Impact of chronic disease multimorbidity on disability in rural middle-aged and elderly adults: a propensity score matching analysis (Postprint)

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Abstract

Objective To investigate the impact of chronic disease multimorbidity on disability among rural middle-aged and elderly adults using propensity score matching (PSM) method, and to provide a reference basis for formulating management strategies for chronic disease multimorbidity and disability in this population. Methods Data from 11,088 rural middle-aged and elderly adults aged $ $45 years from the 2018 China Health and Retirement Longitudinal Study (CHARLS) were utilized. The non-multimorbidity and multimorbidity groups were matched at a 1:1 ratio using propensity score matching method. Conditional logistic regression was applied to analyze the relationship between chronic disease multimorbidity and activities of daily living (ADL) disability and instrumental activities of daily living (IADL) disability. Results A total of 3,391 cases were successfully matched. Before matching, differences in age, gender, education level, economic level, marital status, sleep status, smoking and drinking status, disability status, and social activity participation between the two groups were all statistically significant (P<0.05). After matching, covariates between the two groups achieved balance. Binary conditional logistic regression analysis showed that, compared with rural middle-aged and elderly adults without multimorbidity, chronic disease multimorbidity increased the risk of ADL disability (OR=2.25, 95%CI: 1.96-2.59, P<0.01) and IADL disability (OR=1.52, 95%CI: 1.36-1.71, P<0.01). Conclusion PSM can effectively control confounding bias between study groups and has long-term application value. In rural areas, chronic disease multimorbidity among middle-aged and elderly adults increases the risk of disability. The government should attach importance to resource and policy investment in rural areas, and strengthen the prevention and management of chronic disease multimorbidity and disability among rural middle-aged and elderly adults.

Full Text

Influence of Multimorbidity on Disability among Middle-Aged and Elderly People in Rural Areas Based on Propensity Score Matching

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Abstract

Objective: To evaluate the effect of multimorbidity on disability among middle-aged and elderly individuals in rural areas using propensity score matching (PSM), and to provide evidence for formulating management strategies for multimorbidity and disability in this population.

Methods: Data from 11,088 rural residents aged $ $45 years were extracted from the 2018 China Health and Retirement Longitudinal Study (CHARLS). The PSM method was applied to match the non-multimorbidity group with the multimorbidity group at a 1:1 ratio. Conditional logistic regression was used to analyze the relationship between multimorbidity and both activities of daily living (ADL) disability and instrumental activities of daily living (IADL) disability.

Results: A total of 3,391 pairs were successfully matched. Before matching, the two groups showed statistically significant differences in age, gender, education level, economic status, marital status, sleep quality, smoking and alcohol consumption, disability status, and social activity participation ($P<0.05$). After matching, covariates between the groups were well balanced. Binary conditional logistic regression analysis revealed that, compared with rural middle-aged and elderly individuals with a single chronic disease, those with multimorbidity had a significantly higher risk of ADL disability (OR=2.25, 95%CI: 1.96-2.59, $P<0.01$) and IADL disability (OR=1.52, 95%CI: 1.36-1.71, $P<0.01$).

Conclusion: PSM effectively controls confounding bias between study groups and offers substantial long-term application value. In rural settings, multimorbidity among middle-aged and elderly people increases the risk of disability. The government should prioritize resource allocation and policy investment in rural areas to strengthen prevention and management of multimorbidity and disability among rural middle-aged and elderly populations.

Keywords: Multimorbidity; Propensity score matching; Disability

Introduction

Accelerating population aging and increasing life expectancy pose major challenges to global health and social care systems. Disability refers to the loss or impairment of physiological functions resulting in restricted daily activities and difficulties with self-care [1]. Disability not only severely impacts quality of life for older adults but also creates heavy burdens for families and society [2, 3]. In rural areas, where medical resources and public health services are relatively limited, disability presents an even more severe problem [4]. The development of chronic diseases with advancing age is recognized as a crucial cause of disability [5].

Chronic diseases are characterized by long duration, slow recovery, and high risk of complications. Multimorbidity—defined as the co-occurrence of two or more chronic conditions—further complicates diagnosis, assessment, and treatment due to disease interactions and synergistic effects. This increases the risk of adverse health outcomes, consumes more medical resources, and reduces patients' quality of life [6]. Previous studies have identified associations between chronic diseases and disability [7], as well as close links between multimorbidity and disability [8]. Although numerous studies have examined these relationships [8, 9], few have focused specifically on middle-aged and elderly populations in rural areas. Moreover, confounding factors such as demographic characteristics and lifestyle patterns can affect result accuracy. Propensity score matching (PSM) serves as an effective statistical method for controlling confounding bias and is widely applied in non-randomized studies [10]. Therefore, this study utilizes CHARLS data and employs PSM to control for confounding bias, analyzing the relationship between multimorbidity and disability among rural middle-aged and elderly Chinese to provide scientific evidence for management strategies.

1. Data Sources and Methods

1.1 Data Source

This study utilized data from the China Health and Retirement Longitudinal Study (CHARLS), conducted by the National School of Development at Peking University. CHARLS employs multistage stratified sampling to survey individuals aged 45 years and above every two years across 28 provinces, 150 counties, and 450 communities/villages nationwide, collecting comprehensive information on personal and family demographics, socioeconomic status, health conditions, biomedical measurements, and community environments. The 2018 CHARLS dataset was used for this analysis.

1.2 Study Subjects

Inclusion criteria were: (1) age $ $45 years; (2) diagnosis of at least one chronic disease; and (3) rural residence based on the CHARLS question "Do you mainly live in a rural or urban area?"with respondents answering "rural."After excluding

participants with incomplete data, 11,088 subjects were included in the final analysis.

1.3 Measurements

1.3.1 Multimorbidity and Sociodemographic Characteristics Multimorbidity was defined as the simultaneous presence of two or more chronic diseases from a list of 14 conditions: malignant tumors, hypertension, dyslipidemia, chronic lung disease, cardiomyopathy, diabetes, kidney disease, liver disease, asthma, arthritis or rheumatism, gastric or digestive diseases, stroke, memory-related diseases (e.g., dementia, brain atrophy, Parkinson' s disease), and emotional or mental health problems.

Sociodemographic variables included age, gender, marital status, education level, smoking history, alcohol consumption history, disability status, and social activity participation.

1.3.2 Disability Assessment Disability was assessed using both Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) scales. ADL was evaluated using the Katz Index [11], comprising six items: bathing, dressing, eating, toileting, transferring, and continence. IADL was assessed using the Lawton Scale [12], comprising six items: housekeeping, cooking, shopping, telephone use, medication management, and financial management. Each item was scored on a four-point scale: "no difficulty" (1 point) to "unable to perform" (4 points). Disability was defined as a total score >6, while scores $ $6 indicated independent functioning [13]. The Cronbach' s α coefficient for these scales in this survey was 0.875, and factor analysis yielded two factors consistent with the ADL and IADL domains, demonstrating high reliability [13].

1.4 Statistical Methods

All variables were analyzed using R version 4.0.0. Categorical data were compared using ^{2} tests, and continuous variables using t-tests. PSM was employed to control for confounding. Following previous literature [14], we used multimorbidity status (yes/no) as the outcome variable and demographic information, lifestyle factors, and health status as predictors to fit a logistic regression model for calculating propensity scores. Nearest-neighbor matching with a 1:1 ratio and caliper width of 0.03 was applied. Covariate balance between multimorbidity and single-disease groups was examined after matching. Finally, binary conditional logistic regression was performed on the matched data to analyze the impact of multimorbidity on ADL and IADL disability, with $P<0.05$ considered statistically significant.

2. Results

2.1 Basic Characteristics of Study Subjects

Among the 11,088 rural middle-aged and elderly respondents with chronic diseases, 5,176 (46.7%) were male and 5,912 (53.3%) were female. Regarding disability status, 2,711 (24.4%) had ADL disability and 4,216 (38.0%) had IADL disability. The prevalence of both ADL and IADL disability differed significantly across age, gender, education level, economic status, marital status, sleep quality, smoking and alcohol consumption, disability status, social activity participation, and multimorbidity status ($P<0.05$). The multimorbidity group had an ADL disability rate of 29.7%, substantially higher than the 12.6% in the non-multimorbidity group, and an IADL disability rate of 43.2% compared to 26.4% in the non-multimorbidity group. Detailed demographic characteristics are presented in .

2.2 Propensity Score Matching

Among the 11,088 rural middle-aged and elderly chronic disease patients, 7,673 (69.2%) had multimorbidity. Significant differences existed between the multimorbidity and single-disease groups in age, gender, education level, economic status, marital status, sleep quality, smoking and alcohol consumption, disability status, and social activity participation ($P<0.05$), as shown in . Using propensity scores with 1:1 matching, 3,391 matched pairs (6,782 individuals) were successfully created. After matching, no statistically significant differences remained between groups in any demographic variables, achieving excellent covariate balance and ensuring comparability.

2.3 Impact of Multimorbidity on Disability

Binary conditional logistic regression analysis of the 6,782 matched subjects demonstrated that rural middle-aged and elderly individuals with multimorbidity had 2.25 times higher odds of ADL disability (OR=2.25, 95%CI: 1.96-2.59, $P<0.01$) and 1.52 times higher odds of IADL disability (OR=1.52, 95%CI: 1.36-1.71, $P<0.001$) compared to those with only one chronic disease. These results are summarized in .

Discussion

Confounding factors directly affect the accuracy of estimates regarding multimorbidity' s impact on disability. PSM can control for these confounders, yielding results analogous to randomized controlled trials [15]. With its clear analytical steps and easily interpretable results, PSM is now widely used to control confounding bias in observational studies [16]. This study employed PSM to evaluate multimorbidity' s effect on disability. Before matching, significant differences existed between groups in demographics, lifestyle, and health status,

but after matching, the groups were well balanced, ensuring the accuracy of our effect estimates.

The survey revealed ADL and IADL disability rates of 24.4% and 38.0%, respectively, among rural middle-aged and elderly populations. The higher IADL disability rate reflects the greater cognitive demands and complexity of instrumental activities compared to basic self-care tasks, illustrating the hierarchical nature of disability. Compared with previous studies, our ADL disability rate was lower than reports by Du et al. [17] and Xu et al. [18] (28.4%-31.7%) but higher than Zhang et al.' s finding of 2.1% [19]. IADL disability rates also varied across studies: Bowling CB [20] reported 17.0%, while Su P et al. [21] found 49.17%. In addition to differences in sampling methods, populations, and regions, the lack of standardized criteria for disability severity classification in Chinese studies using international ADL scales contributes to these discrepancies [22, 23].

Regarding the relationship between multimorbidity and disability, our findings contrast with Shiyi C et al. [24], who found no association between chronic disease count and disability. We demonstrated that multimorbidity significantly increased ADL disability risk by 2.25-fold and IADL disability risk by 1.52-fold among rural middle-aged and elderly individuals, consistent with previous research [9, 25]. Using alternative definitions ($ $4 chronic diseases) yielded even stronger associations. A Shanghai study of adults over 75 found that having four or more chronic diseases increased ADL disability risk by 5.61-fold and IADL disability risk by 5.51-fold compared to disease-free individuals [21]. Several factors may explain these effects. First, multimorbid patients are typically older with poorer physiological function, and disease interactions create synergistic effects that prolong treatment, worsen prognosis, increase complications, and impair organ function, ultimately reducing self-care ability [9]. Second, rural residents face lower socioeconomic status, limited social services, and reduced access to quality healthcare. Urbanization has led to rural youth migration, leaving elderly parents in "empty nest" situations with higher multimorbidity risk. Additionally, most rural residents engage in high-intensity agricultural labor that negatively impacts health, particularly during busy seasons when poor sleep quality exacerbates health problems [26, 27].

This study provides new evidence on multimorbidity' s impact on disability among rural Chinese middle-aged and elderly populations, with important policy implications. Recognizing the growing burden of multimorbidity, countries like the UK have developed clinical guidelines emphasizing integrated, patient-centered care [28]. China' s chronic disease prevention and control efforts must shift from single-disease to multimorbidity management models, improving health system capacity through policy guidance, disciplinary development, and clinical program support. The medical consortium service model offers opportunities to explore new tiered management approaches for multimorbidity. Furthermore, addressing multimorbidity must prioritize rural areas, where needs are greatest but health services are limited and dispersed. Strengthening

rural chronic disease service systems will enable timely identification and standardized management of multimorbid patients. Additionally, health education for rural middle-aged and elderly populations should be enhanced to improve chronic disease awareness. As rural "left-behind" populations age rapidly, promoting mental health awareness, enriching cultural life, and encouraging healthy lifestyles—including regular social activities and adequate sleep—are essential for improving health outcomes.

In conclusion, this study used PSM to balance confounding between multimorbidity and single-disease groups, ensuring robust comparability and reliable conclusions. Our PSM-based findings demonstrate that multimorbidity significantly increases disability risk among rural middle-aged and elderly populations. Relevant departments and social sectors must collaborate closely to increase resource and policy investment in rural areas, reorient health system priorities, and strengthen prevention and management of multimorbidity and disability to meet the health needs of rural middle-aged and elderly residents.

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Note: Figure translations are in progress. See original paper for figures.