

# Trends and Determinants of Health Status of Chronically Ill Older Adults In China 2013–2020: A National Panel Data Analysis

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## Abstract

**Background:** With the accelerating ageing of the population and changes in the disease spectrum, demand for elderly care and healthcare continues to rise, placing significant pressure on public finances. Exploring the factors influencing the health of older people and identifying emerging trends has therefore become essential for improving their health and reducing expenditure on healthcare. **Objective:** Drawing on the CHARLS database, this study analyses differences in the health status of middle-aged and older adults across age groups from temporal, spatial and health measurement perspectives, with a view to providing new insights for improving the health of older people. **Methods:** By constructing panel data and employing a fixed-effects model, with ADL, CESD and SP designated as the three explanatory variables, this study examined the factors influencing the physical and mental health as well as social participation of older adults. **Results:** Regarding trends in the physical health status of middle-aged and older adults between 2013 and 2020, ADL scores were inversely correlated with physical health status; higher scores indicated poorer health. Regarding the mental health status of middle-aged and young older adults from 2013 to 2020, CESD scores were inversely proportional to mental health status; the higher the CESD score, the poorer the mental health status. With regard to social participation among this group during the same period, social participation scores were directly proportional to health status; the higher the score, the greater the level of social participation. **Conclusion:** This study examines the factors influencing the health of older adults from three dimensions, whilst also conducting a comparative analysis of the health status of older adults across different age groups. To improve the physical and mental health and social participation of older adults, efforts should be made to develop education for older adults, prioritise emotional communication and social recognition among them, and alleviate the psychological stress associated with loneliness.

## Keywords

Older people; Physical health; Mental health; Social participation.

## 1. Introduction

China currently houses the world's largest population of 1.4 billion (19.13% of the world population). In 2010, there were 111 million (8.2% of the country population) elderly aged 65+, among them 19.3 million were the oldest-old (aged 80+) [1]. With the total population aged 65 and over was about 191 million in 2020, accounting for 13.5% of the total population [2], China began to enter the stage of moderate aging gradually. According to the prediction of the United Nations [3-4], by the middle of the 21st century, the scale of China's elderly population will continue to expand, and the aging process will continue to accelerate and deepen. It is estimated that by 2035, China's population aged 65 and over will exceed 300 million and finally reach the

peak of the 21st century around 2058, with about 385 million people accounting for about 28.0% of the total population. United Nations data show that the growth rate of the elderly in China in the past decade is higher than the world average, and much higher than the average level of developing countries, indicating that China will soon appear "old before rich" situation. Furthermore, an increasing geriatric population is projected to augment the impending burden imposed by dementia [5], chronic renal disease [6], and their myriad risk factors, thereby presenting substantial challenges to both healthcare systems and economic structures [5, 7], which, in a cascading effect, may also exacerbate carbon emissions [8].

The aging process, accompanied by physiological and psychological changes, often leads to an increased vulnerability to various health conditions, thereby highlighting the critical need for a deeper understanding of the determinants and dynamics of health among the elderly. Maintaining a good level of health among the elderly is conducive to extending life expectancy, reducing health care expenditures, and promoting economic development [7, 9].

Although much attention has been paid to the health status of the elderly, a closer examination reveals certain gaps in the current research landscape. Initially, a multitude of cross-sectional investigations into the current status have been conducted [10-11], yet their inherent limitations due to the cross-sectional design only permit the provision of data at a specific point in time, precluding an analysis of long-term trends. Furthermore, there is a paucity of comprehensive age-stratified analyses within the elderly demographic [12-13], with notable disparities in physical, psychological, and social support needs observed among different age cohorts. The absence of detailed age-stratified analysis hinders the development and implementation of targeted intervention strategies for specific age groups of the elderly, thereby compromising the efficacy of health promotion and disease prevention initiatives. Lastly, there is a scarcity of research examining the trajectory of multi-year data [10-12], which complicates the accurate forecasting and timely response to shifts in the health challenges faced by the elderly.

In 2002, the World Health Organization (WHO) introduced the concept of active aging, which evolved from the notion of healthy aging. This concept emphasizes the importance of enhancing the quality of life for older adults as they age. The WHO's policy framework for achieving active aging encompasses three key elements: health, participation, and security. Health refers to a holistic view of health that transcends the traditional absence of disease, incorporating physical, mental, and social well-being into the assessment of overall health. By providing comprehensive healthcare services, this framework promotes the physical and mental health of older adults, thereby enhancing their overall quality of life. Participation entails actively engaging older adults in various aspects of socio-economic life and cultivating their interests and hobbies to maintain their connection with society, thereby reducing feelings of psychological loneliness and loss. Security ensures the basic livelihood protection for older adults, such as social security systems, elderly care services, and medical insurance. When older adults face risks in daily life, they can receive essential economic support, social care, and psychological support [14-16].

Active aging [17] offers a new approach to addressing the challenges of population aging. It drives the development of the "silver economy," where diversified elderly care needs facilitate economic and social transformation and upgrading. This includes establishing a system and standards for the allocation of developmental elderly care service facilities, tapping into the market potential of older adults, and promoting the development of industries such as the greater health industry, cultural tourism, and continuing education. By revitalizing existing resources, active aging achieves a mutually beneficial outcome for all parties involved. Furthermore, as society progresses, there is a growing focus on the mental health of the elderly. Active aging encourages older adults to participate in social activities, drawing sociologists' attention to their mental health and assisting policymakers in refining elderly psychological

education systems. By establishing strong connections between older adults and society, active aging fosters a sense of belonging among the elderly, thereby alleviating psychological pressures. Behind the implementation of active aging lies the support of digital technology, such as telemedicine, intelligent transportation, and e-commerce, which significantly enhances the convenience and quality of life for older adults [18].

Based on the global trend of population aging, scholars at home and abroad have conducted research on factors influencing the health of older adults from various perspectives. Małgorzata Dziechciaż and her colleagues (2014) [19] analyzed the complexity of factors affecting the quality of life and health status of older adults from biological, psychological, and social angles. They believed that psychological conditions are consistent with physical conditions, and as people age, psychological aging occurs, often leading to increased reliance on religious beliefs, which is an important factor affecting the health of older adults. These scholars also argued that continuous participation in social practices by older adults contributes to their physical and mental well-being. Adrian Bauman (2016) and his colleagues [20] emphasized that as global aging intensifies, there is a need to raise awareness about physical activity among older adults. While the concept of healthy aging has focused public attention on chronic diseases, it has overlooked the rising prevalence of psychological disorders among older adults. The authors stressed that physical activity helps prevent non-communicable diseases among older adults, reduces the incidence of psychological disorders, and enhances their overall health. Alexandra L. Harmell and her colleagues [21] examined factors influencing the health of older adults from the perspective of successful aging, analyzing various aspects such as psychology and policy. They believed that physical exercise, cognitively stimulating activities, and social participation (including active involvement in club activities, religious activities, and volunteer work) can intervene in the health of older adults. Laura Zapparoli and her colleagues [22] explored how the human brain copes with the aging process from the perspectives of motor cognition and neurophysiology, presenting a meta-analysis of 40 functional brain imaging studies. The results showed that motor control and age-related changes in brain activity interact, and as people age, they increasingly rely on the nervous system, which affects the execution of motor cognitive tasks. Exercise can mitigate the aging process of the brain and prevent the onset of neurological diseases such as Alzheimer's.

According to existing literature, scholars at home and abroad have mostly focused on the health of older adults in specific regions, with limited use of panel data for research on the overall population of older adults. This paper employs five-year panel data, not only presenting the overall trend in the health of older adults but also controlling for the time dimension to compare their health levels, enabling accurate identification of factors affecting their health and the proposal of intervention measures. This paper divides the health dimension into three levels: physical health, mental health, and social participation. Due to fundamental cultural differences between domestic and international environments, foreign scholars categorize social participation into different factors for individual research, such as volunteer activities, sports, and religious activities. In contrast, the scope of social participation in China is broader and cannot be subdivided. Therefore, scholars at home and abroad rarely include social participation as a separate dimension in the factors affecting health. Furthermore, this paper conducts research based on the background of active aging, which advocates for social participation among older adults, which requires a certain level of health. Therefore, this paper stratifies older adults by age to better study the health disparities among different age groups. The World Health Organization divides older adults into three stages: (1) early old age (60-74 years), (2) late old age (75-90 years), and (3) very old age (90 years and above). Dziechciaż M reviewed the basis for different scholars' classifications of age groups among older adults, such as retirement age and health status, with most scholars dividing older adults' health into three levels [19]. Since this paper is based on longitudinal data, the age composition of the elderly

population is mixed and shows trends. Therefore, based on a synthesis of scholars' classifications, this paper divides the elderly population into two groups: younger older adults (60-69 years) and middle-aged and older adults (70 years and above), to facilitate comparisons of social participation between these two groups.

## **2. Materials and Methods**

### **2.1. Data**

This study uses data from the China Health and Retirement Longitudinal Survey (CHARLS), which is conducted by the National School of Development of Peking University and jointly conducted by the China Social Science Survey Center of Peking University and the Youth League Committee of Peking University, to collect a set of high-quality micro-data representing households and individuals aged 45 and above in China. Used to analyze the problem of population aging in our country. CHARLS conducted preliminary surveys in Zhejiang and Gansu, two typical provinces in the east and west of China, in 2008, officially started the national baseline survey in 2011, and conducted follow-up surveys in 28 provinces, autonomous regions and municipalities across the country in 2013, 2015 and 2018 respectively. The project uses multi-stage sampling with PPS sampling at both the county/district and village sampling stages, and its sample size to date has covered 19,000 respondents in a total of 12,400 households. CHARLS database is the only large household survey data of the middle and old age in China, which has the characteristics of strict quality control, large sample size and strong representativeness, and provides rich demographic information, income and expenditure information and health information. It can provide data reference for economics, sociology, public health and other multidisciplinary studies. Thanks to its rigorous design, standardized implementation process and strict quality control, CHARLS database provides scientific data support for Chinese elderly health research and has become an important database for China's aging and health research, and has gradually played a role in serving the relevant decision-making of the Chinese government.

At present, the academic community does not have very strict standards for the age definition of the elderly. According to the classification standards of WHO, the starting point for the elderly in developed countries is 65 years old, and it is defined as 60 years old in developing countries [23]. As the largest developing country in the world, Article 2 of the Law on the Protection of the Rights and Interests of the Elderly passed in August 1996 clearly stipulates that the starting age of the elderly is 60 years old. Therefore, this study defines the starting age of the elderly as 60 years old based on the universal standard and the basic national conditions of China. At present, most studies on the elderly are regarded as a whole, but the elderly are not a homogenous group, and there are great differences in the physical conditions of the elderly in different ages. Although the academic community has not reached a consensus on the division of the age group of the elderly, most scholars believe that the age group between 60 and 69 belongs to the younger age group. The general characteristics of this group are good physical and mental conditions, economic independence, self-care, need activity places and participation opportunities, and strong desire for re-employment. Elderly people aged 70 and above are usually defined as middle and senior elderly people. In this stage, the visual and auditory organs of the elderly decline significantly, the tissue function and the body's ability to adapt to the normal environment gradually decline, and the self-care ability becomes worse, and some elderly people begin to need assistance from others or instruments. Therefore, in this study, the elderly aged 60-69 years old are defined as the young elderly, and the people aged 70 years and above are defined as the middle-aged elderly.

In this study, data from four follow-up surveys in CHARLS database in 2013, 2015, 2018 and 2020 were selected to measure physical and mental health status and social participation of

young and middle-aged elderly people respectively through ADL score CESD score and social participation frequency, and to compare the health differences of elderly people in different ages.

## 2.2. Variables

### 2.2.1. Measurement of Health

①Physical health This study assessed the degree of independence in the ability of older adults to perform activities of daily living using the Activities of Daily Living Score (ADL Score), which was proposed by Sidney Katz in 1963 and is effective in avoiding subjectivity and has a low measurement error. The general ADL score consists of two components: the Basic Activities of Daily Living (BADL) and the Instrumental Activities of Daily Living (IADL). In the CHARLS questionnaire, BADL is measured by asking respondents if they have six problems, including 'dressing, bathing, eating, going to the toilet, and controlling bowel movements'; IADL is measured by asking five other questions, namely, 'having difficulty with housework, cooking, shopping, money management, and taking medication.' Each question corresponds to the same four choices: (1) no difficulty; (2) difficult but can be done; (3) problematic and need help; (4) cannot be done', respondents who chose choices (1-4) were given scores ranging from 0-3, and the BADL and IADL scores were summed up to obtain the total ADL score. The ADL scores in this study ranged from 0-33, and the scores were inversely proportional to the physical health status of the respondents, i.e., the higher the ADL scores, the worse the physical health status of the respondents. In addition, respondents were defined as 'ADL-impaired' if they had difficulty choosing between BADL or IADL and needed help (choosing options ③-④).

②mental health This study measured the mental health of older adults using the Centre for Epidemiological Studies Depression Scale score (CESD), which was devised by Radloff in 1977 to evaluate the frequency of current depressive symptoms. The CHARLS questionnaire measures depressive symptoms by examining respondents' feelings and behaviours during the previous week through 10 questions. I'm sad about little things; I have a hard time concentrating when I do things; I feel low; I feel like I struggle to do anything; I feel hopeful about the future; I feel scared; I don't sleep well; I'm happy; I feel lonely; and I don't feel like I can go on with my life. Each question had four answers: (i) little or none (<1 day); (ii) not much (1-2 days); (iii) sometimes or half the time (3-4 days); and (iv) most of the time (5-7 days). In this study, the respondents were rated 0-3 for each of the options (i)-(iv) they chose, and all the scores of all the options were added up to get the final CESD scores. The CESD scores ranged from 0-30, and the scores were inversely proportional to the mental health status of the respondents. CESD scores range from 0 to 30, and the scores are inversely proportional to the respondents' mental health status, i.e., the higher the CESD score, the worse the mental health status, and the respondents with CESD scores of 10 or more are defined as "high risk of depression", while the rest of the respondents are defined as "low risk of depression".

③social participation In this study, the frequency of social participation (SP) was used to measure the social participation status of older adults, which was measured by the CHARLS questionnaire with the question, 'Have you participated in social activities in the past month?', and included 10 types of social participation to measure older adults' social participation status, which were categorised into three main forms of social participation. The first is recreation and leisure, which includes five forms: ① socialising with neighbours and friends; ② going to the community room to participate in activities such as mahjong, chess, cards, etc.; ③ going to the park or other places for dancing, fitness, qigong, etc.; ④ Participate in activities organised by associations, such as travelling, cycling, etc.; ⑤ Attending training courses or universities for the elderly. The second is the provision of free services, including: ⑥ Providing care and other assistance to relatives, friends and neighbours who do not live together; ⑦ Providing care and assistance to the sick or disabled who do not live together; and ⑧ Participating in volunteer activities or charitable activities. Finally, there are other forms of participation, which mainly

include two types: ⑨ participating in stocks or funds and other financial securities; and ⑩ surfing on the Internet. If the respondents did not participate in any of the above 10 categories, social participation was defined as 'no', and vice versa, social participation was defined as 'yes'. The frequency of social participation is positively related to the social participation status of the elderly; the higher the frequency of social participation, the higher the level of social participation of the elderly.

### 2.2.2 Independent variables

Based on previous studies, four categories of factors affecting the physical and mental health status and social participation of older persons were collected. The first category was socio-demographic characteristics, including schooling (illiterate or semi-literate, primary, secondary, high school, high school or university and above), gender, couples, chronic diseases, and urban and rural areas. The second category is lifestyle behavioural habits, including smoking and alcohol consumption. The third category is socio-economic status (SES), including average annual income ( $\leq 1000$  RMB,  $1001 \sim 6000$  RMB,  $> 6000$  RMB), pension, and work status. The fourth category is medical insurance, including urban workers' medical insurance, urban residents' medical insurance, the new rural cooperative medical system and urban and rural residents' medical insurance.

## 2.3. Fixed effect model

Using panel data, we built a panel dataset to explore the factors that influence elder adults' physical and mental health and social participation. Based on the panel data of the national health status of the elderly from 2013 to 2020, the fixed effect model was used for analysis:

$$ADL_{it} = \alpha_0 + \beta \sum (Socio_{it} + lifebehavior_{it} + SES_{it} + insurance_{it}) + \chi_j + \mu_t + \varepsilon_{it}$$

$$CESD_{it} = \alpha_0 + \beta \sum (Socio_{it} + lifebehavior_{it} + SES_{it} + insurance_{it}) + \chi_j + \mu_t + \varepsilon_{it}$$

$$Societypar_{it} = \alpha_0 + \beta \sum (Socio_{it} + lifebehavior_{it} + SES_{it} + insurance_{it}) + \chi_j + \mu_t + \varepsilon_{it}$$

In the above formula, ADL, CESD and social participation are the three explained variables of this study respectively,  $\alpha_0$  is the constant term,  $Socio_{it}$  represents the sociodemographic characteristic variable set, including variables such as schooling, gender, Couple, chronic disease and urban and rural areas.  $lifebehavior_{it}$  represents a characteristic variable of lifebehavior, including whether to drink or smoke.  $SES_{it}$  represents the characteristic variables of socio-economic status, including average yearly income, whether they receive pensions and whether they work.  $insurance_{it}$  represents the characteristic variable of medical insurance, including whether you have medical insurance for urban workers, whether you have medical insurance for urban residents, whether you have the new rural cooperative medical insurance and whether you have urban and rural resident medical insurance. In order to deal with the missing variables of city and year dimension in the model, this paper also introduces individual fixed effect and year fixed effect into the model, which are denoted by  $\chi_j$  and  $\mu_t$  respectively.  $\varepsilon_{it}$  is the error term.

## 3. Results

### 3.1. Characteristics of the respondents

Supplementary Table 1 displays the basic characteristics of sociodemographic characteristics, life behavior habit, SES (socioeconomic status), medical insurance of the elderly population by year.

**Table 1. Basic information of the survey sample of elderly people from 2013 to 2020**

| Variables                                          | Category                                       | Young elderly |              |              |              | Middle-aged and elderly people |              |              |              |
|----------------------------------------------------|------------------------------------------------|---------------|--------------|--------------|--------------|--------------------------------|--------------|--------------|--------------|
|                                                    |                                                | 2013          | 2015         | 2018         | 2020         | 2013                           | 2015         | 2018         | 2020         |
| Sociodemographic characteristics                   |                                                |               |              |              |              |                                |              |              |              |
| Schooling                                          | Graduate from primary school                   | 2309(50.21%)  | 1775(50.66%) | 2303(44.21%) | 2161(43.83%) | 897(38.85%)                    | 977(43.06%)  | 1390(49.17%) | 1214(49.49%) |
|                                                    | Graduate from the junior middle school         | 696(15.13%)   | 548(15.64%)  | 1041(19.98%) | 914(18.54%)  | 250(10.83%)                    | 267(11.77%)  | 382(13.51%)  | 322(13.13%)  |
|                                                    | Graduate from high school or Vocational school | 261(5.68%)    | 185(5.28%)   | 545(10.46%)  | 486(9.86%)   | 143(6.19%)                     | 147(6.48%)   | 209(7.39%)   | 130(5.30%)   |
|                                                    | College Degree or above                        | 85(1.85%)     | 52(1.48%)    | 56(1.08%)    | 46(0.93%)    | 55(2.38%)                      | 57(2.51%)    | 75(2.65%)    | 57(2.32%)    |
| Gender                                             | Male                                           | 2352(51.14%)  | 1801(51.40%) | 2639(50.66%) | 2435(49.39%) | 1228(53.18%)                   | 1200(52.89%) | 1506(53.27%) | 1279(52.14%) |
| Spouse                                             | Exist                                          | 4053(88.13%)  | 3034(86.59%) | 4562(87.58%) | 4233(85.86%) | 1570(67.99%)                   | 1601(70.56%) | 2003(70.85%) | 1670(68.08%) |
| Chronic disease                                    | Exist                                          | 3314(72.06%)  | 2542(72.55%) | 4387(84.22%) | 3962(80.37%) | 1654(71.63%)                   | 1701(74.97%) | 2501(88.47%) | 2073(84.51%) |
| Urban and rural                                    | Urban                                          | 1071(23.29%)  | 745(21.26%)  | 1209(23.21%) | 847(17.18%)  | 668(28.93%)                    | 627(27.63%)  | 833(29.47%)  | 516(21.04%)  |
| life behavior habit                                |                                                |               |              |              |              |                                |              |              |              |
| Smoking                                            | Exist                                          | 1746(37.96%)  | 1179(33.65%) | 1555(29.85%) | 1367(27.73%) | 886(37.51%)                    | 680(29.97%)  | 696(24.62%)  | 631(25.72%)  |
| Drinking                                           | Exist                                          | 1645(35.77%)  | 1274(36.36%) | 1842(35.36%) | 1745(35.40%) | 656(28.41%)                    | 653(28.78%)  | 864(30.56%)  | 784(31.96%)  |
| SES (socioeconomic status)                         |                                                |               |              |              |              |                                |              |              |              |
| Average yearly income                              | ≤1000 yuan                                     | 2783(60.51%)  | 2952(84.25%) | 1879(36.07%) | 1009(20.47%) | 1286(55.70%)                   | 1967(86.69%) | 974(34.45%)  | 531(21.65%)  |
|                                                    | 1001~6000 yuan                                 | 545(11.85%)   | 224(6.39%)   | 1515(29.08%) | 2335(47.36%) | 370(16.02%)                    | 213(9.39%)   | 943(33.36%)  | 1235(50.35%) |
| Draw the pension                                   | Yes                                            | 3219(69.99%)  | 2500(71.35%) | 3995(76.69%) | 3820(77.48%) | 1875(81.20%)                   | 1708(75.28%) | 2357(83.37%) | 1920(78.27%) |
|                                                    | Work                                           | 2982(64.84%)  | 2212(63.13%) | 3267(62.72%) | 1005(20.39%) | 846(36.64%)                    | 849(37.42%)  | 1131(40.01%) | 169(6.89%)   |
| medical insurance                                  |                                                |               |              |              |              |                                |              |              |              |
| The Urban Employee Basic Medical Insurance (UEBMI) | Exist                                          | 638(13.87%)   | 459(13.10%)  | 760(14.59%)  | 519(10.53%)  | 385(16.67%)                    | 370(16.31%)  | 546(19.31%)  | 350(14.27%)  |
| The Urban Resident Basic Medical Insurance (URBMI) | Exist                                          | 243(5.28%)    | 171(4.88%)   | 230(4.42%)   | 397(8.05%)   | 128(5.54%)                     | 121(5.33%)   | 110(3.89%)   | 202(8.23%)   |
| The New Rural Cooperative Medical Scheme (NRCMS)   | Exist                                          | 3390(73.71%)  | 2506(71.52%) | 3362(64.54%) | 165(3.35%)   | 1545(66.91%)                   | 1457(64.21%) | 1628(57.59%) | 72(2.94%)    |
| The Urban-Rural Resident Medical Insurance (URRMI) | Exist                                          | 99(2.15%)     | 73(2.08%)    | 661(12.69%)  | 3558(72.17%) | 53(2.30%)                      | 39(1.72%)    | 334(11.81%)  | 1565(63.80%) |

For the sociodemographic characteristics of the subjects, In terms of schooling, the proportion of illiterate or semi-literate young and middle-aged elderly people decreased gradually, from 27.14% and 41.75% in 2013 to 26.84% and 29.76% in 2020, respectively.. At the same time, the proportion of young elderly people with higher education (graduate from high school or vocational school and college degree or above) has increased, from 7.53% in 2013 to 8.57% in 2020. The proportion of middle-aged and elderly people with higher education (graduate from high school or vocational school and college degree or above) has increased, from 8.57% in 2013 to 10.04% in 2018. But the proportion of middle-aged elderly people with higher education (graduate from high school or vocational school and college degree or above) has declined, from 10.04% in 2018 to 7.62% in 2020. A total of 15146 (83.03%) of the young elderly had couples, and 6666 (67.62%) of the middle and senior elderly had couples. Chi-square test results showed that there were significant differences in the proportion of Couples between the two groups ( $\chi^2=874.6824$ ,  $p=0.000$ ). A total of 22,134 elderly people (78.77%) were suffering from chronic diseases, including 14,205 young elderly people (77.87%) and 7929 middle-aged elderly people (80.43%). Chi-square test results showed significant differences ( $\chi^2=25.1254$ ,  $p=0.000$ ). With the development of time, the proportion of chronic diseases in the younger and middle aged elderly people has increased, from 72.06% and 71.63% in 2013 to 84.22% and 88.47% in 2020, respectively. But the proportion of chronic diseases in the younger and middle aged elderly people has declined, from 84.22% and 88.47% in 2018 to 80.37% and 84.51% in 2020, respectively.

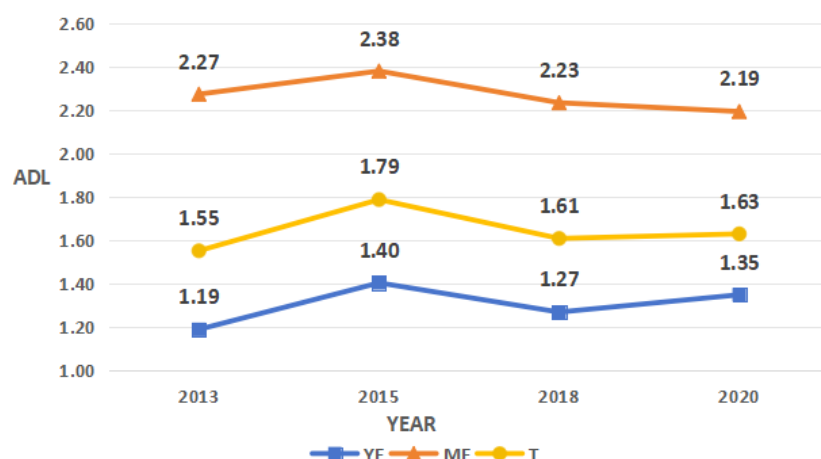
For life behavior habits, among all the old people, 8720 people (31.03%) smoked, including 5847 young old people (32.05%) and 2873 middle-aged elderly people (29.14%), with significant differences between the two groups ( $\chi^2=25.2962$ ,  $p=0.000$ ). From 2013 to 2020, the proportion of young and middle-aged elderly people smoking has declined, from 37.96% and 37.51% in 2013 to 27.73% and 25.72% in 2020, respectively. The total number of elderly people with drinking habits is 9463 (33.68%), among which 6506 young elderly people (35.66%) and 2957 middle-aged elderly people (30.00%) are the majority, and there is a significant difference between the two groups ( $\chi^2=92.0824$ ,  $p=0.000$ ).

For SES (socioeconomic status), Among all the old people, the total number of pensioners is 21,394 (76.14%), among which 13,534 are young (74.19%) and 7,860 are middle-aged (79.73%), and there is a significant difference between the two groups ( $\chi^2=108.1315$ ,  $p=0.000$ ). In terms of work, a total of 9466 young people (51.89%) have works, while 2995 middle-aged elderly people (30.38%) have works, and the difference between them is statistically significant ( $\chi^2=1.2e+03$ ,  $p=0.000$ ). With the development of time, the proportion of young elderly people working fluctuates has declined, from 64.84% in 2013 to 20.39% in 2020. The proportion of middle-aged elderly people working fluctuates has increased, from 36.64% in 2013 to 40.01% in 2018. But the proportion of middle-aged elderly people working fluctuates has declined, from 40.01% in 2013 to 6.89% in 2020.

For medical insurance, as for the medical insurance for urban residents, a total of 1602 elderly people (5.70%) have this insurance, among which 1041 young elderly people (5.71%) and 561 middle-aged elderly people (5.69%), with significant differences between them ( $\chi^2=0.0030$ ,  $p=0.957$ ). In addition, both rates showed roughly the same trend over time, gradually increasing from 2013 to 2018 and then decreasing from 2018 to 2020. The new rural cooperative medical insurance is the medical insurance with the highest coverage among the elderly, with a total of 14,125 people (50.27%) having this kind of medical insurance, of which 9423 people (51.66%) are younger. The elderly are relatively low, and 4702 people (accounting for 47.70%) have this insurance, and the difference is significant ( $\chi^2=40.1076$ ,  $p=0.000$ ). From the perspective of development trend, the coverage ratio of the new rural cooperative medical system in the elderly population shows an increasing trend, among which the young elderly people declined from 73.71% in 2013 to 3.35% in 2020, and the middle-aged and elderly people declined from 66.91% to 2.94%.

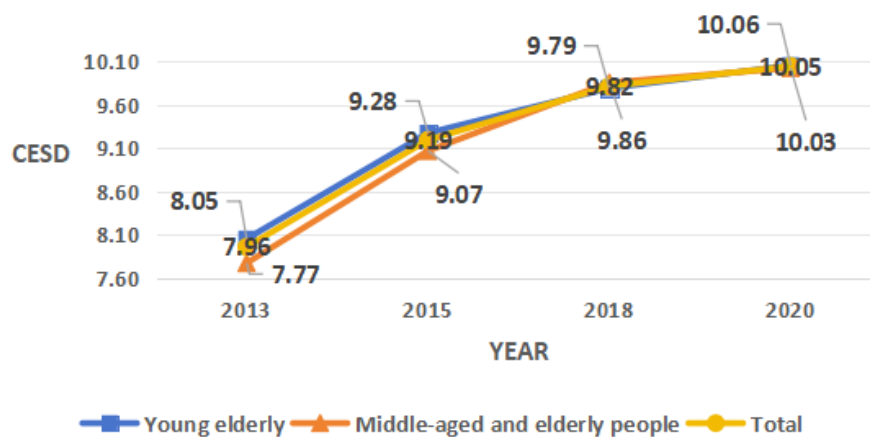
### 3.2. Physical health, mental health and social participation 2013–2020

Figure 1 shows the trend in physical health of young and middle-aged older people from 2013 to 2020, with ADL scores being inversely related to physical health, with higher scores being associated with poorer health. By age stratum, the physical health of young older adults is generally better than that of middle-aged and older adults. The physical health status of the elderly at the same point showed unstable fluctuations; in 2015, the highest values of ADL scores were observed in both young and middle-aged elderly, 1.40 and 2.38, respectively, with the worst physical health status; in 2013, the lowest values of ADL scores were observed in both young and middle-aged elderly, 1.19 and 2.27, respectively, with the best physical health status; and 2020 may be affected by the In 2020, possibly due to the new crown epidemic, ADL scores are again on the rise, and the health of the elderly is deteriorating.



**Figure 1.** Trends of Physical Health Condition 2013-2020

Figure 2 shows the mental health status of young and middle-aged older people from 2013 to 2020, and the CESD score is inversely proportional to the mental health status of older people; the higher the CESD score, the worse the mental health status of older people. By age stratum, the mental health status of middle-aged and elderly people is generally better than that of young elderly people, probably because young elderly people have just faced retirement and cannot adapt to post-retirement life as soon as possible, and they are prone to a sense of loss of their own value, which leads to psychological stress. Overall, the CESD scores of young and middle-aged older adults show a rising trend year by year, with young older adults increasing from 8.05 in 2013 to 10.06 in 2020, and middle-aged older adults increasing from 7.77 in 2013 to 10.03 in 2020, suggesting that older adults' mental health is gradually getting worse, and that there is not a big difference between the CESD scores of young older adults and middle-aged older adults in 2020. The difference between the CESD scores of young and middle-aged people in 2020 is not significant, indicating that all groups of older people face greater psychological pressure and that the mental health of older people should be taken seriously and paid attention to.



**Figure 2.** Trends of Mental Health Status 2013-2020

Figure 3 shows the social participation of young and middle-aged older persons from 2013 to 2020, with social participation scores positively related to the health of older persons; the higher the score, the higher the level of social participation of older persons. By age stratum, the social participation rate of young older people is better than that of middle-aged older people, probably due to the fact that younger older people are more able to participate in more social activities in terms of their physical functioning, and thus have a higher level of social participation. Overall, the social participation rate of older people is on a downward trend and shows similar erratic fluctuations, with the highest social participation in 2013 and the lowest in 2020, probably due to the impact of the new Crown Pneumonia epidemic at the end of 2020, which left most older people in isolation at home, and therefore with a lower level of social participation.

### 3.3. Fixed effect model of Physical health, mental health and social participation

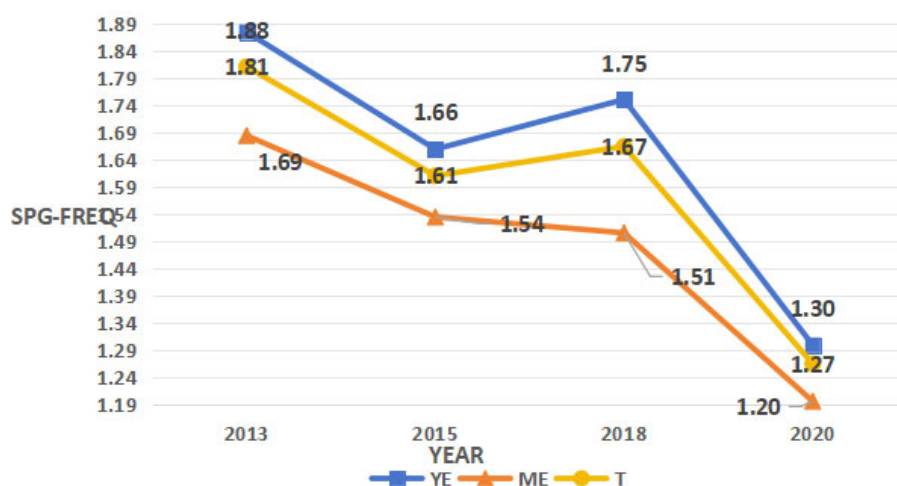
Table 2 shows that the ADL scores of young and middle aged elderly people are taken as dependent variables, sociodemographic characteristics, life behavior habits, socioeconomic status and medical insurance are taken as independent variables to be incorporated into the fixed-effect model, time dummy variables are added to control the time effect, and robust standard error is used to control the heterovariance. The results indicated that education level, gender, chronic diseases, place of residence, smoking, drinking, logarithm of annual average

income, employment, urban employee medical insurance, and urban and rural residents' medical insurance, all with P values less than 0.05, are the primary factors affecting the health of young-old adults. In contrast, education, chronic diseases, place of residence, smoking, drinking, logarithm of annual average income, pension, employment, urban residents' medical insurance, and urban and rural residents' medical insurance, all with P values less than 0.05, are the primary factors influencing the health of middle-aged elderly individuals.

**Table 2.** Fixed effect model of Physical health of young elderly and middle-aged and elderly people, 2013-2020

| Variables                                | Category                                      | Total  |          |       | Young elderly |          |       | Middle-aged and elderly people |          |       |
|------------------------------------------|-----------------------------------------------|--------|----------|-------|---------------|----------|-------|--------------------------------|----------|-------|
|                                          |                                               | Coef.  | Sta. Err | P     | Coef.         | Sta. Err | P     | Coef.                          | Sta. Err | P     |
| Sociodemographic characteristics         |                                               |        |          |       |               |          |       |                                |          |       |
| Schooling(Control group = illiterate)    | Graduate from primary school                  | -0.562 | 0.056    | 0.000 | -0.422        | 0.062    | 0.000 | -0.657                         | 0.108    | 0.000 |
|                                          | Graduate from the junior middle school        | -0.859 | 0.074    | 0.000 | -0.603        | 0.082    | 0.000 | -1.079                         | 0.148    | 0.000 |
|                                          | Graduate from high school or secondary school | -1.115 | 0.083    | 0.000 | -0.828        | 0.087    | 0.000 | -1.459                         | 0.186    | 0.000 |
|                                          | College or above                              | -1.367 | 0.153    | 0.000 | -1.038        | 0.133    | 0.000 | -1.736                         | 0.283    | 0.000 |
| gender(Control group = Female)           | Male                                          | 0.264  | 0.059    | 0.000 | 0.199         | 0.070    | 0.005 | 0.105                          | 0.107    | 0.329 |
| Spouse(Control group = Without)          | Exist                                         | -0.226 | 0.060    | 0.000 | -0.034        | 0.070    | 0.628 | -0.081                         | 0.099    | 0.414 |
| Chronic disease(Control group = Without) | Exist                                         | 1.011  | 0.041    | 0.000 | 0.842         | 0.043    | 0.000 | 1.358                          | 0.087    | 0.000 |
| Urban and rural(Control group = Rural)   | Urban                                         | -0.356 | 0.082    | 0.000 | -0.359        | 0.090    | 0.000 | -0.322                         | 0.158    | 0.042 |
| life behavior habit                      |                                               |        |          |       |               |          |       |                                |          |       |
| Smoking(Control group = Without)         | Exist                                         | -0.178 | 0.052    | 0.001 | -0.132        | 0.059    | 0.024 | -0.207                         | 0.101    | 0.041 |
| Drinking(Control group = Without)        | Exist                                         | -0.395 | 0.045    | 0.000 | -0.303        | 0.051    | 0.000 | -0.512                         | 0.087    | 0.000 |
| SES (socioeconomic status)               |                                               |        |          |       |               |          |       |                                |          |       |
| Logarithm of annual average income       |                                               | -0.046 | 0.008    | 0.000 | -0.036        | 0.008    | 0.000 | -0.079                         | 0.018    | 0.000 |
| Draw the pension(Control group = No)     | Yes                                           | -0.079 | 0.059    | 0.181 | -0.01         | 0.062    | 0.871 | -0.265                         | 0.131    | 0.042 |
| work(Control group = Without)            | Exist                                         | -1.524 | 0.052    | 0.000 | -1.262        | 0.064    | 0.000 | -1.695                         | 0.093    | 0.000 |
| UEBMI(Control group = Without)           | Exist                                         | -0.425 | 0.098    | 0.000 | -0.486        | 0.106    | 0.000 | -0.205                         | 0.174    | 0.239 |
| URBMI(Control group = Without)           | Exist                                         | -0.313 | 0.112    | 0.005 | -0.101        | 0.126    | 0.422 | -0.563                         | 0.204    | 0.006 |
| NRCMS(Control group = Without)           | Exist                                         | 0.035  | 0.097    | 0.720 | 0.150         | 0.110    | 0.171 | -0.009                         | 0.173    | 0.958 |
| URRMI(Control group = Without)           | Exist                                         | -0.349 | 0.103    | 0.001 | -0.255        | 0.112    | 0.023 | -0.323                         | 0.191    | 0.091 |
| Constant                                 |                                               | 2.810  | 0.120    | 0.000 | 2.112         | 0.136    | 0.000 | 3.380                          | 0.214    | 0.000 |
| Observations                             |                                               | 28100  |          |       |               | 18242    |       |                                | 9858     |       |
| R-squared                                |                                               | 0.078  |          |       |               | 0.068    |       |                                | 0.076    |       |
| Year FE                                  |                                               | YES    |          |       |               | YES      |       |                                | YES      |       |

Notes: Robust standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1



**Figure 3.** Trends of Social Participation 2013-2020

The higher the education level (Coef.= -1.038), the urban area of residence (Coef. =-0.359), the habit of smoking (Coef.= -0.132) and drinking (Coef.= -0.303), the higher logarithm of annual average income (Coef.= -0.036), the possession of a job (Coef.= -1.262), urban employee medical insurance (Coef.= -0.486), or urban and rural residents' medical insurance (Coef. = -0.255) among young-old adults, the lower their ADL scores, indicating better physical condition. Conversely, male (Coef.= 0.199) or those suffering from chronic diseases (Coef.= 0.842) among middle-aged elderly people have higher ADL scores, suggesting poorer physical condition.

The higher the education level (Coef. = -1.736) among middle-aged elderly individuals, the more likely they are to reside in urban areas (Coef. = -0.322) and have habits of smoking (Coef. = -0.207) and drinking (Coef. = -0.512). Additionally, a higher logarithm of annual average income (Coef. = -0.079), possession of a job (Coef. = -0.265), and having either urban residents' medical insurance (Coef. = -0.563) or urban and rural residents' medical insurance (Coef. = -0.323) are associated with lower ADL scores, indicating better physical condition. Conversely, among middle-aged elderly individuals, those suffering from chronic diseases (Coef. = 1.358) tend to have higher ADL scores, which suggests poorer physical condition.

**Table 3.** Fixed effect model of mental health of young elderly and middle-aged and elderly people, 2013-2020

| Variables                                | Category                                      | Total  |          |       | Young elderly |          |       | Middle-aged and elderly people |          |       |
|------------------------------------------|-----------------------------------------------|--------|----------|-------|---------------|----------|-------|--------------------------------|----------|-------|
|                                          |                                               | Coef.  | Sta. Err | P     | Coef.         | Sta. Err | P     | Coef.                          | Sta. Err | P     |
| Sociodemographic characteristics         |                                               |        |          |       |               |          |       |                                |          |       |
| Schooling(Control group = illiterate)    | Graduate from primary school                  | -0.110 | 0.087    | 0.209 | -0.273        | 0.112    | 0.015 | 0.054                          | 0.143    | 0.706 |
|                                          | Graduate from the junior middle school        | -0.389 | 0.109    | 0.000 | -0.587        | 0.136    | 0.000 | -0.157                         | 0.190    | 0.409 |
|                                          | Graduate from high school or secondary school | -0.461 | 0.132    | 0.000 | -0.733        | 0.161    | 0.000 | 0.017                          | 0.237    | 0.943 |
|                                          | College or above                              | -0.649 | 0.190    | 0.001 | -0.651        | 0.259    | 0.012 | -0.597                         | 0.280    | 0.033 |
| gender(Control group = Female)           | Male                                          | -1.635 | 0.083    | 0.000 | -1.534        | 0.108    | 0.000 | -1.733                         | 0.136    | 0.000 |
| Spouse(Control group = Without)          | Exist                                         | -0.685 | 0.091    | 0.000 | -1.024        | 0.133    | 0.000 | -0.488                         | 0.131    | 0.000 |
| Chronic disease(Control group = Without) | Exist                                         | 1.833  | 0.074    | 0.000 | 1.854         | 0.091    | 0.000 | 1.758                          | 0.130    | 0.000 |
| Urban and rural(Control group = Rural)   | Urban                                         | -0.552 | 0.115    | 0.000 | -0.545        | 0.144    | 0.000 | -0.611                         | 0.192    | 0.001 |
| life behavior habit                      |                                               |        |          |       |               |          |       |                                |          |       |
| Smoking(Control group = Without)         | Exist                                         | 0.144  | 0.079    | 0.069 | 0.178         | 0.099    | 0.072 | 0.062                          | 0.133    | 0.644 |
| Drinking(Control group = Without)        | Exist                                         | -0.083 | 0.073    | 0.254 | -0.095        | 0.091    | 0.297 | -0.118                         | 0.124    | 0.344 |
| SES (socioeconomic status)               |                                               |        |          |       |               |          |       |                                |          |       |
| Logarithm of annual average income       |                                               | -0.062 | 0.012    | 0.000 | -0.071        | 0.015    | 0.000 | -0.031                         | 0.023    | 0.171 |
| Draw the pension(Control group = No)     | Yes                                           | -0.083 | 0.092    | 0.367 | -0.102        | 0.109    | 0.348 | -0.058                         | 0.172    | 0.735 |
| work(Control group = Without)            | Exist                                         | -0.168 | 0.076    | 0.028 | -0.438        | 0.097    | 0.000 | 0.199                          | 0.132    | 0.133 |
| medical insurance                        |                                               |        |          |       |               |          |       |                                |          |       |
| UEBMI(Control group = Without)           | Exist                                         |        |          |       | -0.643        | 0.184    | 0.000 | -0.094                         | 0.199    | 0.636 |
| URBMI(Control group = Without)           | Exist                                         | -0.360 | 0.135    | 0.008 | 0.034         | 0.221    | 0.877 | 0.186                          | 0.276    | 0.501 |
| NRCMS(Control group = Without)           | Exist                                         | 0.157  | 0.171    | 0.360 | 0.052         | 0.179    | 0.772 | 0.475                          | 0.208    | 0.023 |
| URRMI(Control group = Without)           | Exist                                         | 0.268  | 0.135    | 0.047 | -0.236        | 0.199    | 0.235 | 0.437                          | 0.249    | 0.079 |
| Constant                                 |                                               | 0.073  | 0.154    | 0.636 | 10.776        | 0.243    | 0.000 | 9.124                          | 0.269    | 0.000 |
| Observations                             | 28100                                         |        |          |       |               | 18242    |       |                                | 9858     |       |
| R-squared                                | 0.082                                         |        |          |       |               | 0.087    |       |                                | 0.08     |       |
| Year FE                                  | YES                                           |        |          |       |               | YES      |       |                                | YES      |       |

Notes: Robust standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 3 conducted a multivariate regression analysis on the mental health status of young-old and middle-aged elderly individuals, using CESD scores as the dependent variable. After incorporating control variables, the regression analysis was performed under a fixed-effects model. The results indicated that education level, gender, marital status (having a spouse), chronic diseases, place of residence, smoking, logarithm of annual average income, employment, and urban employee medical insurance, all with P values less than 0.05, are the primary factors influencing the health of young-old adults. For middle-aged elderly individuals, the main factors affecting their health, with P values also less than 0.05, are education level, gender, marital

status, New Rural Cooperative Medical System (NCMS), and urban and rural residents' medical insurance.

Among these factors, higher education level (Coef. < 0), being male (Coef. = -1.534), having a spouse (Coef. = -1.024), residing in urban areas (Coef. = -0.545), a higher logarithm of annual average income (Coef. = -0.071), being employed (Coef. = -0.438), and having urban employee medical insurance (Coef. = -0.643) are protective factors for the mental health of young-old adults. Conversely, smoking habits (Coef. = 0.178) and suffering from chronic diseases (Coef. = 1.854) are risk factors for their mental health.

For middle-aged elderly individuals, having an education level of junior college or above (Coef. = -0.597), being male (Coef. = -1.733), having a spouse (Coef. = -0.488), and residing in urban areas (Coef. = -0.611) are protective factors for their mental health. However, suffering from chronic diseases (Coef. = 1.758), being enrolled new rural cooperative medical system (Coef. = 0.475), or having urban and rural residents' medical insurance (Coef. = 0.473) are risk factors for their mental health.

**Table 4.** Fixed effect model of social participation of young elderly and middle-aged and elderly people, 2013-2020

| Variables                                      | Category                                      | Total  |          |       | Young elderly |          |       | Middle-aged and elderly people |          |       |
|------------------------------------------------|-----------------------------------------------|--------|----------|-------|---------------|----------|-------|--------------------------------|----------|-------|
|                                                |                                               | Coef.  | Sta. Err | P     | Coef.         | Sta. Err | P     | Coef.                          | Sta. Err | P     |
| Sociodemographic characteristics               |                                               |        |          |       |               |          |       |                                |          |       |
| Schooling(Control group = illiterate)          | Graduate from primary school                  | 0.326  | 0.027    | 0.000 | 0.318         | 0.035    | 0.000 | 0.309                          | 0.045    | 0.000 |
|                                                | Graduate from the junior middle school        | 0.651  | 0.043    | 0.000 | 0.661         | 0.053    | 0.000 | 0.484                          | 0.071    | 0.000 |
|                                                | Graduate from high school or secondary school | 1.159  | 0.069    | 0.000 | 1.244         | 0.084    | 0.000 | 0.886                          | 0.120    | 0.000 |
|                                                | College or above                              | 1.822  | 0.159    | 0.000 | 2.240         | 0.237    | 0.000 | 1.414                          | 0.206    | 0.000 |
| gender(Control group = Female)                 | Male                                          | -0.462 | 0.032    | 0.000 | -0.464        | 0.042    | 0.000 | -0.339                         | 0.050    | 0.000 |
| Spouse(Control group = Without)                | Exist                                         | -0.132 | 0.032    | 0.000 | -0.156        | 0.047    | 0.001 | -0.221                         | 0.045    | 0.000 |
| Chronic disease(Control group = Without)       | Exist                                         | 0.049  | 0.030    | 0.104 | 0.105         | 0.037    | 0.005 | -0.051                         | 0.051    | 0.320 |
| Urban and rural(Control group = Rural)         | Urban                                         | 0.337  | 0.048    | 0.000 | 0.374         | 0.062    | 0.000 | 0.306                          | 0.073    | 0.000 |
| life behavior habit                            |                                               |        |          |       |               |          |       |                                |          |       |
| Smoking(Control group = Without)               | Exist                                         | 0.118  | 0.031    | 0.000 | 0.108         | 0.040    | 0.007 | 0.082                          | 0.049    | 0.097 |
| Drinking(Control group = Without)              | Exist                                         | 0.309  | 0.030    | 0.000 | 0.310         | 0.037    | 0.000 | 0.264                          | 0.048    | 0.000 |
| SES (socioeconomic status)                     |                                               |        |          |       |               |          |       |                                |          |       |
| Logarithm of annual average income             |                                               | 0.028  | 0.005    | 0.000 | 0.020         | 0.006    | 0.001 | 0.048                          | 0.008    | 0.000 |
| Draw the pension(Control group =No)            | Yes                                           | 0.034  | 0.033    | 0.290 | 0.065         | 0.040    | 0.105 | -0.007                         | 0.056    | 0.906 |
| work(Control group =Without) medical insurance | Exist                                         | -0.171 | 0.028    | 0.000 | -0.275        | 0.037    | 0.000 | -0.079                         | 0.046    | 0.088 |
| UEBMI(Control group =Without)                  | Exist                                         | 0.564  | 0.072    | 0.000 | 0.644         | 0.099    | 0.000 | 0.376                          | 0.102    | 0.000 |
| URBMI(Control group = Without)                 | Exist                                         | 0.106  | 0.073    | 0.148 | 0.024         | 0.097    | 0.803 | 0.027                          | 0.113    | 0.243 |
| NRCMS(Control group = Without)                 | Exist                                         | -0.142 | 0.050    | 0.004 | -0.264        | 0.068    | 0.000 | 0.027                          | 0.072    | 0.804 |
| URRMI(Control group = Without)                 | Exist                                         | 0.101  | 0.055    | 0.065 | 0.046         | 0.075    | 0.539 | 0.005                          | 0.081    | 0.202 |
| Constant                                       |                                               | 1.143  | 0.060    | 0.000 | 1.327         | 0.086    | 0.000 | 1.031                          | 0.086    | 0.000 |
| Observations                                   | 28100                                         |        |          |       | 18242         |          |       | 9858                           |          |       |
| R-squared                                      | 0.104                                         |        |          |       | 0.125         |          |       | 0.079                          |          |       |
| Year FE                                        | YES                                           |        |          |       | YES           |          |       | YES                            |          |       |

Notes: Robust standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 4 presents an analysis of the fixed-effects model on social participation among young-old and middle-aged older adults. The results indicate that the following factors, with p-values all less than 0.05, are the primary determinants of social participation among young-old adults: education level, gender, marital status (having a spouse), chronic illness, place of residence, smoking, alcohol consumption, the logarithm of annual average income, employment status, urban employee basic medical insurance, and new rural cooperative medical system. For middle-aged older adults, the main factors influencing their health status, also with p-values

below 0.05, include education level, gender, marital status, place of residence, smoking, alcohol consumption, the logarithm of annual average income, employment status, and urban employee basic medical insurance.

Among young-old adults, being male (Coef. = -0.464), having a spouse (Coef. = -0.156), being employed (Coef. = -0.275), and participating in new rural cooperative medical system (Coef. = -0.264) are associated with lower frequencies of social participation. In contrast, higher education levels (Coef. > 0), having chronic illnesses (Coef. = 0.105), residing in urban areas (Coef. = 0.374), smoking (Coef. = 0.108), consuming alcohol (Coef. = 0.310), a higher logarithm of annual average income (Coef. = 0.020), and being covered by urban employee basic medical insurance (Coef. = 0.644) positively correlate with increased social participation frequencies.

For middle-aged older adults, being male (Coef. = -0.339), having a spouse (Coef. = -0.221), and being employed (Coef. = -0.079) are negatively related to social participation frequencies. Conversely, higher education levels (Coef. > 0), residing in urban areas (Coef. = 0.306), smoking (Coef. = 0.082), consuming alcohol (Coef. = 0.264), a higher logarithm of annual average income (Coef. = 0.048), and being covered by urban employee basic medical insurance (Coef. = 0.376) positively impact social participation frequencies.

#### **4. Discussion**

This study selects the sample data of CHARLS database from 2013 to 2020 to make a series of analysis and research on the physical and mental health status and social participation of the young and middle aged elderly. Specifically, this study analyzed the influencing factors of health for the young and middle-aged elderly respectively, and analyzed the main influencing factors through fixed effect model. Compared with most previous studies [24], the results of this study confirm that the young and middle aged elderly are not homogenous groups, and their physical and mental health and social participation status are significantly different. The results indicate that the primary factors influencing the physical health of older adults are sociodemographic characteristics, lifestyle behaviors, and socioeconomic status. For mental health, the main influencing factors are sociodemographic characteristics, socioeconomic status, and medical insurance coverage. Regarding social participation, the key factors are sociodemographic characteristics, lifestyle behaviors, and socioeconomic status. Notably, the factors affecting health vary across different age groups of older adults. In summary, the main findings of this study are as follows:

Compared with the middle-aged and elderly, the younger elderly have better physical health, worse mental health and better social participation. In this study, it was found that younger elderly people had better physical health than middle-aged elderly people, which was the same as most studies [25]. Due to their lower age, the body organs and physiological functions have not declined significantly, and they have not long left the formal labor market, generally maintain regular work and rest, and have better physical health. This study also found that the mental health status of the young elderly was worse than that of the middle and old elderly [26-28]. Continuity Theory holds that each stage of human life has a high degree of continuity, and stable values, norms and habits are integrated into the personality and social adaptation of the elderly. After the young elderly retire from their works, the changes in their roles and living habits will bring serious discomfort to them. At the same time, the changes in interpersonal relationships brought by retirement will lead to emotional alienation, so the mental health of the young elderly is relatively low. In addition, the younger elderly have better social participation than the middle-aged and elderly people [29-31], because the younger elderly have better physical health, higher enthusiasm and initiative for social participation, stronger social needs and the importance of maintaining cognitive ability.

For middle-aged and elderly individuals, the higher their education level, the more they prioritize their physical and mental health, particularly those residing in urban areas with relatively favorable social environments. Consequently, they tend to enjoy better physical and mental health, resulting in a higher level of social participation. Meanwhile, the factors influencing the physical and mental health, as well as social participation, of middle-aged, elderly, and younger elderly individuals, share commonalities and unique characteristics. The commonalities are primarily manifested in the following aspects: Firstly, sociodemographic characteristics significantly impact the mental health status and level of social participation of all elderly individuals. Elderly individuals with higher education levels tend to possess better human capital, enabling them to make more proactive and diverse arrangements in their later years, which in turn leads to better mental health and a higher level of social participation [32-24].

The mental health status of older male adults is relatively better, but their level of social participation is lower than that of older female adults [35]. Compared to individuals from single-parent families, middle-aged and elderly people in a couple often enjoy better mental health but participate in social activities less frequently. Having a spouse provides these middle-aged individuals with a long-term and stable marital life, where both partners tend to share similar lifestyles and emotions, thereby reducing the likelihood of emotional conflicts. Through communication, both partners can gain more emotional comfort and reduce feelings of loneliness. However, elderly individuals with spouses may have to assume the responsibility of caring for their partner, which limits their opportunities to engage in social activities. Additionally, emotionally and psychologically, elderly people with spouses often receive sufficient solace, reducing their need to seek emotional support through social activities [36-37].

Second, life behavior habits have a significant impact on physical and mental health and social participation. Smoking and drinking have a negative impact on mental health [38-39], but to a certain extent, they promote certain social participation behaviors, which may be explained by the influence of Chinese social culture. In social interaction activities, adults smoking is a recognized social custom, which helps to establish and maintain interpersonal relationships and social bonds, and drinking behavior is also a social activity. Older people are more likely to be exposed to alcohol in the course of social activities, especially in social environments where drinking is more common or where drinking culture is accepted. Third, socioeconomic status has a significant impact on physical and mental health status and social participation [30]. The higher the average yearly income, the better to protect their own quality of life and health care, so as to better maintain physical and mental health, often have a better social status and social network, to establish a wider range of interpersonal relationships, so as to better promote social participation and social integration [40]. Build good interpersonal relationships with others; Having a work [41-42] will maintain physical activity, enhance self-worth, enhance social connection and life purpose, and effectively improve the physical health, mental health and social participation of older people.

In terms of characteristics, first, compared with the middle-aged and elderly people, smoking, drinking and other life behavior habits have a significant impact on the mental health status of the young elderly [43]. It may be because with the growth of age, the mental toughness of middle-aged and elderly people is improved, and the ability to adapt to life is stronger. Meanwhile, this can be attributed to the aging process and the decline in physical functions, as the demand for maintaining good health necessitates a reduction in their dependence on tobacco and alcohol. Secondly, an increase in the logarithm of annual income and socioeconomic status such as job position has a positive effect on the physical health, mental health, and social participation of younger elderly individuals., but have no significant effect on the middle-aged and elderly [44]. It may be because with the growth of age, the physical functions

of middle-aged and elderly people gradually decline, and some chronic diseases also begin to appear, while the effect of increasing income on reducing the incidence of chronic diseases is relatively small. At the same time, due to the decline of physical function and the emergence of chronic diseases, it may be difficult to continue to work or participate in social activities, so work has less impact on them. In addition, middle-aged and elderly people may have formed their own social networks and life behavior, and the impact of work on their social participation is relatively small; Third, medical insurance for urban workers has a promoting effect on the physical and mental health of the young elderly [45]. Middle-aged and elderly people may have difficulty accessing health facilities for treatment or, if they do go, accessing quality health services; Psychological problems such as widowhood and loneliness, which have little to do with medical insurance, require more social support and psychological intervention.

## **5. Limitations**

There are several limitations. Since the latest data of CHARLS database is only from 2020, the results of this study are not applicable to the situation from 2021 to 2023. In this study, due to adjustments made to the questionnaire in 2020, some indicators were replaced. Additionally, there was a relatively high number of elderly individuals who withdrew from the survey in 2020, which may have resulted in a potential bias in the sample size. More research data are still needed to analyze the changes of physical and mental health and social participation of the elderly in China in recent years. As the sample size of elderly people (aged 80 and above) in the CHARLS database is insufficient, in order to avoid large errors, this study did not analyze middle-aged elderly people (aged 70-79) and elderly people separately. In future studies, more databases can be used to analyze and compare the differences among young, middle and elderly people respectively. Some potential influencing factors may not have been included in the study, resulting in inaccurate estimates. For example, factors such as dietary habits and family medical history can affect health in older adults, but may not be fully considered in existing research.

## **6. Conclusions**

From 2013 to 2020, the physical health of all elderly individuals improved, while their mental health and social participation rates showed a deteriorating trend. The worsening mental health condition may stem from age-related factors and chronic diseases, as well as the role transitions brought about by retirement. As the Internet era advances, seniors struggle to keep pace with technological updates, encountering difficulties in using modern technology products like smartphones and online payment systems. Additionally, aging-related issues such as declining vision and cognitive abilities hinder their effective use of internet products, leading to feelings of marginalization, anxiety, and loneliness. Furthermore, seniors' inadequate awareness of cybersecurity makes them highly vulnerable to online fraud, resulting in financial stress and psychological unease. The drastic decline in social participation rates in 2020 can be attributed to the COVID-19 pandemic and the subsequent isolation measures implemented.

Compared to middle-aged and older seniors, younger seniors tend to enjoy better physical health but suffer from poorer mental health and, paradoxically, higher levels of social participation. Nearly all variables considered have an impact on the physical and mental health, as well as social participation, of middle-aged and older adults. Notably, sociodemographic characteristics like education, urban residency, and urban employee medical insurance significantly enhance mental health and social participation. Lifestyle behaviors such as smoking and drinking have negative effects on both physical and mental health and, to some extent, increase social participation. Higher socioeconomic status, indicated by average annual income, pension access, and employment, significantly contributes to better physical and mental health, as well as social participation.

To improve the physical and mental health, and social participation of seniors, we should prioritize the development of senior education in China, ensuring educational equity and encouraging emotional exchanges and social recognition among seniors to alleviate loneliness and psychological stress. We should also assist seniors in avoiding tobacco and alcohol consumption and fostering healthy lifestyles. By expanding social security, we can broaden seniors' income sources and narrow income gaps. Enhancing pension levels and establishing a more equitable and sustainable pension system are crucial. Additionally, implementing flexible retirement policies can safeguard seniors' basic employment rights.

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