



## Research article

## Multiple chronic conditions among older adults in China: differences in socio-demographic characteristics

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## ABSTRACT

**Objective:** There are relatively few studies on multiple chronic conditions (MCC) among older adults in China. This study sought to assess the potential differences in the risk of MCC among different elderly populations, and thus to identify the most vulnerable populations at higher risk of developing the MCC.

**Methods:** A sample of 5320 adults aged 60 years or above from the China's Health-Related Quality of Life Survey for Older Adults 2018 (CHRQLS-OA 2018) were included in this study. Descriptive statistics frequencies and proportions were used to summarize the sample characteristics, and logistic regression models were conducted to identify the differences in the risk of having MCC among different populations.

**Results:** Overall, 52.6% of respondents had been clearly diagnosed with at least one chronic disease with 25.3% having MCC. The males ((adjusted odds ratio [AOR] = 0.84; 95% confidence interval [CI] = 0.73–0.98) were less likely to have MCC. This was also true among female elderly with a non-agricultural hukou (AOR = 0.75; 95% CI = 0.57–0.99). The elderly with a non-agricultural hukou aged 60–64 (AOR = 0.55; 95% CI = 0.34–0.88) had a lower risk of having MCC. Those whose average annual household income per capita were 15,000–30,000 RMB (AOR = 1.42; 95% CI = 1.03–1.96) were more likely to suffer from MCC. The odds ratios of having MCC were smaller as the personal savings increases in total samples (all  $P < 0.05$ ).

**Conclusions:** The findings suggest that different policies or approaches should target these specific populations who are most in need and are most likely to suffer from MCC.

## 1. Introduction

Population aging is occurring worldwide—both in terms of the number and proportion of older adults in the population. Globally, the number of older adults aged 60 years or above was expected to more than double in size from 901 million in 2015 to more than 2.1 billion by 2050 [1]. Moreover, it is expected that nearly 8 in 10 of the world's older population will live in less developed countries in 2050 [2]. As a typical developing country, China is the most populated country with the largest number of elderly people in the world. According to the National Bureau of Statistics of China, at the end of 2020, the number of elderly people over 60 years old exceeded 264 million, and the population over 65 years old exceeded 190 million, accounting for 18.7% and 13.5% of the total population, respectively [3]. Aging issues have a great impact on social and economic development, healthcare delivery and disease epidemic patterns [4, 5].

One of the biggest challenges of aging is health-related issues, most notably chronic disease [6]. Admittedly, chronic disease has become one of the biggest threats to human health, especially to the elderly. The World Health Organization (WHO) reported that there were 41 million deaths caused by chronic illnesses each year, accounting for 71% of all deaths globally, which have a particular impact on low- and middle-income countries [7]. *Report on Nutrition and Chronic Disease Status of Chinese Residents 2015* pointed out that the proportion of deaths due to chronic diseases is 86.6% [8], which is much higher than the global level, especially the elderly, are at high risk of chronic diseases. The data provided by the National Health Commission of China shows that the proportion of elderly people suffer from one or more chronic diseases is 75%, and more than 50% of these elderly with chronic diseases in China suffer from multiple chronic conditions (MCC) [9].

MCC is defined as two or more chronic diseases coexisting in the same patient, which is a universal problem in the field of global health [10,

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11]. MCC have been consistently associated with higher risk of mortality, functional decline, disability, and poor quality of life [12]. Moreover, due to the characteristics of high prevalence and incidence, slow onset and long course of chronic conditions, the economic burden of MCC may increase a lot [13]. As a simple, economical and practical means of prevention, primary prevention plays an important role in protecting high-risk groups [14]. It is of great significance to improve the quality of life and reduce the cost of diseases by doing a good job of primary prevention of MCC. The premise of primary prevention is to grasp the high-risk groups and key groups of MCC. There are many related studies reports related to the elderly with chronic diseases in China. Yet, previous related studies conducted in China have mainly focused on the prevalence and incidence of chronic diseases in the elderly population and relevant prevention and control measures [15, 16, 17]. However, little is currently known about the MCC among older adults in China.

Therefore, from the perspective of demographic differences, this study sought to assess the potential differences in the risk of MCC among different elderly populations, and thus to identify the most vulnerable populations at higher risk of developing the MCC. Findings from the present study will provide the necessary scientific basis for government in their attempt to develop more impactful related policies and effective health-prevention programs to better prevent and control the MCC in the elderly by targeting the specific populations, and as such, the current study will contribute to the practice of healthy aging strategy and accelerate the promotion of the Healthy China initiative. Moreover, similar assessments may be of use in other developing countries like India.

## 2. Material and methods

### 2.1. Description of the sample

This study used the China's Health-Related Quality of Life Survey for Older Adults 2018 (CHRQLS-OA 2018) data. The CHRQLS-OA 2018 is a large-scale cross-sectional population-based survey initiated by the Global Health Institute of Wuhan University. The survey recruited older adults aged 60 years or above across the country, and was conducted during the special period of Spring Festival in 2018, with the intention of ensuring a balanced distribution of the country's population. Details of the project can be obtained in our previously published work [18]. In the present study, 122 subjects without any information on non-communicable diseases were discovered before we performed the data analysis, who were excluded from the study sample, which accounted for 2.24% of the total number of respondents. Finally, 5320 participants (97.76%) were included in the final data analysis.

### 2.2. Description of the variables

#### 2.2.1. Dependent variables

The questionnaire asked the participants to self-report whether they had been clearly diagnosed with the following noncommunicable diseases by a physician: 1) Hypertension; 2) Diabetes; 3) Coronary artery disease; 4) Cancer/Tumor; 5) Chronic obstructive pulmonary disease; 6) Disc disease; 7) Asthma; 8) Rheumatoid arthritis; 9) Gastroenteritis; 10) Cataract; 11) Cerebrovascular disease; and 12) Others, specify: \_\_\_\_\_. These diseases are the most prevalent noncommunicable diseases in China and are under national priority surveillance. In the present study, the total number of these noncommunicable diseases was calculated, and the results were used to measure the dependent variables. Thus, the dependent variable is whether the participants had been clearly diagnosed with at least two noncommunicable disease (no = 1 or less, yes = 2 or more).

#### 2.2.2. Independent variables

The following nine individual and familial socio-demographic characteristics of the subjects were included in this study and considered as

the independent variables, including participants' gender, age, nationality, body mass index (BMI), years of education, permanent address, marital status, average annual household income (CNY), and personal savings. The survey asked respondents about their individual height and weight, from which we calculated the BMI. BMI were classified as underweight ( $<18.50 \text{ kg/m}^2$ ), normal ( $18.50 \text{ kg/m}^2$  to  $23.99 \text{ kg/m}^2$ ), overweight ( $24.00 \text{ kg/m}^2$  to  $27.99 \text{ kg/m}^2$ ), and obese ( $\geq 28.00 \text{ kg/m}^2$ ) according to Chinese criteria [19].

### 2.3. Statistical analysis

The Statistical Package for the Social Sciences (SPSS) version 23.0 for Windows (SPSS Inc., Chicago, IL, USA) was used to analyze the data. The alpha level was set at 0.05 to determine statistical significance. Data analysis was performed in the following five parts:

Firstly, individual and familial socio-demographic characteristics of the participants were summarized by total samples, agricultural and non-agricultural hukou via initial descriptive analysis with frequencies and proportions. Secondly, univariate logistic regression models were performed to assess bivariate associations of whether the participants had been clearly diagnosed with at least two noncommunicable disease versus individual and familial socio-demographic variables such as gender, age, nationality, body mass index (BMI), years of education, permanent address, marital status, average annual household income (CNY), and personal savings in the total samples, agricultural and non-agricultural registered samples, respectively. Thirdly, multivariable logistic regression analyses were conducted to identify the main socio-demographic indicators that were most predictive of whether the participants had been clearly diagnosed with at least two noncommunicable disease in the total samples, agricultural and non-agricultural registered samples, respectively.

Corresponding to the above analysis steps, the results of this study are presented in the form of three tables. For univariable analysis, the results were presented as a crude odds ratio (COR) value with a 95% confidence interval (95% CI). For multivariable analysis, the adjusted odds ratio (AOR) value with a 95% confidence interval (95% CI) were reported.

### 2.4. Institutional review board statement

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of School of Health Science and Faculty of Medical Sciences, Wuhan University (IRB number: 2019YF2050). Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the patient(s) to publish this paper.

## 3. Results

General demographic characteristics of respondents are shown in Table 1. Our final sample size included a total of 5320 subjects, including 69.2% of the elderly with an agricultural hukou. We had 2663 females and 2619 males in the study. More than half of the participants (52.6%) had been clearly diagnosed with at least one chronic disease in the total samples with 25.3% self-reported having two or more chronic diseases. These self-report rates were higher among the agricultural registered samples with 28.2% of those having one chronic disease and 26.4% of those having two or more chronic diseases. Among these participants, 26.8% of them in the total sample, 24.3% of them in the agricultural sample, and 32.7% of them in the non-agricultural sample were overweight. The majority of the elderly were the Han nationality and married. The education level of the elderly in China is expected to be low, where 53.3% of participants in the total sample and 63.3% of the rural elderly only had an education level of less than 5 years. The annual per capita income of the family in 36.0% of the study population was less than 15,000 yuan, and 38.6% of the old elderly's personal savings was less than 10,000 yuan.

**Table 1.** Socio-demographic characteristics of the samples (n = 5320).

Variables	Definition	Total samples	Agricultural hukou	Non-agricultural hukou
Gender ( $\chi^2 = 8.64, p = 0.003$ )	Male	2619 (49.6)	1735 (48.3)	841 (52.7)
	Female	2663 (50.4)	1859 (51.7)	755 (47.3)
Age ( $\chi^2 = 19.33, p = 0.001$ )	60–64	1178 (22.2)	828 (23.0)	319 (19.9)
	65–69	1262 (23.8)	875 (24.3)	357 (22.3)
	70–74	1223 (23.1)	824 (22.9)	385 (24.1)
	75–79	765 (14.4)	478 (13.3)	276 (17.3)
	≥80	873 (16.5)	599 (16.6)	262 (16.4)
National minority ( $\chi^2 = 15.70, p < 0.001$ )	No	4964 (95.3)	3403 (96.1)	1476 (93.5)
	Yes	246 (4.7)	139 (3.9)	102 (6.5)
BMI ( $\chi^2 = 73.92, p < 0.001$ )	Thin	548 (10.6)	441 (12.6)	95 (6.0)
	Normal	3233 (62.6)	2207 (63.1)	968 (61.3)
	Overweight	1388 (26.8)	849 (24.3)	516 (32.7)
Years of education ( $\chi^2 = 685.58, p < 0.001$ )	0	1142 (23.2)	1030 (30.8)	100 (6.7)
	1–5	1486 (30.1)	1089 (32.5)	377 (25.1)
	6–8	988 (20.0)	657 (19.6)	315 (21.0)
	9–11	709 (14.4)	363 (10.8)	324 (21.6)
	≥12	609 (12.3)	207 (6.2)	386 (25.7)
Marital status ( $\chi^2 = 64.00, p < 0.001$ )	Others	1697 (32.1)	1281 (35.6)	390 (24.4)
	Married/Cohabiting	3588 (67.9)	2313 (64.4)	1208 (75.6)
Average annual household income per capita (CNY) ( $\chi^2 = 1205.43, p < 0.001$ )	<15,000	1880 (36.0)	1679 (47.3)	175 (11.0)
	15,000–30,000	1307 (25.0)	1012 (28.5)	269 (16.9)
	30,000–45,000	989 (18.9)	520 (14.7)	457 (28.8)
	45,000–60,000	556 (10.7)	185 (5.2)	360 (22.7)
	>60,000	491 (9.4)	151 (4.3)	328 (20.6)
Personal savings (CNY) ( $\chi^2 = 1284.53, p < 0.001$ )	<10,000	2033 (38.6)	1804 (50.4)	206 (13.0)
	10,000–30,000	1102 (21.0)	843 (23.6)	239 (15.1)
	30,000–50,000	693 (13.2)	443 (12.4)	233 (14.7)
	50,000–100,000	739 (14.0)	328 (9.2)	396 (25.0)
	>100,000	692 (13.2)	161 (4.5)	512 (32.3)
Number of chronic diseases ( $\chi^2 = 20.39, p < 0.001$ )	0	2525 (47.4)	1645 (45.5)	837 (52.1)
	1	1450 (27.3)	1018 (28.2)	404 (25.2)
	≥2	1345 (25.3)	953 (26.4)	365 (22.8)

Notes: Sample sizes of the demographic characteristic variables may not sum to n = 5320 due to missing values.

Abbreviations: BMI, body mass index; CNY, Chinese yuan.

As shown in Table 2, the results of univariate analysis showed that in the total samples, males (COR = 0.76; 95% CI = 0.67–0.86) were less likely to have MCC than females, and the result also applied to the elderly with different hukou. In the total samples, the elderly aged 60–64 (COR = 0.78; 95% CI = 0.64–0.95) had a lower risk of having MCC as compared with those aged 80 or above. Among the elderly with non-agricultural hukou, those aged less than 75 years had a lower risk of having MCC as compared with those aged 80 or above (all CORs <1, and all  $p < 0.05$ ). In terms of BMI, those with who were classified as thin or normal had a lower probability of having MCC than the overweight elderly. In terms of the participants' education level, the uneducated elderly (COR = 1.68; 95% CI = 1.33–2.12) were more likely to develop MCC as compared with those received 12 years of education or more in the total samples, and this result also applied to the elderly with different hukou. The elderly who were single/divorced/widowed were more likely to have MCC than those who were married or living with a partner. The odds ratios of having MCC were smaller as the average annual household income per capita and personal savings increases.

In multivariable analyses, similar results were identified for BMI and marital status. As shown in Table 3, the multivariable analysis indicated that males (AOR = 0.84; 95% CI = 0.73–0.98) were less likely to have MCC than females, and the result also applies to the elderly with a non-agricultural hukou (AOR = 0.75; 95% CI = 0.57–0.99). The elderly with a non-agricultural hukou aged 60–64 (AOR = 0.55; 95% CI = 0.34–0.88) had a lower risk of having MCC as compared with those aged 80 or above.

Among the elderly with agricultural hukou, those who received 9–11 years of education (AOR = 1.59; 95% CI = 1.00–2.51) had a higher risk of having MCC as compared with those received 12 years of education or more. The results also showed that those whose average annual household income per capita were 15,000–30,000 RMB (AOR = 1.42; 95% CI = 1.03–1.96) were more likely to suffer from MCC as compared to those making more than 60,000 RMB in total samples. The odds ratios of having MCC were smaller as the personal savings increases in total samples.

#### 4. Discussion

In the present study, a total of 52.6% of the elderly self-reported having at least one chronic disease, and 25.3% of the participants self-reported having at least two chronic disease. Such findings are somewhat out of line with reports from the China Center for Disease Control and Prevention (CCDC). According to the CCDC, the proportion of elderly people aged 60 years or older with one chronic disease or more in China was 76.35%, and 37.2% of the elderly were suffering from MCC [20]. Yet, the fact is that there is no unified and recognized data on the prevalence of MCC in China. Studies revealed a prevalence of 6.4%–76.5% among the elderly in China with a large range of fluctuations [21]. On the other hand, the design of this study may generate recall bias in the self-reported survey study. In our study, only those who had been clearly diagnosed with the specific chronic diseases listed in the questionnaire by a physician were identified as having chronic diseases, and as such,

**Table 2.** Univariate analysis of MCC among the elderly by socio-demographic characteristics.

Variables	Total samples			Agricultural hukou			Non-agricultural hukou		
	N	COR	95% CI	n	COR	95% CI	n	COR	95% CI
<b>Gender</b>									
Male	593	0.76	(0.67, 0.86)***	417	0.79	(0.68, 0.92)**	167	0.71	(0.56, 0.89)**
Female	743	1		530	1		196	1	
<b>Age</b>									
60–64	267	0.78	(0.64, 0.95)*	215	0.99	(0.78, 1.25)	45	0.38	(0.25, 0.57)***
65–69	314	0.88	(0.72, 1.70)	226	0.98	(0.77, 1.24)	80	0.67	(0.47, 0.96)*
70–74	304	0.88	(0.72, 1.70)	211	0.97	(0.76, 1.23)	87	0.68	(0.47, 0.96)*
75–79	219	1.06	(0.86, 1.32)	143	1.20	(0.92, 1.57)	73	0.83	(0.57, 1.21)
≥80	239	1		157	1		79	1	
<b>National minority</b>									
No	1240	0.84	(0.63, 1.11)	885	0.73	(0.51, 1.06)	333	0.95	(0.59, 1.52)
Yes	70	1		45	1		24	1	
<b>BMI</b>									
Thin	134	0.79	(0.63, 0.99)*	119	0.87	(0.67, 1.13)	13	0.43	(0.23, 0.79)**
Normal	770	0.76	(0.66, 0.88)***	552	0.79	(0.66, 0.94)**	203	0.71	(0.56, 0.91)**
Overweight	403	1		253	1		140	1	
<b>Years of education</b>									
0	353	1.68	(1.33, 2.12)***	309	1.91	(1.31, 2.78)***	38	2.11	(1.32, 3.37)**
1–5	368	1.24	(0.99, 1.55)	289	1.61	(1.10, 2.34)**	73	0.82	(0.58, 1.17)
6–8	237	1.19	(0.93, 1.51)	171	1.56	(1.06, 2.32)**	61	0.82	(0.57, 1.19)
9–11	187	1.35	(1.04, 1.74)*	99	1.67	(1.10, 2.54)**	85	1.22	(0.87, 1.72)
≥12	128	1		38	1		87	1	
<b>Marital status</b>									
Others	523	1.52	(1.33, 1.73)***	288	1.36	(1.17, 1.59)***	128	2.00	(1.55, 2.58)***
Married/Cohabiting	814	1		559	1		237	1	
<b>Average annual household income per capita (CNY)</b>									
<15,000	533	1.79	(1.39, 2.30)***	470	1.51	(1.00, 2.27)	53	2.11	(1.37, 3.25)***
15,000–30,000	378	1.84	(1.42, 2.38)***	294	1.59	(1.04, 2.41)*	78	1.98	(1.34, 2.93)***
30,000–45,000	206	1.19	(0.90, 1.57)	109	1.03	(0.66, 1.61)	96	1.29	(0.90, 1.86)
45,000–60,000	101	1.00	(0.73, 1.37)	24	0.58	(0.32, 1.03)	74	1.26	(0.86, 1.85)
>60,000	89	1		31	1		56	1	
<b>Personal savings (CNY)</b>									
<10,000	636	2.60	(2.07, 3.28)***	559	2.84	(1.79, 4.50)***	68	2.78	(1.91, 4.06)***
10,000–30,000	285	2.00	(1.56, 2.56)***	212	2.12	(1.32, 3.42)**	65	2.11	(1.45, 3.07)***
30,000–50,000	145	1.51	(1.15, 2.00)**	82	1.44	(0.86, 2.39)	60	1.96	(1.34, 2.87)***
50,000–100,000	155	1.52	(1.15, 2.00)**	66	1.59	(0.94, 2.69)	87	1.59	(1.13, 2.23)**
>100,000	103	1		22	1		77	1	

Notes: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

Abbreviations: BMI, body mass index; CNY, Chinese yuan.

some elderly people might not know the name of specific chronic diseases or they didn't have a professional clinical diagnosis.

Consistent with the conclusions reported by many previous studies [22, 23, 24, 25] this study found that the prevalence rate of MCC was also significantly associated with gender in the total sample. Specifically, men are less likely to develop MCC than women, which also applies to the elderly with non-agricultural hukou. The gender differences may due to the influence of biological and social factors [26]. From a biological point of view, women are more vulnerable than men to non-fatal diseases such as osteoarthritis and mental disorders because the hormone level in women drops more obviously than men after entering menopause [27, 28]. Besides, studies have showed that longer life span will increase the risk of chronic diseases, and thus increasing the probability of having MCC among elderly women since women's mortality advantage contributes to more life years [29]. According to our logistic regression analysis, the prevalence rate of having MCC in non-agricultural hukou population aged 60–64 is lower than that in population aged over 80, which also confirms the influence of age on the prevalence rate of having MCC [23, 24, 27, 30].

In addition, significant differences were observed in the prevalence of MCC between different BMI groups regardless of whether they are agricultural or non-agricultural hukou. Specifically, the prevalence of MCC in elderly people with lower or normal BMI is lower than that in overweight elderly people. A cross-sectional study pointed out that the prevalence of MCC in obese people was 7 times that of normal BMI people [27]. The cause-and-effect relationship between obesity and different kinds of chronic diseases has been widely recognized and supported by many studies [31, 32, 33]. Marriage is often identified as an important protective factor for the health of older adults. Our results also showed that the single/divorced/widowed senior citizens tended to be likely to suffer from MCC as compared to the married/cohabiting elderly. Due to the slow onset and long course of chronic diseases, humanistic care and social support from the family members are very important for the elderly with chronic diseases [34, 35, 36]. Beverly et al pointed out that spouse's support can improve diabetes by adhering to a healthy diet [37].

A number of limitations of the present study can be identified. For instance, we only asked the most prevalent noncommunicable diseases in

**Table 3.** Multivariable analysis of MCC among the elderly by socio-demographic characteristics.

Variables	Total samples		Agricultural hukou		Non-agricultural hukou	
	AOR	95% CI	AOR	95% CI	AOR	95% CI
<b>Gender</b>						
Male	0.84	(0.73, 0.98)*	0.88	(0.74, 1.04)	0.75	(0.57, 0.99)*
Female	1		1		1	
<b>Age</b>						
60–64	0.90	(0.72, 1.14)	1.11	(0.84, 1.45)	0.55	(0.34, 0.88)*
65–69	0.90	(0.72, 1.12)	1.03	(0.79, 1.35)	0.72	(0.46, 1.13)
70–74	0.90	(0.73, 1.13)	1.02	(0.79, 1.33)	0.72	(0.47, 1.11)
75–79	1.08	(0.86, 1.37)	1.19	(0.90, 1.59)	0.87	(0.56, 1.34)
≥80	1		1		1	
<b>National minority</b>						
No	0.74	(0.55, 1.01)	0.69	(0.47, 1.01)	0.81	(0.47, 1.39)
Yes	1		1		1	
<b>BMI</b>						
Thin	0.64	(0.50, 0.83)***	0.75	(0.57, 1.00)*	0.25	(0.12, 0.51)***
Normal	0.71	(0.61, 0.83)***	0.70	(0.58, 0.85)***	0.70	(0.52, 0.93)*
Overweight	1		1		1	
<b>Years of education</b>						
0	1.10	(0.83, 1.47)	1.44	(0.94, 2.21)	1.28	(0.71, 2.30)
1–5	1.05	(0.81, 1.37)	1.42	(0.94, 2.16)	0.87	(0.56, 1.33)
6–8	1.02	(0.78, 1.34)	1.49	(0.97, 2.29)	0.68	(0.45, 1.03)
9–11	1.15	(0.87, 1.52)	1.59	(1.00, 2.51)*	0.95	(0.64, 1.39)
≥12	1		1		1	
<b>Marital status</b>						
Others	1.25	(1.08, 1.46)**	1.24	(1.03, 1.48)*	1.50	(1.10, 2.04)*
Married/Cohabiting	1		1		1	
<b>Average annual household income per capita (CNY)</b>						
<15,000	1.21	(0.87, 1.67)	1.21	(0.75, 1.95)	1.19	(0.67, 2.12)
15,000–30,000	1.42	(1.03, 1.96)*	1.42	(0.88, 2.31)	1.41	(0.86, 2.31)
30,000–45,000	1.04	(0.75, 1.44)	1.04	(0.63, 1.72)	1.08	(0.68, 1.69)
45,000–60,000	1.08	(0.76, 1.53)	0.72	(0.38, 1.35)	1.31	(0.83, 2.06)
>60,000	1		1		1	
<b>Personal savings (CNY)</b>						
<10,000	2.47	(1.80, 3.40)***	2.40	(1.37, 4.23)**	2.60	(1.57, 4.31)***
10,000–30,000	1.89	(1.38, 2.59)***	1.83	(1.03, 3.23)*	1.69	(1.05, 2.72)*
30,000–50,000	1.59	(1.14, 2.20)**	1.45	(0.80, 2.62)	1.60	(1.00, 2.56)*
50,000–100,000	1.52	(1.11, 2.06)**	1.66	(0.91, 3.01)	1.37	(0.92, 2.03)
>100,000	1		1		1	

Notes: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

Abbreviations: BMI, body mass index; CNY, Chinese yuan.

China that are under national priority surveillance. Although we set up an open-ended question so that respondents could self-report the clinically diagnosed diseases that were not on the predefined list, the prevalence of MCC among the elderly may still unavoidably underestimated. Besides, the convenient sample was not drawn from all possible provinces throughout China and as such this may affect generalizability. Moreover, the cross-sectional study design can only understand the current status of, and the potential differences in the risk of MCC among different elderly populations. In addition, given that MCC could be related or unrelated and the diagnoses can be concordant or discordant in nature. MCC may not only due to shared risk factors but also due to pathological pathways or networks, whereby one disease may increase the risk of another disease. This is a key point that has long been inadequately taken into account in existing related studies and should be noted in future studies. Last, some socio-demographic characteristic variables of the elderly, like occupation before retirement, social network (e.g., family size, living status) are more related to MCC, were not included in the data analysesd. These limitations should be taken into account in future studies.

## 5. Conclusion

In the present study, we reported that the most vulnerable populations at higher risk of developing the MCC, which is most evident among those who were female, single/divorced/widowed senior citizens, those with poor financial status. Given the risk of having MCC showed variation between different populations, which may suggest the different policies or approaches to working with these populations. Some practical measures should be considered when policy makers formulating corresponding strategies for the prevention and treatment of MCC. Firstly, from the perspective of cost-effectiveness, target specific populations who are most in need and are most likely to suffer from MCC, like the elderly who were female, single/divorced/widowed senior citizens, those with poor financial status. Secondly, carry out health interventions, public education, and support initiatives for the elderly, especially for weight control. Thirdly, pay more attention to early screening and diagnosis of chronic diseases. Moreover, there is a gap between urban and rural areas in the factors affecting the prevalence of MCC in the elderly, and the older adults with an agricultural hukou



showed a higher risk of having MCC. Therefore, it's recommended that government should pay attention to the management and prevention of chronic diseases among rural residents. In general, relevant government departments should carry out targeted primary prevention measures based on the different characteristics of the elderly.

## Declarations

### Author contribution statement

Xiaojun Liu: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Fang Song: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Fengyu Liu: Performed the experiments; Wrote the paper.

Zongfu Mao: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data.

Shuming Qu: Conceived and designed the experiments; Wrote the paper.

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### Data availability statement

Data will be made available on request.

### Declaration of interest's statement

The authors declare no conflict of interest.

### Additional information

No additional information is available for this paper.

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