Journal of Clinical and Nursing Research, 2025, Volume 9, Issue 4
http://ojs.bbwpublisher.com/index.php/JCNR
Online ISSN: 2208-3693
Print ISSN: 2208-3685

The Association between Cardiometabolic Multimorbidity and Frailty among Middle-Aged and Older Adults in China

Qinrou Yu[1], Yuexian Tao[1]*, Qi Zhou[2]

[1]School of Public Health and Nursing, Hangzhou Normal University, Hangzhou 311121, Zhejiang, China
[2]Department of Nursing, Linping District Integrated Traditional Chinese and Western Medicine Hospital, Hangzhou 310000, Zhejiang, China

***Corresponding author:** *Yuexian Tao, yuextao@outlook.com*

Abstract: *Objective:* To explore the association between cardiometabolic multimorbidity and frailty among middle-aged and older adults in China. *Methods:* Data were derived from the 2013 wave of the China Longitudinal Healthy Longevity Survey, including a total of 6,179 individuals aged 45 years and above with complete follow-up records. Basic demographic information was collected, and frailty status was assessed using a physical frailty scale. Generalized linear models were employed to analyze the association between the number and combinations of cardiometabolic conditions—such as hypertension, diabetes, heart disease, and stroke—and frailty. *Results:* The prevalence of cardiometabolic multimorbidity among middle-aged and older adults was 14.23%. After adjusting for sociodemographic covariates, individuals with cardiometabolic multimorbidity had a significantly increased risk of frailty compared to those without such conditions (OR = 1.78, 95% CI: 1.45–2.19), along with higher frailty scale scores (β = 0.26, 95% CI: 0.19–0.34). Compared to individuals without cardiometabolic diseases, those with both hypertension and stroke (OR = 1.18, 95% CI: 1.06–1.31) and those with hypertension, heart disease, and stroke (OR = 1.46, 95% CI: 1.24–1.73) exhibited notably higher frailty risks. *Conclusion:* There is a significant association between cardiometabolic multimorbidity and frailty in middle-aged and older adults in China, particularly for comorbidity patterns involving hypertension. These findings provide evidence for developing targeted health interventions for aging populations.

Keywords: Cardiometabolic multimorbidity; Frailty; Middle-aged and older adults; Nursing

Online publication: April 29, 2025

1. Introduction

China is currently facing a severe challenge of population aging, and the health issues of middle-aged and older adults have attracted increasing attention. With advancing age, the prevalence of chronic diseases rises steadily

in this population, and the phenomenon of individuals suffering from multiple chronic conditions simultaneously (known as multimorbidity) has become increasingly common. Previous studies have shown that 55.77% of middle-aged and older adults in China suffer from two or more chronic diseases simultaneously [1,2]. Among the various chronic disease patterns, cardiometabolic multimorbidity (CMM) is one of the most prevalent and relatively stable combinations [3], referring to the co-occurrence of two or more cardiometabolic diseases (CMD) in an individual. Frailty is a common geriatric syndrome characterized by a decline in physiological reserves and multiple organ functions with aging [4]. The coexistence of multiple chronic diseases may lead to functional decline, reduced endurance, and immobility among middle-aged and older adults, ultimately resulting in frailty and increasing the risks of disability, hospitalization, and mortality. Previous studies have confirmed that cardiometabolic multimorbidity is a significant risk factor for frailty in middle-aged and older populations [5,6].

Most existing studies have focused on single or a limited number of specific disease combinations, or have examined the relationship between the number of chronic conditions and frailty without fully considering the cumulative effects of different combinations of cardiometabolic diseases. Therefore, this study draws upon data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS) to systematically examine the association between cardiometabolic multimorbidity and frailty from two perspectives: the number of diseases and their specific combinations. The aim is to provide scientific evidence for delaying frailty in China's middle-aged and older population.

2. Participants and methods

2.1. Study population

The data used in this study were obtained from the publicly available database of the Chinese Longitudinal Healthy Longevity Survey (CLHLS), which covers 28 provinces, municipalities, and autonomous regions across China and is highly representative. However, due to the incompleteness of physical examination data (such as height, weight, grip strength, and walking speed) in the 2015 and 2018 waves, frailty could not be assessed in those years. Therefore, this study used data from the 2013 wave. A total of 13,138 participants aged 45 years and above were initially included. After excluding 6,959 individuals with missing information on cardiometabolic diseases or the frailty scale, 6,179 participants remained in the final analysis. All participants had signed informed consent forms prior to the survey. The use of all data in this study was exempted from ethical review by the hospital ethics committee (Application number: 2025-L-007).

2.2. Research methods

2.2.1. Basic information

In this study, cardiometabolic diseases included hypertension, diabetes, heart disease, and stroke. CMM was defined as the simultaneous presence of two or more of these conditions in an individual [7-9]. Information on whether participants had been diagnosed with hypertension, diabetes, heart disease, or stroke was obtained through a structured questionnaire. In addition, basic demographic and health-related variables were collected, including gender, age, type of residence, marital status, education level, smoking behavior, alcohol consumption, body mass index (BMI), history of falls, sleep duration at night, and self-rated health status.

2.2.2. Physical Frailty Phenotype (PFP)

This study used the Physical Frailty Phenotype (PFP), developed by Fried *et al.*, to assess frailty status [10]. The scale consists of five criteria: slowness, weakness, weight loss, low physical activity, and exhaustion. All data

were sourced from the CLHLS database, with reference to established criteria used in prior frailty studies based on CLHLS data [11,12]. Slowness: Assessed by measuring the time required to walk 2.5 meters. The average of two trials was used, and slowness was defined as being in the slowest 20% of walking speed based on gender and height. Weakness: Measured using grip strength of the dominant hand. The highest value from the two trials was recorded. If there was no dominant hand, the highest value of both hands was used. Weakness was defined as grip strength in the lowest 20%, adjusted for gender and BMI. Weight loss: Defined as a self-reported unintentional weight loss of more than 5 kg since the last survey or a BMI < 18.5. Low physical activity: Defined as the inability to walk or engage in physical activity for at least 10 minutes in a typical week, based on self-report. Exhaustion: Measured using two items from the 10-item Center for Epidemiologic Studies Depression Scale (CESD-10): "I felt that everything I did was an effort" and "I could not get going." Participants were considered exhausted if they responded "sometimes or occasionally (3–4 days)" or "most of the time (5–7 days)" to either item. Each criterion that meets the standard is assigned 1 point, resulting in a total score ranging from 0 to 5. Based on the total score, participants are classified into three categories: 0 points: non-frail; 1–2 points: pre-frail; 3–5 points: frail.

2.3. Statistical analysis

In this study, data organization and analysis were performed using Stata 18.0 software. The sociodemographic characteristics of the participants were summarized using descriptive statistics, including median, interquartile range, frequency, and percentage (%). The main exposure variables were the number and combination patterns of cardiometabolic diseases in 2013, while the outcome variables included the presence of frailty and the PFP score. In the analysis, sociodemographic covariates were adjusted, and a generalized linear model was used to explore the association between cardiometabolic multimorbidity patterns and frailty. The analysis of frailty status used a Logit link function, while the analysis of the PFP score used an Identity link function. The significance level for statistical tests was set at $\alpha = 0.05$, and all tests were two-tailed.

3. Results

3.1. Basic characteristics of the study participants

This study included 6,179 participants, with an age range primarily between 60 and 74 years, and an average age of 66 (66 ± 10) years. In terms of gender distribution, there were 3,116 males (49.69%) and 3,063 females (50.31%). Among the participants, 1,067 (17.30%) were in a frail state. A total of 2,766 participants had cardiometabolic diseases, distributed as follows: 1,263 individuals had only hypertension, accounting for 9.51%; 171 individuals had only diabetes, accounting for 6.18%; 397 individuals had only heart disease, accounting for 14.35%; 56 individuals had only stroke, accounting for 2.02%; 182 individuals had both hypertension and diabetes, accounting for 6.58%; 408 individuals had both hypertension and heart disease, accounting for 14.75%; 73 individuals had both hypertension and stroke, accounting for 2.64%; 40 individuals had both diabetes and heart disease, accounting for 1.45%; 7 individuals had both diabetes and stroke, accounting for 0.25%; 9 individuals had both heart disease and stroke, accounting for 0.33%; 90 individuals had hypertension, diabetes, and heart disease, accounting for 3.25%; 30 individuals had hypertension, heart disease, and stroke, accounting for 1.08%; 18 individuals had hypertension, diabetes, and stroke, accounting for 0.65%; 4 individuals had diabetes, heart disease, and stroke, accounting for 0.14%; 18 individuals had hypertension, diabetes, heart disease, and stroke, accounting for 0.65%. Among the participants, 879 individuals had cardiometabolic multimorbidity, accounting for 14.23%. Detailed

data are presented in **Table 1.**

Table 1. Basic characteristics of study participants in two groups

Item	Category	Number	Cardiometabolic multimorbidity
Age	45–59 years	471	49 (10.4%)
	60–74 years	4,687	684 (14.6%)
	≥ 75 years	1,021	146 (14.3%)
Gender	Male	3,116	503 (16.1%)
	Female	3,063	376 (12.3%)
Living type	Rural	4,943	617 (12.5%)
	Urban	1,236	262 (21.2%)
Education level	No education	2,162	274 (12.7%)
	Primary school or below	2,832	378 (13.3%)
	High school or below (vocational)	1,101	208 (18.9%)
	College or above	84	19 (22.6%)
Marital status	Married or cohabiting	1,230	203 (16.5%)
	Not married (divorced, single, or widowed)	4,949	676 (13.7%)
BMI (kg/m^2)	<18.5	511	34 (6.7%)
	18.5–24.9	3,781	374 (9.9%)
	≥25.0	1,887	471 (25.0%)
Fall situation	Had a fall (within the last two years)	1,132	195 (17.2%)
	No fall	5,047	684 (13.6%)
Smoking behavior	Never smoked	3,358	536 (16.0%)
	Currently smoking	2,323	250 (10.8%)
	Former smoker	498	93 (18.7%)
Drinking habit	Never drank	3,389	524 (15.5%)
	Currently drinking	1,982	206 (10.4%)
	Former drinker	808	149 (18.4%)
Nighttime sleep duration	≤ 6h	3,301	510 (15.4%)
	6–8h	1,056	127 (12.0%)
	≥ 8h	1,822	242 (13.3%)
Self-reported health	Excellent	674	38 (5.6%)
	Very good	247	12 (4.9%)
	Good	1,957	219 (11.2%)
	Fair	2,255	341 (15.1%)
	Poor	1,046	269 (25.7%)
Frailty	Yes	1,067	189 (17.7%)
	No	5,091	690 (13.6%)
Hypertension	Yes	2,123	819 (38.6%)
	No	4,056	60 (1.5%)
Diabetes	Yes	535	359 (67.1%)
	No	5,644	520 (9.2%)
Heart disease	Yes	1,008	599 (59.4%)
	No	5,171	280 (5.4%)
Stroke	Yes	217	159 (73.3%)
	No	5,962	720 (12.1%)

Note: Unit: Person (%).

3.2. Relationship between the number of cardiometabolic diseases and frailty

The results of this study indicate that among the 6,179 elderly individuals, the prevalence of CMM is 14.23%, with 189 individuals (21.50%) experiencing frailty. After adjusting for sociodemographic covariates, compared to individuals without CMD, those with 1 type of CMD and CMM had higher PFP scores (β = 0.12, 95% CI: 0.07–0.18; β = 0.26, 95% CI: 0.19–0.34) and a higher risk of frailty (OR = 1.32, 95% CI: 1.12–1.55; OR = 1.78, 95% CI: 1.45–2.19). Compared to individuals with 1 type of CMD, those with CMM had elevated PFP scores (β = 0.14, 95% CI: 0.06–0.22) and a higher risk of frailty (OR = 1.35, 95% CI: 1.09–1.67). The analysis results of the generalized linear models for frailty status and PFP scores with the number of CMD are shown in **Tables 2** and **3.**

Table 2. Generalized linear model analysis of cardiometabolic disease number and frailty

Cardiometabolic disease number	OR (95% CI)	β	SE	Wald χ^2	*P*
1 type (Compared to no disease)	1.32 (1.12–1.55)	0.28	0.08	11.42	< 0.01
≥ 2 types (Compared to no disease)	1.78 (1.45–2.19)	0.58	0.11	29.60	< 0.01
≥ 2 types (Compared to 1 disease group)	1.35 (1.09–1.67)	0.30	0.11	7.62	< 0.01

Note: Adjusted for age, gender, living type, marital status, education level, fall history, smoking behavior, drinking habits, BMI, night sleep duration, and self-rated health status.

Table 3. Generalized linear model analysis of cardiometabolic disease number and PFP score

Cardiometabolic disease number	β (95% CI)	Wald χ^2	*P*
1 type (Compared to no disease)	0.12 (0.07–0.18)	19.38	< 0.01
≥ 2 types (Compared to no disease)	0.26 (0.19–0.34)	45.19	< 0.01
≥ 2 types (Compared to 1 disease group)	0.14 (0.06–0.22)	12.60	< 0.01

Note: Adjusted for age, gender, living type, marital status, education level, fall history, smoking behavior, drinking habits, BMI, night sleep duration, and self-rated health status.

3.3. Cardiometabolic disease combinations and frailty

Compared to individuals without CMD, elderly individuals with only hypertension (OR = 1.05, 95% CI: 1.02–1.07), hypertension and stroke (OR = 1.18, 95% CI: 1.06–1.31), and those with hypertension, heart disease, and stroke (OR = 1.46, 95% CI: 1.24–1.73) showed a significantly increased risk of frailty ($P < 0.01$), as shown in **Table 4.**

Compared to individuals without CMD, elderly individuals with only hypertension (β = 0.13, 95% CI: 0.07–0.19), only heart disease (β = 0.12, 95% CI: 0.03–0.22), hypertension and diabetes (β = 0.22, 95% CI: 0.08–0.36), hypertension and heart disease (β = 0.18, 95% CI: 0.08–0.29), hypertension and stroke (β = 0.51, 95% CI: 0.26–0.76), hypertension, diabetes, and heart disease (β = 0.31, 95% CI: 0.12–0.51), and hypertension, heart disease, and stroke (β = 0.83, 95% CI: 0.42–1.24) had significantly higher PFP scores ($P < 0.01$), as shown in **Table 5.**

Table 4. Generalized linear model analysis of cardiometabolic disease combinations and frailty

Comorbidity combination	Diseases involved	Frailty status [*n* (%)]	OR (95% CI)	β	SE	Wald χ^2	*P*
0 diseases		529 (15.50%)					
1 disease	Hypertension only	238 (18.84%)	1.05 (1.02–1.07)	0.05	0.01	13.14	< 0.01
	Diabetes only	23 (13.45%)	1.00 (0.94–1.04)	-0.01	0.03	0.07	0.79
	Heart Disease only	72 (18.14%)	1.03 (1.01–1.04)	0.03	0.02	1.91	0.17
	Stroke only	16 (28.57%)	1.13 (1.00–1.26)	0.12	0.06	4.32	< 0.05
2 diseases	Hypertension, diabetes	31 (17.03%)	1.06 (1.00–1.12)	0.06	0.03	3.76	0.05
	Hypertension, heart disease	81 (19.85%)	1.05 (1.01–1.10)	0.05	0.02	5.81	< 0.05
	Hypertension, stroke	24 (32.88%)	1.18 (1.06–1.31)	0.17	0.05	9.62	< 0.01
	Diabetes, heart disease	8 (20.00%)	1.08 (0.95–1.22)	0.07	0.06	1.36	0.24
	Diabetes, stroke	2 (28.57%)	1.15 (0.82–1.61)	0.14	0.17	0.57	0.44
	Heart disease, stroke	2 (22.22%)	1.06 (0.82–1.31)	0.06	0.13	0.18	0.67
3 diseases	Hypertension, diabetes, heart disease	16 (17.78%)	1.09 (1.01–1.18)	0.09	0.04	4.28	< 0.05
	Hypertension, diabetes, stroke	4 (22.22%)	1.13 (0.91–1.39)	0.12	0.09	1.31	0.19
	Hypertension, heart disease, stroke	16 (53.33%)	1.46 (1.24–1.73)	0.38	0.08	20.47	< 0.01
	Diabetes, heart disease, stroke	0 (0.00%)	0.87 (0.80–0.94)	-0.14	0.04	11.09	< 0.01
4 diseases	Hypertension, diabetes, heart disease, stroke	5 (27.78%)	1.18 (1.04–1.34)	0.17	0.11	2.47	0.12

Note: Adjusted for age, gender, living type, marital status, education level, fall history, smoking behavior, drinking habits, BMI, night sleep duration, and self-rated health status.

Table 5. Generalized linear model analysis of cardiometabolic disease combinations and PFP score

Comorbidity group	Diseases involved	PFP score	β (95% CI)	SE	Wald χ^2	*P*
0 diseases		1.51 ± 0.99	0.00			
1 disease	Hypertension only	1.59 ± 1.00	0.13 (0.07–0.19)	0.01	13.14	< 0.01
	diabetes only	1.46 ± 0.93	0.00 (-0.14–0.14)	0.03	0.07	0.10
	Heart disease only	1.61 ± 0.96	0.12 (0.03–0.22)	0.02	1.91	< 0.01
	Stroke only	1.79 ± 1.29	0.25 (-0.05–0.56)	0.06	4.32	0.10
2 diseases	Hypertension, diabetes	1.59 ± 0.95	0.22 (0.08–0.36)	0.03	3.76	< 0.01
	Hypertension, heart disease	1.65 ± 1.01	0.18 (0.08–0.29)	0.02	5.81	< 0.01
	Hypertension, stroke	2.03 ± 1.14	0.51 (0.26–0.76)	0.05	9.62	< 0.01
	Diabetes, heart disease	1.65 ± 1.12	0.24 (-0.07–0.55)	0.06	1.36	0.13
	Diabetes, stroke	2.00 ± 1.41	0.53 (-0.44–1.50)	0.17	0.57	0.29
	Heart disease, stroke	1.44 ± 1.13	-0.08 (-0.73–0.56)	0.13	0.18	0.80
3 diseases	Hypertension, diabetes, heart disease	1.62 ± 0.95	0.31 (0.12–0.51)	0.04	4.28	< 0.01
	Hypertension, diabetes, stroke	1.61 ± 0.92	0.28 (-0.09–0.65)	0.09	1.31	0.13

Table 5 (Continued)

Comorbidity group	Diseases involved	PFP score	β (95% CI)	SE	Wald χ^2	*P*
	Hypertension, heart disease, stroke	2.30 ± 1.26	0.83 (0.42–1.24)	0.08	20.47	< 0.01
	Diabetes, heart disease, stroke	1.25 ± 0.50	-0.21 (-0.63–0.20)	0.04	11.09	0.31
4 diseases	Hypertension, diabetes, heart disease, stroke	1.89 ± 1.02	0.54 (0.07–1.01)	0.11	2.47	< 0.05

Note: Adjusted for age, gender, living type, marital status, education level, fall history, smoking behavior, drinking habits, BMI, night sleep duration, and self-rated health status.

4. Discussion

This study found that as the number of CMD increases, the risk of frailty among Chinese middle-aged and elderly individuals also increases [13]. Similar to previous studies, we found that older adults with multiple chronic conditions are more likely to experience worsening frailty over time [14,15]. As the number of diseases increases, elderly populations with cardiovascular-metabolic multimorbidity are more prone to muscle loss, with multiple diseases interacting synergistically [16]. Hanlon *et al.* showed that the increase in frailty prevalence is associated with a greater number of chronic diseases among elderly individuals with multimorbidity [17]. Multimorbidity leads to greater physiological burden, and the side effects of polypharmacy may exacerbate the risk of frailty [18].

The effect of different combinations of CMD on frailty varies. This study found that cardiovascular-metabolic multimorbidity that includes hypertension is associated with a higher risk of frailty, consistent with previous studies [19,20]. Hypertension and other chronic diseases are considered significant risk factors for frailty [21]. Hypertension activates chronic inflammation, which often involves pathological changes in the nervous, musculoskeletal, endocrine, immune, and blood systems [22,23]. This leads to cognitive decline, physical frailty, and a higher risk of falls, which accelerates the onset of frailty. Hypertension, diabetes, heart disease, and stroke share common risk factors such as obesity, smoking, and lack of physical activity [24]. Additionally, the physiological and biological mechanisms linking hypertension, diabetes, heart disease, stroke, and frailty are similar, including inflammation and immune dysfunction, mitochondrial dysfunction, and endocrine-metabolic imbalance leading to physical decline (sarcopenia) [25,26]. Ultimately, these factors contribute to the onset of frailty.

5. Conclusion

This study, based on nationwide representative data of middle-aged and elderly individuals in China, provides results with general applicability. From the dual perspective of the number and combination patterns of cardiovascular-metabolic multimorbidity and their relationship with frailty, this study offers a new methodological approach and exploration for investigating the correlation between multimorbidity patterns and frailty outcomes. However, this study has several limitations. Firstly, the data on cardiovascular-metabolic multimorbidity in the CLHLS database are primarily based on self-reports from the participants, which may lead to recall bias and reporting bias, thus affecting the accuracy of morbidity rates. Secondly, due to data accessibility constraints, this study did not conduct more detailed classifications of hypertension, diabetes, heart disease, or stroke, nor did it delve into the progression and severity of cardiovascular-metabolic diseases. Future research will further explore the specific impact of different disease subtypes and their severity on frailty.

In summary, as aging intensifies, frailty not only poses a severe challenge to the health of the middle-aged

and elderly population but also brings significant burdens to families and society. It has become an urgent public health issue that needs to be addressed. Cardiovascular-metabolic multimorbidity, especially the multimorbidity involving hypertension, is closely related to the onset of frailty. Therefore, tailored treatment and care strategies for specific cardiovascular-metabolic multimorbidity patterns should be developed, with scientific and effective prevention and intervention measures implemented in the early stages of multimorbidity. This is not only crucial for reducing the risk of frailty among the middle-aged and elderly population but also an important pathway for promoting healthy aging.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Wang H, Zhang L, Fang X, et al., 2022, The Prevalence and Spatial Distribution of Chronic Multimorbidity among Middle-Aged and Elderly People in China. Chinese General Practice, (10): 1186–1190.

[2] Seghieri C, Tortu C, Trico D, et al., 2024, Learning Prevalent Patterns of Co-Morbidities in Multichronic Patients using Population-Based Healthcare Data. Scientific Reports, 14(1): 2186.

[3] Zhao Y, Long F, Wu X, et al., 2025, Dose-Response Relationship between the Age at Diagnosis of Cardiovascular Metabolic Multimorbidity and Cognitive Impairment among Middle-Aged and Older Adults in China. Geriatric Nursing, 61: 311–315.

[4] Zhang L, Li Y, Qian Y, et al., 2021, The Status and Research Progress of Geriatric Multimorbidity. Chinese Journal of Geriatric Multiple Organ Diseases, (1): 67–71.

[5] Tazzeo C, Rizzuto D, Calderon-Larranaga A, et al., 2021, Multimorbidity Patterns and Risk of Frailty in Older Community-Dwelling Adults: A Population-Based Cohort Study. Age and Ageing, 50(6): 2183–2191.

[6] Luo Y, Chen Y, Wang K, et al., 2023, Associations between Multimorbidity and Frailty Transitions among Older Americans. Journal of Cachexia, Sarcopenia and Muscle, 14(2): 1075–1082.

[7] Han Y, Hu Y, Yu C, et al., 2021, Lifestyle, Cardiometabolic Disease, and Multimorbidity in a Prospective Chinese Study. European Heart Journal, 42(34): 3374–3384.

[8] Liu G, Wang J, Zeng L, et al., 2023, The Relationship between Cardiovascular Metabolic Multimorbidity and Cognitive Function in Elderly Chinese. Nursing Research, (10): 1701–1706.

[9] Huang Z, Luo Y, Su H, et al., 2021, The Relationship between Cardiovascular Metabolic Multimorbidity and Depressive Symptoms in Elderly Chinese. Chinese Journal of Chronic Disease Prevention and Control, (9): 644–648.

[10] Fried LP, Tangen CM, Walston J, et al., 2001, Frailty in Older Adults: Evidence for a Phenotype. The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences, 56(3): 146–156.

[11] Wang Q, Dai X, Liu J, et al., 2021, The Incidence and Influencing Factors of Frailty among Community-Dwelling Elderly People in China. Journal of Southern Medical University, (11): 1719–1724.

[12] Xu W, Li YX, Wu C, 2019, Incidence of Frailty among Community-Dwelling Older Adults: A Nationally Representative Profile in China. BMC Geriatrics, 19(1): 378.

[13] He B, Ma Y, Wang C, et al., 2019, Prevalence and Risk Factors for Frailty among Community-Dwelling Older People in China: A Systematic Review and Meta-Analysis. The Journal of Nutrition, Health and Aging, 23(5): 442–450.

[14] Vetrano DL, Palmer K, Marengoni A, et al., 2019, Frailty and Multimorbidity: A Systematic Review and Meta-Analysis. The Journals of Gerontology: Series A, 74(5): 659–666.

[15] Mendonca N, Kingston A, Yadegarfar M, et al., 2020, Transitions between Frailty States in the Very Old: The Influence of Socioeconomic Status and Multi-Morbidity in the Newcastle 85+ Cohort Study. Age and Ageing, 49(6): 974–981.

[16] He L, Lin S, Yang J, et al., 2024, Associations between Multimorbidity Patterns and Sarcopenia Transitions in Chinese Older Adults. Geriatrics & Gerontology International, 24(11): 1137–1143.

[17] Hanlon P, Nicholl BI, Jani BD, et al., 2018, Frailty and Pre-Frailty in Middle-Aged and Older Adults and its Association with Multimorbidity and Mortality: A Prospective Analysis of 493,737 UK Biobank Participants. The Lancet. Public Health, 3(7): e323–e332.

[18] Gutierrez-Valencia M, Izquierdo M, Cesari M, et al., 2018, The Relationship between Frailty and Polypharmacy in Older People: A Systematic Review. Wiley, 84(7): 1432–1444.

[19] Chen Y, Zhang X, Cao J, et al., 2022, The Status and Influencing Factors of Frailty in Elderly Hypertensive Patients in the Community. Chinese Journal of Geriatrics, (2): 459–462.

[20] Kang H, Liu J, 2024, The Research Progress of HRR, Cr/Cys-C in Frailty in Elderly Patients with Hypertension Combined with Coronary Heart Disease. Clinical Personalized Medicine, (2): 354–362.

[21] Hoogendijk EO, Afilalo J, Eesrud KE, et al., 2019, Frailty: Implications for Clinical Practice and Public Health. The Lancet, 394(10206): 1365–1375.

[22] Shi J, Tao Y, Chen S, et al., 2024, Interaction between Hypertension and Frailty and Their Impact on Death Risk in Older Adults: A Follow-Up Study. BMC Geriatrics, 24(1): 187.

[23] Soysal P, Arik F, Smith L, et al., 2020, Inflammation, Frailty and Cardiovascular Disease. Advances in Experimental Medicine and Biology, 1216: 55–64.

[24] Mensah GA, Roth GA, Fuster V, 2019, The Global Burden of Cardiovascular Diseases and Risk Factors: 2020 and Beyond. Journal of the American College of Cardiology, 74(20): 2529–2532.

[25] Ferrucci L, Fabbri E, 2018, Inflammageing: Chronic Inflammation in Ageing, Cardiovascular Disease, and Frailty. Nature Reviews Cardiology, 15(9): 505–522.

[26] Sato R, Vatic M, Peixoto da Fonseca GW, et al., 2024, Biological Basis and Treatment of Frailty and Sarcopenia. Cardiovascular Research, 120(9): 982–998.