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A study on multimorbidity patterns, Inpatient care utilization, and associated factors in inpatients with Multimorbidity in township health centers of Guangxi

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ABSTRACT

Background: The epidemiology of multimorbidity, inpatient care utilization, and associated factors among inpatients in rural primary health care facilities in China remains unclear, hindering effective prevention and management of multimorbidity in rural populations.

Objectives: This study aims to investigate the patterns of multimorbidity, inpatient care utilization, and related factors among hospitalized patients in township health centers (rural primary healthcare facilities) in Guangxi, China.

Methods: A multistage stratified and cluster random sampling method was employed to select 10 township health centers (rural primary healthcare facilities) in Nanning, Wuzhou, Liuzhou, Yulin, and Guigang of Guangxi Autonomous Region of China. De-identified inpatient medical records from January 1, 2021, to June 30, 2023, were retrieved from inpatient and chronic disease management systems. Statistical analyses, including the Kruskal-Wallis H test, Mann-Whitney U test, and multinomial logistic regression, were used to explore the demographic characteristics, multimorbidity prevalence, comorbidity number, multimorbidity patterns, hospitalization frequency, and associated factors among inpatients with multimorbidity.

Results: A total of 9,330 patients with multimorbidity were included, with an average age of 68.1 ±11.8 years, and 52.6 % were female. The overall prevalence of multimorbidity was 31.24 %. The most prevalent comorbidity number was 2 (53.22 %), followed by 3 (28.76 %), 4 (12.92 %), and ≥5(5.1 %). Hypertension was the most prevalent co-existing chronic condition, and the most common multimorbidity patterns included combinations of hypertension, chronic cervical and lumbar spondylosis, chronic gastrointestinal diseases, stroke, diabetes mellitus, hyperlipidemia, and chronic pulmonary diseases. The median number of hospitalization frequency for the top 10 multimorbidity patterns ranged from 1 to 4.5, with significant differences in hospitalization frequency across multimorbidity groups. Age, BMI, gender, smoking, alcohol consumption, ethnicity, marital status, and medical insurance were significantly associated with number of co-existing chronic conditions, while age, gender, smoking, alcohol consumption, ethnicity, marital status, education level, medical insurance, and number of co-existing chronic conditions were significantly associated with hospitalization frequency.

Conclusions: The prevalence of multimorbidity among inpatients in township health centers(rural primary healthcare facilities) in Guangxi is high. Hypertension was the most prevalent co-existing condition, with frequent combinations involving chronic cervical and lumbar spondylosis, gastrointestinal diseases, stroke, diabetes, hyperlipidemia, and chronic pulmonary diseases. Multiple factors influence both number of co-exsiting chronic conditions and hospitalization frequency, emphasizing the need for comprehensive, multifaceted strategies to manage the challenges of multimorbidity in rural primary healthcare facilities.

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Multimorbidity refers to the co-occurrence of two or more chronic health conditions in an individual. These conditions can include diagnosed chronic diseases, such as hypertension and diabetes, as well as geriatric syndromes, like frailty, depression, and dementia.[1] Multimorbidity is associated with premature death, reduced health-related quality of life, functional decline, depression, polypharmacy, and frequent health service utilization, making it a significant global public health issue all over the world.[2] In China, the prevalence of multimorbidity is high and increases with age. Data from the 2018 China Health and Retirement Longitudinal Study (CHARLS) indicated that 43.48 % of individuals aged 45–59 had multimorbidity, with this percentage rising to 62.86 % among those aged 60–69, and 69.42 % among those aged 70 and older.[3] The mechanisms underlying multimorbidity are complex, involving aging, genetics, inflammation, psychological and behavioral factors, and socioeconomic determinants.[4-5] In recent years, Chinese researchers have explored multimorbidity from various aspects, including multimorbidity patterns, disease burden, risk factors, and health hazards.[6]

However, few studies have focused on hospitalized patients in rural primary health care facilities, and much of the existing literature is based on self-reported data from community residents, urban tertiary hospitals, or urban community health centers (urban primary health care facilities), which may limit the accuracy of the findings. Compared to single chronic condition, patients with multimorbidity exhibit higher utilization of inpatients care, emergency services, and other health care resources, along with significantly higher medical expenses.[7-8] Investigating the prevalence and patterns of multimorbidity among hospitalized patients in rural primary health care facilities can help identify the epidemiological characteristics of multimorbidity in such settings.This study aims to provide an epidemiological basis for improving the prevention and management of chronic diseases in rural primary healthcare facilities. Using electronic inpatient records from township health centers (rural primary healthcare facilities) in Guangxi, this study examines the prevalence, multimorbidity patterns, hospitalization frequency, and influencing factors associated with multimorbidity, offering suggestions for improving the quality of health services in rural areas.

Data and methods

Data collection

De-identified inpatient medical records of multimorbidity patients from January 1, 2021, to June 30, 2023 were collected based on the inpatient and chronic disease management systems of township health centers (rural primary health care facilities) in Guangxi. The extracted variables included gender, age, ethnicity, marital status, education level, insurance type, whether the patient was from a low-income household or a beneficiary of the Five Guarantees program (a Chinese welfare program providing support in five essential areas: food, clothing, housing, medical care, and burial expenses), occupation, BMI, smoking and alcohol consumption habits, number of co-existing chronic conditions, multimorbidity patterns, and hospitalization frequency over the two and a half-year period. The extracted data were organized into a standardized survey form and distributed to each township health center, where they were completed by the directors of the medical departments. The inpatient system records comprehensive inpatient diagnostic and treatment information, including demographic information, admission and discharge diagnoses, treatment processes during hospitalization, and discharge instructions. The chronic disease management system documents chronic disease management data for both outpatient and inpatient patients, encompassing demographic information, chronic disease diagnoses, and visit dates. Data were primarily collected from the inpatient system. When patient indicators were missing from these records, additional information was retrieved from the chronic disease management system.

Both systems have been widely implemented across rural primary health care facilities in Guangxi since late 2020. Before data collection, two researchers conducted a one-day online training for the directors of medical departments at the selected township health centers (rural primary health care facilities). The training focused on data export procedures, accurately completing survey forms, applying inclusion and exclusion criteria, and matching multiple hospitalizations for the same patient. The researchers responsible for training also regularly monitored data quality and maintained communication with health center contacts to promptly resolve any data entry issues.

Inclusion and exclusion criteria

The inclusion criteria were as follows: (1)De-identified medical records from township health centers (rural primary healthcare facilities) between January 1, 2021, and June 30, 2023; (2)discharge diagnosis of two or more chronic diseases. The exclusion criteria were as follows: (1)Incomplete medical records, defined as those missing data points, even after cross-referencing both the inpatient and chronic disease management systems; (2)hospitalization duration of less than 24 hours.

Types and numbers of chronic diseases included

This study categorized 22 chronic diseases based on the "Guangxi Basic Medical Insurance Outpatient Special Chronic Disease Management Measures" (Gui Yibao Gui No. 2)[9] and common chronic diseases found in rural areas of Guangxi.[10] The diseases included: hypertension; diabetes (type 1 and type 2); hyperlipidemia; stroke (including cerebral infarction, cerebral hemorrhage, and sequelae); chronic lung diseases (including chronic bronchitis, chronic obstructive pulmonary disease, emphysema, pulmonary hypertension, pulmonary heart disease, bronchiectasis, tuberculosis, and asthma); chronic cervical and lumbar spine diseases(including cervical spondylosis and lumbar spondylosis); coronary artery disease; chronic heart failure (including rheumatic heart disease); atrial fibrillation; liver diseases (such as cirrhosis and chronic hepatitis); malignant tumors; emotional and mental disorders (including sleep disorders, insomnia, anxiety, depression, and schizophrenia); dementia (including Alzheimer's disease, vascular dementia, and senile dementia); chronic gastrointestinal diseases (including chronic gastritis and chronic enteritis); chronic kidney diseases (including chronic renal insufficiency, renal failure, uremia, and nephrotic syndrome); thyroid diseases (such as hyperthyroidism and hypothyroidism); prostate diseases (including benign prostatic hyperplasia and chronic prostatitis); joint diseases (including rheumatoid arthritis and osteoarthritis); hematologic diseases (including aplastic anemia, thalassemia, and primary immunologic thrombocytopenia); immune system diseases(including systemic lupus erythematosus, psoriasis, HIV/AIDS, and ankylosing spondylitis); neurological diseases (including Parkinson's disease, epilepsy, cerebral palsy, and myasthenia gravis); and metabolic diseases (including hyperuricemia, gout, and osteoporosis). Patients with multimorbidity in this study were defined as those whose discharge diagnosis included any combination of two or more of the 22 chronic diseases listed above.

Sampling method and minimum sample size calculation

A multi-stage stratified sampling and cluster sampling method was employed to randomly select five cities in Guangxi based on geographical location (eastern, southern, western, northern, and central regions): Wuzhou, Nanning, Yulin, Liuzhou, and Guigang. From each city, one central township health center was randomly selected from those with an annual income above the median for township health centers(rural primary health care facilities) in Guangxi in 2022, and one non-central township health center was selected from those below the median. This resulted in a total sample of 10 health centers. The minimum sample

size was estimated using the formula[11]: $n = (z_{\alpha}^2 \times pq)/d^2$, where p (the estimated prevalence of multimorbidity) was set at 0.5, q=1−p, Z is the Z-value corresponding to a 95 % confidence level (1.96 for α=0.05, d=0.0.5). Based on this, each township health center required at least 384 multimorbidity inpatients, resulting in a total minimum sample size of 3840 across all 10 health centers.

Statistical analysis

Data were entered using Excel 2010 and analyzed with SPSS 27.0. Descriptive statistics (frequencies and percentages) were used to summarize demographic information. The Chi-squared test, Kruskal-Wallis H test, and Fisher's exact test were used to compare demographic differences across varying number of co-existing chronic conditions. The top 10 multimorbidity patterns by prevalence were described using frequencies and composition ratios. Hospitalization frequency for each multimorbidity pattern were summarized using median and percentile values, and the most frequent multimorbidity patterns with the highest hospitalization frequency were identified. The Kruskal-Wallis H test was applied to compare hospitalization frequency differences among the top 10 multimorbidity patterns. Univariate Pearson and Spearman correlation analyses, as well as unordered and ordered multinomial logistic regression, were conducted to explore factors influencing number of chronic conditions and hospitalization frequency. Statistical significance was set at $P < 0.05$.

Results

Basic characteristics of hospitalized patients with multimorbidity

Between 2021 and June 2023, a total of 29,865 inpatients were admitted to the 10 sampled township health centers(rural primary healthcare facilities). Among them, 9365 patients were diagnosed with multimorbidity, all of whom were included in this study. After excluding 35 cases due to incomplete data or hospitalization duration of less than 24 hours, a final sample of 9330 patients was analyzed, exceeding the estimated minimum sample size. Patients with multimorbidity accounted for 31.24 % of the total inpatients.

Distribution across the five cities was as follows: Wuzhou (2198), Nanning (1969), Yulin (1702), Liuzhou (1154), and Guigang (2307). The number of co-existing chronic conditions per patient ranged from 2 to 9, with an average of 2.7±0.9. The majority of patients (53.22 %) had two chronic conditions (n = 4966), followed by 28.76 % with three conditions (n = 2683), 12.92 % with four conditions (n = 1205), and 5.1 % with five or more conditions (n = 476). Female patients with multimorbidity were more prevalent than males. The average age of patients was 68.1 ± 11.8 years, with those aged 60 and above (n = 7024) accounting for 75.3 % of the sample, significantly more than those under 60 years.

The ethnic composition was predominantly Han and Zhuang, accounting for 96.6 % of the total (n = 9007). Education levels were generally low, with 82.6 % of patients having only elementary education or being illiterate(n = 7707). Farming was the most common occupation, significantly outnumbering non-farming professions. The majority of patients were married, and most were covered by the Urban and Rural Residents' Basic Medical Insurance. A relatively small proportion of patients were from low-income households or households entitled to the Five Guarantees. Among hospitalized patients with multimorbidity, non-smokers outnumbered both current and former smokers, and those who did not drink or had quit alcohol far exceeded current drinkers. Patients with a normal BMI or those hospitalized only once comprised slightly more than 50 % of the sample. There were significant demographic differences among patients with 2, 3, 4, and ≥5 chronic diseases. Detailed data are presented in Table 1.

Multimorbidity patterns

In total, 993 unique multimorbidity patterns(various combinations of multiple chronic conditions) were identified among hospitalized patients with multiple chronic conditions in township health centers (rural primary health care facilities) across Guangxi. Among these, 133 patterns involved two co-existing chronic conditions, 266 involved three, 309 involved four, and 285 involved five or more conditions. Hypertension was the most commonly co-existing chronic disease. The top 10 most prevalent patterns of co-existing diseases for patients with two, three, four, and five or more chronic conditions, along with their respective frequencies and proportions, are presented in Table 2.

Hospitalization frequency of common multimorbidity patterns

The total hospitalization frequency for patients with two, three, four, and five or more chronic conditions over the 2.5-year period ranged from 1–10, 1–16, 1–15, and 1–18 times, respectively. Significant differences were observed in the distribution of hospitalization frequency across different multimorbidity patterns, with patients having more co-existing conditions experiencing significantly higher hospitalization frequency than those with fewer conditions. There were statistically significant differences in hospitalization frequency among the top 10 most prevalent multimorbidity patterns for patients with two, three, and four co-existing conditions. However, no significant differences were found for patients with five or more co-existing conditions (details in Table 3).

Pairwise comparisons revealed specific patterns with significantly different hospitalization frequency. For instance, patients with hypertension and chronic cervical or lumbar disease had significantly higher hospitalization frequency than those with hypertension and stroke or hypertension and diabetes ($P < 0.05$, see Appendix 1–1 for details). Comprehensive pairwise comparison results can be found in Appendices 1–1, 1–2, and 1–3.

Multimorbidity patterns with the highest median hospitalization frequency

The multimorbidity patterns with the highest median hospitalization frequency differed from those with the highest prevalence. For example, among patients with two co-existing chronic diseases, the pattern with the highest hospitalization frequency was chronic cervical/lumbar disease and atrial fibrillation, rather than the most prevalent combination of hypertension and stroke. However, there were no statistically significant differences in hospitalization frequency among the top three multimorbidity patterns for patients with two, three, four, or five or more chronic diseases ($P > 0.05$, see Table 4).

Factors influencing the number of chronic conditions in hospitalized patients

The number of co-existing chronic conditions in hospitalized patients in Guangxi's township health centers(rural primary health care facilities) was set as the dependent variable (y), while relevant demographic indicators were considered independent variables (x). Detailed variable values are provided in Appendix 2. Pearson or Spearman analysis was used to identify independent variables for multivariate logistic regression. The results showed that age, BMI, gender, ethnicity, occupation, marital status, health insurance type, poverty status (low-income household or household entitled to the Five Guarantees), educational level, smoking history, and alcohol consumption were all associated with number of co-existing chronic conditions (Appendix 3). Unordered multinomial logistic regression analysis further revealed that age, BMI, gender, smoking, alcohol consumption, ethnicity, marital status, and health insurance type significantly influenced number of chronic conditions. Age and smoking history were significant in all six group comparisons: 2 diseases vs. 3 diseases, 2 vs. 4, 2 vs. ≥5, 3 vs. 4, 3 vs. ≥5, and 4 vs.

Table 1
Basic demography of inpatients with multimorbidity in township health centers(rural primary health care facilities) in Guangxi.

Item	Number(n)	Proportion(%)	Number of chronic conditions				H/χ^2	P
			2	3	4	≥5		
Gender								
Male	4424	47.4 %	2301(52.0 %)	1287(29.1 %)	582(13.2 %)	254(5.7 %)	9.781	0.021
Female	4906	52.6 %	2665(54.3 %)	1396(28.5 %)	623(12.7 %)	222(4.5 %)		
Age								
<60	2306	24.7 %	1384(60 %)	650(28.2 %)	221(9.6 %)	51(2.2 %)	65.498	<0.001
60–70	2543	27.3 %	1282(50.4 %)	776(30.5 %)	350(13.8 %)	135(5.3 %)		
70–80	2830	30.3 %	1399(49.4 %)	826(29.2 %)	413(14.6 %)	192(6.8 %)		
≥80	1651	17.7 %	901(54.6 %)	431(26.1 %)	221(13.4 %)	98(5.9 %)		
Ethnicity								
Han	5764	61.8 %	3164(54.9 %)	1668(28.9 %)	663(11.5 %)	269(4.7 %)	59.239	<0.001
Zhuang	3243	34.8 %	1666(51.4 %)	926(28.6 %)	473(14.6 %)	178(5.5 %)		
Other Minorities	323	3.5 %	136(42.1 %)	89(27.6 %)	69(21.4 %)	29(9.0 %)		
Education level								
Illiterate	2613	28.0 %	1332(51.0 %)	770(29.5 %)	339(13.0 %)	172(6.6 %)	56.496	<0.001
Primary school	5094	54.6 %	2680(52.6 %)	1456(28.6 %)	714(14.0 %)	244(4.8 %)		
Middle school	1296	13.9 %	755(58.3 %)	362(27.9 %)	124(9.6 %)	55(4.2 %)		
High school or above	327	3.5 %	199(60.9 %)	95(29.1 %)	28(8.6 %)	5(1.5 %)		
Occupation								
Farmer	8873	95.1 %	4682(52.8 %)	2561(28.9 %)	1165(13.1 %)	465(5.2 %)	21.177	<0.001
Non-farmer	457	4.9 %	284(62.1 %)	122(26.7 %)	40(8.8 %)	11(2.4 %)		
Marital Status								
Married	7653	82.0 %	4107(53.7 %)	2246(29.4 %)	955(12.5 %)	345(4.5 %)	67.770	<0.001
Widowed	1303	14.0 %	671(51.5 %)	344(26.4 %)	193(14.8 %)	95(7.3 %)		
Unmarried	243	2.6 %	112(46.1 %)	54(22.2 %)	49(20.2 %)	28(11.5 %)		
Divorced	131	1.4 %	76(58.0 %)	39(29.8 %)	8(6.1 %)	8(6.1 %)		
Insurance type								
Urban resident basic medical insurance	7691	82.4 %	4286(55.7 %)	2149(27.9 %)	925(12.0 %)	331(4.3 %)	0	0.000*
Urban employee basic medical insurance	333	3.6 %	180(54.1 %)	111(33.3 %)	35(10.5 %)	7(2.1 %)		
Poverty Assistance	1269	13.6 %	470(37.0 %)	417(32.9 %)	244(19.2 %)	138(10.9 %)		
Self-paying	37	0.4 %	30(81.1 %)	6(16.2 %)	1(2.7 %)	0(0.0 %)		
Low-income household or household entitled to the Five Guarantees								
No	8083	86.6 %	4501(55.7 %)	2277(28.2 %)	966(12.0 %)	339(4.2 %)	217.155	<0.001
Yes	1247	13.4 %	465(37.3 %)	406(32.6 %)	239(19.2 %)	137(11.0 %)		
Smoking Status								
Non-smoker	6322	67.8 %	3650(57.7 %)	1844(29.2 %)	687(10.9 %)	141(2.2 %)	456.684	<0.001
Smoker or Former Smoker	3008	32.2 %	1316(43.8 %)	839(27.9 %)	518(17.2 %)	335(11.1 %)		
Alcohol Consumption								
Non-drinker or Former Drinker	7363	78.9 %	4176(56.7 %)	2175(29.5 %)	810(11.0 %)	202(2.7 %)	567.203	<0.001
Non-drinker or Former Drinker	1967	21.1 %	790(40.2 %)	508(25.8 %)	395(20.1 %)	274(13.9 %)		
BMI								
<18.5	1146	12.3 %	653(57.0 %)	304(26.5 %)	151(13.2 %)	38(3.3 %)	81.393	<0.001
18.5–24	4816	51.6 %	2670(55.4 %)	1386(28.8 %)	553(11.5 %)	207(4.3 %)		
24–28	2482	26.6 %	1289(51.9 %)	702(28.1 %)	345(13.9 %)	146(5.9 %)		
≥28	886	9.5 %	354(40.0 %)	291(32.8 %)	156(17.6 %)	85(9.6 %)		
Hospitalization frequency								
1	5127	54.9 %	3309(64.5 %)	1340(26.1 %)	363(7.1 %)	115(2.2 %)	1050.310	<0.001
2	2056	22.0 %	1054(51.3 %)	643(31.3 %)	252(12.3 %)	107(5.2 %)		
≥3	2147	23.0 %	603(28.1 %)	700(32.6 %)	590(27.5 %)	254(11.8 %)		

≥5 ($P < 0.05$). BMI was significant in all comparisons except 3 vs. 4 diseases ($P < 0.05$). Gender was significant in all comparisons except 2 vs. 3 diseases($P < 0.05$), and alcohol consumption was significant in all but the 2 vs. 3 disease comparison ($P < 0.05$). Thus, age, BMI, gender, smoking, and alcohol consumption were key factors influencing number of chronic conditions. Specifically, older age, higher BMI, female, and smoking or alcohol use were associated with a higher likelihood of multimorbidity. Ethnicity, marital status, and health insurance type were also significantly associated with number of co-existing chronic conditions in several comparisons. For instance, compared to Han or Zhuang ethnicities, patients of other minority ethnicities were more likely to have four or more chronic diseases. Additionally, Zhuang patients had higher odds of having four comorbidities compared to Han patients in the 3 vs. 4 comparison. Additionally, patients with poverty assistance or urban employee basic medical insurance(UEBMI) were more likely to have three or four chronic diseases compared to those with urban resident basic medical insurance(URBMI). The effect of marital status on the number of co-existing chronic conditions was more complex; for instance, married individuals were more likely to have three conditions in the 2 vs. 3 comparison, while unmarried individuals were more likely to have four or five conditions in the 2 vs. 4 and 2 vs. 5 comparisons.

Occupation, education level, and poverty status showed associations with number of chronic conditions in few or in no comparisons, indicating that these factors were not consistently associated with the number of chronic conditions(see Table 5 for details).

Table 2
The most common multimorbidity patterns of inpatients in township health centers(rural primary health care facilities) in Guangxi.

Number of chronic conditions	Rank	Multimorbidity pattern	Number	Proportion of total (%)	Proportion of category (%)
2 chronic conditions (n= 4966)	1*	Hypertension + Stroke	637	6.8 %	12.8 %
	2*	Hypertension + Diabetes	515	5.5 %	10.4 %
	3*	Hypertension + Chronic Cervical/Lumbar Disease	508	5.4 %	10.2 %
	4*	Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	412	4.4 %	8.3 %
	5*	Hypertension + Hyperlipidemia	241	2.6 %	4.9 %
	6*	Hypertension + Hyperlipidemia	231	2.5 %	4.7 %
	7*	Hypertension + Chronic Lung Disease	208	2.2 %	4.2 %
	8*	Hypertension + Chronic Gastrointestinal Disease	170	1.8 %	3.4 %
	9*	Chronic Cervical/Lumbar Disease + Joint Disease	148	1.6 %	3.0 %
	10*	Hyperlipidemia + Chronic Cervical/Lumbar Disease	104	1.1 %	2.1 %
3 chronic conditions (n= 2683)	1*	ypertension + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	227	2.4 %	8.5 %
	2*	Hypertension + Hyperlipidemia + Chronic Cervical/Lumbar Disease	122	1.3 %	4.6 %
	3*	Hypertension + Diabetes + Stroke	121	1.3 %	4.5 %
	4*	Hypertension + Diabetes + Hyperlipidemia	120	1.3 %	4.5 %
	5*	Hypertension + Diabetes + Chronic Cervical/Lumbar Disease	117	1.3 %	4.4 %
	6*	Hypertension + Hyperlipidemia + Stroke	94	1.0 %	3.5 %
	7*	Hypertension + Stroke + Chronic Cervical/Lumbar Disease	94	1.0 %	3.5 %
	8*	Hypertension + Chronic Lung Disease + Chronic Gastrointestinal Disease	92	1.0 %	3.4 %
	9*	Hypertension + Chronic Lung Disease + Chronic Gastrointestinal Disease	83	0.9 %	3.1 %
	10*	Hypertension + Chronic Lung Disease + Chronic Gastrointestinal Disease	73	0.8 %	2.7 %
4 chronic conditions (n = 1205)	1*	Hypertension + Diabetes + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	53	0.6 %	4.4 %
	2*	Hypertension + Diabetes + Hyperlipidemia + Stroke	43	0.5 %	3.6 %
	3*	Hypertension + Hyperlipidemia + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	42	0.5 %	3.5 %
	4*	Hypertension + Hyperlipidemia + Chronic Cervical/Lumbar Disease + Metabolic Disease	40	0.4 %	3.3 %
	5*	Hypertension + Stroke + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	34	0.4 %	2.9 %
	6*	Hypertension + Diabetes + Hyperlipidemia + Chronic Cervical/Lumbar Disease	33	0.4 %	2.7 %
	7*	Hypertension + Chronic Lung Disease + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	32	0.3 %	2.7 %
	8*	Hypertension + Diabetes + Stroke + Chronic Gastrointestinal Disease	24	0.3 %	2.0 %
	9*	Hypertension + Hyperlipidemia + Stroke + Chronic Cervical/Lumbar Disease	22	0.2 %	1.8 %
	10*	Hypertension + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease + Joint Disease	21	0.2 %	1.7 %
≥5 chronic conditions (n = 476)	1*	Hypertension + Hyperlipidemia + Stroke + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	11	0.1 %	2.3 %
	2*	Hypertension + Diabetes + Hyperlipidemia + Chronic Cervical/Lumbar Disease + Metabolic Disease	10	0.1 %	2.1 %
	3*	Hypertension + Hyperlipidemia + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease + Metabolic Disease	9	0.1 %	1.9 %
	4*	Hypertension + Stroke + Chronic Lung Disease + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	9	0.1 %	1.9 %
	5*	Hypertension + Hyperlipidemia + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease + Joint Disease	8	0.1 %	1.7 %
	6*	Hypertension + Diabetes + Hyperlipidemia + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	8	0.1 %	1.7 %
	7*	Hypertension + Diabetes + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease + Metabolic Disease	8	0.1 %	1.7 %
	8*	Hypertension + Hyperlipidemia + Stroke + Chronic Cervical/Lumbar Disease + Metabolic Disease	7	0.1 %	1.5 %
	9*	Hypertension + Diabetes + Stroke + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	7	0.1 %	1.5 %
	10*	Hypertension + Diabetes + Hyperlipidemia + Stroke + Chronic Cervical/Lumbar Disease	6	0.1 %	1.3 %

Factors influencing the hospitalization frequency for patients with multimorbidity

The total number of hospitalizations over 2.5 years was set as the dependent variable, with demographic indicators as independent variables (Appendix 2). Pearson or Spearman analysis was used to identify variables for multivariate logistic regression. Age, BMI, gender, ethnicity, occupation, marital status, health insurance, poverty status, education level, smoking, alcohol consumption, and number of co-existing chronic conditions were all associated with hospitalization frequency (Appendix 4). Ordered multinomial logistic regression analysis revealed significant relations between hospitalization frequency and factors such as age, gender, ethnicity, marital status, health insurance, education level, smoking, alcohol consumption, and number of co-existing chronic conditions. Increased age correlated with higher hospitalization frequency, and female patients had more frequent hospitalizations than males. Minority ethnic patients experienced more hospitalizations than Han and Zhuang patients. Married or widowedor divorced patients had lower hospitalization frequency compared to unmarried individuals. Patients paying out-of-pocket had fewer hospitalizations, while those receiving poverty assistance had more compared to those with URBMI. Education also influenced hospitalization frequency, with patients who had middle or high school education having lower hospitalization frequency than those with no formal education. Non-smokers and non-drinkers (or those who had quit) had lower hospitalization frequency compared to current smokers and drinkers. Patients with two or three chronic conditions had lower hospitalization frequency than those with five or more, with lower number of co-existing chronic conditions generally related with lower hospitalization frequency (Table 6).

Table 3
Hospitalization frequency among various multimorbidity patterns in township health centers(rural primary health care facilities) in Guangxi.

Number of chronic conditions	Rank	Multimorbidity pattern	Hospitalization frequency [M (Q_1, Q_3)]	H	P
Total sample (n=9330)	A	Two multimorbidity patterns	1 (1, 2)	1140.654	<0.001
	B	Three multimorbidity patterns	2 (1, 3)		
	C	Four multimorbidity patterns	2 (1, 4)		
	D	Five or more multimorbidity patterns	3 (2, 5)		
2 chronic conditions (n = 4966)	1*	Hypertension + Stroke	1 (1,2)	129.304	<0.001
	2*	Hypertension + Diabetes	1 (1,2)		
	3*	Hypertension + Chronic Cervical/Lumbar Disease	2 (1,2)		
	4*	Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	1 (1,2)		
	5*	Hypertension + Hyperlipidemia	1 (1,1)		
	6*	Chronic Lung Disease + Chronic Gastrointestinal Disease	1 (1,2)		
	7*	Hypertension + Chronic Lung Disease	1 (1,2)		
	8*	Hypertension + Chronic Gastrointestinal Disease	1 (1,2)		
	9*	Chronic Cervical/Lumbar Disease + Joint Disease	2 (1,2)		
	10*	Hyperlipidemia + Chronic Cervical/Lumbar Disease	1 (1,1)		
3 chronic conditions (n = 2683)	1*	Hypertension + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	2 (1,3)	39.617	<0.001
	2*	Hypertension + Hyperlipidemia + Chronic Cervical/Lumbar Disease	1 (1,2)		
	3*	Hypertension + Diabetes + Stroke	1 (1,2)		
	4*	Hypertension + Diabetes + Hyperlipidemia	1 (1,2)		
	5*	Hypertension + Diabetes + Chronic Cervical/Lumbar Disease	2 (1,3)		
	6*	Hypertension + Hyperlipidemia + Stroke	1 (1,2)		
	7*	Hypertension + Stroke + Chronic Cervical/Lumbar Disease	1 (1,3)		
	8*	Hypertension + Stroke + Chronic Cervical/Lumbar Disease	1 (1,3)		
	9*	Hypertension + Stroke + Chronic Gastrointestinal Disease	1 (1,3)		
	10*	Hypertension + Chronic Cervical/Lumbar Disease + Joint Disease	1 (2,3)		
4 chronic conditions	1*	Hypertension + Diabetes + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	2 (1,4)	32.918	<0.001
	2*	Hypertension + Diabetes + Hyperlipidemia + Stroke	2 (1,3)		
	3*	Hypertension + Hyperlipidemia + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	2 (1,3.25)		
	4*	Hypertension + Hyperlipidemia + Chronic Cervical/Lumbar Disease + Metabolic Disease	3 (1,5)		
	5*	Hypertension + Stroke + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	3 (1,4)		
	6*	Hypertension + Diabetes + Hyperlipidemia + Chronic Cervical/Lumbar Disease	3 (2,5)		
	7*	Hypertension + Chronic Lung Disease + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	3 (2,5)		
	8*	Hypertension + Diabetes + Stroke + Chronic Gastrointestinal Disease	2 (1,3.75)		
	9*	Hypertension + Hyperlipidemia + Stroke + Chronic Cervical/Lumbar Disease	1.5 (1,3.25)		
	10*	Hypertension + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease + Joint Disease	4 (2.5,6)		
≥5 chronic conditions (n = 476)	1*	Hypertension + Hyperlipidemia + Stroke + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	2 (1,3)	13.018	0.162
	2*	Hypertension + Diabetes + Hyperlipidemia + Chronic Cervical/Lumbar Disease + Metabolic Disease	2 (1.75,3)		
	3*	Hypertension + Hyperlipidemia + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease + Metabolic Disease	2 (1,4)		
	4*	Hypertension + Stroke + Chronic Lung Disease + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	4 (2.5,12)		
	5*	Hypertension + Hyperlipidemia + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease + Joint Disease	4.5 (2,8.5)		
	6*	Hypertension + Diabetes + Hyperlipidemia + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	3 (1,4)		
	7*	Hypertension + Diabetes + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease + Metabolic Disease	3 (2,5.75)		
	8*	Hypertension + Hyperlipidemia + Stroke + Chronic Cervical/Lumbar Disease + Metabolic Disease	1 (1,3)		
	9*	Hypertension + Diabetes + Stroke + Chronic Cervical/Lumbar Disease + Chronic Gastrointestinal Disease	2 (1,3)		
	10*	Hypertension + Diabetes + Hyperlipidemia + Stroke + Chronic Cervical/Lumbar Disease	2 (1,5)		

Discussion

This study focuses on the epidemiological characteristics of multimorbidity in rural primary healthcare facilities, specifically examining the demographic characteristics, prevalence, multimorbidity patterns, and hospitalization frequency among inpatients in township health centers (rural primary healthcare facilities) in Guangxi from January 2021 to June 2023. Additionally, we identified factors influencing the number of co-existing chronic conditions and hospitalization frequency among these patients. As the first study to examine multimorbidity trends in rural primary healthcare facilities in China, the findings offer critical insights into the challenges these facilities face and provide recommendations for enhancing the quality of health services in managing multimorbidity.

Epidemiological characteristics of multimorbidity in township health centers (rural primary healthcare facilities) in Guangxi

Our study revealed a multimorbidity prevalence of 31.24 % among inpatients at township health centers (rural primary healthcare facilities) in rural Guangxi, predominantly affecting individuals aged 60 and older. This age group constitutes 75.3 % of all multimorbidity cases, sig-

Table 4
Multimorbidity patterns with the highest median of hospitalization frequency in township health centers(rural primary health care facilities) in Guangxi.

Number of chronic conditions	Rank	Multimorbidity pattern	Hospitalization frequency [M (Q1, Q3)])	*H*	*P*
2 chronic conditions (n = 4966)	1*	Chronic cervical/lumbar disease + Atrial fibrillation	3 (2, 3.5)	19.042	0.454
	2*	Chronic cervical/lumbar disease + Immune system disease	3 (1, 3)		
	3*	Liver disease + Metabolic disease	2.5 (2, 3)		
3 chronic conditions(n = 2683)	1*	Chronic lung disease + Chronic cervical/lumbar disease + Liver disease	7 (7, 7)	15.376	0.497
	2*	Hypertension + Chronic lung disease + Emotional and mental disorders	6.5 (5.0, 7.25)		
	3*	Diabetes + Chronic heart failure + Chronic gastrointestinal disease	6 (1, 8.5)		
4 chronic conditions(n = 1205)	1*	Hypertension + Diabetes + Hyperlipidemia + Neurological disease	13 (13, 13)	3.419	0.992
	2*	Diabetes + Chronic lung disease + Coronary artery disease + Atrial fibrillation	11 (11, 11)		
	3*	Diabetes + Chronic lung disease + Atrial fibrillation + Chronic gastrointestinal disease	10 (10, 10)		
	4*	Chronic lung disease + Chronic cervical/lumbar disease + Chronic heart failure + Joint disease	10 (10, 10)		
≥5 chronic conditions(n = 476)	1*	Hypertension + Diabetes + Chronic lung disease + Chronic cervical/lumbar disease + Chronic gastrointestinal disease + Joint disease	18 (18, 18)	13.256	0.351
	2*	Hypertension + Diabetes + Stroke + Chronic cervical/lumbar disease + Prostate disease	15 (15, 15)		
	3*	Hypertension + Diabetes + Hyperlipidemia + Stroke + Chronic kidney disease + Chronic cervical/lumbar disease + Coronary artery disease + Chronic gastrointestinal disease + Metabolic disease	15 (15, 15)		

Table 5
Multinomial logistic regression of demography factors and number of chronic conditions.

Variable	2 vs. 3 Conditions		2 vs. 4 Conditions		2 vs. ≥5 Conditions		3 vs. 4 Conditions		3 vs. ≥5 Conditions		4 vs. ≥5 Conditions	
	OR	P	OR	P	OR	P	OR	P	OR	P	OR	P
Age	0.992	0.005	0.976	<0.001	0.949	<0.001	0.983	<0.001	0.956	<0.001	0.972	<0.001
BMI	0.964	<0.001	0.957	<0.001	0.913	<0.001	0.992	0.420	0.947	<0.001	0.954	0.002
Gender (ref: female)												
Male	1.132	0.059	2.824	<0.001	18.814	<0.001	2.495	<0.001	16.621	<0.001	6.662	<0.001
Ethnicity (ref: other minorities)												
Han	1.118	0.434	2.041	<0.001	1.907	0.008	1.827	<0.001	1.707	0.032	0.934	0.787
Zhuang	1.138	0.369	1.776	<0.001	1.982	0.005	1.560	0.010	1.741	0.027	1.116	0.664
Occupation (ref: non-farmers)												
Farmers	0.484	<0.001	0.588	0.083	1.028	0.954	1.214	0.563	2.123	0.128	1.749	0.296
Marital status (ref: unmarried)												
Married	0.678	0.029	1.259	0.240	1.544	<0.001	1.857	0.004	2.278	0.002	1.226	0.449
Widowed	0.85	0.404	1.449	0.092	1.928	0.254	1.704	0.027	2.268	0.007	1.331	0.356
Divorced	0.673	0.136	2.308	0.048	0.898	0.731	3.428	0.005	1.333	0.562	0.389	0.103
Insurance type (ref: Urban resident basic medical insurance)												
Self-pay	2.418	0.050	5.763	0.086	—	—	2.383	0.423	—	—	—	—
Poverty assistance	0.225	0.006	0.192	0.011	0.28	0.254	0.856	0.779	1.244	0.838	1.453	0.736
Urban employee basic medical insurance	0.314	<0.001	0.359	0.004	0.794	0.731	1.141	0.716	2.525	0.172	2.213	0.265
Low-income household or household entitled to the Five Guarantees(ref: no)												
Yes	0.4	0.093	0.427	0.190	0.955	0.967	1.068	0.907	2.389	0.414	2.238	0.467
Education level (ref: illiterate)												
High school and above	1.458	0.095	1.584	0.185	3.456	0.080	1.086	0.821	2.37	0.228	2.182	0.299
Middle School	1.115	0.235	1.017	0.898	0.813	0.309	0.912	0.519	0.729	0.129	0.799	0.318
Primary school	1.043	0.489	0.835	0.030	1.045	0.728	0.801	0.012	1.002	0.990	1.251	0.102
Smoking history (ref: current or former smoker)												
Non-smoker	1.319	<0.001	2.914	<0.001	33.19	<0.001	2.209	<0.001	25.165	<0.001	11.392	<0.001
Alcohol consumption (ref: current drinker)												
Non-drinker or former drinker	1.083	0.295	2.208	<0.001	3.202	<0.001	2.039	<0.001	2.956	<0.001	1.45	0.019

nificantly higher than the proportion of patients under 60 (24.7 %), with the prevalence being particularly high among those aged 70 and above compared to the 60–70 age group. Globally, multimorbidity prevalence rates among adults aged 18 and older range from 3 % to 68 % in countries such as China, Brazil, South Africa, India, Mexico, and Iran.[12] In the U.S., the prevalence is 58.4 % among adults aged 20 and older,[13] while rates in countries like Finland, Poland, Russia, and Spain among adults aged 50 and older range from 57.92 % to 71.93 %.[14] The prevalence of multimorbidity varies significantly across provinces and cities in China. For example, the prevalence among individuals aged 18–79 in Jilin Province is 24.7 %,[15] while the prevalence among the elderly aged 60 and above in rural Anhui Province is 36.4 %.[16] In Guangdong Province, the prevalence among those aged 65 and above is 47.5 %.[17] These variations are likely influenced by differences in diagnostic criteria, the age of the surveyed populations, the number and types of chronic conditions included, and the quality of disease detection and case ascer-

Table 6
Cumulative logit regression of hospitalization frequency of multimorbidity.

Variable	*B*	*SE*	Wald	*P* value	95 %*CI*
Age	0.007	0.002	9.338	0.002	(0.003, 0.012)
BMI	0	0.006	0.002	0.963	(-0.012, 0.011)
Gender (ref: female)					
Male	-0.201	0.060	11.277	<0.001	(-0.319, -0.084)
Ethnicity (ref: other minorities)					
Han	-1.588	0.115	189.184	<0.001	(-1.814, -1.362)
Zhuang	-0.649	0.116	31.275	<0.001	(-0.876, -0.422)
Occupation (ref: non-farmers)					
Farmers	-0.298	0.169	3.094	0.079	(-0.629, 0.034)
Marital Status (ref: unmarried)					
Married	-0.571	0.139	16.941	<0.001	(-0.843, -0.299)
Widowed	-0.624	0.154	16.443	<0.001	(-0.926, -0.323)
Divorced	-0.805	0.232	11.988	<0.001	(-1.260, -0.349)
Insurance Type (ref: Urban employee basic medical insurance)					
Self-pay	-2.854	1.014	7.913	0.005	(-4.842∼-0.865)
Poverty assistance	1.420	0.436	10.628	0.001	(0.566, 2.274)
Urban employee basic medical insurance	-0.237	0.218	1.183	0.277	(-0.664, 0.190)
Low-income household or household entitled to the Five Guarantees(ref: no)					
Yes	0.832	0.438	3.609	0.057	(-0.026, 1.690)
Education Level (ref: illiterate)					
High School and Above	-0.639	0.212	9.079	0.003	(-1.054, -0.223)
Middle School	-0.520	0.084	38.235	<0.001	(-0.684, -0.355)
Primary School	-0.094	0.053	3.128	0.077	(-0.198, 0.010)
Smoking History (ref: current or former smoker)					
Non-smoker	-0.363	0.071	26.005	<0.001	(-0.503, -0.224)
Alcohol History (ref: current drinker)					
Non-drinker or former drinker	-0.147	0.065	5.044	0.025	(-0.275, -0.019)
Number of chronic conditions(ref: ≥5 chronic conditions)					
2 chronic conditions	-1.623	0.101	260.357	<0.001	(-1.820, -1.426)
3 chronic conditions	-0.894	0.102	77.275	<0.001	(-1.093, -0.695)
4 chronic conditions	-0.067	0.108	0.382	0.537	(-0.278, 0.145)

tainment. However, most studies consistently show that multimorbidity prevalence increases with age, particularly among women,[18] which aligns with the patterns observed in this study's population of rural inpatients.

Among the patients at township health centers (rural primary health care facilities) in Guangxi, the most common pattern involved two co-existing chronic conditions, followed by three or four conditions. Hypertension was the most frequently observed chronic condition, commonly co-occurring with chronic cervical and lumbar diseases, gastrointestinal disorders, stroke, diabetes, hyperlipidemia, and chronic pulmonary disease. In contrast, studies from urban hospitals and urban community health centers (urban primary health care facilities) have reported different patterns of multimorbidity. For example, in tertiary hospitals such as the Chinese PLA General Hospital, The First Affiliated Hospital of Zhejiang University School of Medicine, The First Affiliated Hospital of Guangxi Medical University and others, the most common number of chronic conditions among elderly inpatients is two, followed by five, six, four, seven, eight, and three. The most frequent multimorbidity patterns include hypertension combined with ischemic heart disease, hypertension with diabetes, hypertension with malignant tumors, ischemic heart disease with diabetes, and hypertension with cerebrovascular disease.[19] Similarly, a study of inpatients at Tianjin Medical University's Second Hospital found that three chronic conditions were most common (33.1 %), with cancer, diabetes, and hyperlipidemia frequently co-occurring.[20] In a community health center in Shanghai's Pengpu Town, patients with four or more chronic conditions were most common, with combinations involving hypertension, stroke, coronary heart disease, osteoporosis, diabetes, and COPD.[21] In three urban community health centers (urban primary health care facilities) in Jing'an District, Shanghai, 24.46 % of elderly outpatients had two co-existing chronic diseases, 17.55 % had three, 13.57 % had four, and 8.92 % had five or more, and the most frequent combinations included hypertension, ischemic heart disease, diabetes, hyperlipidemia, cerebrovascular disease, and peptic ulcers.[22] In contrast, hospitalized patients in Guangxi township health centers(rural primary healthcare facilities) exhibited fewer multimorbidity patterns involving coronary heart disease, malignant tumors, and emotional or mental disorders, which are more commonly observed in urban health centers. However, there was a higher rate of chronic cervical and lumbar disease co-occurrence. The proportion of patients with three or more chronic conditions was lower than in tertiary hospitals and urban community health centers (urban primary healthcare facilities), indicating a lower complexity of multimorbidity in rural hospitals. These differences may be attributed to disparities in chronic disease diagnosis and treatment capabilities, referral needs, and the age of the populations in urban and rural healthcare facilities.

Inpatient care utilization among multimorbidity patients in Guangxi township health centers (rural primary health care facilities)

This study demonstrates that during a 2.5-year period, the number of hospital admissions increased as the number of co-existing chronic conditions rose. A cohort study of 50,045 Iranians aged 40–75 confirmed that in low- and middle-income countries, the more chronic conditions a patient has, the greater their risk of hospitalization and the higher the frequency of admissions.[23] This positive correlation between number of co-existing chronic conditions and hospital admissions has also been observed in high-income countries.[24-25] In China, related studies have often used length of stay as a primary measure of inpatient care utilization among multimorbidity patients. For instance, LI et al.[26] found that the hospitalization duration among multimorbidity patients in a tertiary hospital in Guangxi increased with the number of chronic conditions.[2] CHEN et al.[27], using household survey data from 4598 patients with chronic diseases in Jiangsu Province, found that for each additional chronic condition, hospitalization duration increased by 1.73 times, and outpatient visits by 1.44 times. These results align with our findings, suggesting that a higher number of chronic conditions is associated with greater use of inpatients care in rural township health centers(rural primary health care facilities) in Guangxi. These findings, consistent with our study, suggest a positive relation between the number of chronic conditions and increased utilization of inpatient care in rural township health centers(rural primary health care facilities) in Guangxi. Furthermore, this study identified specific multimorbidity pat-

terns correlated with higher hospital admissions. For example, among patients with two comorbidities, the combination of hypertension and chronic cervical and lumbar diseases resulted in more hospitalizations than the combination of hypertension and stroke or hypertension and diabetes. Among patients with three comorbidities, those with hypertension, diabetes, and chronic cervical/lumbar diseases were hospitalized more often than patients with other combinations, such as hypertension, hyperlipidemia, and chronic cervical/lumbar diseases, or hypertension, diabetes, and stroke. Among patients with four comorbidities, the combination of hypertension, diabetes, hyperlipidemia, and chronic cervical and lumbar diseases resulted in more frequent hospitalizations than combinations such as hypertension, diabetes, hyperlipidemia, and stroke. Interestingly, this study also found that the most prevalent multimorbidity patterns did not always correlate with the highest hospitalization frequency. For instance, among patients with two chronic diseases, the most common combinations—hypertension with stroke, hypertension with diabetes, and hypertension with chronic cervical/lumbar diseases—did not account for the highest hospitalizations. Instead, patterns such as chronic cervical/lumbar diseases combined with atrial fibrillation, chronic cervical/lumbar diseases with immune system disorders, and liver diseases with metabolic disorders led to more frequent hospital admissions. Identifying these chronic disease combinations and their related hospitalization frequency can provide valuable epidemiological insights for effectively managing multimorbidity in rural primary healthcare facilities.

Factors influencing multimorbidity and hospital admissions in multimorbidity patients at Guangxi township health centers (rural primary healthcare facilities)

This study identified several factors influencing the number of co-existing chronic conditions among hospitalized patients in Guangxi's township health centers(rural primary healthcare facilities), including age, BMI, gender, smoking, alcohol consumption, ethnicity, marital status, and insurance type. Additionally, age, gender, number of co-existing chronic conditions, ethnicity, marital status, insurance type, education level, smoking, and alcohol consumption were all significantly associated with hospital admission frequency. Previous studies have reported similar findings regarding the determinants of multimorbidity and inpatient service utilization. LI et al.[28] found that gender, chronic disease duration, exercise habits, sleep quality, self-rated health, medication use, education level, and insurance type were factors influencing the number of chronic conditions in elderly patients with multimorbidity in Guangdong Province. WANG et al.[29] identified that factors such as age, widowhood, being overweight or obese, and smoking history were associated with number of chronic conditions among older adults in Shanghai. International studies have also identified that the number of co-existing chronic conditions significantly impacts hospitalization frequency and frequency of admissions among patients with multimorbidity.[30-35] These findings are consistent with the findings of this study. Moreover, many of the factors commonly associated with the risk of developing multimorbidity, such as aging, smoking, alcohol consumption, physical activity, BMI, sleep duration, and social activities, also influence both the number of co-existing chronic conditions and hospital admissions. This overlap suggests that the determinants of multimorbidity may be closely linked to hospitalization risk and frequency, underscoring the need for targeted strategies that address socioeconomic, behavioral, and aging-related factors to improve the prevention and management of multimorbidity and reduce hospital admissions. By understanding these influencing factors, rural primary healthcare facilities can develop more comprehensive strategies to enhance multimorbidity management and alleviate the burden on hospital resources.

Limitations of the study

This study was based on medical record data from hospitalized patients with multimorbidity in township health centers (rural primary healthcare facilities) in Guangxi, limiting its generalizability to broader rural populations. Additionally, the diagnostic and treatment capacity for multimorbidity in these township health centers (rural primary healthcare facilities) is limited, and there is a high demand for referral services. Both may have affected the accuracy of the data to some extent.

Conclusion

The prevalence of multimorbidity is high among hospitalized patients in township health centers (rural primary healthcare facilities)in Guangxi, with hypertension being the most common co-existing chronic condition. The most frequent multimorbidity patterns involve combinations of hypertension with chronic cervical and lumbar diseases, gastrointestinal disorders, stroke, diabetes, hyperlipidemia, and chronic lung diseases. The factors influencing the number of co-existing chronic conditions and inpatient care utilization are complex and multifaceted. Addressing these challenges requires a multi-level strategy and preventive measures to improve the management of multimorbidity in rural primary healthcare facilities.

Declarations

Not applicable.

Authors' contributions

Conceptualization, S.Y.; Methodology, S.Y.; Data curation, X.Q., J.S., P.H. Q.J., W.X. and Z.Y.; Formal analysis, S.Y., X.Q., Z.C. and Z.Y.; Funding acquisition, not applicable; Project administration, not applicable; Resources, not applicable; Supervision, S.Y.; Validation, S.Y.;

Writing—original draft, X.Q.; Writing—review and editing, S.Y. All authors have read and agreed to the published version of the manuscript.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

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Authors' other information

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Competing interests

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Appendix 1–1. All pairwise comparisons of hospitalization frequency of multimorbidity patterns within patients with 2 chronic diseases Z (P)

	1*	2*	3*	4*	5*	6*	7*	8*	9*
2*	3.397								
	(0.001)								
3*	8.703	5.175							
	(0.000)	(0.000)							
4*	1.606	1.440	6.086						
	(0.108)	(0.150)	(0.000)						
5*	1.517	3.939	7.678	2.611					
	(0.129)	(0.000)	(0.000)	(0.009)					
6*	2.695	0.193	3.461	1.306	3.380				
	(0.007)	(0.847)	(0.001)	(0.191)	(0.001)				
7*	2.282	0.161	3.798	0.932	3.075	0.324			
	(0.023)	(0.872)	(0.000)	(0.351)	(0.002)	(0.746)			
8*	1.655	0.587	3.913	0.460	2.541	0.642	0.342		
	(0.098)	(0.557)	(0.000)	(0.645)	(0.011)	(0.521)	(0.732)		
9*	5.922	3.570	0.177	4.368	6.042	2.668	2.999	3.155	
	(0.000)	(0.000)	(0.860)	(0.000)	(0.000)	(0.008)	(0.003)	(0.002)	
10*	1.223	2.927	5.545	2.025	0.147	2.686	2.471	2.111	4.783
	(0.221)	(0.003)	(0.000)	(0.043)	(0.008)	(0.007)	(0.013)	(0.035)	(0.000)

Notes: 1 = Hypertension + Stroke; 2 = Hypertension + Diabetes; 3 = Hypertension + Chronic Cervical and Lumbar Disease; 4 = Chronic Cervical and Lumbar Disease + Chronic Gastrointestinal Disease; 5 = Hypertension + Hyperlipidemia; 6 = Chronic Pulmonary Disease + Chronic Gastrointestinal Disease; 7 = Hypertension + Chronic Pulmonary Disease; 8 = Hypertension + Chronic Gastrointestinal Disease; 9 = Chronic Cervical and Lumbar Disease + Joint Disease; 10 = Hyperlipidemia + Chronic Cervical and Lumbar Disease.

Appendix 1–2. All pairwise comparisons of hospitalization frequency of multimorbidity patterns within patients with 3 chronic diseases Z (P)

	1*	2*	3*	4*	5*	6*	7*	8*	9*
2*	1.815								
	(0.070)								
3*	1.318	0.399							
	(0.187)	(0.690)							
4*	3.200	1.351	1.701						
	(0.001)	(0.177)	(0.089)						
5*	2.095	3.560	3.047	4.798					
	(0.036)	(0.000)	(0.002)	(0.000)					
6*	2.568	0.961	1.304	0.195	4.002				
	(0.010)	(0.337)	(0.192)	(0.845)	(0.000)				
7*	0.497	0.888	0.566	1.991	1.995	1.660			
	(0.619)	(0.375)	(0.517)	(0.047)	(0.046)	(0.097)			
8*	0.699	0.820	0.430	1.987	2.321	1.593	0.160		
	(0.485)	(0.412)	(0.667)	(0.047)	(0.020)	(0.111)	(0.873)		
9*	1.335	0.201	0.178	1.358	2.893	1.023	0.679	0.558	
	(0.182)	(0.840)	(0.859)	(0.135)	(0.004)	(0.306)	(0.497)	(0.577)	
10*	1.688	3.089	2.597	4.208	0.122	3.543	1.697	1.991	2.531
	(0.091)	(0.002)	(0.009)	(0.000)	(0.903)	(0.000)	(0.090)	(0.046)	(0.011)

Notes:1 = Hypertension + Chronic Cervical and Lumbar Disease + Chronic Gastrointestinal Disease; 2 = Hypertension + Hyperlipidemia + Chronic Cervical and Lumbar Disease; 3 = Hypertension + Diabetes + Stroke; 4 = Hypertension + Diabetes + Hyperlipidemia; 5 = Hypertension + Diabetes + Chronic Cervical and Lumbar Disease; 6 = Hypertension + Hyperlipidemia + Stroke; 7 = Hypertension + Stroke + Chronic Cervical and Lumbar Disease; 8 = Hypertension + Chronic Pulmonary Disease + Chronic Gastrointestinal Disease; 9 = Hypertension + Stroke + Chronic Gastrointestinal Disease; 10 = Hypertension + Chronic Cervical and Lumbar Disease + Joint Disease.

Appendix 1–3. All pairwise comparisons of hospitalization frequency of multimorbidity patterns within patients with 4 chronic diseases Z (P)

	1*	2*	3*	4*	5*	6*	7*	8*	9*
2*	1.485 (0.137)								
3*	0.310 (0.757)	1.297 (0.195)							
4*	1.442 (0.149)	2.817 (0.005)	1.970 (0.049)						
5*	0.822 (0.411)	2.324 (0.020)	1.181 (0.238)	0.808 (0.419)					
6*	1.769 (0.077)	3.270 (0.001)	2.292 (0.022)	0.045 (0.964)	1.015 (0.310)				
7*	2.021 (0.043)	3.437 (0.001)	2.485 (0.013)	0.427 (0.669)	1.336 (0.181)	0.327 (0.744)			
8*	0.428 (0.669)	0.754 (0.451)	0.221 (0.825)	1.513 (0.130)	1.087 (0.277)	1.842 (0.066)	2.092 (0.036)		
9*	1.130 (0.259)	0.022 (0.982)	0.944 (0.345)	2.103 (0.035)	1.732 (0.083)	2.440 (0.015)	2.629 (0.009)	0.628 (0.530)	
10*	2.821 (0.005)	4.175 (0.000)	3.396 (0.001)	1.280 (0.200)	2.276 (0.023)	1.404 (0.160)	0.938 (0.348)	2.743 (0.006)	3.199 (0.001)

Notes: 1 = Hypertension + Diabetes + Chronic Cervical and Lumbar Disease + Chronic Gastrointestinal Disease; 2 = Hypertension + Diabetes + Hyperlipidemia + Stroke; 3 = Hypertension + Hyperlipidemia + Chronic Cervical and Lumbar Disease + Chronic Gastrointestinal Disease; 4 = Hypertension + Hyperlipidemia + Chronic Cervical and Lumbar Disease + Metabolic Disorders; 5 = Hypertension + Stroke + Chronic Cervical and Lumbar Disease + Chronic Gastrointestinal Disease; 6 = Hypertension + Diabetes + Hyperlipidemia + Chronic Cervical and Lumbar Disease; 7 = Hypertension + Chronic Pulmonary Disease + Chronic Cervical and Lumbar Disease + Chronic Gastrointestinal Disease; 8 = Hypertension + Diabetes + Stroke + Chronic Gastrointestinal Disease; 9 = Hypertension + Hyperlipidemia + Stroke + Chronic Cervical and Lumbar Disease; 10 = Hypertension + Chronic Cervical and Lumbar Disease + Chronic Gastrointestinal Disease + Joint Disease

Appendix 2. Variable assignment

Variables	Assignments
Independent variables	
Age	Continuous variable
BMI	Continuous variable
Gender	0 = Male, 1 = Female
Ethnicity	0 = Han, 1 = Zhuang, 2 = Other minorities
Insurance type	0 = Self-funded, 1 = Poverty assistance, 2 = Urban employee basic medical insurance, 3 = Urban employee basic medical insurance
Low-income household or household entitled to the Five Guarantees	0 = Yes, 1 = No
Occupation	0 = Farmer, 1 = Non-farmer
Marital status	0 = Married, 1 = Widowed., 2 = Divorced, 3 = Unmarried
Smoking history	0 = Non-smoker, 1 = Former or current smoker
Alcohol consumption history	0 = Non-drinker or former drinker, 1 = Current drinker
Education level	0 = High school and above, 1 = Junior high school, 2 = Elementary school 3 = Illiterate
Dependent variables	
Number of chronic conditions	0 = 2 chronic conditions, 1 = 3 chronic conditions, 2 = 4 chronic conditions, 3 = ≥5 chronic conditions
Hospitalization frequency (over 2.5 years)	0 = 1 hospitalization, 1 = 2 hospitalizations, 2 = ≥3 hospitalizations

Appendix 3. Pearson or Spearman coefficients of demography factors and number of chronic conditions

Factor	Number of chronic conditions	
	Correlation coefficient	*P value*
Age	0.091	<0.001
BMI	0.103	<0.001
Gender	0.027	0.01
Ethnicity	0.059	<0.001
Occupation	-0.046	<0.001
Marital status	0.038	<0.001
Insurance type	-0.124	<0.001
Low-income household or household entitled to the Five Guarantees	0.144	<0.001
Education level	0.056	<0.001
Smoking history	0.173	<0.001
Alcohol consumption history	0.187	<0.001

Appendix 4. Pearson or Spearman coefficients of demography factors and hospitalization frequency

Factor	Hospitalization frequency	
	Correlation coefficient	*P value*
Age	0.084	<0.001
BMI	0.033	<0.001
Gender	-0.029	0.005
Ethnicity	0.272	<0.001
Occupation	-0.068	<0.001
Marital status	0.068	<0.001
Insurance type	-1.43	<0.001
Low-income household or household entitled to the Five Guarantees	0.188	<0.001
Education level	0.107	<0.001
Smoking history	0.135	<0.001
Alcohol consumption history	0.133	<0.001
Number of chronic conditions	0.338	<0.001

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