task in public health today.

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The etiology of dementia is complex, and its pathogenesis remains unclear, with no current pharmacological treatments available to cure or alleviate the disease.[4] However, the prodromal phase of dementia can last for decades, which has shifted the focus of prevention from pharmacological interventions to non-pharmacological strategies during the preclinical stage. Previous studies indicated that genetic susceptibility and exposure to risk factors, particularly chronic diseases (such as hypertension, cardiovascular diseases, and metabolic disorders), lead to a series of molecular changes and structural alterations in brain tissue, which are primary causes of cognitive impairment.[5] As a result, preventing chronic diseases in the elderly is widely regarded as an effective strategy to reduce the risk of dementia.[6,7] A recent study published in The Lancet suggests that targeting modifiable risk factors, particularly chronic diseases in older adults, could prevent up to 45 % of dementia cases.[8]

As the population ageing in China, the coexistence of multiple diseases among older adults has become increasingly common. Research using data from three waves (2011, 2013, and 2015) of the China Health and Retirement Longitudinal Study (CHARLS) found that the self-reported prevalence of multimorbidity among individuals aged 50 and above was 42.4 %, while objective assessments revealed an even higher rate of 68.1 %. Among the most prevalent comorbidities, hypertension was the most common, followed by diabetes.

While existing studies have explored the relationship between multimorbidity and all-cause dementia, the findings remain inconclusive, often focusing on metabolic and cardiovascular comorbidities, and neglecting the influence of conditions like insomnia and autonomic nervous system disorders on cognitive health. Therefore, it is critical to examine the burden of comorbidity, particularly hypertension, in relation to a broader range of diseases and its potential impact on dementia.

This study investigated the comorbidity of hypertension and five other chronic diseases associated with cognitive impairment—hypertension, diabetes, heart disease, cerebrovascular disease, insomnia, and autonomic nervous dysfunction—among urban and rural residents aged 65 and older. The research was conducted across eight dementia research centers in China. The goal was to examine the relationship between hypertension, its comorbidities, and dementia, providing evidence for dementia prevention and promoting healthy aging in China.

Materials and methods

Study population

CMDS was conducted from 2018 to 2023.[9] Considered regional dietary differences across China, eight survey centers were selected based on the country's administrative divisions: Northeast (Jilin), North China (Tianjin), East China (Fujian), Central South (Hubei and Hainan), Southwest (Chongqing and Guizhou), and Northwest (Xinjiang). Each center selected 1–2 urban communities (under the jurisdiction of second-level or higher hospitals) and 1–2 rural communities (under the jurisdiction of county-level hospitals) for face-to-face interviews, neuropsychological testing, physical examinations, and clinical assessments.

The inclusion criteria for study participants were as follows: (1) Long-term residents of the target communities; age≥ 65 years old; accessible electronic health records at the local hospitals.

Exclusion criteria: (1)Bedridden or too weak to stand or walk; (2) severe mental disorders (e.g., major depressive disorder, bipolar disorder, schizophrenia) or life-threatening diseases; (3) severe hearing or vision impairments that prevent participation in the survey.

After the study's purpose and procedures were clearly explained to participants, written informed consent was obtained from all of them. This study was approved by the Ethics Committee of Huanhu Hospital in Tianjin (No. 201,940) and the Medical Ethics Committee of Wuhan University of Science and Technology (No. 201,945).

Research methods

The survey was conducted through face-to-face interviews. Participants, either individually or accompanied by a knowledgeable person, took part in a relatively private space for a survey lasting approximately 30 to 40 mins. The survey consisted of four components: a structured questionnaire, physical examination, neuropsychological testing, and blood sample collection.

General information

Face-to-face survey and measurement were conducted by trained investigators (qualified clinical doctors and medical graduate students). The data collected included residence, gender, age, education level, marital status(participants were categorized as "currently married" if their spouse was alive or they had remarried, and as "currently unmarried" if they were divorced, widowed, or had never married), BMI, Smoking(smoking at least one cigarette daily for over six months, either continuously or cumulatively), alcohol consumption(drinking spirits at least once per week, with each consumption exceeding 25 g), social activity frequency("rarely" for less than once per week, "occasionally" for 1–2 times per week, and "frequently" for 3 or more times per week).

Disease conditions

The disease conditions assessed in this study included hypertension, diabetes, heart disease (hypertensive heart disease and coronary atherosclerotic heart disease), and cerebrovascular diseases (cerebral hemorrhage and cerebral infarction). These conditions were self-reported by elderly participants and were either diagnosed by secondary or tertiary medical institutions or recorded in hospital electronic health records.

Hypertension was diagnosed based on systolic blood pressure≥140 mmHg and/or diastolic blood pressure≥90 mmHg. Diabetes was diagnosed when fasting blood glucose levels≥7.0 mmol/L. Insomnia was assessed using the Athens Insomnia Scale (AIS),[10] which consists of 8 items. A total score > 6 defined the presence of insomnia.

The severity of autonomic nervous symptoms was assessed using the COMPASS-31 scale. This scale evaluates six domains over the past year: orthostatic intolerance, vascular tone regulation, glandular secretion, gastrointestinal motility, bladder function, and pupillary reflex, comprising 31 items in total. Higher scores indicate more severe autonomic dysfunction. According to studies by Greco C[11] and Zhang Zhiyin,[12] a score>19.5 was used as the threshold for diagnosing autonomic nervous system dysfunction.

Cognitive function screening

A series of standardized neuropsychological assessment scales were used to evaluate the participants' cognitive function and activities of daily living.[13]

The Mini-Mental State Examination (MMSE)[14] was used to assess overall cognitive function. It consists of 30 items, including time-space orientation, memory, calculation, language, attention, and executive abilities. The total score is 30 points, with lower scores indicating poorer cognitive function.

The Activity of Daily Living Scale (ADL)[15] was used to assess daily living abilities. It includes 20 items, covering both basic self-care activities and instrumental activities of daily living. Scores range from 20 to 80 points, with higher scores indicating greater impairment in daily living abilities.

The Neuropsychiatric Inventory (NPI) assesses various psychiatric and behavioral symptoms, including emotional symptoms, psychotic symptoms, disinhibition, and hyperactivity. The scale includes 12 types of symptoms, providing insight into the participant's emotional and mental well-being.

For the diagnosis of dementia, this study followed the criteria outlined by Petersen et al.[16] and the "2018 Chinese Dementia and Cognitive

Disorder Diagnosis and Treatment Guidelines".[17,18] The diagnostic criteria for dementia include: (1)Cognitive impairment reported by an informant (family member or physician); (2)Objective cognitive impairment (MMSE: illiterate group≤17, primary school group≤20, middle school or higher group≤24); (3)Impaired daily living ability (ADL>23 for participants under 75 years old; ADL >25 for participants aged 75 and older); (4)Psychobehavioral symptoms that cannot be explained by delirium or other mental illness.

This comprehensive screening approach ensured accurate assessment of participants' cognitive status, enabling reliable dementia diagnosis.

Quality control

Before the survey, a pilot study was conducted to standardize the survey procedures and verbal instructions for the assessment scales across all research centers. All investigators had clinical medical backgrounds and underwent three rounds of training, followed by two assessments one week after the training. Each research center established a quality control team responsible for daily random checks and auditing of survey quality. Dementia diagnoses were made by two neurologists who independently assessed the scale scores and symptom presentations. In case of disagreement, a third expert was consulted to reach a consensus. On the data collection day, EpiData 3.0 was used for parallel data entry by two investigators. Data comparisons and validation were performed to ensure accuracy. This rigorous process ensured the reliability and validity of the data throughout the study.

Statistical analysis

Data were analyzed using SPSS 26.0 and R 4.1.3 software. Counting data are presented as frequencies and percentages, while measurement data are described by means and standard deviations (SD). Differences between groups were assessed using Chi-square (χ^2) tests or T-tests, as appropriate. Multivariate logistic regression was used to evaluate the association between hypertension and the number of co-occurring diseases, as well as the association between hypertension with specific diseases and dementia. Covariates such as residence, gender, age, education level, marital status, BMI, smoking, alcohol consumption, and social activity were included in the analysis. We also conducted age- and gender-stratified analyses. For the multivariate logistic regression analysis of hypertension and comorbidities in relation to dementia, we applied the rule of five for sample size (at least five times the number of independent variables). This ensured sufficient statistical power and model accuracy, especially considering that the sample size decreases with more comorbiditie.[19] The significance level was set at α= 0.05.

Results

General information, chronic diseases, and prevalence of dementia

This study included 14,732 participants aged 65 and above. Among them, 7108 (48.2 %) were from rural areas, 8161 (55.4 %) were women, and 4593 (31.2 %) were aged 75 or older. Regarding educational background, 8001 (54.3 %) had ≤6 years of formal education, and 3724 (25.3 %) were without a spouse. The prevalence of chronic diseases among the study population was as follows: 7786 individuals (52.9 %) had hypertension, 2376 individuals (16.1 %) had diabetes, 2407 individuals (16.3 %) had heart disease, 2462 individuals (16.7 %) had cerebrovascular diseases, 5557 individuals (37.7 %) had insomnia, 6256 individuals (42.5 %) had autonomic dysfunction.

The proportion of participants with comorbidities was 8293 (56.3 %). Of these, 7786 individuals (52.9 %) had hypertension and other comorbidities, including 2569 individuals (17.4 %) with hypertension and one comorbidity, 2064 individuals (14.0 %) had hypertension and two comorbidities, 1018 individuals (6.9 %) had hypertension and three comorbidities, 443 individuals (3.0 %) had hypertension and four or more comorbidities. The detailed data are presented in Tables 1 and 2.

In the study population of 14,732 elderly individuals, 1111 (7.5 %) were diagnosed with dementia. Significant differences in dementia prevalence were observed based on residence, gender, age, educational level, marital status, smoking, social activity, hypertension, heart disease, cerebrovascular disease, autonomic dysfunction, and comorbidity status (P<0.05). Additionally, BMI differed significantly between the dementia and non-dementia groups (P<0.05). These results are shown in Table 1.

Hypertension comorbidity and its association with dementia in the elderly

A multivariate logistic regression analysis was conducted, with dementia status as the dependent variable and number of hypertension comorbidities, as well as hypertension with specific comorbid diseases, as independent variables. The analysis controlled for residence, gender, age, education level, marital status, BMI, smoking, alcohol consumption, and social activity.

The results showed that compared to elderly individuals without comorbidities, those with hypertension alone had a 1.516 times higher risk of developing dementia (P=0.042). Among individuals with hypertension and comorbidities of diabetes, heart disease, cerebrovascular disease, insomnia, and autonomic dysfunction, the odds ratios (OR) for dementia risk were: 1 disease: OR=1.879 (P< 0.05); 2 diseases: OR=2.071 (P<0.05); 3 diseases: OR=2.338 (P<0.05)

4 or more diseases: OR=2.591 (P < 0.05). Further analysis of specific diseases in hypertension comorbidities showed that elderly individuals with hypertension and diabetes, heart disease, cerebrovascular disease, or autonomic dysfunction had 2.128, 2.248, 2.550, and 1.792 times higher risk of developing dementia, respectively, compared to those without these conditions (P<0.05). These results are detailed in Table 2.

Association of hypertension comorbidity and dementia risk by gender and age

A further stratified analysis by gender and age was conducted to examine the relationship between number of hypertension comorbidities and dementia. The results revealed that as the number of hypertension comorbidities increased, the risk of dementia also significantly increased (P<0.05). Male elderly individuals with hypertension and cerebrovascular disease had a higher risk of developing dementia compared to those without any of the 6 diseases (OR=2.842, P=0.032). Female elderly individuals with hypertension and cerebrovascular disease (OR=2.348, P=0.036) and those with hypertension and autonomic dysfunction (OR=2.104, P=0.015) showed an increased risk of dementia. For elderly individuals aged <75 years, those with hypertension and diabetes had an increased risk of dementia (OR=2.833, P = 0.041). For elderly individuals aged≥75 years, hypertension combined with heart disease (OR=2.571, P=0.022) and hypertension with cerebrovascular disease (OR=2.707, P=0.020) were associated with a higher risk of dementia. These findings are illustrated in Fig. 1.

Association between >2 hypertension comorbidities and dementia risk

A multivariate logistic regression analysis was conducted with dementia as the dependent variable and hypertension comorbidities with multiple specific chronic diseases as the independent variable. The analysis controlled for variables such as residence, gender, age, education level, marital status, BMI, smoking, alcohol consumption, and social activity. The results revealed the following key findings: Among individuals without comorbidities, those with hypertension and comorbidity of two diseases had the highest dementia prevalence when hypertension, heart disease, and cerebrovascular disease coexisted (OR=3.559,

Table 1
Comparison of dementia prevalence in community-dwelling elderly aged 65 and above with different basic characteristics.

Characteristic	Participants (n=14,732)	Non-dementia (n=13,621)	Dementia (n=1111)	χ^2/t value	*P* value
Residence				427.046	<0.001
Rural	7 108 (48.2)	6 241 (45.8)	867 (78.0)		
Urban	7 624 (51.8)	7 380 (54.2)	244 (22.0)		
Gender				101.551	<0.001
Male	6 571 (44.6)	6 236 (45.8)	335 (30.2)		
Female	8 161 (55.4)	7 385 (54.2)	776 (69.8)		
Age (years)				367.545	<0.001
<75	10 139 (68.8)	9 659 (70.9)	480 (43.2)		
≥75	4 593 (31.2)	3 962 (29.1)	631 (56.8)		
Education level (years)				1319.890	<0.001
<1	3 356 (22.8)	2 629 (19.3)	727 (65.4)		
1–6	4 645 (31.5)	4 368 (32.1)	277 (24.9)		
7–12	5 273 (35.8)	5 178 (38.0)	95 (8.6)		
>12	1 458 (9.9)	1 446 (10.6)	12 (1.1)		
Marital status				289.881	<0.001
No spouse	3 724 (25.3)	3 206 (23.5)	518 (46.6)		
With spouse	11 008 (74.7)	10 415 (76.5)	593 (53.4)		
BMI (kg/m^2, $\bar{x}$±SD) [a]	23.6±3.5	23.6±3.4	23.1±3.9	4.000[b]	<0.001
Smoking[a]				46.743	<0.001
No	10 724 (72.9)	9 821 (72.1)	903 (81.6)		
Yes	3 996 (27.1)	3 793 (27.9)	203 (18.4)		
Alcohol consumption [a]				0.752	0.386
No	10 866 (73.9)	10 037 (73.8)	829 (75.0)		
Yes	3 847 (26.1)	3 570 (26.2)	277 (25.0)		
Social activity [a]				501.346	<0.001
Rarely	2 512 (17.3)	2 058 (15.3)	454 (42.1)		
Occasionally	7 094 (48.9)	6 705 (50.0)	389 (36.1)		
Frequently	4 891 (33.7)	4 656 (34.7)	235 (21.8)		
Diseases					
Hypertension (Yes)	7 786 (52.9)	7 041 (51.7)	745 (67.1)	97.313	<0.001
Diabetes (Yes)	2 376 (16.1)	2 181 (16.0)	195 (17.6)	1.800	0.180
Heart disease (Yes)	2 407 (16.3)	2 149 (15.8)	258 (23.2)	41.656	<0.001
Cerebrovascular disease (Yes)	2 462 (16.7)	2 205 (16.2)	257 (23.1)	35.586	<0.001
Insomnia (Yes)	5 557 (37.7)	5 125 (37.6)	432 (38.9)	0.692	0.405
Autonomic dysfunction (Yes)	6 256 (42.5)	5 729 (42.1)	527 (47.4)	12.145	<0.001
Comorbidity				51.956	<0.001
No (0–1 conditions)	6 439 (43.7)	6 068 (44.5)	371 (33.4)		
Yes (≥2 conditions)	8 293 (56.3)	7 553 (55.5)	740 (66.6)		

Notes: [a] indicates that some data are missing, and the missing rate is <20 %; [b] indicates the t-value.

Table 2
Association between hypertension, comorbidity types, specific disease comorbidity, and dementia in the general population.

Hypertension and number of comorbidities				Hypertension and specific disease comorbidity			
Disease	Cases	*OR* (95 % CI)	*P* value	Disease	Cases	*OR* (95 % CI)	*P* value
No disease	2341	1.000 (ref.)		No disease	2341	1.000 (ref.)	
H	1692	1.516 (1.014–2.267)	0.042	H+D	286	2.128 (1.066–4.249)	0.032
H+X	2569	1.879 (1.312–2.692)	0.001	H+HD	414	2.248 (1.171–4.316)	0.015
H+2X	2064	2.071 (1.428–3.004)	<0.001	H+C	270	2.550 (1.384–4.700)	0.003
H+3X	1018	2.338 (1.612–3.392)	<0.001	H + I	711	1.350 (0.792–2.300)	0.270
H+≥4X	443	2.591 (1.634–4.108)	<0.001	H + A	885	1.792 (1.142–2.811)	0.011

Notes: *OR* is the odds ratio, and *CI* is the confidence interval. H (Hypertension), D (Diabetes), HD (Heart Disease), C (Cerebrovascular Disease), I (Insomnia), A (Autonomic Dysfunction); X refers to any one of the following diseases: Diabetes, Heart Disease, Cerebrovascular Disease, Insomnia, or Autonomic Dysfunction. The *P* value and *OR* value are statistics adjusted for variables including residence, gender, age, education level, marital status, BMI, smoking, drinking, and social activity.

P=0.011). The next highest prevalence was observed in individuals with hypertension, diabetes, and cerebrovascular disease (*OR*=3.159, *P*=0.026).

In the group with hypertension and comorbidity of three diseases, the highest dementia prevalence was found in individuals with hypertension, heart disease, cerebrovascular disease, and autonomic dysfunction (*OR*=3.881, *P*=0.001). This was followed by those with hypertension, diabetes, cerebrovascular disease, and autonomic dysfunction (*OR*=3.024, *P*=0.041). For individuals with hypertension and comorbidity of four diseases, the highest dementia prevalence was observed in those with hypertension, heart disease, cerebrovascular disease, insomnia, and autonomic dysfunction (*OR*=2.850, *P*=0.002). When all six diseases (hypertension, diabetes, heart disease, cerebrovascular disease, insomnia, and autonomic dysfunction) coexisted, the risk of dementia increased significantly (*OR*=3.266, *P*=0.010). These results are summarized in Table 3.

Discussion

This study, conducted across eight centers in both rural and urban communities in China, investigated elderly individuals aged 65 and above. The results show the prevalence of chronic diseases self-reported

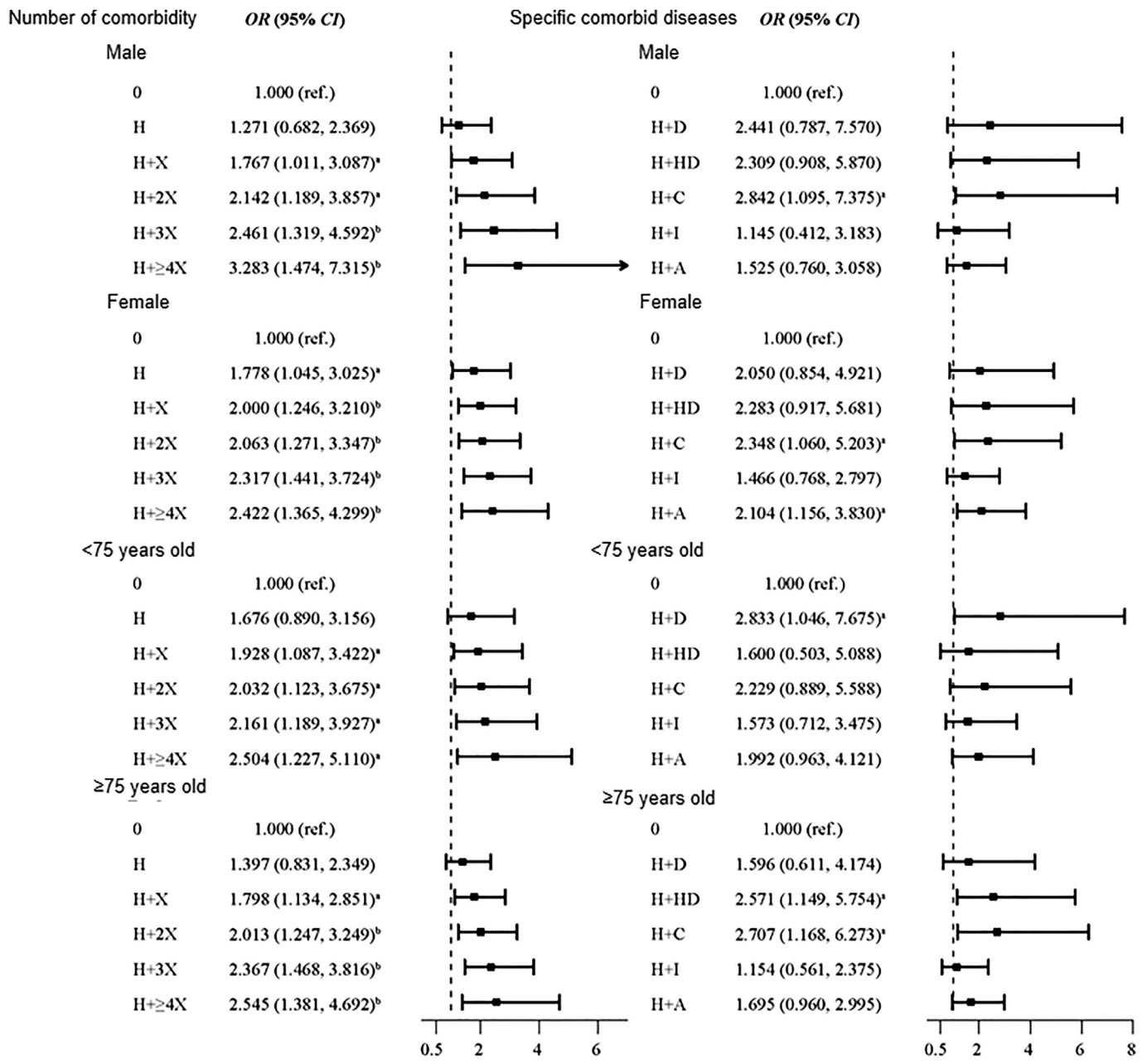

Fig. 1. Multivariate Logistic regression analysis of hypertension and dementia in patients with hypertension and its comorbidities of different genders and ages
Notes: *OR* is the odds ratio, and *CI* is the confidence interval. H (Hypertension), D (Diabetes), HD (Heart Disease), C (Cerebrovascular Disease), I (Insomnia), A (Autonomic Dysfunction); X refers to any one of the following diseases: Diabetes, Heart Disease, Cerebrovascular Disease, Insomnia, or Autonomic Dysfunction. The model is adjusted for residence, gender, age, education level, marital status, BMI, smoking, drinking, and social activity. [a] indicates $P < 0.05$, and [b] indicates $P < 0.01$.

by the elderly, with the following ranking: hypertension (52.9 %), autonomic dysfunction (42.5 %), insomnia (37.7 %), cerebrovascular diseases (16.7 %), ischemic heart disease (16.3 %), and diabetes (16.1 %). The overall comorbidity rate was 56.3 %, with hypertension comorbidity accounting for 41.4 %. Additionally, the prevalence of dementia was 7.5 %.

These findings align with recent cohort studies in China. For example, the CHARLS reported a hypertension prevalence of 46.46 % among individuals aged 60 and above. This study also found that the prevalence of chronic diseases in the elderly increases with age, and comorbidity patterns differ across age groups.[20] Furthermore, a meta-analysis of chronic comorbidities among the Chinese middle-aged and elderly population (≥45 years), conducted between 2010 and 2019, indicated a comorbidity rate of 41 %.[21] Notably, in hospitalized patients, the prevalence of comorbidities is particularly high, with the combination of heart disease and hypertension being the most common.[22]

The dementia prevalence observed in our study (7.5 %) aligns with findings from several other cohort studies on dementia in China.[23-25] Differences in dementia prevalence rates across studies may be attributed to variations in research methodologies, participant age, and the urban-rural distribution of the populations involved. The observed discrepancies in chronic diseases and dementia prevalence may also reflect differences in sample size, demographic characteristics, and regional healthcare access.

Our study underscores the role of hypertension and its comorbidities in increasing the risk of dementia. Notably, elderly individuals with hy-

Table 3
Multivariate Logistic regression analysis of hypertension with multiple specific comorbidities and dementia.

Hypertension with multiple comorbidities	Cases	*B* value	*SE* value	Waldχ2 value	*P* value	*OR* value (95 %*CI*)
0 (No disease as reference group)	2341					1.000 (ref.)
H+D+HD	83	0.988	0.588	2.823	0.093	2.685 (0.848~8.499)
H+D+C	76	1.150	0.517	4.944	0.026	3.159 (1.146~8.705)
H+D+I	140	0.255	0.561	0.207	0.649	1.290 (0.430~3.871)
H+D+A	181	0.650	0.452	2.069	0.150	1.916 (0.790~4.647)
H+HD+C	79	1.270	0.499	6.469	0.011	3.559 (1.338~9.468)
H+HD+I	146	0.618	0.492	1.577	0.209	1.856 (0.707~4.871)
H+HD+A	212	1.119	0.383	8.527	0.003	3.062 (1.445~6.490)
H+C+I	173	0.930	0.404	5.290	0.021	2.534 (1.147~5.595)
H+C+A	235	1.033	0.397	6.778	0.009	2.809 (1.291~6.111)
H+I+A	742	0.527	0.242	4.741	0.029	1.693 (1.054~2.720)
H+D+HD+I	63	0.914	0.571	2.561	0.110	2.494 (0.814~7.636)
H+D+HD+A	88	0.804	0.421	3.649	0.056	2.234 (0.979~5.098)
H+D+C+A	62	1.106	0.541	4.183	0.041	3.024 (1.047~8.730)
H+D+I+A	176	0.881	0.325	7.352	0.007	2.413 (1.277~4.562)
H+HD+C+I	76	1.033	0.401	6.647	0.010	2.810 (1.281~6.165)
H+HD+C+A	81	1.356	0.411	10.912	0.001	3.881 (1.736~8.677)
H+HD+I+A	202	0.613	0.283	4.669	0.031	1.845 (1.059~3.216)
H+C+I+A	189	1.007	0.285	12.473	<0.001	2.739 (1.566~4.790)
H+D+HD+I+A	91	0.959	0.445	4.655	0.031	2.609 (1.092~6.235)
H+D+C+I+A	76	0.789	0.478	2.721	0.099	2.200 (0.862~5.614)
H+HD+C+I+A	131	1.047	0.339	9.553	0.002	2.850 (1.467~5.536)
H+D+HD+C+I+A	63	1.184	0.462	6.555	0.010	3.266 (1.320~8.084)

Note: *OR* is the odds ratio, and *CI* is the confidence interval. Disease abbreviations: H (Hypertension), D (Diabetes), HD (Heart Disease), C (Cerebrovascular Disease), I (Insomnia), A (Autonomic Dysfunction). a The model is adjusted for residence, gender, age, education level, marital status, BMI, smoking, alcohol consumption, and social activity. Based on the principle that the sample size for regression analysis should be 5–10 times the number of independent variables, the number of people included in the analysis is greater than 50 cases.

pertension and additional chronic conditions exhibited a higher risk of dementia. This finding supports the hypothesis that comorbidities accelerate cognitive decline in older adults, emphasizing the importance of managing multiple chronic conditions in elderly populations to reduce the dementia burden. Multiple lines of evidence confirm that hypertension is a significant risk factor for all-cause dementia. Large meta-analyses, such as those by Tully et al.[26] and Ding et al.,[27] demonstrate that individuals with controlled hypertension have a lower risk of developing Alzheimer's disease and dementia compared to those with uncontrolled hypertension. This suggests that effectively managing hypertension could be crucial in reducing dementia risk.

The association between hypertension and dementia risk is influenced by factors such as the age of onset, duration, severity, and changes in blood pressure during later years. For example, a 26-year cohort study involving 1440 participants by McGrath et al.[28] found that consistent high blood pressure during old age was associated with a significantly higher risk of all-cause dementia, compared to those whose blood pressure normalized. Furthermore, a significant decrease in blood pressure in late life was linked to a higher risk of dementia, indicating that the relationship between late-life blood pressure changes and dementia is more complex than previously thought.

Our study found that elderly individuals with hypertension alone had a 1.516 times higher risk of developing dementia compared to those without any chronic diseases. Notably, women exhibited a higher risk (1.778 times) than men. Although the overall prevalence of dementia increased with age and hypertension, no significant associations were found in other age groups or among men. The findings of this study contribute to the evidence emphasizing the importance of managing hypertension, particularly in older adults, to not only protect cardiovascular health but also reduce the risk of cognitive impairment and dementia. As hypertension is a modifiable risk factor, this presents a clear public health opportunity to target hypertension control as a preventive measure against dementia in aging populations. Further research is needed to investigate the mechanisms underlying this association, including how the timing and treatment of hypertension influence cognitive aging.

Comorbidity as a risk factor for dementia has been extensively explored, though the results are highly heterogeneous, complicating the interpretation of these findings. One key focus area in dementia research, particularly in the context of chronic diseases, is cerebral small vessel disease (CSVD). CSVD is implicated in 25 % of vascular cereblral infarction events and 30 % of lacunar infarction. Although CSVD-related lesions may not present with acute symptoms, they progressively worsen brain damage, white matter changes, and contribute to approximately 45 % of dementia cases. Age, chronic diseases, infections, and genetic factors are known to be risk factors for CSVD.[29]

The pathogenic mechanisms behind CSVD remain unclear but are generally believed to involve chronic hypoperfusion, brain inflammation, and altered oxidative stress responses, leading to endothelial activation and tissue remodeling.[30] These processes disrupt vascular supply to the brain, contributing to cognitive decline. Zhao et al.[31] analyzed 14 longitudinal cohort studies, revealing that cardiometabolic multimorbidity (e.g., hypertension, hyperlipidemia, diabetes, stroke, and heart disease) is linked to lower cognitive function and accelerated cognitive decline. Similarly, Akushevich et al.,[32] using data from the HRS cohort, identified chronic comorbidities (such as hypertension, brain injury, and cerebrovascular diseases) and genetic factors (specifically the APOE4 gene) as strong predictors of dementia. Notably, comorbidity was found to have predictive power comparable to genetic susceptibility. Additionally, Hainsworth et al.[33] confirmed the significance of CSVD lesions through the ROSMAP cohort, which included over 1700 donated brains. The study found that CSVD was closely associated with age and hypertension, with >50 % of individuals aged 65 or older showing small vessel disease, which was neuropathologically manifest as diffuse white matter lesions, small ischemic lesions, and subcortical microbleeds. These findings highlight the increased dementia risk in older adults with hypertension.

Our study aligns with these findings, demonstrating that the risk of dementia increases significantly as the number of comorbid conditions rises in individuals with hypertension. Specifically, dementia risk was found to be 1.879 times higher for those with one comorbid disease, 2.071 times higher for two comorbid diseases, 2.338 times higher for three comorbid diseases, and 2.591 times higher for individuals with four or more comorbidities ($P < 0.05$). This suggests that comorbid conditions exert vascular and functional effects that may exacerbate hypertensive CSVD, thereby increasing the risk of dementia. However, an

interesting observation in our study was that hypertension comorbid with insomnia did not significantly increase the risk of dementia. This may be explained by the bidirectional relationship between insomnia and dementia, as individuals with dementia often report less insomnia, a finding supported by other studies.[34] Furthermore, the mechanisms linking insomnia and dementia remain complex and may vary depending on the type of dementia or comorbidities involved.

This study also identified significant gender and age differences in the relationship between comorbidities and dementia risk. Specifically, individuals with both hypertension and cerebrovascular disease had the highest dementia risk, regardless of gender. In women, hypertension combined with autonomic dysfunction was associated with an increased dementia risk. Among individuals aged <75 years, those with both hypertension and diabetes showed a higher risk of dementia, whereas in those aged 75 years and older, the combination of hypertension with heart disease and cerebrovascular disease significantly increased dementia risk.

These findings are consistent with the limited existing research on gender and age differences in the relationship between chronic diseases and dementia. In the ROSMAP cohort, studies have shown that arteriosclerosis (a feature of CSVD) is significantly correlated with the degree of hypertension and age, with a higher prevalence of CSVD in women.[35] Furthermore, Levine et al.[36] demonstrated that the increased risk of dementia in older age is associated with comorbidities, such as hypertension, that manifest in midlife. This suggests that early vascular changes predispose individuals to cognitive decline later in life.

The pathology of CSVD, which involves vascular changes in the brain, is heterogeneous. Its impact on cognitive function depends on various factors, such as the severity of comorbidities (e.g., hypertension, diabetes), the type and location of CSVD lesions, and their proximity to critical brain regions essential for cognitive function.[37] Lesions in these regions are particularly likely to cause cognitive impairment. Whether CSVD leads to dementia also depends on individual brain resilience and plasticity, which are influenced by prior brain conditions, cognitive reserve, age, and immune responses triggered by comorbidities, resulting in chronic inflammation.

The results of this study further reflect the complexity of these interactions. Among individuals with hypertension and two comorbidities, the highest prevalence of dementia was observed in those with hypertension and heart disease (OR=3.559). Similarly, among those with hypertension and three comorbidities, the highest dementia rates were found in individuals with hypertension combined with heart disease, cerebrovascular disease, and autonomic dysfunction (OR=3.881). While other combinations of comorbidities had ORs greater than 1, statistical significance was not reached due to the limited sample size.

The innovation of this study lies in extending the traditional focus on the impact of cardiovascular chronic diseases on dementia by integrating insomnia and autonomic dysfunction. These conditions, both prevalent in the elderly, are associated with small vessel dysregulation. In existing research on multimorbidity among older adults, autonomic dysfunction is often overlooked, primarily due to limited objective measurement methods. Assessing cardiac autonomic dysfunction involves multiple mechanisms, complex etiologies, and potential bidirectional causal relationships between factors, complicating its clinical application. Recent studies have highlighted a high prevalence of autonomic dysfunction in patients with all-cause dementia. Thus, recognizing autonomic dysfunction through symptoms not only aids in understanding its relationship with dementia but also improves treatment and care for dementia patients.

Conclusion

This study investigated the association between hypertension, comorbidities, and dementia based on data from a community population aged 65 and above. However, there are certain limitations: the study is cross-sectional, so it cannot establish causality between risk factors and dementia; self-reported variables may introduce bias into the research; and the study only considered six diseases, neglecting the potential impact of other possible conditions. Future research, with the addition of follow-up data, will further explore the associations and mediating mechanisms between chronic diseases and dementia.

As China continues to age, the prevalence of hypertension and related chronic diseases among older adults poses a significant risk for dementia and warrants attention. Addressing and mitigating these risks is an effective approach to dementia prevention and control. Given the strong connection between comorbidities and dementia, regular health check-ups and chronic disease screening for older adults are crucial for early disease detection. Community health education can help older adults gain accurate medical knowledge and improve self-management. Standardizing the treatment of chronic diseases can help reverse or delay disease progression, while promoting a healthy lifestyle (such as proper diet, physical exercise, and intellectual leisure activities) benefits the physical health of the elderly.

Declarations

Not applicable.

Authors' contributions

Conceptualization, N.Q.; Methodology, N.Q. and C.G.; Data curation, S.D. and L.J.; Formal analysis, N.Q.; Funding acquisition, X.L.; Project administration, C.G.; Resources, C.G.; Supervision, X.L.; Validation, Z.L.; Writing—original draft, N.Q.; Writing—review and editing,N.Q. and C.G. All authors have read and agreed to the published version of the manuscript.

Ethical approval and consent to participate

The study received approval from Tianjin Huanhu Hospital Ethics Committee (No.201940).

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

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Authors' other information

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Declaration of competing interest

All authors declare that there are no competing interests.

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