

Exploring the relationship between depression and different multimorbidity patterns among older people covered by long-term care insurance in Shanghai, China

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Abstract

Background: Depression is common in patients with multimorbidity, but little is known about the relationship between depression and multimorbidity. The purpose of our research was to investigate multimorbidity patterns and their association with depression in a sample of older people covered by long-term care insurance in Shanghai, China.

Method: This was a population-based cross-sectional study, and participants included older people covered by long-term care insurance in Shanghai. We collected information on chronic conditions using a self-reported medical history, and we used the 30-item Geriatric Depression Scale to evaluate depressive symptoms. Patterns of multimorbidity were identified with exploratory factor analysis, using oblimin rotation. Logistic regression was used to estimate the relationship between multimorbidity patterns and depressive symptoms.

Results: Hypertension, cardiovascular disease, cerebrovascular disease (CVD), and cataract showed strong associations with depression when co-occurring with other conditions. Three patterns of multimorbidity were identified: a musculoskeletal pattern, cardiometabolic pattern, and degenerative disease pattern. Among these, the cardiometabolic (adjusted odds ratio [AOR] 1.223; 95% confidence interval [CI] 1.102, 1.357) and degenerative disease (AOR 1.185; 95% CI 1.071, 1.311) patterns were associated with a higher risk of depressive symptoms.

Conclusion: Two of three multimorbidity patterns were found to be associated with depression. Physical and psychological dimensions require greater attention in the care of older adults who are covered by long-term care insurance.

1. Background

Depression is a major global health problem with a lifetime prevalence ranging from 1.5–19%(1). It is one of the main diseases causing disease burden and the third leading cause of years lived with disability globally(2). Multimorbidity is generally defined as the co-occurrence of two or more chronic diseases(3). Accelerated aging of the global population has largely contributed to the increased prevalence of multimorbidity(4). Among people over 50 years old in European countries, the prevalence of multimorbidity is 37%(5). A study of the prevalence of multimorbidity in Australia found that 75% of those aged 65–74 years had multimorbidity, and this proportion rose to 80% among people 75 years and older(6). Additionally, the prevalence of multimorbidity ranges from 24.1–83% among the population over 60 years old in South Asia(7) and from 6.4–76.5% among the population over 60 years old in China(8).

A large number of studies have proved that multimorbidity is associated with various poor health outcomes, such as poor health-related quality of life (HRQL) (9) and higher health care expenditures and resource utilization(5, 10). Compared with patients who have a single disease, management of the medical needs of patients with multimorbidity increases complexity and a series of impacts on social and emotional functions should be considered(11).

In the context of global aging, people have begun to pay greater attention to the relationship between multimorbidity and depression. Previous research has documented that people with one or more chronic physical diseases have a higher proportion of depression than those with no chronic illness(12). Several meta-analyses have found that the risk of depression is twice as high among people with multimorbidity than in those without multimorbidity and three times greater for people with multimorbidity than those without any chronic physical conditions(13). In further research, it was found that quality of life in patients with both multiple diseases and depression was significantly lower than in those with chronic diseases but who were not depressed(12). Multimorbidity together with depression is a huge public health challenge for low- and middle-income countries with limited health resources(14).

China's older population is expected to reach 400 million by 2050(15). To be able to address problems caused by a large aging population, China began to explore a long-term care insurance system in 2016(16). Previous research shows that older people with chronic diseases are at higher risk of depression(17, 18), especially those living in long-term care facilities(3). Better understanding and greater attention paid to the relationship between multimorbidity and depression are needed, to promote more targeted measures for reducing the burden of disease and to improve the health of the population(12). Therefore, research on the relationship between multimorbidity and depression is critically important. For China, such research will help improve its long-term care insurance system, to help promote a healthy aging population. However, there is little research in this area and related studies have mostly been carried out in Western countries. In the Chinese older population, some studies on chronic diseases and depression have emerged in recent years, but most of these have focused on the relationship between a single disease or the number of diseases and depression. Few studies have examined the relationship between multimorbidity patterns and depression. Moreover, there is nearly no research among participants in long-term care insurance. The purpose of this study was to explore multimorbidity patterns among people covered by long-term care insurance in Shanghai and the relationship with depression. The selected data were obtained from a population of older people in a study of the Shanghai long-term care insurance system.

2. Methods

2.1 Study Population and Data Collection

This was a population-based cross-sectional study conducted among participants in a study of older people covered by long-term care insurance in Shanghai, China. Our study adopted stratified cluster sampling. The city of Shanghai was divided into 17 districts in 2015, and further divided into levels according to the city center, suburbs, and outer suburbs. Random sampling was carried out at each level; three, two, and one sample districts were selected from the city center, suburbs, and outer suburbs, respectively. In the six sample districts selected, one street was selected as the survey street, based on the Chinese character stroke order of the street name.

We randomly selected one to three neighborhood committees from the corresponding survey streets, randomly selected according to their age composition.

We excluded individuals with severe cognitive impairment and those who were unable to participate owing to hearing, language, or mental impairment. Finally, a total of 1,871 older individuals were included in the present study. This research mainly used survey questionnaires to collect information. The questionnaires were completed by specially trained investigators in face-to-face interviews.

This study was approved by the Fudan University Research Ethics Committee and performed in accordance with the current institutional and state guidelines and regulations.

Written informed consent was obtained from all participants.

2.2 Sociodemographic and Health-Related Variables

Social demographic variables include sex, age (60–69, 70–79, 80–89 and ≥ 90 years), education level (illiterate, primary school, middle school or technical school, college or above), marital status (divorced, widowed, never married, or married), children (with or without), monthly income in Chinese yuan (< 1800, 1800–3499, 3500–3999 and ≥ 4000)(19), and care mode (home or facility).

In this study, we also used the Perceived Social Support Scale (PSSS) to investigate social support among participants. PSSS is a validated 12-item instrument used to evaluate perceived support from three groups, namely, family, friends, and significant others. The PSSS score ranges from 12 to 84; the higher the score, the higher the perceived level of social support. The Chinese version of the PSSS has been verified and has good internal reliability. In this study, social support was divided into three categories, the first category comprised scores of 12–31 points, the second category was 32–50 points, and the third category was 51–84 points(20–22).

2.3 Definition of Chronic Conditions and Multimorbidity

Chronic diseases are measured based on participants' answers to the following question: "Have you had a chronic disease diagnosed by a doctor in the past 6 months?" This referred to 33 chronic diseases, including hypertension, diabetes, cardiovascular disease (heart attack and other cardiovascular disorders), cerebrovascular disease (CVD), bronchitis, pneumonia, emphysema, asthma or chronic obstructive pulmonary disease, tuberculosis, cataract, glaucoma, cancer, prostatitis/prostatic hypertrophy, Parkinson disease, bedsores, injury or poisoning, rheumatoid arthritis, intervertebral disc disease, chronic low back pain, dyslipidemia, severe vision loss, psychiatric disease, lower extremity varicose veins, gout, hemorrhoids, hypothyroidism, non-inflammatory gynecological diseases, psoriasis, osteoporosis, chronic cholecystitis/gallstones, urinary stones, and anemia. Multimorbidity was defined as having two or more of the 33 chronic diseases at the same time.

2.4 Assessments of Depression

To assess depression, we used the 30-item Geriatric Depression Scale (GDS-30), which contains 30 questions. Respondents answer "yes" or "no" based on how they have felt in the past week(23). Among the questions, 20 questions receive 1 point for a response of "yes" and 0 points for "no". The other 10 questions are reverse scored; the full score is 30, and an individual score ≥ 11 is considered to indicate depressive symptoms. The GDS-30 is widely used as an effective screening tool for depressive symptoms in older people(24, 25), and it is also applicable to people over age 60 years in China(26, 27).

2.5 Statistical Analyses

Descriptive analysis was used to describe the demographic characteristics of participants. The chi-square test was used for categorical variables. Exploratory factor analysis is often used to identify multimorbidity patterns(28, 29). We applied the principal factor method based on a tetrachoric correlation matrix. The Kaiser–Meyer–Olkin method and Bartlett test of sphericity were performed to estimate adequacy of the data for our model. Eigenvalues greater than 1 and a scree plot were used to determine the number of retained factors(30). A condition with factor loading ≥ 0.40 was regarded as having a strong association(31), and one condition was assigned to the pattern with larger factor loading if its factor loadings were > 0.40 in more than one pattern when labeling patterns. To improve robustness, we excluded conditions with a prevalence $< 5.0\%$ (28).

Binary logistic regression was used to estimate the relationship between multimorbidity patterns and depressive symptoms, and to adjust for sociodemographic variables. We used IBM SPSS version 25.0 for all data analyses (IBM Corp., Armonk, NY, USA).

3. Results

3.1 General Characteristics of Participants

Tables 1 and 2 show the characteristics of participants with respect to depression and multimorbidity. Among the 1871 participants, 1,142 (61%) were women; most participants were 80–89 years old, accounting for 53.9%. Overall, the study population reported having a good degree of social support. Among all participants, 64.6% were considered to have depressive symptoms; those with depressive symptoms were more likely to be receiving home-based care and to have a primary school education and low social support scores. Differences with respect to sex, marital status, and age between participants with and without depressive symptoms was not significant. Multimorbidity was present in 64.7% of participants. Compared with people with no chronic physical conditions, those multimorbidity mainly lived at home and had higher social support scores.

Table 1
 Characteristics of the Study Participants According to Depression.

| Characteristic | N(%) | No depression, (%) | Depression, (%) | χ^2 | P-value |
|-----------------------------------|-------------|-----------------------|-----------------|----------|---------|
| Total | 1871(100.0) | 662(35.4) | 1209(64.6) | | |
| Care mode | | | | 10.093 | 0.001 |
| Home | 1067(57.0) | 345(32.3) | 722(67.7) | | |
| Facility | 804(43.0) | 317(39.4) | 487(60.6) | | |
| Sex | | | | 0.619 | 0.431 |
| Male | 729(39.0) | 250(34.3) | 479(65.7) | | |
| Female | 1142(61.0) | 412(36.1) | 730(63.9) | | |
| Age,years | | | | 4.997 | 0.172 |
| 60–69 | 123(6.6) | 36(29.3) | 87(70.7) | | |
| 70–79 | 345(18.4) | 116(33.6) | 229(66.4) | | |
| 80–89 | 1009(53.9) | 378(37.5) | 631(62.5) | | |
| ≥ 90 | 394(21.1) | 132(33.5) | 262(66.5) | | |
| Education levels | | | | 16.712 | 0.001 |
| Illiteracy | 656(35.0) | 243(37.0) | 413(63.0) | | |
| primary school | 473(25.3) | 140(29.6) | 333(70.4) | | |
| Middle school or technical school | 574(30.7) | 201(35.0) | 373(65.0) | | |
| Junior college or above | 168(9.0) | 78(46.4) | 90(53.6) | | |
| Marital status | | | | 1.350 | 0.245 |
| Divorced, widowed, never married | 1080(57.7) | 394(36.5) | 686(63.5) | | |
| Married | 791(42.3) | 268(33.9) | 583(66.1) | | |
| Children | | | | 1.834 | 0.176 |
| No | 78(4.2) | 22(28.2) | 56(71.8) | | |
| Yes | 1793(95.8) | 640(35.7) | 1153(64.3) | | |
| Income,CNY [†] | | | | 14.012 | 0.003 |
| ≤1800 | 460(24.6) | 177(38.5) | 283(61.5) | | |
| 1800–3499 | 375(20.0) | 121(32.3) | 254(67.7) | | |
| 3500–3999 | 239(12.8) | 63(26.4) | 176(73.6) | | |
| ≥ 4000 | 797(42.6) | 301(37.8) | 496(62.2) | | |
| Social support | | | | 101.347 | 0.000 |
| 12–31 | 58(3.1) | 12(20.7) | 46(79.3) | | |
| 32–50 | 706(27.7) | 156(22.1) | 550(77.9) | | |
| 51–84 | 1107(59.2) | 494(35.4) | 613(55.4) | | |
| † Chinese yuan. | | | | | |

Table 2
 Characteristics of Study Participants According to Multimorbidity.

| Characteristic | N(%) | Without multimorbidity(%) | Multimorbidity(%) | χ^2 | P-value |
|-----------------------------------|-------------|---------------------------|-------------------|----------|---------|
| Total | 1871(100.0) | 660(35.3) | 1211(64.7) | | |
| Care mode | | | | 5.255 | 0.022 |
| Home | 1067(57.0) | 353(33.1) | 714(66.9) | | |
| Facility | 804(43.0) | 307(38.2) | 497(61.8) | | |
| Sex | | | | 1.157 | 0.282 |
| Male | 729(39.0) | 268(36.8) | 461(63.2) | | |
| Female | 1142(61.0) | 392(34.3) | 750(65.7) | | |
| Age, years | | | | 7.821 | 0.050 |
| 60–69 | 123(6.6) | 47(38.2) | 76(61.8) | | |
| 70–79 | 345(18.4) | 106(30.7) | 239(69.3) | | |
| 80–89 | 1009(53.9) | 349(34.6) | 660(65.4) | | |
| ≥ 90 | 394(21.1) | 158(40.1) | 236(59.9) | | |
| Education levels | | | | 0.718 | 0.869 |
| Illiteracy | 656(35.0) | 235(35.8) | 421(64.2) | | |
| Primary school | 473(25.3) | 160(33.8) | 313(66.2) | | |
| Middle school or technical school | 574(30.7) | 203(35.4) | 371(64.6) | | |
| Junior college or above | 168(9.0) | 62(36.9) | 106(64.1) | | |
| Marital status | | | | 1.624 | 0.204 |
| Divorced, widowed, never married | 1080(57.7) | 368(34.1) | 712(65.9) | | |
| Married | 791(42.3) | 292(36.9) | 499(63.1) | | |
| Children | | | | 3.283 | 0.070 |
| No | 78(4.2) | 35(44.9) | 43(55.1) | | |
| Yes | 1793(95.8) | 625(34.9) | 1168(65.1) | | |
| Income, [†] CNY | | | | 4.603 | .203 |
| ≤1800 | 460(24.6) | 176(38.3) | 284(61.7) | | |
| 1800–3499 | 375(20.0) | 133(35.5) | 242(64.5) | | |
| 3500–3999 | 239(12.8) | 72(30.1) | 167(69.9) | | |
| ≥ 4000 | 797(42.6) | 279(35.0) | 518(65.0) | | |
| Social support | | | | 12.487 | 0.002 |
| 12–31 | 58(3.1) | 25(43.1) | 33(56.9) | | |
| 32–50 | 706(37.7) | 280(39.7) | 426(60.3) | | |
| 51–84 | 1107(59.2) | 355(32.1) | 752(67.9) | | |

[†] Chinese yuan.

3.2 Chronic Diseases and Depression

Of the 33 somatic conditions included in our study, 10 with a prevalence of >5% were included in the analysis. Table 3 (end of the document text file) shows the prevalence of chronic disease, depression under different conditions, and the relationship between chronic diseases and depression. Hypertension showed the highest prevalence in this population. Further, only hypertension had an association with the presence of depressive symptoms when occurring without multimorbidity. Most conditions were significantly associated with depression when co-occurring with other conditions, after adjusting for all potential confounding factors.

Table 3
Associations Between Chronic Diseases and Depression (N = 1871).

| Chronic Diseases | Prevalence, n(%) | | Depression Prevalence, n(%) | | Adjusted [†] OR [§] (95%CI) | | |
|--|------------------------|---------------------|-----------------------------|---------------------|---|---------------------------|---------------------------|
| | Without Multimorbidity | With Multimorbidity | Without Multimorbidity | With Multimorbidity | No Condition | Without Multimorbidity | With Multimorbidity |
| Hypertension | 106(16.1) | 911(75.2) | 57(3.0) | 614(32.8) | Reference | 0.601(0.377,0.957) | 1.516(1.132,2.030) |
| Diabetes | 16(2.4) | 396(32.7) | 7(0.3) | 275(14.7) | | 0.513(0.180,1.461) | 1.274(0.965,1.682) |
| Cardiovascular disease | 49(7.4) | 605(50.0) | 34(1.8) | 420(22.4) | | 1.178(0.600, 2.311) | 1.467(1.135,1.897) |
| CVD [¶] | 26(3.9) | 237(19.6) | 20(1.1) | 170(9.1) | | 1.678(0.627,4.493) | 1.666(1.191,2.331) |
| Cataract | 6(0.9) | 151(12.5) | 4(0.2) | 79(4.2) | | 1.167(0.186,7.311) | 0.451(0.307,0.662) |
| Severe vision loss | 0(0.0) | 105(8.7) | 0(0.0) | 63(3.4) | | ‡ | 0.902(0.564,1.442) |
| Rheumatoid arthritis | 6(0.9) | 151(12.5) | 0(0.0) | 118(6.3) | | ‡ | 0.935(0.659,1.326) |
| Intervertebral disc Disease | 3(0.5) | 114(9.4) | 2(0.1) | 76(4.1) | | 1.772(0.143,21.962) | 1.486(0.909,2.426) |
| Chronic low back pain | 0(0.0) | 134(11.1) | 0(0.0) | 78(4.2) | | ‡ | 0.708(0.455,1.102) |
| Osteoporosis | 7(1.1) | 164(13.5) | 4(0.2) | 96(5.1) | | 0.680(0.138,3.338) | 0.912(0.623,1.333) |
| [†] Participants without the condition were regarded as the reference group in all models. All patterns were adjusted for care mode, age, sex, marital status, education level, personal income, children, and social support. Boldface indicates statistical significance (P < .05). | | | | | | | |
| [‡] There were no patients with depression among participants with no multimorbidity. | | | | | | | |
| [§] Odds Ratio. | | | | | | | |
| [¶] Cerebrovascular disease | | | | | | | |

3.3 Patterns of Chronic Multimorbidity

Among the 10 diseases analyzed, we identified three patterns of chronic multimorbidity, which could explain 45.1% of the total variance (Table 4): a musculoskeletal pattern (including rheumatoid arthritis, intervertebral disc disease, and chronic low back pain), cardiometabolic pattern (including hypertension, diabetes, cardiovascular diseases, and CVD), and degenerative diseases pattern (including cataract, severe vision loss, and osteoporosis)

Table 4
Factor Loadings of the Three Multimorbidity Patterns for Each Disease

| Chronic Diseases and Parameters | Factor [†] | | |
|---|---------------------|-------------|--------------|
| | Factor1 | Factor2 | Factor3 |
| Rheumatoid arthritis | 0.52 | 0.25 | 0.16 |
| Intervertebral disc disease | 0.78 | 0.09 | -0.07 |
| Chronic low back pain | 0.76 | 0.06 | -0.15 |
| Hypertension | 0.01 | 0.71 | -0.11 |
| Diabetes | -0.07 | 0.62 | -0.04 |
| Cardiovascular disease | -0.01 | 0.55 | -0.22 |
| CVD | 0.14 | 0.45 | 0.26 |
| Cataract | -0.09 | 0.18 | -0.65 |
| Severe vision loss | 0.08 | 0.07 | -0.69 |
| Osteoporosis | 0.32 | 0.08 | -0.52 |
| Eigenvalue | 2.12 | 1.33 | 1.06 |
| Cumulative percentage | 21.2% | 34.5% | 45.1% |
| [†] Factor loadings indicate the strength of association between each variable and each factor, with a factor loading of ≥ 0.4 considered to be strong in this study (indicated in bold). | | | |
| [‡] Cerebrovascular disease. | | | |

3.4 Different Multimorbidity Patterns and Depression

Table 5 shows the results of binary logistic regression between multimorbidity patterns and depression. After adjusting for potential confounding variables, the increase in factor scores in cardiometabolic and degenerative disease patterns was associated with a high risk of depressive symptoms.

Table 5
Associations Between Multimorbidity Patterns with the Presence of Depressive Symptoms (N = 1871).

| Multimorbidity Patterns | Unadjusted | | Adjusted [†] | |
|---|-----------------|--------------------|-----------------------|--------------------|
| | OR [‡] | 95%CI [§] | OR | 95%CI |
| Musculoskeletal | 0.964 | 0.8761-1.061 | 0.992 | 0.896-1.099 |
| Cardiometabolic | 1.190 | 1.079-1.313 | 1.223 | 1.102-1.357 |
| Degenerative diseases | 1.157 | 1.053-1.272 | 1.185 | 1.071-1.311 |
| [†] All patterns were adjusted for care mode, age, sex, marital status, education level, personal income, children, and social support. Boldface indicates statistical significance (P < .05). | | | | |
| [‡] Odds Ratio. | | | | |
| [§] Confidence Interva. | | | | |

4. Discussion

In this study, the prevalence of both multimorbidity and depression was high and social support was associated with multimorbidity and depression. Hypertension, cardiovascular disease, CVD, and cataract had strong associations with depression when they co-occurred with other conditions. Compared with having a single disease, there were more diseases associated with depression in a multimorbid state. In addition, three patterns of multimorbidity were identified: a musculoskeletal pattern, cardiometabolic pattern, and degenerative disease pattern. Among these, the cardiometabolic and degenerative disease patterns were associated with a higher risk of the presence of depressive symptoms.

The prevalence of multimorbidity in this study was 64.7%, which is in line with the findings of Hu that older people in Chinese communities have rates of multimorbidity between 6.4% and 76.5%(8); however, our results were higher than the 41.56% found in communities of eastern China(32). Depression is known to be the most common psychological disorder among older adults. In the United States, approximately 15-20% of older adults experience depression each year(33). Studies that have investigated the prevalence of depression among older people in mainland China have reported depression rates ranging from 15.8-30.8%(34-36), probably owing to the use of different methodologies. The prevalence of depression was 64.6%. This may be because our participants were covered by long-term care insurance and had poor physical conditions, with most over age 80 years. Their physical functions were greatly reduced, but multimorbidity may share common pathologic pathways with mental disorders(37, 38). The impact of social support on multimorbidity and depression has

been reported. Social support is negatively related to depression(39, 40). In our research as well, social support scores were lower for people with multimorbidity and depression. Impaired social support and feelings of loneliness are considered to be risk factors for depression in older people(41, 42). When we performed regression analysis, social support was included as an adjustment variable, taking full account of the impact of social support on multimorbidity and depression.

Previous studies concerning the associations between chronic disease and depression have mostly focused on a single condition or the number of comorbid conditions. A large volume of literature has demonstrated that depression is associated with several somatic conditions such as hypertension, heart diseases, and stroke(43–45), which was also observed in our study. Indeed, the simultaneous presentation of diseases in one individual may have a multiplicative, rather than additive, effect on the individual's health(46). Thus, compared with those who have no chronic diseases or without multimorbidity, people with multimorbidity are indeed more prone to depressive symptoms.

The multimorbidity patterns in this study were similar to those observed previously, and common antecedents and disease pathways may explain these patterns. A systematic review found three major multimorbidity patterns among older adults living in Western countries, which are cardiovascular–metabolic, mental health, and musculoskeletal disorders(28). In China, a cohort study also identified four multimorbidity patterns: a cardiometabolic pattern, respiratory pattern, arthritic–digestive–visual pattern, and hepatic–renal–skeletal pattern(31). In our research, the musculoskeletal model includes chronic low back pain, rheumatoid arthritis, and intervertebral disc disease. Previous studies have also found the existence of this model, and all of them included at least one musculoskeletal disease(28). Musculoskeletal patterns or arthritis included in these patterns are often associated with the occurrence of depressive symptoms(47–49). In this study, there may be no correlation between the two owing to the low prevalence of related diseases; however, this warrants further investigation. The cardiometabolic pattern is the most widely described pattern in previous studies. The diseases included in this model differ in each study, but the core diseases are the same, such as heart disease, hypertension, diabetes, and others(28, 50). Moreover, the relationship between this model and depression has also been confirmed in many studies(13). Among the three multimorbidity patterns found, the cardiometabolic pattern had the strongest association with depression, which is consistent with previous studies. Degenerative diseases include cataract, severe vision loss, and osteoporosis. In previous studies, multimorbidity patterns including joint and eye diseases have been found(9, 31, 51, 52). Such multimorbidity patterns are not scarce in such studies; previous evidence supports an association between conditions in this pattern through factors such as inflammation, side effects of medications, and so on(53, 54). The strong correlation between bone diseases and eye diseases may permit the discovery of potential links. The differences in multimorbidity patterns across studies might be partly attributable to remarkable heterogeneity in the number, type, and assessment approach of chronic conditions as well as in characteristics of the study samples. However, common components have been identified.

In estimation of the three multimorbidity patterns and depression, two were found to be associated with depression, namely, the cardiometabolic and degenerative disease patterns. In addition, strong correlations were found between cardiovascular diseases and some degenerative diseases and depression in previous studies(55, 56). Further, the cardiovascular–degenerative disease pattern has been identified, and this pattern has the strongest association with poor HRQL and is the only pattern associated with poor HRQL in the mental health dimension(9). Some confirmed multimorbidity patterns and their overlap may indicate common underlying pathological mechanisms(52). In future research, these connections should be considered.

This is the first study of the association of multimorbidity patterns and depression among people covered by China's long-term care insurance. Our findings may be helpful for the improvement of China's long-term care insurance system and the optimization of service content. In addition, exploratory factor analysis was used to explore the multi-disease model and the oblimin rotation method was used; factors were allowed to be associated with each other, which is helpful in researching comorbidity between diseases(29, 57). Identifying specific disease patterns related to depression can help to improve understanding of the impact of multimorbidity on depression, not only focusing on the physical health of older people but also on mental health, which is equally important.

Our research also has some limitations. First, the cross-sectional nature of the study design does not allow causal inference of the observed associations. Thus, caution is needed when interpreting the findings. Second, some chronic diseases were ascertained based only on self-reported information, such that differential recall bias cannot be ruled out, with more severe diseases being more likely to be reported. Third, we did not consider the impact of disease severity; future research should incorporate more objective diagnoses and take disease severity into consideration.

5. Conclusions

In the present study, we found two of three different multimorbidity patterns to be associated with depression. Further, although certain physical conditions may not be associated with depression, they may have a strong correlation with depression after the formation of a specific disease pattern. Our study findings can help in exploring the possible interactions between different chronic diseases and to highlight mental health, which can improve approaches for managing chronic diseases as well as mental health in the older population. First, when assessing the nursing care level of older people with long-term care insurance, evaluation of their psychological status should be considered. Further, medical directors and physicians should pay greater attention to the mental health of the population with multimorbidity, to help prevent depression. Second, the psychological impact of patients' physical conditions should also be considered when treating depression. Finally, the impact of social support on physical and mental health should be emphasized in possible treatment.

Acronyms

CVD, cerebrovascular disease; AOR, adjusted odds ratio; CI, Confidence Interval; HRQL, health-related quality of life; PSSS, Perceived Social Support Scale; GDS-30, the 30-item Geriatric Depression Scale; CNY: Chinese yuan; OR, odds ratio.

Declarations

Ethics approval and consent to participate: This study was approved by the ethical committee of School of Public Health Fudan University (IRB# 2020-07-0840). The study was performed in accordance with the current institutional and state guidelines and regulations. Written informed consent was obtained from all participants. Informed consent of illiterate participants was obtained from legally authorized representative on their behalf.

Consent for publication: Not applicable.

Availability of data and materials: The datasets obtained and/or analyzed during the current study are available from the corresponding author on reasonable request.

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