Analysis of Risk Factors for Cognitive Dysfunction in Disabled Elderly Patients in Chengdu, China

Background: With the aging population comes an increase in functional disability that leads to dependency and institutionalization, as well as social, medical, and economic challenges. This study aimed to classify and assess the factors affecting cognitive deficits in disabled elderly people.

Material/Methods: Disabled patients ≥60 years old were assessed by face-to-face cross-sectional surveys, which were conducted using advanced peer-to-peer software. The ability to perform daily life tasks was assessed using the Modified Barthel Index. Cognitive function was evaluated with the Mini-cognitive assessment instrument. Using these surveys, 9471 individuals were included in this study. The rank-sum test was used to investigate differences between groups. Disordered multi-class logistic regression was used to correct related confounding factors for multivariate analysis.

Results: The ratios of normal cognitive function, cognitive impairment, and dementia were 3.71%, 38.59%, and 57.70%, respectively. The univariate analysis and multivariate analysis showed that older individuals (≥80 years), women, illiterate individuals, and lonely persons were more prone to dementia. Moreover, a history of hypertension, diabetes, osteoporosis, and fractures were significantly associated with dementia.

Conclusions: The proportion of dementia in the elderly disabled patients is very high (57.7%) in Chengdu City. Age (≥80 years), female sex, education level (illiterate individuals), living conditions, and chronic disease were closely correlated with cognitive functions.

MeSH Keywords: Aging • Chronic Disease • Cognition • Disabled Persons

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Background

China is an aging society in which elderly individuals constituted 11% of the total population in 2017 [1]. With population aging comes an increase in functional disability that leads to dependency, institutionalization, and social, medical, and economic concerns [1–3]. An estimated 33 million Chinese individuals over the age of 60 years have mental or physical disabilities, and almost one-third are dependent on others for assistance [3]. The importance of mental health disorders is highlighted by the WHO “mental health action plan 2013–2020”, which stressed the importance of promoting mental health and well-being to prevent mental disorders [4]. The major mental disability is dementia, defined as a decline in mental ability that affects memory, thinking, concentration, and perception [5]. Dementia is the result of neuronal cell death in brain areas that control thought processes. According to recent Alzheimer’s disease (AD) international reports, approximately 44.4 million people were living with dementia in China in 2013 and this number is estimated to reach 75.6 million by 2030 [6], and the costs associated with mental disorders are increasing steadily [1,7]. Given the rapid growth in the elderly population in China, mental health-care costs will pose a challenge to Chinese healthcare systems and the Chinese economy.

For many years, it has been known that mental health disorders are more prevalent in people with physical and learning disabilities, but research in this area remains sparse [2,5,8–11]. Cognitive impairment leads to a loss of independence in daily activities, which accelerates institutionalization, disability, and illness [3,12,13]. Despite this increased prevalence, data regarding cognitive dysfunction in the elderly disabled population in China remains limited. The aim of this study was to investigate the levels of cognitive dysfunction in the Chinese population and discover related factors in disabled elderly individuals through population-based cross-sectional surveys of elderly individuals living in Chengdu, China.

Material and Methods

Study design

Face-to-face cross-sectional surveys were conducted using advanced peer-to-peer (APP) software. The ability to perform daily life tasks was assessed using the Modified Barthel Index [14]. Cognitive function was evaluated with the Mini-cognitive assessment instrument (Mini-cog) [15]. We collected data on common diseases and living conditions. Assessments were performed using a centralized approach to homes, the community, and hospitals.

This study was approved by the Biomedical Ethics Committee of West China Hospital, Sichuan University (approval No. 2017 Trial (303)).

Participants

Inclusion criteria were individuals over age of 60 years who had been disabled for at least 6 months. Exclusion criteria included psychiatric patients, individuals admitted to hospital due to acute illness during the assessment period, and refusal to undergo an assessment. The assessment team consisted of 1070 assessors that included rehabilitation doctors and clinicians. The assessors participated in a training course for senior comprehensive assessment at the National Clinical Research Center of Geriatrics. After the training course, doctors and clinicians were tested via theoretical examination and practical assessment. For the trainees who are qualified in theory and practice, the Chinese Medical Association and National Clinical Research Center of Geriatrics would issue the elderly comprehensive evaluation certificate. The above examination and comprehensive evaluation certificate guarantee the reliability of data.

Written informed consent was obtained from all subjects, and human data included in this article were obtained in compliance with the Helsinki Declaration.

Mini-cog test

In this study, the cognition of patients was evaluated using the Mini-cog test as described in a previous study [16]. The Mini-cog test mainly includes a 3-word recall task for evaluating memory and clock drawing test for assessing the cognitions (language, cognitive functions, visual/motor capability, and executive functions). The standard Mini-cog scoring system involves the score from 0 to 3 points for word recall task representing correct recall for 0 words, 1 word, 2 words, and 3 words, respectively. The clock drawing test results were scored as “abnormal” or “normal”. In the Mini-cog scoring system, 0 points combining abnormal clock drawing test represents dementia, 3 points represents no cognitive impairment, and 1 point or 2 points represents cognitive impairment (if also with abnormal clock drawing test) or no cognitive impairment (if with normal clock drawing test).

Data analysis

Data were analyzed using IBM SPSS (Version 21.0, SPSS, Inc., Chicago, IL, USA). The rank-sum test was used to investigate differences between groups. Disordered multi-class logistic regression was used to correct the related confounding factors for multivariate analysis. A p < 0.05 was deemed statistically significant.
Results

Univariate analysis of general characteristics and cognitive function

A total of 9471 disabled individuals were included, with a mean age of 80.1±8.8 years, consisting of 57.7% females and 42.3% males. The ratios of normal cognitive function, dementia-cognitive impairment, and dementia were 3.7%, 38.6%, and 57.7%, respectively. General characteristics of the patient population are shown in Table 1.

Multivariate analysis of general characteristics and cognitive function

An ordered logistic regression analysis produced a parallel line test of P<0.01, which fails to satisfy the “proportional advantage” hypothesis of ordered logistic regression analysis. Therefore, we used disordered multi-class logistic regression. We explored the correlation between age, sex, education level, living conditions, marital status, other diseases, disability, and cognitive function.

Table 1. Univariate analysis of general characteristics and cognitive function.

| General characteristics | Normal cognitive function | Cognitive impairment | Dementia | Total number | Z-statistic | P-value |
|-------------------------|---------------------------|----------------------|----------|--------------|-------------|---------|
| **Current age**         |                           |                      |          |              |             |         |
| 60–79 years             | 258 (73.30%)              | 1877 (51.37%)        | 1988 (36.38%) | 4123 (43.53%) | -17.439     | <0.01   |
| ≥80 years               | 94 (26.70%)               | 1777 (48.63%)        | 3477 (63.62%) | 5348 (56.47%) | -11.801     | <0.01   |
| **Sex**                 |                           |                      |          |              |             |         |
| Female                  | 117 (33.24%)              | 1939 (53.07%)        | 3412 (62.43%) | 5468 (57.73%) | -11.801     | <0.01   |
| Male                    | 235 (66.76%)              | 1715 (46.93%)        | 2053 (37.57%) | 4003 (42.27%) | -7.392      | <0.01   |
| **Education level**     |                           |                      |          |              |             |         |
| Educated                | 340 (96.59%)              | 2892 (79.15%)        | 4110 (75.21%) | 7342 (77.52%) | -7.392      | <0.01   |
| Illiterate              | 12 (3.41%)                | 762 (20.85%)         | 1355 (24.79%) | 2129 (22.48%) | 0.069       | 0.945   |
| **Income**              |                           |                      |          |              |             |         |
| Pension                 | 339 (96.31%)              | 3524 (96.44%)        | 5268 (96.40%) | 9131 (96.41%) | -0.069      | 0.945   |
| Other                   | 13 (3.69%)                | 130 (3.56%)          | 197 (3.60%)   | 340 (3.59%)   | 0.945       |         |
| **Marital status**      |                           |                      |          |              |             |         |
| Other                   | 97 (27.56%)               | 1511 (41.35%)        | 2768 (50.65%) | 4376 (46.20%) | -10.783     | <0.01   |
| Married                 | 255 (72.44%)              | 2143 (58.65%)        | 2697 (49.35%) | 5095 (53.80%) | 0.069       | 0.945   |
| **Living situation**    |                           |                      |          |              |             |         |
| Not live with family    | 82 (23.30%)               | 1087 (29.75%)        | 2520 (46.11%) | 3689 (38.95%) | -16.857     | <0.01   |
| Other                   | 270 (76.70%)              | 2567 (70.25%)        | 2945 (53.89%) | 5782 (61.05%) | 0.069       | 0.945   |
| **Combined disease**    |                           |                      |          |              |             |         |
| <5                      | 168 (47.73%)              | 1534 (41.98%)        | 2450 (44.83%) | 4152 (43.84%) | -1.921      | 0.055   |
| ≥5                      | 184 (52.27%)              | 2120 (58.02%)        | 3015 (55.17%) | 5319 (56.16%) | 0.069       | 0.945   |
| **Disability level**    |                           |                      |          |              |             |         |
| Mild                    | 55 (15.63%)               | 209 (5.72%)          | 84 (1.54%)    | 348 (3.67%)   | 0.069       | 0.945   |
| Moderate                | 112 (31.82%)              | 752 (20.58%)         | 342 (6.26%)   | 1206 (12.73%) | -1.921      | 0.055   |
| Severe                  | 185 (52.5%)               | 2693 (73.70%)        | 5039 (92.20%) | 7917 (83.59%) | 0.069       | 0.945   |
Table 2. Multivariate analysis of general characteristics and cognitive function.

| General characteristics | Dementia – Normal cognitive function | Dementia – Cognitive impairment |
|-------------------------|--------------------------------------|-------------------------------|
|                         | Wald       | P          | OR (95%CI)     | Wald    | P          | OR (95%CI)     |
| 60–79 years             | 77.355     | <0.01     | 3.254 (2.502, 4.233) | 101.294 | <0.01     | 1.638 (1.488, 1.803) |
| Female                  | 46.332     | <0.01     | 0.420 (0.328, 0.539) | 32.903  | <0.01     | 0.754 (0.684, 0.830) |
| Married                 | 0.041      | 0.840     | 1.029 (0.777, 1.364) | 0.085   | 0.770     | 1.015 (0.917, 1.125) |
| Illiterate              | 35.499     |           | 6.105 (3.367, 11.070) | 2.351   | 0.125     | 1.093 (0.976, 1.225) |
| Pension                 | 0.100      | 0.752     | 1.102 (0.604, 2.010) | 0.252   | 0.616     | 1.063 (0.838, 1.347) |
| Not live with family    | 16.633     | <0.01     | 0.563 (0.427, 0.742) | 108.806 |           | 0.602 (0.547, 0.662) |
| <5 combined diseases    | 0.011      | 0.918     | 0.988 (0.787, 1.241) | 12.636  | <0.01     | 0.850 (0.777, 0.930) |
| Mild disability         | 219.924    | <0.01     | 19.10 (12.938, 28.21) | 126.420 | <0.01     | 4.490 (3.456, 5.833) |
| Moderate disability     | 232.518    | <0.01     | 8.089 (6.183, 10.582) | 348.538 |           | 3.760 (3.272, 4.321) |

Older individuals were more prone to dementia (dementia-normal cognitive function $\chi^2=77.355$, $P<0.01$, dementia-cognitive impairment $\chi^2=101.294$, $P<0.01$). Disabled females were more prone to dementia than males (dementia-normal cognitive function $\chi^2=46.332$, $P<0.01$, dementia-cognitive impairment $\chi^2=32.903$, $P<0.01$). Those with low education level were more likely to develop dementia than those with higher education (dementia-normal cognitive function $\chi^2=35.499$, $P<0.01$). Those not living with their family were more prone to dementia (dementia-normal cognitive function $\chi^2=16.633$, $P<0.01$, dementia-cognitive impairment $\chi^2=108.806$, $P<0.01$). The specific analysis is shown in Table 2.

Univariate analysis of common diseases and cognitive functions

The top 8 diseases were hypertension, stroke sequelae, osteoporosis, constipation, diabetes, coronary heart disease, fracture, and hyperlipidemia. The proportion of patients with disability and dementia with 2 or more comorbidities was 93.9%. Univariate analysis showed a significant association of hypertension, diabetes, hyperlipidemia, constipation, fracture, and osteoporosis with cognitive functions (Table 3).

Multivariate analysis of common diseases and cognitive functions

After correcting for age, sex, economic sources, living conditions, marital status, and disability levels, the influence of other diseases was assessed using a unified model for ordered logistic regression analysis, but the parallel line test showed a $P<0.01$. We therefore used a disordered multi-class logistical regression analysis to explore the effects of disease on cognitive function.

Hypertensive patients were more prone to dementia than non-hypertensive patients (dementia-normal cognitive function $\chi^2=4.643$, $P=0.031$, dementia-cognitive impairment $\chi^2=12.677$, $P<0.01$). Elderly disabled individuals with fractures were more likely to develop dementia than non-fracture patients ($\chi^2=17.594$, $P<0.01$). Disabled elderly patients with osteoporosis were more prone to dementia ($\chi^2=25.889$, $P<0.01$). Those with diabetes were also more likely to develop dementia ($\chi^2=5.573$, $P=0.018$) (Table 4).

Discussion

In this study 57.70% of the disabled elderly assessed had dementia, which is higher than statistics from the general elderly populations of China, Europe, and America [17–19]. Dementia therefore affects a significant proportion of the disabled elderly. Our findings are in agreement with international studies identifying that older age is associated with dementia [17,19–26]. Females have prevalence rates of dementia than males [27,28], which might be attributable to the different hormone levels and the lifestyle-specific differences of between males and females [28]. It is important to understand the association of sex and hormones (such as estrogen levels, although the female patients are postmenopausal) with dementia. Elderly with low education level are more likely to develop dementia than those with higher education [29]. The prevalence of dementia fell by 7% per year of increased education. Individuals with higher education tended to have better cognitive abilities, which may compensate for dementia-related brain pathology [29–32].

In this study, we applied the Mini-cog test [16], a 3-minute test, to evaluate cognition. The Mini-cog test is usually only slightly
affected by education level and the language ability and is easily used by outpatient physicians and patients. Importantly, the specificity and sensitivity of screening patients with dementia, cognitive impairment, and normal cognition are higher compared to the MMSE [16,33,34]. Therefore, based on our clinical practice and the published studies cited above, we believed that the 3-min-Mini-cog test can discriminate between cognitively healthy people, cognitively impaired people, and people with dementia.

We found that those not living with family members were more prone to dementia. These patients may lack day-to-day care, have reduced interaction and communication with others, and thus have lower mood levels and an increased risk of depression, which is a major risk factor for dementia [35–38]. It should be noted that when elderly patients develop more severe cognitive dysfunction, families frequently send patients to nursing homes due to a lack of professional care, skills, and time. Thus, those in nursing homes may have developed serious cognitive dysfunction at home. As this study was cross-sectional, we cannot confirm that those living at home with their families have a reduced dementia risk. However, we emphasize the value of family members as care-providers, which represents an important public point of care planning for elderly individuals in China.

| Diseases                  | Normal cognitive function | Cognitive impairment | Dementia | Total number | Z-statistic | P-value |
|---------------------------|---------------------------|----------------------|----------|--------------|-------------|---------|
| Hypertension              |                           |                      |          |              |             |         |
| No                        | 124 (35.23%)              | 1391 (38.07%)        | 2376 (43.48%) | 3891 (41.08%) | -5.623      | <0.01   |
| Yes                       | 228 (64.77%)              | 2263 (61.93%)        | 3089 (56.52%) | 5580 (58.92%) |             |         |
| Coronary heart disease    |                           |                      |          |              |             |         |
| No                        | 270 (76.70%)              | 2601 (71.18%)        | 3888 (71.14%) | 6759(71.37%)  | -0.891      | 0.373   |
| Yes                       | 82 (23.30%)               | 1053 (28.82%)        | 1577 (28.86%) | 2712(28.63%)  |             |         |
| Diabetes                  |                           |                      |          |              |             |         |
| No                        | 244 (69.32%)              | 2517 (68.88%)        | 3969 (72.63%) | 6730 (71.06%) | -3.852      | <0.01   |
| Yes                       | 108 (30.68%)              | 1137 (31.12%)        | 1496 (27.37%) | 2741 (28.94%) |             |         |
| Hyperglycemia             |                           |                      |          |              |             |         |
| No                        | 249 (70.74%)              | 2712 (74.22%)        | 4239 (77.57%) | 7200 (76.02%) | -4.290      | <0.01   |
| Yes                       | 103 (29.26%)              | 942 (25.78%)         | 1226 (22.43%) | 2271 (23.98%) |             |         |
| Stroke sequelae           |                           |                      |          |              |             |         |
| No                        | 223 (63.35%)              | 2333 (61.11%)        | 3440 (62.95%) | 5896 (62.25%) | -1.476      | 0.14    |
| Yes                       | 129 (36.65%)              | 1421(38.89%)         | 2025 (37.05%) | 3575 (37.75%) |             |         |
| Constipation              |                           |                      |          |              |             |         |
| No                        | 216 (61.36%)              | 2342 (64.09%)        | 3686 (67.45%) | 6244 (65.93%) | -3.761      | <0.01   |
| Yes                       | 136 (38.64%)              | 1312 (35.91%)        | 1779 (32.55%) | 3227 (34.07%) |             |         |
| Fracture                  |                           |                      |          |              |             |         |
| No                        | 280 (79.55%)              | 2713 (74.25%)        | 4159 (76.10%) | 7152 (75.51%) | -1.191      | 0.234   |
| Yes                       | 72 (20.45%)               | 941 (25.75%)         | 1306 (23.90%) | 2319 (24.49%) |             |         |
| Osteoporosis              |                           |                      |          |              |             |         |
| No                        | 234 (66.48%)              | 2255 (61.71%)        | 3604 (65.95%) | 6093 (64.33%) | -3.505      | <0.01   |
| Yes                       | 118 (33.52%)              | 1399 (38.29%)        | 1861 (34.05%) | 3378 (35.67%) |             |         |
Table 4. Multivariate analysis of common diseases and cognitive functions.

| Diseases               | Dementia – Normal cognitive function | Dementia – Cognitive impairment |
|------------------------|--------------------------------------|--------------------------------|
|                        | Wald       | OR (95%CI)              | Wald     | OR (95%CI)              |
| Hypertension           | 4.643      | 0.031 (0.759, 0.975)    | 12.677   | <0.01 (0.840, 0.975)    |
| Diabetes               | 0.165      | 0.685 (0.948, 1.227)    | 5.573    | 0.018 (0.885, 0.979)    |
| Coronary heart disease | 0.827      | 0.363 (1.137, 1.500)    | 0.680    | 0.410 (0.958, 1.061)    |
| Osteoporosis           | 3.300      | 0.069 (0.786, 1.019)    | 25.889   | <0.01 (0.772, 0.853)    |
| Stroke sequelae        | 4.640      | 0.031 (1.306, 1.666)    | 0.374    | 0.541 (1.030, 1.132)    |
| Hyperglycemia          | 0.001      | 0.970 (1.005, 1.319)    | 0.764    | 0.382 (1.051, 1.174)    |
| Fracture               | 2.986      | 0.084 (0.773, 1.035)    | 17.594   | <0.01 (0.793, 0.884)    |
| Constipation           | 2.283      | 0.131 (0.828, 0.648)    | 0.311    | 0.577 (0.973, 1.072)    |

In agreement with previous studies, we found that chronic diseases (e.g., diabetes, hypertension, and obesity) were risk factors for dementia [27,39–42]. Hypertension induces cerebral arterial stiffening and micro-vascular dysfunction, contributing to dementia pathophysiology. Although many of the individuals in this study were disabled, we identified hypertension and diabetes as risk factors for dementia. Addressing treatment of chronic diseases, particularly those related to vascular risks, is an important issue for dementia prevention.

We found that elderly disabled patients with a history of fractures were more likely to develop dementia. Previous studies performed in Taiwan showed that the overall incidence rates of dementia in individuals with fractures were 41% higher than in those without fractures [6.05 vs. 4.30 per 1000 person-years] [43]. It is predicted that disabled elderly patients with fractures have reduced mobility, lower levels of physical exercise, loss of social engagement, reduced emotional communication, and less brain activity, which can lead to a reduced interest in activities, reduced emotional state, and lower cognitive function. Conversely, dementia is a known risk factor for falls and hip fractures [44–46]. Earlier studies estimated that elderly individuals with dementia experience hip fractures approximately 3 times more frequently than patients without dementia [46]. Others have shown that dementia patients constitute a significant proportion of the total elderly population with hip fractures (up to 29%) [47]. This makes it difficult to distinguish the cause-and-effect relationship between fractures and dementia.

We found that osteoporosis was associated with dementia in disabled elderly patients, a finding consistent with previous studies. Chang et al. [48] found that osteoporosis patients exhibit a 1.46-fold and 1.39-fold higher risk of dementia and Alzheimer’s disease, respectively, compared to matched non-osteoporosis patients. Osteoporosis patients receiving bisphosphonate treatment or estrogen supplementation had a significantly lower risk of dementia compared to osteoporosis patients without such treatment [49].

We found that 57.7% of elderly disabled individuals in Chengdu had dementia. Multiple factors, including age, sex, education level, living conditions, a history of fractures, and chronic diseases (e.g., diabetes, hypertension, and osteoporosis) were associated with cognitive dysfunction. A comprehensive understanding of these pathways and their relative effects on the outcomes of dementia may provide a basis for development of new interventions. However, many challenges in this area remain, primarily due to the poor awareness of dementia among the Chinese public. Many people mistake cognitive dysfunction in dementia as a normal process of aging and fail to pay attention to elderly people with dementia. Even when cognitive decline leads to serious consequences, many families remain unwilling to allow relatives with dementia to receive hospital care due to lack of belief in the benefits of dementia medical care. Discrimination and stigmatization of dementia also remain, particularly in the elderly with low education levels. In addition, the knowledge regarding dementia among medical professionals and caregivers has remained low, primarily because education regarding dementia is not included as part of the regular Chinese medical curriculum. Dementia service systems also remain under-developed and have relied too heavily on home-based care. The high cost of dementia care and the significant economic burden on those with dementia and their families in China also presents problems.

Therefore, it is clear that although China has the largest number of people with dementia worldwide, an effective system to cope with its challenges is lacking. Promoting public awareness and understanding of dementia, increased training of health
professionals, and promoting social awareness through mental health education in hospitals is required. China has begun to address these issues with the recent five-year plan for mental health that prioritizes dementia care. In Chengdu, our data on dementia risk factors in disabled elderly patients can inform policies and promote precise and personalized dementia management strategies that prioritize women, those with low educational levels, and those with previous injuries. For example, by enhancing the general educational standards in the Chinese population, we can produce individuals with higher educational backgrounds and thus a 7% reduction in their likelihood of developing dementia in later life.

The strengths of this study include the use of population-based data that are highly representative of the general population. However, the evidence derived from cross-sectional studies is generally low in statistical quality compared to that from prospective cohort studies. In addition, we cannot exclude the possibility of a bidirectional relationship between dementia and disability, due to the long pre-clinical phase of dementia development. Due to the non-specific testing for dementia with the 3-min Mini-cog test, the rate of patients with dementia was higher, which is a limitation of this study. In subsequent research, we will use more specific tests for evaluating dementia. Although there are many types of dementia in the aging population, the present study did not differentiate them, and future research should explore specific types of dementia.

Conclusions

We demonstrated that the prevalence of dementia in elderly disabled patients is very high (57.7%) in Chengdu. Age (>80 years), female sex, education level (illiterate individuals), living conditions, and chronic disease were closely correlated to cognitive functions. It is therefore clear that the specific management of disabled dementia patients should differ from that of non-disabled patients. To establish the success of personalized dementia therapies, further studies, including prospective longitudinal studies and randomized controlled case-control trials, are required for specific populations. Success in this area may revolutionize personalized dementia care, improving patient outcomes and reducing economic costs. The Chinese government has launched a long-term care insurance program to help these disabled elderly people. Our findings suggest this program should pay more attention to dementia in disabled elderly individuals.

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Conflict of interests

None.

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