Study on the trajectory of depression among middle-aged and elderly disabled people in China: Based on group-based trajectory model

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ABSTRACT

Background: Previous studies have shown that middle-aged and elderly adults with disabilities are at higher risk for depressive symptoms. However, there are few studies on the long-term trajectories of depressive symptoms in the Chinese middle-aged and elderly disabled population.

Objective: This study aimed to identify the different development trajectories of depressive symptoms and their influencing factors in middle-aged and elderly people with disabilities in China.

Methods: Using data from the China Health and Retirement Longitudinal Study (CHARLS) in 2011, 2013, 2015, and 2018, a longitudinal cohort was formed for the study. A total of 2053 participants underwent at least two measures of depressive symptoms, assessed using the Center for Epidemiological Studies Depression Scale (CES-D10), a depression symptom assessment scale. We constructed a Group-Based Trajectory Model (GBTM) to identify the development trajectory of depressive symptoms in 2053 middle-aged and elderly disabled individuals, screened the potential predictors using lasso regression, and analyzed the factors affecting the development trajectory of depression through multivariate logistic regression.

Results: We identified four depression symptom trajectories throughout the follow-up process: "low depressive symptom group", "worsening depressive symptom group", "relieved depressive symptom group", and "high depressive symptom group". We found that there were differences in basic characteristics among different subgroups of depression trajectory. However, middle-aged and elderly disabled women living in rural areas, with limited ADL or IADL, physical pain, poor self-reported health and self-reported memory, short sleep time, and no relatives and friends to take care of them were the key groups for the prevention and treatment of depressive symptoms.

Conclusion: There is heterogeneity in the trajectories of depressive symptoms in the Chinese middle-aged and elderly disabled population, it is necessary to focus on the characteristics of the trajectories of different subgroups.

1. Introduction

Population aging is one of the major social issues of universal concern in the world today. Mental health, as an important component of healthy aging strategy, has always been a hot research issue in the field of mental health at home and abroad (Li et al., 2023). Depression has become the most common mental disorder after Alzheimer's disease that seriously endangers the mental health of the elderly, and it tends to be more significant with the increase of aging problems. Disability usually refers to the difficulty or inability to perform tasks necessary for daily life, affecting social roles, and may be the result of physical,

emotional, cognitive or sensory limitations (Albrecht et al.). And depression, as one of the most common secondary disorders associated with disability, has a profound impact on the mental health of individuals through the interaction between health status, environmental factors and personal factors (Jung et al., 2021; Learnihan et al., 2022).

According to the second disability sampling survey in China in 2006, the disabled elderly accounted for 24.43% of all the elderly and 53.24% of the total disabled population (National bureau of statistics of, 2007). As per the data from the China Statistical Yearbook 2022, the population aged 45 years and above accounted for 43.43%, and the population aged 60 years and above accounted for 18.94% (National bureau of statistics

of, 2022). With the exacerbation of the aging problem, the number of middle-aged and elderly people with disabilities is also increasing, and the stock of disabled middle-aged and elderly people is large.

Older adults with disabilities are more likely to experience symptoms of depression than the general elderly population (de et al., 2016; Canoui-Poitrine et al., 2016). According to the 2013 China Health and Retirement Longitudinal Study (CHARLS), the detection rate of depressive symptoms among middle-aged and older adults (45 years and older) in China was 31.2% (Jia-sen & Wen-jun, 2017), while another study, also based on 2013 CHARLS data, showed that the detection rate of depressive symptoms among middle-aged and older adults with physical disabilities was as high as 46.1% (Yang et al., 2017), which was significantly higher than the overall detection rate of depressive symptoms among middle-aged and older adults, and the situation of depression among middle-aged and older adults with disabilities is not optimistic.

Existing research on depression among middle-aged and elderly disabled individuals in China is limited. The majority of relevant studies are regional surveys conducted primarily in Hong Kong and Taiwan (Chen et al., 2005; Chiu et al., 2005; Chou & Chi, 2005; Woo et al., 1994). There is a significant lack of nationwide research on depression symptoms among the middle-aged and elderly disabled population. Most previous studies on the relationship between depressive symptoms and disability have been based on cross-sectional surveys, without considering individual characteristics of depressive symptom change (Gao et al., 2009; Gong et al., 2018; Li et al., 2011; Mirza et al., 2016; Zhao et al., 2018). However, the evaluation of individual depression symptoms is influenced by individual subjective emotions and can change with the change of life course (Kessler & Bromet, 2013). This developmental change is not constant and heterogeneity exists in groups with different characteristics (Lai, 2009; Liu et al., 1997). Although some existing studies have noted the importance of different patterns of depressive symptom development, most of them have focused on community residents rather than on the middle-aged and elderly population with disabilities (He et al., 2019; Mallett et al., 2022; Tampubolon & Maharani, 2017). Therefore, exploring the different developmental trajectories of depressive symptoms in the Chinese middle-aged and elderly disabled population will facilitate a better understanding of the timing of the development of increased and decreased symptoms.

Most longitudinal studies generally use linear models or linear mixtures (Chou & Chi, 2000; Hsu, 2009). While linear mixed models are useful for accounting for variations in baseline depressive symptoms and temporal trends among individuals, they have limitations when it comes to identifying distinct developmental trajectories within a specific group of individuals. The Group-Based Trajectory Model (GBTM) is a valuable statistical approach that overcomes the limitations of linear mixed models in identifying long-term trajectories of depression. Unlike traditional models that estimate a mean value for the entire study population, GBTM is a finite mixture modeling technique that enables the estimation of multiple trajectories simultaneously. This approach is particularly advantageous as it allows for the identification of distinct subgroups with different developmental trajectories of depression within the population under study. By capturing the heterogeneity of individual trajectories, GBTM provides a more comprehensive understanding of the long-term patterns of depression in the population. (Nagin & Odgers, 2010).

Based on this, we focused on the middle-aged and elderly disabled people in China. Using GBTM model, the diversity of depression trajectory was revealed and the influencing factors were analyzed. It is helpful to formulate personalized intervention and treatment strategies according to the depression trajectory of different subgroups. According to the characteristics of different subgroups, we can identify high-risk groups more accurately. The purpose of this study is to improve the understanding of depression among middle-aged and elderly disabled people and provide practical strategies for prevention and intervention.

2. Methods

2.1. Study participants

This study used data from the China health and retirement longitudinal study (CHARLS) in 2011, 2013, 2015, and 2018. CHARLS is a national cohort survey, and the 2011 national baseline survey used a multistage sampling strategy. The survey covered 28 provinces, 150 counties/districts, and 450 villages/communities across China, and follow-up surveys were conducted in 2013, 2015, and 2018, respectively, to provide comprehensive information on the health status and related factors of the Chinese elderly population. The CHARLS study was approved by the Biomedical Ethics Review Committee of Peking University, and the participants were asked to sign informed consent (Zhao et al., 2014). In this manuscript, based on the exclusion of middle-aged and older adults who were < 45 years old at baseline and did not have physical, intellectual, visual, hearing, or speech disabilities, we further excluded the participants who lacked basic demographic information at baseline and those who only had baseline depression measurement, so as to ensure that each respondent included in the study had at least two years' survey data on depression symptoms. Finally, 2053 middle-aged and older adults with disabilities aged $\geq$ 45 years were included in the study (Fig. 1), 252 (12.27%) had two years of depressive symptom data, 507 (24.70%) had three years of depressive symptom data, and 1294 (63.03%) had four years of depressive symptom data.

2.2. Assessment of depressive symptoms

A condensed version of the Center for Epidemiological Studies Depression Scale (CES-D10) was used in this study to measure depressive symptoms. The CES-D10 scale has strong reliability and validity for measuring depressive symptoms in older adults as a quick screening tool for those symptoms (Chen & Mui, 2014; Cheng et al., 2006). The scale consists of 10 items: (1) bothered by small things, (2) have trouble concentrating, (3) feel depressed, (4) struggle to do anything, (5) have hope for the future, (6) feel afraid, (7) have trouble sleeping, (8) feel happy, (9) feel lonely, (10) can't move on with life. Each item was assigned a score of 0, 1, 2 and 3 depending on the option (two positively worded items were reverse coded). Respondents' depressive symptom scores were derived from the total scores of the above 10 items and ranged from 0 to 30, with higher scores indicating higher levels of depressive symptoms. Consistent with previous studies (Chen & Mui, 2014), we utilized a score of 12 as a threshold to assess the depressive status of participants.

2.3. Disability assessment

According to the questionnaire "Do you have the following disability problems", the participants made a self-report on disability, including the following four items: (1) physical disability, (2) brain damage/mental deficiency, (3) blindness or semi-blindness, (4) deafness or semi-deafness, and (5) dumb or severe stuttering. Participants with one of the above disabilities were selected and assessed as disabled people.

2.4. Covariates

2.4.1. Sociodemographic variables
The items were composed age (expressed by mean and standard deviation), sex (male, female), education level (illiteracy, primary school, middle school or above), adult education (participation or non participation), marital status (married/cohabiting, unmarried/separated), type of residence before age 16 (rural, urban) (He et al., 2019).

2.4.2. Health condition
According to the self-reported disability, the number of disabilities was divided into two groups (1 type, $\geq$ 2 types). ADL status was
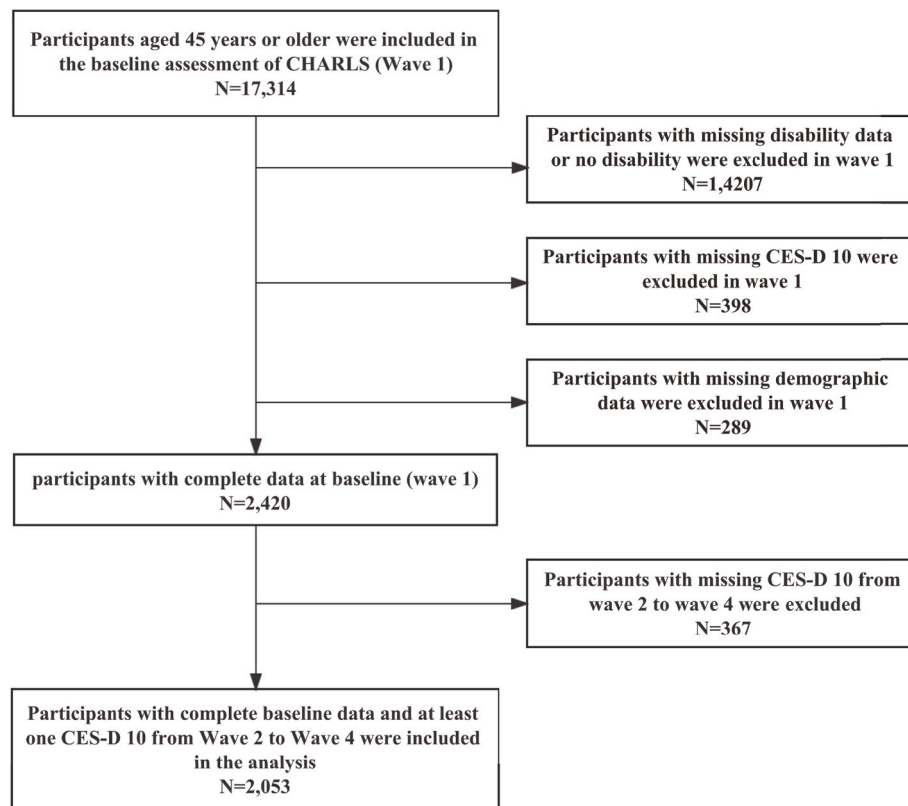
Fig. 1. Study design.

measured by six ADLs items (dressing, bathing, eating, getting on and off the bed, going to the toilet, controlling urination and defecation). IADL status was measured by five IADLs items (housework, food preparation, shopping, financial management and taking drugs). Each item provided four choices: (1) no difficulties, (2) some difficulty but doable, (3) some difficulty requiring help, and (4) unable to complete. Dividing each ADL and IADL items into 0 indicated that it was not difficult, and 1 indicated that it was difficult or impossible to implement (Lyu & Kim, 2016). That was, the range of IADL status score was 0–6, and the range of IADL status score was 0–5, which indicated the total number of physical limitations when performing ADL and IADL. In this study, ADL status and ADL status was further divided into three groups: No difficulty (0 score), Some difficulty (1–2 score) and severe difficulty (≥ 3 score) (Ferrucci et al., 1996). Chronic diseases were measured by the following questions: "Have you been diagnosed with by a doctor?" If you have one of the chronic diseases, you are considered to have chronic diseases. The results were divided into two groups (Have chronic diseases, No chronic diseases). Self-reported health was measured by the question "How to evaluate your health?". The answers included: (1) very good, (2) good, (3) fair, (4) poor, and (5) very poor. We divided these five items into three groups: good (item 1 combined with item 2), fair (item 3) and poor (item 4 combined with item 5). Self-reported memory status was measured by the question "How do you evaluate your memory?". The answers included: (1) excellent, (2) very good, (3) good, (4) fair, and (5) poor. We divided these five items into three groups: good (item 1 and item 2 combined with item 3), fair (item 4) and poor (item 5). Physical pain was divided into two groups (Pain, No pain) (He et al., 2019; Schoevers et al., 2000).

2.4.3. Health behavior

The items were composed sleep time (<6 h/day, 6–8 h/day, ≥ 8 h/day), smoking status (current smoker, former smoker, never smoker), and drinking status(current drinker, never drinker) (Sun et al., 2018).

2.4.4. Social support

Social support included emotional, behavioral and information support provided by family members, neighbors and friends (Lu et al., 2020). The social support of this study was measured by the question: "Can relatives (except spouse) or friends take care of you for a long time in daily life?" It was divided into two groups (someone takes care of you, no one takes care of you).

2.5. Statistical analyses

StataMP17, R4.2.1 and SPSS26 software were used for statistical analysis. Using GBTM to identify potential categories of changes in the development of depressive symptoms in the middle-aged and elderly disabled population. GBTM identifies individual categories with similar trajectories through the maximum likelihood estimation method, and identifies several subgroups with different trajectory types from the population. The primary outcome of the study was the CES-D10 scale score, which can be considered as approximately normal continuous-type data. Therefore, a censored normal model was used for fitting the trajectories in this study. Fitting in statistical software starts with fewer subgroups, each subgroup starts with a higher-order function, and if the higher-order function is not significant, it is removed and the lower-order function continues to be fitted. According to Bayesian information criterion (BIC), Akaike information criterion (AIC) and average posterior probability (AvePP), the optimal model is selected. The smaller BIC and AIC, the better the model is, and AvePP >0.7 indicates that the model is acceptable (Nagin). We used variance analysis of numerical variables and chi-square test of discrete variables to compare the baseline characteristics of participants with different depressive symptom trajectories. A logistic least absolute shrinkage and selection operator (LASSO) regression was used to select potential predictors to reduce multicollinearity. Then, we used 10-fold cross-validation to screen the best subset of predictive variables. According to the results of LASSO regression, multivariate Logistic regression model is used to determine

the predictive factors.

In order to test the robustness of the results, we conducted sensitivity analysis. Studies showed that the estimation of trajectory analysis of participants with three or more measurements was more stable (Nguena et al., 2020), so participants with four waves of depressive symptoms were selected to repeat the main analysis.

All statistical tests in this study were performed using a two-sided test, with $p < 0.05$ indicating that the difference was statistically significant.

3. Results

3.1. Sample characteristics

Among the 2053 participants included at baseline, the average age was 61.93 (standard deviation [SD] 9.74) years. Men (52.46%), spouses (82.03%), primary school graduates (44.03%) and people who lived in rural areas before the age of 16 (93.62%) accounted for the majority. A total of 1637 participants (79.74%) reported having one disability, and 416 participants (20.26%) reported having more than two disabilities (Table 1). The comparison of baseline characteristics between the

Table 1

Basic characteristics of different trajectory groups.

Variable	Total sample (n = 2053)	Trajectories group of depressive				P value
		Group1 (n = 1083)	Group2 (n = 378)	Group3 (n = 341)	Group4 (n = 251)	
Age (years), mean ± SD	61.93 ± 9.74	62.57 ± 10.04	60.69 ± 9.11	62.00 ± 9.57	60.96 ± 9.42	0.004
Sex, n (%)						< 0.001
Male	1077 (52.46)	662 (61.13)	182 (48.15)	150 (43.99)	83 (33.07)	
Female	976 (47.54)	421 (38.87)	196 (51.85)	191 (56.01)	168 (66.93)	
Residence, n (%)						< 0.001
Rural	1922 (93.62)	986 (91.04)	360 (95.24)	331 (97.07)	245 (97.61)	
Urban	131 (6.38)	97 (8.96)	18 (4.76)	10 (2.93)	6 (2.39)	
Educational level, n (%)						< 0.001
Illiterate	705 (34.34)	351 (32.41)	125 (33.07)	128 (37.54)	101 (40.24)	
Primary school	904 (44.03)	441 (40.72)	194 (51.32)	152 (44.57)	117 (46.61)	
Middle school or above	444 (21.63)	291 (26.87)	59 (15.61)	61 (17.89)	33 (13.15)	
Adult Education, n (%)						0.022
Yes	129 (6.28)	83 (7.66)	13 (3.44)	17 (4.99)	16 (6.37)	
No	1924 (93.72)	1000 (92.34)	365 (96.56)	324 (95.01)	235 (93.63)	
Marital status, n (%)						0.001
Married/cohabiting	1684 (82.03)	916 (84.58)	314 (83.07)	61 (76.54)	193 (76.89)	
Unmarried/separated	369 (17.97)	167 (15.42)	64 (16.93)	80 (23.46)	58 (23.11)	
Number of disabilities, n (%)						< 0.001
1	1637 (79.74)	909 (83.93)	295 (78.04)	248 (72.73)	185 (73.71)	
≥2	416 (20.26)	174 (16.07)	83 (21.96)	93 (27.27)	66 (26.29)	
ADL status, n (%)						< 0.001
No difficulty	1419 (69.12)	858 (79.22)	263 (69.58)	192 (56.30)	106 (42.23)	
Some difficulty	416 (20.26)	166 (15.33)	85 (22.49)	85 (24.93)	80 (31.87)	
Severe difficulty	218 (10.62)	59 (5.45)	30 (7.94)	64 (18.77)	65 (25.90)	
IADLstatus, n (%)						< 0.001
No difficulty	1260 (61.37)	781 (72.11)	232 (61.38)	161 (47.21)	86 (34.26)	
Some difficulty	498 (24.26)	214 (19.76)	99 (26.19)	97 (28.45)	88 (35.06)	
Severe difficulty	295 (14.37)	88 (8.13)	47 (12.43)	83 (24.34)	77 (30.68)	
Chronic disease, n (%)						< 0.001
Yes	1586 (77.25)	773 (71.38)	300 (79.37)	285 (83.58)	228 (90.84)	
No	467 (22.75)	310 (28.62)	78 (20.63)	56 (16.42)	23 (9.16)	
Physical pain, n (%)						< 0.001
Yes	963 (46.91)	343 (31.67)	182 (48.15)	233 (68.33)	205 (81.67)	
No	1090 (53.09)	740 (68.33)	196 (51.85)	108 (31.67)	46 (18.33)	
Self-reported health, n (%)						< 0.001
Good	314 (15.29)	241 (22.25)	43 (11.38)	18 (5.28)	12 (4.78)	
Fair	881 (42.91)	566 (52.26)	157 (41.53)	102 (29.91)	56 (22.31)	
Poor	858 (41.79)	276 (25.48)	178 (47.09)	221 (64.81)	183 (72.91)	
Self-reported memory, n (%)						< 0.001
Good	264 (12.86)	171 (15.79)	41 (10.85)	32 (9.38)	20 (7.97)	
Fair	783 (38.14)	499 (46.08)	126 (33.33)	96 (28.15)	62 (24.70)	
Poor	1006 (49.00)	413 (38.13)	211 (55.82)	213 (62.46)	169 (67.33)	
Sleep time, n (%)						< 0.001
1- h/day	743 (36.19)	277 (25.58)	151 (39.95)	167 (48.97)	148 (58.96)	
6- h/day	688 (33.51)	397 (36.66)	130 (34.39)	98 (28.74)	63 (25.10)	
8- h/day	622 (30.30)	409 (37.77)	97 (25.66)	76 (22.29)	40 (15.94)	
Smoking status, n (%)						< 0.001
Current smoker	699 (34.05)	409 (37.77)	124 (32.80)	109 (31.96)	57 (22.71)	
Former smoker	236 (11.50)	133 (12.28)	37 (9.79)	35 (10.26)	31 (12.35)	
Never smoker	1118 (54.46)	541 (49.95)	217 (57.41)	197 (57.77)	163 (64.94)	
Drinking status, n (%)						< 0.001
Current drinker	689 (33.56)	424 (39.15)	109 (28.84)	94 (27.57)	62 (24.70)	
Never drinker	1364 (66.44)	659 (60.85)	269 (71.16)	247 (72.43)	189 (75.30)	
Care of relatives and friends, n (%)						< 0.001
Yes	1398 (68.10)	796 (73.50)	263 (69.58)	210 (61.58)	129 (51.39)	
No	655 (31.90)	287 (26.50)	115 (30.42)	131 (38.42)	122 (48.61)	
CES-D score, mean ± SD	10.69 ± 7.05	6.15 ± 4.17	10.38 ± 4.31	18.56 ± 3.83	20.08 ± 4.75	< 0.001

Abbreviation: n: number, SD: standard deviation.

participants finally included in the analysis and those excluded due to missing data was shown in Supplementary Table 1.

3.2. Trajectories of depressive symptoms

The trajectories for the development of depressive symptoms were fitted considering different groups (1–5 groups) and functional forms (intercept, linear, square, cubic). Combined with its BIC (−22582.74), AIC (−22529.29) and Avepp (all >0.7), it was found that the model with four trajectories was the best (Supplementary Table 2). Therefore, we identified four different groups of depressive symptom trajectories throughout the follow-up (Fig. 2).

Group 1 had the highest number of middle-aged and elderly people with disabilities (n = 1083, 52.75%), whose CES-D scores remained low (all scores <12) and were therefore named the "low depressive symptom group". The CES-D scores of middle-aged and elderly persons with disabilities in group 2 (n = 378, 18.41%) showed a decreasing trend at the beginning of the survey and increased yearly after 2013 (score ≥ 12), suggesting a risk of clinical depressive symptoms, so they were named the "worsening depressive symptoms group". The CES-D scores of the middle-aged and elderly persons with disabilities in group 3 (n = 341, 16.61%) were at a high level at the beginning of the survey, but gradually decreased over time (score <12), indicating that the depressive symptoms of the middle-aged and elderly persons with disabilities in this group were in remission. Therefore, the group was named as "relieved depressive symptoms group". In contrast to group 1, the middle-aged and elderly disabled people in group 4 (n = 251, 12.23%) had consistently high CES-D scores (all scores ≥ 12) and were named the "high depressive symptom group" considering that their clinical depressive symptoms might be more severe.

3.3. Basic characteristics of trajectory grouping

Basic characteristics and univariate analysis results of middle-aged and elderly disabled people grouped according to different development tracks of depressive symptoms (Table 1). The results showed that there were differences between the study participants in each subgroup in terms of age, sex, type of residence before the age of 16, education level, adult education, marital status, number of disabilities, ADL status, IADL status, chronic disease, physical pain, self-reported health, self-reported memory, sleep time, smoking status, drinking status, and care of relatives and friends, all of which were statistically significant.
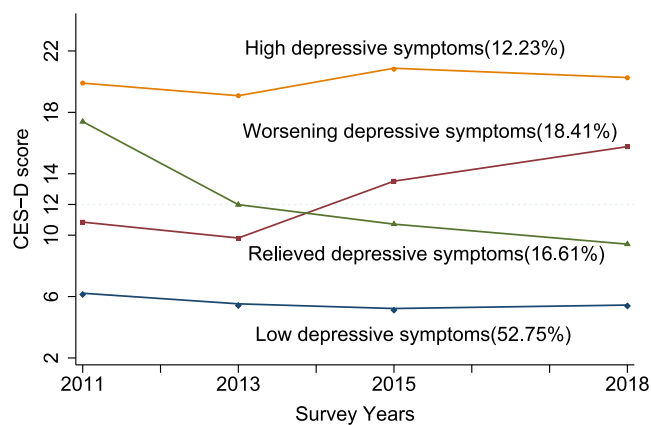

Fig. 2. Trajectories of depressive symptoms.

3.4. Logistic regression analysis of influencing factors of depression trajectory

LASSO regression was used to screen out 11 most potential predictors (age, sex, type of residence before the age of 16, marital status, ADL status, IADL status, physical pain, self-reported health, self-reported memory, sleep time, care of relatives and friends) (Supplementary Figs. 1 and 2). The above 11 predictors were used as independent variables, and the trajectory attribution category was included in the multivariate logistic regression analysis as the dependent variables (Fig. 3).

Using the "low depressive symptoms group" as a reference, multiple logistic regression analysis showed that there were some differences in population characteristics among different subgroups. Younger middle-aged and elderly people, who lived in rural areas before the age of 16, had poor self-reported health and self-reported memory, and unmarried/separated women who slept less than 6 h were more likely to be classified into "worsening depressive symptoms group". Younger middle-aged and elderly people, unmarried/separated women who lived in rural areas before the age of 16, had serious difficulties in IADL, physical pain, self-reported fair or poor health, slept less than 6 h and were not cared for by relatives and friends were more likely to be classified as "relieved depressive symptom group". Middle-aged and elderly women who were younger and lived in rural areas before the age of 16, had difficulties in ADL and IADL, physical pain, poor self-reported health, slept less than 6 h and had no relatives and friends to take care of them were more likely to be classified as "high depressive symptom group".

3.5. Sensitivity analysis

The trajectory of depressive symptoms calculated by sensitivity analysis of participants with four rounds of depressive symptoms measurement was similar to that in the main analysis (Supplementary Fig. 3). Using this trajectory classification, we further conducted multiple logistic regression and found the estimated value similar to the main analysis (Supplementary Table 3).

4. Discussion

China has the largest elderly population in the world, and the challenges and threats of aging population are relatively severe (Williams et al., 2017). In addition, the mental health problems of the elderly are particularly prominent (Fernández et al., 2018). As a special group, the depression rate of middle-aged and elderly people with disabilities is higher than that of ordinary middle-aged and elderly people, which should attract wide attention from the society. At present, most of the studies on depressive symptoms are aimed at the whole middle-aged and elderly population, and most of the studies on depressive symptoms of middle-aged and elderly disabled people are based on cross-sectional survey data, and there are few studies on the development trajectory of depressive symptoms of middle-aged and elderly disabled people in time series. Therefore, this study explored the developmental trajectories of depression and risk factors in the middle-aged and elderly disabled population in China based on the CHARLS data from 2011 to 2018.

The study identified four different trajectories of depressive symptoms, which were named "low depressive symptom group", "worsening depressive symptom group", "relieved depressive symptom group", and "high depressive symptom group". In this study, 52.75% of middle-aged and older adults with disabilities were classified in the "low depressive symptom group", with a stable trajectory of CES-D scores that remained in the depression-free zone (<12 scores). 18.41% of middle-aged and older adults with disabilities were classified in the "worsening depressive symptoms group", and the CES-D scores of this group were already close to the threshold at the beginning of the survey and increased
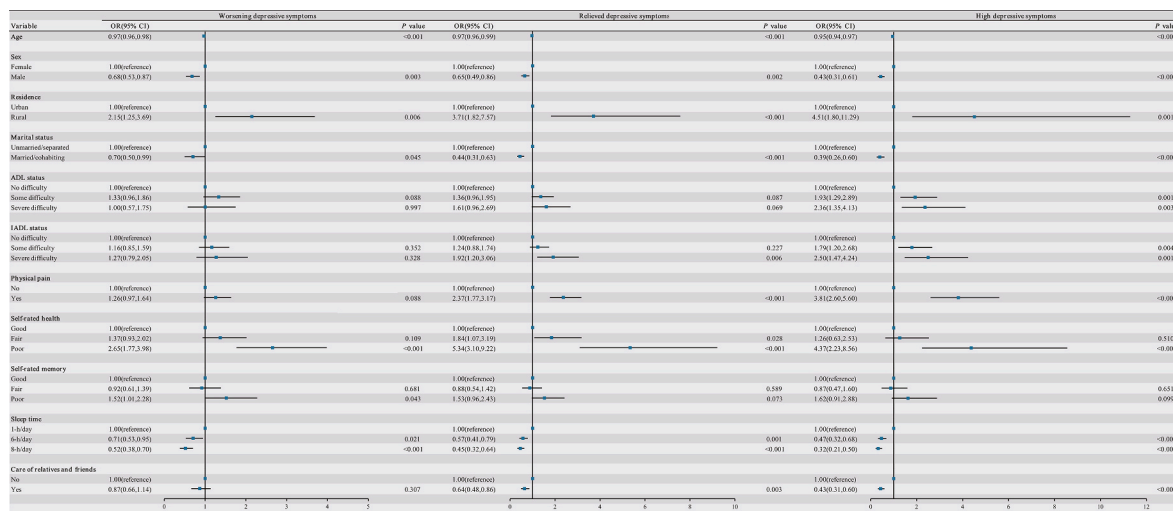
Variable	Worsening depressive symptoms OR(95% CI)	P value	Relieved depressive symptoms OR(95% CI)	P value	High depressive symptoms OR(95% CI)	P value
Age	0.97(0.96,0.98)	<0.001	0.97(0.96,0.99)	<0.001	0.95(0.94,0.97)	<0.001
Sex						
Female	1.00(reference)		1.00(reference)		1.00(reference)	
Male	0.68(0.53,0.87)	0.003	0.65(0.49,0.86)	0.002	0.43(0.31,0.61)	<0.001
Residence						
Urban	1.00(reference)		1.00(reference)		1.00(reference)	
Rural	2.15(1.25,3.69)	0.006	3.71(1.82,7.57)	<0.001	4.51(1.80,11.29)	0.001
Marital status						
Unmarried/separated	1.00(reference)		1.00(reference)		1.00(reference)	
Married/cohabiting	0.70(0.50,0.99)	0.045	0.44(0.31,0.63)	<0.001	0.39(0.26,0.60)	<0.001
ADL status						
No difficulty	1.00(reference)		1.00(reference)		1.00(reference)	
Some difficulty	1.33(0.96,1.86)	0.088	1.36(0.96,1.95)	0.087	1.93(1.29,2.89)	0.001
Severe difficulty	1.00(0.57,1.75)	0.997	1.61(0.96,2.69)	0.069	2.36(1.35,4.13)	0.003
IADL status						
No difficulty	1.00(reference)		1.00(reference)		1.00(reference)	
Some difficulty	1.16(0.85,1.59)	0.352	1.24(0.88,1.74)	0.227	1.79(1.20,2.68)	0.004
Severe difficulty	1.27(0.79,2.05)	0.328	1.92(1.20,3.06)	0.006	2.50(1.47,4.24)	0.001
Physical pain						
No	1.00(reference)		1.00(reference)		1.00(reference)	
Yes	1.26(0.97,1.64)	0.088	2.37(1.77,3.17)	<0.001	3.81(2.60,5.60)	<0.001
Self-rated health						
Good	1.00(reference)		1.00(reference)		1.00(reference)	
Fair	1.37(0.93,2.02)	0.109	1.84(1.07,3.19)	0.028	1.26(0.63,2.53)	0.510
Poor	2.65(1.77,3.98)	<0.001	5.34(3.10,9.22)	<0.001	4.37(2.23,8.56)	<0.001
Self-rated memory						
Good	1.00(reference)		1.00(reference)		1.00(reference)	
Fair	0.92(0.61,1.39)	0.681	0.88(0.54,1.42)	0.589	0.87(0.47,1.60)	0.651
Poor	1.52(1.01,2.28)	0.043	1.53(0.96,2.45)	0.073	1.62(0.91,2.88)	0.099
Sleep time						
1-h/day	1.00(reference)		1.00(reference)		1.00(reference)	
6-h/day	0.71(0.53,0.95)	0.021	0.57(0.41,0.79)	0.001	0.47(0.32,0.68)	<0.001
8-h/day	0.52(0.38,0.70)	<0.001	0.45(0.32,0.64)	<0.001	0.32(0.21,0.50)	<0.001
Care of relatives and friends						
No	1.00(reference)		1.00(reference)		1.00(reference)	
Yes	0.87(0.66,1.14)	0.307	0.64(0.48,0.86)	0.003	0.43(0.31,0.60)	<0.001

Fig. 3. Multivariate logistic regression analysis of depression trajectory grouping.

significantly in the subsequent follow-ups. 16.61% of middle-aged and older adults with disabilities were classified in the "relieved depressive symptom group" and had high CES-D scores at baseline. However, overtime, depressive symptoms in this group receded and CES-D scores decreased to the no depressive symptoms range (<12 scores). 12.23% of middle-aged and older adults with disabilities were classified in the "high depressive symptom group", and CES-D scores in this group remained high and relatively stable throughout the observation period ($\geq$ 12 scores). Studies have shown that the initial severity of depressive symptoms and long-term residual symptoms are predictors of mild and severe depression (Xiang, 2020). Therefore, the "high depressive symptom group" should be a priority target for depression prevention and treatment, and early screening and targeted interventions should be carried out to improve depressive status. The results of this study suggested that there was heterogeneity in the trajectory of depressive symptoms development among the middle-aged and older disabled population in China. It also indicated the importance of developing policies and interventions to improve the mental health of middle-aged and older adults with disabilities based on heterogeneous trajectories.

This study further explored the factors influencing the trajectories of depressive symptoms among middle-aged and older adults with disabilities. The results of multiple logistic regression showed that age, sex, type of residence before the age of 16, marital status, ADL status, IADL status, physical pain, self-reported health, self-reported memory, sleep time, and care of relatives and friends significantly affected the attribution of depressive symptoms of middle-aged and elderly disabled people (all $P < 0.05$). Demographically, male, older and having a spouse were protective factors for the presence of depressive symptoms in the middle-aged and older disabled population. Previous studies (Noh et al., 2016; Reisner et al., 2016) have shown that the detection rate of depressive symptoms is higher in women than in men at different ages and races. This may be related to women's own physical and psychological characteristics. Physiologically, middle-aged and elderly women are prone to irritability, anxiety and other emotions due to the special physiological period of menopause, which can lead to depressive symptoms; psychologically, women are emotionally delicate and sensitive and are easily affected by the external environment and experience mood swings (Slavich & Sacher, 2019; Wu et al., 2019), while men are less likely to be troubled by this and therefore less likely to experience depressive symptoms. The risk of depression decreases with increasing age. This may be related to the fact that quality of life and mental health issues are more prominent in middle-aged people with disabilities, while older people with disabilities may have adapted to and accepted disability status. Middle-aged people with disabilities may be burdened

with the dual pressures of work and family, as well as issues such as child independence and parental aging, and these pressures may contribute to depression. As people age, these pressures gradually decrease and they have more time and opportunities to engage in social and recreational activities, which have a positive impact on mental health (Wu et al., 2019). Compared with people with spouses, low social support can partly explain the increase of depression symptoms of those without spouses, because spouses, as the main source of individual social support, play an important role in promoting the mental health of the elderly (Bulloch et al., 2017). The type of residence being rural is a risk factor for depressive symptoms in middle-aged and older people with disabilities. The risk of depression is greater among middle-aged and older adults with disabilities living in rural areas, which is consistent with existing studies (Xin & Ren, 2022). Probably influenced by the difference in resource allocation between urban and rural areas, middle-aged and elderly people with disabilities living in rural areas are disadvantaged compared to urban middle-aged and elderly people with disabilities in terms of detection and treatment of depressive symptoms, economic level, education level, social participation, and health level.

In terms of health conditions, ADL or IADL limitation, physical pain, poor self-reported health and poor self-reported memory are risk factors for depression in middle-aged and elderly people with disabilities. Previous studies have shown that ADL limitation is related to depressive symptoms (Bowen & Ruch, 2015; Xie et al., 2018). Related research shows that relying on others in daily activities such as going to the toilet and taking a bath may lead to inferiority and psychological burden, which may lead to the occurrence of depressive symptoms. In addition, people with limited IADL are in poor physical condition, often worried about their own health, and their mood is worse than those without difficulties in IADL, and they are more likely to have depression and other states (Yaka et al., 2014). Physical pain is a powerful predictor of the onset and persistence of depression (Bair et al., 2003; Kroenke et al., 2008; Ohayon & Schatzberg, 2003). Chronic pain will interfere with daily activities and damage the quality of life, affect mood and then cause depression (Breivik et al., 2006; Fredheim et al., 2008). Self-reported health is an important influencing factor of depression and an important means to report physical and mental health. Previous studies have shown that people with poor self-reported health have more serious depressive symptoms, which indicates that self-reported health is also an important social determinant of mental health problems (Fan et al., 2021). Poor health may be a stressor, and their emotional distress and physical dysfunction may trigger and aggravate the occurrence and development of depressive symptoms (Ma et al., 2015; Zhang et al., 2018). In this study, self-reported memory is a

predictor of depression. It may be that in the state of depression, negative emotions will continue to fill the body and mind and distract attention, thus affecting the energy and concentration of doing things, resulting in poor memory and memory decline. Among health-related behaviors, sleep time is protective factors for depressive symptoms in middle-aged and older adults with disabilities. The risk of depression decreases with increasing sleep time, and the risk of depression is lowest in middle-aged and older people with disabilities who sleep ≥ 8 h/day. A study (Shandra et al., 2014) showed that people with disabilities themselves are less likely to get optimal sleep time compared to non-disabled people, thus attention should be paid to sleep aspects in the management of depressive symptoms in middle-aged and older people with disabilities. In terms of social support, related research found that support from friends or relatives (except spouses or children) has a significant and strong correlation with less depressive symptoms in the elderly, but it has nothing to do with young people (Fiori et al., 2006; Okun & Keith, 1998, pp. P4–P20). Perhaps relatives and friends can provide some emotional support, encouragement and companionship, which helps to reduce loneliness and emotional burden, thus reducing the risk of depressive symptoms. In this study, there are differences in the population characteristics of different depression trajectory groups, and personalized prevention and control measures can be taken for people with different trajectory characteristics. Synthesize the characteristics of each group, middle-aged and elderly disabled women who live in rural areas, have limited ADl or IADL, physical pain, poor self-reported health and self-reported memory, short sleep time, and have no relatives and friends to take care of them are the priority groups for preventing and treating depressive symptoms.

The main strength of this study is that it somewhat extends the understanding of the relationship between middle-aged and older Chinese people with disabilities and their depressive symptom trajectories in a Chinese socioeconomic and cultural context. Based on GBTM, the study examines the variety of depressive symptom trajectories. We were able to classify the trajectories using up to four depressive symptom assessments in the study. The characteristics and trends of different trajectory subgroups captured can help to formulate detailed intervention and support strategies to improve the mental health of middle-aged and elderly disabled people. In addition, the study is based on a big group-based cohort of Chinese individuals of middle-aged and older, thus the results are highly generalizable.

This study has several limitations that should be acknowledged. Firstly, the assessment of depressive symptoms relied on self-reported scales, which could induce information bias. Secondly, there may have been some selection bias due to the exclusion of participants who lacked baseline demographic data and had insufficient CES-D score data. Thirdly, our study primarily focused on the situation after depression had occurred among middle-aged and elderly disabled individuals, while overlooking their circumstances before the onset of depression, such as the relationship between disability and depression, which was also worth studying. Fourthly, this study did not make sufficient use of panel data, which may lead to potential endogeneity problems due to the presence of time-invariant variables. Lastly, the study sample was limited to participants from China, and therefore, the generalizability of the findings to other countries or populations remains uncertain.

5. Conclusions

There is heterogeneity in the developmental trajectories of depressive symptoms in the Chinese middle-aged and elderly disabled population, so it is necessary to focus on the characteristics of the developmental trajectories of different subgroups, which can help predict different risk factors and more accurately distinguish the populations at risk, with a view to providing more effective monitoring and interventions.

Data availability

Readers can obtain data and information by contacting the author via the author's email address.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2023.101510.

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