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Prevalence of multimorbidity among urban–rural older adults in Mongolia: a cross-sectional study

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Abstract

Background Multimorbidity presents medical challenges, incurs high medical costs, burdens the economy, and increases mortality risk among adults. Despite its impact, recent surveys identifying risk factors for multimorbidity and its association with quality of life in Mongolia are lacking. This study aimed to investigate the prevalence of multimorbidity and its risk factors for multimorbidity among older adults (aged sixty years and above) in urban and rural areas in Mongolia.

Methods A face-to-face, questionnaire-based cross-sectional study was conducted with 720 valid participants aged ≥ 60 years in Mongolia from June to September 2023.

Results The study revealed that (1) the prevalence of multimorbidity among older adults was 66.94%, with 51.87% of rural respondents and 48.13% of urban respondents affected; (2) the multimorbidity rate was significantly higher among low-income older adults (80.68%) than among middle-income older adults (58.24%), with a significant difference ($\chi^2 = 35.94$, $P < 0.001$); (3) the multimorbidity rates were 4.72% for two chronic diseases, 12.50% for three, 15.42% for four, and 10.83% for five chronic diseases; and (4) seven patterns of multimorbidity associated with rheumatoid arthritis were identified in rural older adults, whereas six patterns related to hypertension were observed in urban older adults.

Conclusion The prevalence of multimorbidity is notably high among older adults in both rural and urban Mongolia, with distinct differences in chronic disease patterns and risk factors. The implementation of systemic transformations may help reduce multimorbidity rates and increase the overall health of older adults across various settings.

Keywords Older adults, Multimorbidity, Risk factors, Urban–Rural areas, Health management

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Background

Aging is a global trend expected to persist in the future [1]. By 2050, the population of adults aged 60 years and older is projected to nearly triple worldwide [2]. Multimorbidity is characterized by the presence of two or more chronic conditions in an individual [3]. The prevalence of multimorbidity increases sharply with age, with 67% occurring among adults aged 65 and older [4]. Multimorbidity poses significant challenges for treatment, incurs high medical costs, burdens the economy, and increases mortality risk among adults [5–14]. In 2021, the prevalence of multimorbidity among adults globally was 33.1%, highlighting its status as a significant and rapidly growing public health issue [15]. NCDs account for 41 million deaths annually, predominantly in low- and middle-income countries [16]. A notable increase in chronic diseases has been observed in these regions. Multimorbidity affects two-thirds of older adults and has been linked to poor healthcare services and low income [12]. Previous studies have shown that multimorbidity is associated with numerous adverse health outcomes and represents a significant public health challenge that impedes economic and social development [17, 18].

Mongolia, located in East Asia and home to 3.4 million inhabitants, is classified as a low- to middle-income country, with an economy primarily based on mining and agriculture [19]. Mongolia is among the world's least densely populated countries [20]. The healthcare structure is organized into two tiers, each offering primary care and specialized treatment, including referral services. Family group practices have been integrated into primary health care (PHC), alongside the establishment of regional diagnostic and treatment centers (RDTCs) [21]. According to Mongolia's integrated statistical database, individuals aged 60 and older constitute 8.1% of the total population. Mongolian statistics reported that in 2023, the average life expectancy of the population was 71.99 years. For men, the average life expectancy is 67.3 years, whereas for women, it is 76.7 years [22]. In 2022, the leading causes of mortality per 10,000 people were as follows: respiratory system diseases 3.9, digestive system diseases 4.8, cardiovascular diseases 16.4, cancer 13.6, injuries, poisoning, and other external causes 13.7. Among those who underwent outpatient examinations, 38.9% were men and 61.1% were women. Specifically, 6.5% of the patients screened were aged 60–64 years, whereas 9% were 60 years or older [23]. These statistical data indicate that outpatient screening is inadequate for older adults, resulting in insufficient medical care.

Several surveys have been conducted in Mongolia to identify risk factors for chronic diseases [24–28], but few studies have focused on the risk factors for multimorbidity and its association with quality of life in urban and rural areas. The scarcity of studies on multimorbidity among older adults underscores the need for enhanced management of health services for this population. This study aims to promote proactive prevention and management of multimorbidity. Our objective was to investigate the prevalence and risk factors for multimorbidity among older adults (aged 60 years and older) in both urban and rural settings.

Methods

This study aims to promote proactive prevention and management of multimorbidity by investigating its prevalence and risk factors among older adults (aged 60 years and older) in both urban and rural settings in Mongolia.

Participants

A questionnaire-based cross-sectional study was conducted in Mongolia from June to September 2023. The questionnaire comprises five main sections, including a total of 48 lifestyle-related questions and 16 health-related inquiries, and is administered to 800 elderly individuals in Ulaanbaatar capital city and rural areas. We compiled a comprehensive database focused on 16 chronic diseases prevalent in these regions that significantly impact health status. These diseases included hypertension, diabetes, rheumatism or rheumatoid arthritis, coronary heart disease, hearing impairment, gastrointestinal diseases, osteoporosis, eye diseases, respiratory diseases, cancer, angina, trauma, stroke, reproductive diseases, and neurological diseases.

Personal characteristics, socioeconomic status, interpersonal networks, and behavioral characteristics were evaluated through face−to-face interviews. The criteria for participation in our study included (1) being aged 60 years or older, (2) residing at their current address for at least five years, and (3) having clear awareness and accessible communication skills. Trained interviewers with medical knowledge conducted the face−to−face interviews via a standardized questionnaire. Diagnostic information was obtained through self-reports and corroborated by medical records or prescriptions. The survey data were obtained from the Senior Citizen's Committee, which serves older adults in Mongolia. Participation was voluntary, and individuals were invited to complete the questionnaire. A total of 800 older adults were surveyed, representing approximately 0.3% of the older adult population, with 720 respondents completing the questionnaires, resulting in an effective response rate of 90%.

Statistical analysis

In this study, we used the Apriori algorithm with IBM SPSS Modeler Version 27.0 to analyze patterns of multimorbidity among older adults. The Apriori algorithm is a data mining technique used to discover association

rules in large datasets, which can help identify relationships between different diseases that frequently co-occur. Support refers to the proportion of transactions in the dataset that contain both diseases. It is a measure of how frequently a pair of diseases occurs together in the data. A higher support value indicates that the association between the diseases is more common. Confidence refers to the conditional probability of finding a second disease or risk factor (B) given the presence of another disease or risk factor (A). The thresholds for support and confidence were selected based on a balance between capturing meaningful associations and ensuring statistical significance. It indicates the strength of the relationship between two diseases, with higher confidence values suggesting a stronger association. Lift is a measure of the strength of an association between two items, calculated as the ratio of the observed support to the expected support if the items were independent. Lift measures the strength of the association between diseases A and B relative to what would be expected by chance. A lift value greater than 1 suggests a positive association, while a lift value less than 1 indicates a negative association or no significance [29–32]. An association rule is defined as an implication of the form {A} → {B}, where A and B are sets of diseases. The rules indicate relationships between diseases that frequently occur together. The minimum support was established at 2.00, the minimum confidence was 30.00, and the lift was greater than 1.00. We utilized the chi-square test to compare the prevalence of chronic diseases among older adults. A result is regarded as statistically significant if the p-value is less than 0.05.

Results

Multimorbidity and chronic disease incidence among older adults

The respondents were 50% male and 50% female, with an average age of 68.1 years. By age group, those aged 60–69 years accounted for 66.39%, those aged 70–79 years accounted for 25.42%, and those aged 80 years and above accounted for 8.19%. The combined rate of overweight and obesity was 65.56%, whereas the rates of smoking, drinking, and empty-nesting were 22.22%, 24.03%, and 56.11%, respectively. The prevalence of chronic diseases among older adults was 79.72%, including 74.91% with hypertension, 58.7% with rheumatoid arthritis, 44.9% with digestive system diseases, 45.1% with osteoporosis, and 33.7% with coronary heart disease. A total of 51.87% of the respondents in rural areas had multimorbidity, whereas 48.13% of those in urban areas also had multimorbidity. The overall prevalence of multimorbidity among older adults was 66.94%.

The ten most common chronic conditions were hypertension, diabetes, rheumatoid arthritis, hearing impairment, digestive system diseases, coronary heart disease, kidney disease, eye diseases, neurological diseases and osteoporosis.

Table 1 presents sex and residence differences in the most common chronic diseases in older adults. Hypertension, rheumatoid arthritis, osteoporosis, digestive system diseases, coronary heart disease, and eye disease were the most prevalent conditions in both settings. The results indicated that 54.88% of older adults in urban areas suffered from hypertension, while 45.12% of older

Table 1 Sex and residence differences in the most common chronic diseases in older adults

Variable	Total	Male (%)	Female (%)	*P* Value	Urban (%)	Rural (%)	*P* Value
Hypertension	430	53.49	46.51	**0.023**	54.88	45.12	**0.035**
Diabetes	83	44.58	55.42	0.294	54.22	45.78	0.621
Rheumatoid or rheumatoid arthritis	337	52.23	47.77	0.263	44.51	55.49	**< 0.001**
Coronary heart disease	194	45.88	54.12	0.179	46.39	53.61	0.085
Hearing impairment	184	51.09	48.91	0.733	50.54	49.46	0.724
Digestive system disease	258	46.12	53.88	0.12	46.90	53.10	0.056
Osteoporosis	259	49.81	50.19	0.938	47.49	52.51	0.093
Eye disease	274	47.81	52.19	0.357	49.27	50.73	0.313
Respiratory diseases	115	45.22	54.78	0.263	39.13	60.87	**0.003**
Stroke	72	63.89	36.11	**0.013**	52.78	47.22	0.842
Cancer	23	52.17	47.83	0.832	17.39	82.61	**< 0.001**
Neurological diseases	113	46.90	53.10	0.473	45.13	54.87	0.13
Kidney	193	38.86	61.14	**< 0.001**	45.08	54.92	**0.032**
Chronic hepatitis/fatty liver	114	43.86	56.14	0.188	35.09	64.91	**< 0.001**
Angine	73	39.73	60.27	0.064	17.81	82.19	**< 0.001**
Trauma	42	40.48	59.52	0.203	11.90	88.10	**< 0.001**
Multimorbidity [b]	482	52.70	47.30	**0.039**	48.13	51.87	**0.007**
No NCD	146	52.05	47.95	0.578	61.64	38.36	**0.007**
One NCD	92	32.61	67.39	**< 0.001**	54.35	45.65	0.582
Two NCDs	34	44.12	55.88	0.482	11.76	88.24	**< 0.001**

adults in rural areas were affected. Additionally, the prevalence of rheumatoid arthritis was higher in rural areas (55.49%) compared to urban areas (44.51%). The prevalence of hypertension was also greater in males (53.49%) than in females (46.51%). Sex differences were statistically significant for hypertension ($P = 0.023$), stroke ($P = 0.013$), kidney disease ($P < 0.001$), multimorbidity ($P = 0.039$), and one NCD ($P < 0.001$). Furthermore, the prevalence of hypertension, rheumatoid arthritis, respiratory diseases, cancer, kidney disease, chronic hepatitis/fatty liver disease, angina, trauma, multimorbidity, no NCDs, and two NCDs differed significantly based on residence.

Table 2 presents the prevalence of chronic multimorbidity among older adults in Mongolia. The distribution

Table 2 Prevalence of chronic multimorbidity among older adults

Features	People %	*Prevalence*[a] (%)						multimorbidity[b] (%)	X^2 Value	*P* value
		0 kind	1 kind	2 kinds	3 kinds	4 kinds	5 kinds			
Age									11.1	0.004
60–69	66.39	21.34	13.81	3.97	11.72	18.41	12.55	64.85		
70–79	25.42	22.40	11.48	7.10	14.21	7.65	7.65	66.12		
80+	8.19	5.08	8.47	3.39	13.56	15.25	6.78	86.44		
Sex									4.24	0.039
Female	50.00	9.72	8.61	2.64	5.69	5.97	4.44	63.33		
Male	50.00	10.56	4.17	2.08	6.81	9.44	6.39	70.56		
Residence									7.29	0.007
Urban	51.67	24.19	13.44	0.81	12.90	20.43	11.02	62.37		
Rural	48.33	16.09	12.07	8.91	12.07	10.06	10.63	71.84		
BMI									23.53	< 0.001
Underweight	1.94	64.29	14.29	0	7.14	0	0	21.43		
Normal	32.50	23.50	16.67	6.41	7.26	18.38	7.69	59.83		
Overweight and Obese	65.56	17.37	10.81	4.03	15.25	14.41	12.71	71.82		
Smoking status									9.08	0.011
Smoking	22.22	15.6	8.1	5.00	19.38	21.25	3.13	76.25		
Quit smoking	6.25	15.5	13.3	11.11	8.89	6.67	4.44	71.11		
Never	71.53	22.14	14.17	4.08	10.68	14.37	13.79	63.69		
Drinking status									21.38	< 0.001
Drinking	24.03	24.86	9.25	4.62	13.29	9.83	13.29	65.90		
Quit drinking	22.08	10.69	7.55	3.14	20.75	28.93	7.55	81.76		
Never	53.89	22.16	16.49	5.41	8.76	12.37	11.08	61.34		
Sleep Quality									11.1	0.04
Severe sleep difficulty	2.64	0.00	5.26	0	26.32	0	15.79	94.74		
No sleep difficulty	53.47	23.38	13.77	6.49	12.73	17.40	9.61	62.86		
Moderate sleep difficulty	43.89	17.72	12.03	2.85	11.39	13.92	12.03	70.25		
Marital status									1.99	0.158
Married	68.19	21.79	9.57	4.28	12.02	15.07	12.02	68.64		
Other	31.81	17.03	19.65	5.68	13.54	16.16	8.30	63.32		
Empty nest status									0.519	0.774
No children	8.47	16.39	18.03	0	16.39	27.87	11.48	65.57		
Empty nest	56.11	23.02	10.89	5.69	12.87	9.90	12.87	66.09		
Non empty nest	35.42	16.86	14.51	4.31	10.98	21.18	7.45	68.63		
Education level									9.80	0.007
Elementary and below	31.81	20.96	6.99	7.42	11.35	14.41	6.55	72.05		
Secondary	31.53	22.91	18.06	3.52	7.93	9.25	13.66	59.03		
Higher and above	36.67	17.42	13.26	3.41	17.42	21.59	12.12	69.32		
Monthly income									35.94	< 0.001
Low	36.67	10.23	9.09	5.30	19.70	18.94	8.33	80.68		
Middle	48.89	24.72	17.05	5.11	9.38	13.92	8.52	58.24		
High	14.44	30.77	7.69	1.92	4.81	11.54	25.00	61.54		
Total	100.00	20.28	12.78	4.72	12.50	15.42	10.83	66.94		

Prevalence[a] refers to the percentage of individuals within the population who have combinations of up to five diseases, while multimorbidity[b] indicates the co-occurrence of two or more chronic conditions in an individual, expressed as a percentage

of chronic diseases among older adults in the sample area indicated that the multimorbidity. rate for two and more chronic diseases was significantly greater in men (70.56%) than in women (63.33%) (χ^2=4.24, P = 0.039). The multimorbidity rate among older adults with low income (80.68%) was significantly greater than that among their middle-income counterparts (58.24%) (χ^2=35.94, P < 0.001). As age increased, the prevalence of multimorbidity increased. Age was identified as a significant risk factor for multimorbidity (χ^2 = 11.1, P = 0.004). Age, gender, residence, BMI, smoking status, alcohol consumption, sleep quality, education level, and monthly income were identified as a significant risk factor for multimorbidity. The multimorbidity rates were as follows: 4.72% for two chronic diseases, 12.50% for three chronic diseases, 15.42% for four chronic diseases, and 10.83% for five chronic diseases.

In Table 3, *P*-values were obtained using the chi-square test to assess the differences between urban and rural areas in the distribution of risk factors between the sexes. A *P*-value less than 0.05 indicate statistical significance. Family medical history, BMI, frequency of fresh fruit consumption, smoking status, alcohol consumption, sleep quality, marital status, empty nest status, and education

Table 3 Distribution of risk factors by sex and residence area

Variable	People (%)	Male (%)	Female (%)	*P* Value	Urban (%)	Rural (%)	*P* Value
Family history							
Yes	11.25	51.85	48.15	0.723	40.74	59.26	**0.037**
No	88.75	49.77	50.23		53.05	46.95	
BMI							
Underweight	1.94	64.29	35.71	0.546	78.57	21.43	**0.012**
Normal	32.51	49.15	50.85		45.30	54.70	
Overweight and Obese	65.55	50.00	50.00		54.03	45.97	
Regularity of three meals							
Yes	66.53	43.63	56.37	**< 0.001**	49.27	50.73	**0.07**
No	33.47	62.66	37.34		56.43	43.57	
Frequency of fresh fruit consumption							
Eat almost every day	85	46.57	53.43	**< 0.001**	53.92	46.08	**0.004**
Other	15	69.44	30.56		38.89	61.11	
Smoking							
Never	71.53	40.58	59.42	**< 0.001**	52.82	47.18	**< 0.001**
Quit	22.22	73.13	26.88		56.25	43.75	
Smoking	6.25	75.56	24.44		22.22	77.78	
Drinking							
Never	53.89	42.27	57.73	**< 0.001**	43.30	56.70	**< 0.001**
Quit	24.03	69.94	30.06		52.02	47.98	
Drinking	22.08	47.17	52.83		71.70	28.30	
Sleep Quality							
No sleep difficulty	53.47	48.31	51.69	0.541	47.01	52.99	**0.024**
Severe sleep difficult	2.64	57.89	42.11		63.16	36.84	
Marital Status							
Married	68.19	56.62	43.38	**< 0.001**	48.27	51.73	**0.008**
Other	31.81	35.81	64.19		58.95	41.05	
Empty nest status							
No children	8.47	50.82	49.18	0.926	65.57	34.43	**0.002**
Empty nest	56.11	50.50	49.50		46.29	53.71	
Non empty nest	35.42	49.02	50.98		56.86	43.14	
Education level							
Elementary and below	31.81	45.41	54.59	**0.002**	35.81	64.19	**< 0.001**
Secondary	31.53	44.49	55.51		44.93	55.07	
Higher and above	36.67	58.71	41.29		71.21	28.79	
Monthly income							
Low	37.22	54.10	45.90	**< 0.001**	52.99	47.01	0.059
Middle	49.17	42.09	57.91		48.02	51.98	
High	13.61	67.35	32.65		61.22	38.78	

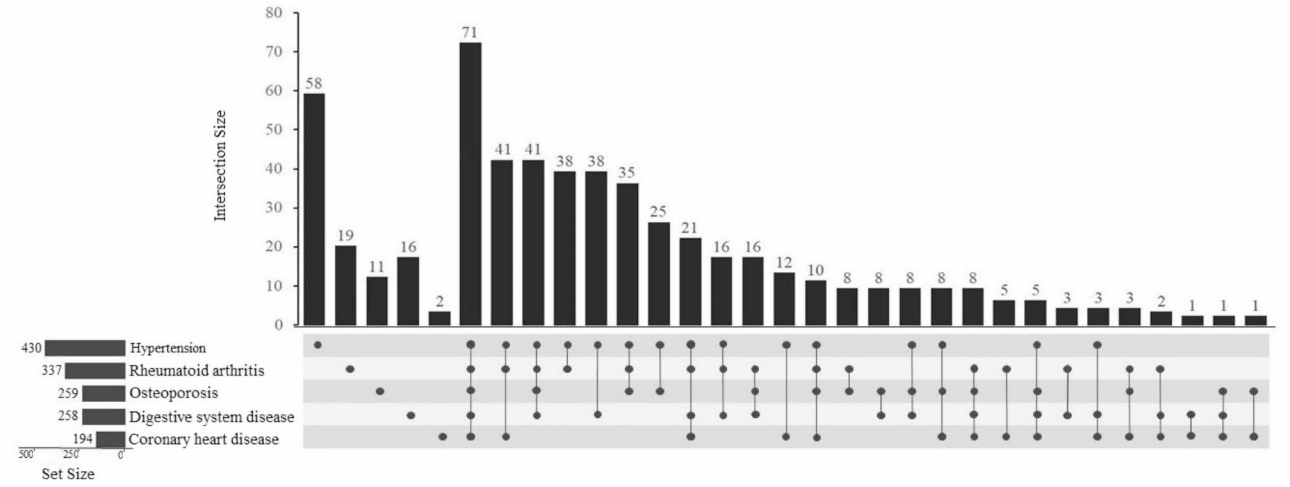

Fig. 1 The pattern of chronic multimorbidity with high prevalence among older adults

Table 4 Analysis results of sex differences in association rules for Multimorbidity

Sex	Antecedent	Consequent	Support (%)	Confidence (%)	Lift
Female	Hypertension	Rheumatic or Rheumatoid arthritis	3.47	77.64	1.4
	Hypertension	Osteoporosis	2.75	76.15	1.37
	Rheumatic or Rheumatoid arthritis	Osteoporosis	2.78	76.92	1.72
Male	Hypertension	Rheumatic or Rheumatoid arthritis	4.11	84.09	1.32
	Hypertension	Digestive system disease	2.67	80.67	1.26
	Hypertension	Osteoporosis	2.89	80.62	1.26

The minimum support > 2.00, the minimum confidence > 30.00, and the lift > 1

level significantly differed by residence. Moreover, the regularity of three meals, frequency of fresh fruit consumption, smoking status, alcohol consumption, marital status, education level, and monthly income significantly differed between the sexes (see Table 3).

Analysis of association rules in chronic multimorbidity

The UpSet plot figure shows the distribution of the five most common chronic diseases among individuals. The most prevalent conditions were Hypertension, Rheumatoid or Rheumatoid Arthritis, Osteoporosis, Digestive System Diseases, and Coronary Heart Diseases in 534 individuals, representing 74.17% of all participants (Fig. 1).

The UpSet plot is useful for displaying the intersection of multiple sets of chronic condition combinations and their prevalence. In the plot, a single dot represents one disease, while two dots indicate the presence of two diseases, and two or more dots indicates the presence of multiple diseases. The bars above the dots display the number of individuals affected by the disease combination.

Among this in individuals, the most frequent occurrence was the coexistence of all five diseases, affecting 71 individuals (13.30%). This was followed by hypertension alone, observed in 58 individuals (10.86%). Additionally, 41 individuals (7.68%) had a combination of hypertension, rheumatoid or rheumatoid arthritis, and coronary heart disease. Another 41 individuals (7.68%) had hypertension, rheumatoid or rheumatoid arthritis, osteoporosis, and digestive system diseases.

The data were analyzed by sex, and 27 association rules for multimorbidity were identified (19 for females and 8 for males). We present the three highest confidence percentages for each sex. Two patterns of multimorbidity associated with rheumatoid arthritis were found in females: {hypertension} → {rheumatoid or rheumatoid arthritis} and {rheumatoid or rheumatoid arthritis} → {osteoporosis}. In males, three patterns of multimorbidity associated with hypertension were identified: {hypertension} → {rheumatoid or rheumatoid arthritis}, {hypertension} → {digestive system disease}, and {hypertension} → {osteoporosis}. Among the identified association rules, the consequents included three chronic diseases: digestive system disease, osteoporosis, and rheumatoid or rheumatoid arthritis. The antecedents included two chronic diseases: hypertension and rheumatoid or rheumatoid arthritis (as shown in Table 4. Analysis results of sex differences in association rules for multimorbidity).

The 18 association rules related to residents and seven patterns of multimorbidity associated with rheumatoid / rheumatoid arthritis was found in rural older adults. Six

Table 5 Analysis results of urban–rural differences in association rules for Multimorbidity

Urban				
Antecedent	Consequent	Support (%)	Confidence (%)	Lift
Rheumatic or Rheumatoid arthritis	Hypertension	3.87	61.02	1.51
Coronary heart disease	Hypertension	2.42	38.14	1.58
Digestive system disease	Hypertension	2.74	43.22	1.33
Osteoporosis	Hypertension	3.01	47.46	1.44
Osteoporosis	Rheumatic or Rheumatoid arthritis	2.37	58.67	1.77
Hypertension, Osteoporosis	Rheumatic or Rheumatoid arthritis	2.20	54.67	1.82
Rheumatic or Rheumatoid arthritis, Osteoporosis	Hypertension	2.20	34.75	1.47
Rural				
Antecedent	Consequent	Support (%)	Confidence (%)	Lift
Hypertension	Rheumatic or Rheumatoid arthritis	3.71	68.98	1.24
Hypertension	Digestive system disease	2.90	73.72	1.32
Hypertension	Osteoporosis	2.61	66.91	1.20
Coronary heart disease	Hypertension	2.33	41.75	1.40
Coronary heart disease	Rheumatic or Rheumatoid arthritis	2.50	46.52	1.56
Digestive system disease	Rheumatic or Rheumatoid arthritis	3.05	56.68	1.44
Digestive system disease	Osteoporosis	2.70	69.12	1.76
Osteoporosis	Rheumatic or Rheumatoid arthritis	2.99	55.61	1.42
Hypertension, Digestive system disease	Rheumatic or Rheumatoid arthritis	2.39	44.39	1.53
Hypertension, Osteoporosis	Rheumatic or Rheumatoid arthritis	2.16	40.11	1.53
Digestive system disease, Osteoporosis	Rheumatic or Rheumatoid arthritis	2.21	41.18	1.52

The minimum support > 2.00, the minimum confidence > 30.00, and the lift > 1

patterns of multimorbidity associated with hypertension were found in urban older adults. The highest support was rheumatoid or rheumatoid arthritis and hypertension in both areas. The highest confidence was observed for rheumatoid / rheumatoid arthritis and digestive system diseases in rural areas. In the association rules derived, the consequent term included two chronic diseases rheumatoid /rheumatoid arthritis and hypertension. The incidence of hypertension was higher than that of rheumatoid /rheumatoid arthritis in urban areas. In contrast, the consequent term in rural areas included four chronic diseases rheumatoid /rheumatoid arthritis, digestive system diseases, osteoporosis, and hypertension with a higher incidence of rheumatoid /rheumatoid arthritis compared to the other conditions. Additionally, the number of association rules for chronic diseases was greater in rural areas than in urban areas, as shown in Table 5.

Discussion

Multimorbidity has become a major public health concern globally [33]. It is commonly defined as the simultaneous presence of two or more chronic conditions in a single individual [34]. A high rate of multimorbidity is associated with increased mortality and greater use of healthcare services. Approximately one-third of adults worldwide experience multimorbidity, leading to significant challenges for health systems and an economic burden [35]. The annual costs associated with multimorbidity per individual range from $800 to $150,000, varying on the basis of the combination of diseases, country, cost factors, and other study characteristics [36]. NCDs account for more deaths worldwide than all other causes combined, with four specific NCDs, cardiovascular disease, cancer, chronic respiratory diseases, and diabetes, contributing to 84% of this mortality [37]. Mongolia's health indicators from 2022 revealed that the leading causes of morbidity per 10,000 people were as follows: respiratory system 1214.7, digestive system 1563.4, cardiovascular system 1013.4, urinary system 870.9, injuries, poisoning, and other external causes 987.9. Additionally, these morbidity rates have increased since 2021 [38]. Mongolian health indicators have not yet included rates of chronic disease and multimorbidity. Therefore, our study aimed to contribute to the investigation and creation of data on multimorbidity by examining its prevalence and risk factors among older adults (aged 60 years and older) in both urban and rural settings in Mongolia. Our study included 720 older adults aged 60 years and above. The most prevalent conditions in both urban and rural areas were hypertension, rheumatoid arthritis, osteoporosis, digestive system diseases, coronary heart disease, and eye diseases. The most common chronic diseases were hypertension (74.91%) and rheumatoid arthritis (58.7%). The prevalence of multimorbidity was 66.94%, while the prevalence of chronic diseases was 79.72%.

Non-communicable diseases, including cardiovascular diseases, gastrointestinal disorders, respiratory diseases, and metabolic conditions, are the leading chronic diseases in Mongolia. Similarly, in Iran and China, these

non-communicable diseases are also the most prevalent chronic conditions. The risk factors for these diseases such as obesity, age, alcohol consumption, smoking, income level, family history of genetic disorders, and living conditions are comparable across these countries, as they are in Mongolia [25, 28, 39–43].

In a study conducted in Iran and China, the prevalence of multimorbidity was 36.6% among 1,493 participants, with an average age of 61.6 ± 9.5 years in Iran, 58.5% among 3250 participants, with 60 years and above in China [44, 45].

The studies have examined the risk factors for multimorbidity, focusing on the associations between chronic diseases and various demographic variables, including age, sex, residence, body mass index, dietary habits, smoking status, alcohol consumption, sleep quality, education level, marital status, empty nest status, monthly income, and chronic diseases [44–46]. We included similar demographic variables in our study. The rates of overweight and obesity were 65.56%, whereas the rate of alcohol consumption was 24.03%, all of which were higher than those reported in studies conducted in India and China [45, 46]. The smoking rate of 22.22% in this study was little bit more than the 19.3% reported in China but lower than the 59.45% reported in India. In this study, the rate of low income was 37.2%, which was significantly lower than the 48.9% reported in China and the 43.6% reported in India. Additionally, the percentage of individuals with an elementary education or below was 31.8% in this study, whereas it was 50.4% in China and 24.4% in India. The likelihood of developing chronic diseases and multimorbidity is influenced by lifestyle, health education, and income level.

The prevalence of multimorbidity was reported to be greater in rural areas than in urban areas in India (35.4% vs. 19.1%) [46]. In China, the prevalence of multimorbidity is greater among rural older adults than among urban older adults [45, 47]. Similarly, our results indicated that multimorbidity was more prevalent in rural areas than in urban areas (71.8% vs. 62.3%). The prevalence rate of multimorbidity was higher than that reported in China and India. This discrepancy may be influenced by the geographical features of the country and the capacity of the healthcare system. The inconsistency may be partly attributed to differences in sampling methods, sample sizes, and health systems, as well as varying risk factors across regions. A comparison of rural and urban areas revealed a significant disparity in the prevalence of multimorbidity. Compared with their urban counterparts, rural older adults typically face lower socioeconomic status, fewer social services, and less access to quality medical care, which may significantly contribute to their higher rates of multimorbidity.

Therefore, creating an environment that supports older adults through income and social care services, leisure activities, and exercise is essential. According to a previous study in Mongolia, one out of every five people were obese, and half of the population was overweight, with a hypertension prevalence of 43.4% [28]. In this study, the rates of hypertension and obesity (59.72% and 65.56%, respectively) were significantly higher than those reported in earlier studies. Obesity and hypertension are highly correlated, and hypertension often produces no symptoms; however, it increases the risk of heart disease, stroke, and other serious health conditions.

An increasing number of studies have explored the patterns and factors associated with multimorbidity [48]. In a study conducted in China, seven multimorbidity patterns associated with rheumatic or rheumatoid arthritis were identified in rural areas, whereas eight patterns associated with hypertension were found in urban areas [45]. Our study revealed a similar pattern associated with rheumatic or rheumatoid arthritis in rural areas and identified six patterns associated with hypertension among urban older adults. Notably, rheumatoid arthritis was linked to antecedents in the association rules, indicating a connection with osteoporosis in rural areas. Owing to their heavy workload, older adults in rural areas are more likely to suffer from arthritis than their urban counterparts are [45].

A high Lift value indicates a strong association between diseases, with values above 1 suggesting a positive correlation. In our study, we found positive associations between hypertension and other conditions. The Lift values for hypertension and osteoporosis in rural areas were 1.20, hypertension and rheumatic or rheumatoid arthritis were 1.24, hypertension and osteoporosis in men were 1.26, and hypertension and digestive system diseases in men were 1.26.

This underscores the need for increased attention to the multimorbidity of rheumatoid arthritis in terms of prevention and treatment. There are more association rules related to hypertension in the urban older population than in the rural older adult population, suggesting that urban elderly individuals are exposed to risk factors for hypertension, such as stress, obesity, and poor diet. This indicates a significant gap in the patterns and factors associated with multimorbidity in urban versus rural areas.

There are more association rules related to hypertension in males than in females, whereas more association rules related to rheumatoid arthritis are found in females. When genetic and environmental factors are combined, researchers report that sex hormones may contribute to the development of rheumatoid arthritis [49]. Therefore, rheumatoid arthritis is more common in women than in men [50]. In our study, smoking status, alcohol

consumption, and stress were greater in men than in women, which may have caused men to suffer more from hypertension. Risk factors for hypertension include smoking status, alcohol consumption, and stress [25]. The studies revealed that the most important factors in preventing hypertension are health education, exercise and a healthy lifestyle. In Mongolia, men are significantly less likely than women to seek medical attention and education [51]. Mortality rates are highly dependent on an individual's education level, and Mongolian families typically prioritize their daughters' education over their sons' education. As of 2017, women accounted for more than 60% of all university graduates in Mongolia [52]. This trend indicates that women dominate in certain occupations. Supporting the education of more girls is likely to have a positive effect on health.

Mongolians have a nomadic lifestyle, and the nation is governed by 21 provinces (aimags) along with the capital city municipality (Ulaanbaatar) [53]. Delivering healthcare in the country is difficult because of the extremely low nomadic population density across vast geographic areas. Additionally, in Mongolia, the healthcare system is typically organized into three levels. First-level hospitals are primary care facilities often located in rural areas that provide basic health services. Second level hospitals are district hospitals that offer more specialized services and care than first level hospitals do. Third-level hospitals are specialized facilities usually found in urban areas that provide advanced medical care and treatments. However, third level hospitals are located only in the capital city, Ulaanbaatar, where healthcare waiting lists are long and patients often need to wait a significant amount of time to see a doctor [54]. For rural residents, it is common to receive services only at the first level, and accessing third-tier services can be both time-consuming and costly. For example, a rural citizen may need to travel more than 100 km to reach tertiary care. This issue is rooted in the nomadic lifestyle and extensive coverage of the healthcare system, and it is believed to contribute to the chronicity of diseases [53]. Another challenge is that family health centers operate as private hospitals that enter into agreements with the government to provide healthcare services funded by public money [21]. However, these centers often face budget constraints and heavy workloads, resulting in insufficient resources and capacity for family group practitioners. To address these issues, the government of Mongolia has introduced a per capita payment mechanism aimed at establishing contracts with the National Health Service. For citizens with full health insurance, the government sets a payment rate for healthcare [21]. However, this rate is too low and varies across age groups and residential areas, necessitating an increase. Furthermore, individuals who do not pay for health insurance are unable to access healthcare services due to several factors, including remoteness, economic difficulties, internal migration, unemployment, geographical barriers, and a lack of health-seeking behavior. Therefore, providing health insurance, particularly at the PHC level, is crucial.

Since 2016, mobile health (mHealth) technology has been introduced in Mongolia to overcome geographical barriers and improve access to healthcare services for herders and the rural population [55]. The government is conducting preventive and early detection checkups to increase preventive screenings and diagnoses [56]. However, the distribution of resources is uneven between urban and rural areas, and the lack of qualified doctors, medical specialists, diagnostic tests, and equipment in rural areas may be less of a barrier to the provision of accessible mHealth and preventive and early detection checkups. To improve health outcomes, government policies, infrastructure investment, and access to insurance should be tailored to the specific needs of urban and rural areas. There are more complex patterns of multimorbidity in rural areas than in urban settings, making enhancing the quality of healthcare and ensuring equitable resource distribution a priority. Improving the affordability of healthcare services for all is essential for transforming the health system.

Additionally, enhancing coordination among healthcare providers is necessary to effectively manage multiple chronic conditions. The collection of data on the health needs of older adults in both urban and rural settings will enable targeted interventions. By implementing these system transformations, Mongolia can reduce the prevalence of multimorbidity and improve the overall health of older adults across diverse settings.

Limitations

This study revealed the relationship between the prevalence of multimorbidity in older adults and the multimorbidity of chronic diseases, providing valuable insights for the prevention and management of multimorbidity. However, several limitations should be acknowledged. First, the reliance on self-reported data rather than comprehensive lifetime samples may lead to incomplete information. The limitation of this study is the voluntary nature of participant recruitment, which may have introduced selection bias. Participants were recruited from a community-based organization, and those who chose to participate might have had specific health concerns or a higher level of engagement in community activities. This may limit the generalizability of the findings to the broader population of older adults. Additionally, this study is short in duration; a long-term investigation would likely yield more robust and accurate results. Addressing these limitations in future research could enhance our understanding of multimorbidity in older

populations. Mongolia is a vast country, and lifestyles vary significantly on the basis of geographical location. Rural areas are divided into four regions according to economic classification: the Western, Khangai, Central, and Eastern regions. This study is limited by the fact that it does not examine these regions separately. Additional research is necessary to bridge this gap.

Conclusion

Multimorbidity has emerged as a significant public health concern globally, with a prevalence that underscores its impact on healthcare systems and economies. Our study highlighted a troubling prevalence of multimorbidity among older adults in Mongolia. In this study, multimorbidity was found to be more prevalent among older adults in rural areas than among their urban counterparts. Future health system development in Mongolia should shift its focus from merely preventing and managing individual chronic diseases to addressing the issue of multimorbidity among older adults, with particular emphasis on rural regions. Additionally, there are notable differences in the patterns and contributing factors of multimorbidity between urban and rural older populations. Specifically, factors such as family medical history, BMI, frequency of fresh fruit consumption, drinking, marital status, and income have varying effects on multimorbidity in these two settings.

The disparities in multimorbidity rates between rural and urban populations suggest that geographic and socioeconomic factors play critical roles in health outcomes. Rural residents often face barriers to accessing quality healthcare, leading to higher rates of chronic conditions. Our findings reinforce the need for tailored health interventions that address these inequalities and increase access to care, particularly in rural areas. This highlights the need for comprehensive public health strategies focused on health education, lifestyle modifications, and preventive care.

In conclusion, addressing the complexities of multimorbidity in Mongolia requires a multifaceted approach, including improved health policies, increased investment in healthcare infrastructure, and enhanced support for health education. By prioritizing these areas, we can work toward reducing the prevalence of multimorbidity and improving the overall health of older adults.

Abbreviations

BMI	Body mass index
NCDs	Noncommunicable Diseases
PHC	Primary health care
RDTCs	Regional Diagnostic and Treatment Centers

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Author contributions

ZC and OU conceived the concept. OU, ZX, and ZM participated in the statistical analysis and data collection. OU wrote the manuscript's draft. The paper was edited by ZX and ZM. The paper has read and approved by all authors.

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Data availability

Sequence data that support the findings of this study have been deposited in Zenodo and can be accessed at https://doi.org/10.5281/zenodo.14002184.

Declarations

Ethics approval and consent to participate

This research adhered to the ethical guidelines established by the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board of Southern Medical University. All participants provided their written informed consent prior to inclusion in the study, permitting the use of their data for research purposes.

Consent for publication

All participants provided their consent for publication.

Competing interests

The authors declare no competing interests.

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