Analysis of Prevalence Trends and Association Rules of Chronic Disease Comorbidity among Rural Residents in Ningxia Hui Autonomous Region (Postprint)

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Abstract

Abstract

Background: In recent years, chronic diseases have posed a serious threat to human health, and the prevalence of multimorbidity has been increasing annually. Understanding the epidemic trends and primary disease types of chronic disease multimorbidity among rural residents in Ningxia Hui Autonomous Region is conducive to formulating targeted public health policies and promoting healthy lifestyles among residents.

Objective: To understand the dynamic epidemic trends of chronic disease multimorbidity among rural residents in Ningxia Hui Autonomous Region over a 10-year period, explore its influencing factors and multimorbidity patterns, and reveal the complex associations of potential influencing factors, thereby providing new insights for developing chronic disease prevention and control strategies and measures.

Methods: The data for this study were derived from a merged dataset of the health follow-up cohort data of rural residents in Ningxia Hui Autonomous Region and National Natural Science Foundation project data, which includes six phases of panel data over 15 years. Using the disease counting method, this study selected four phases (2015, 2019, 2022, and 2024) of the population cohort from the 10-year period between 2015 and 2024. Ultimately, 70,667 rural residents aged $\geq$ 18 years with clear information on key variables were included as research subjects. The χ^2 test and trend χ^2 test were used to analyze the epidemic trends of chronic disease multimorbidity. Based on the 2024 data, the Apriori algorithm was employed to analyze chronic disease multimorbidity patterns. Based on the health ecology model, independent variables were selected

from five layers—individual traits, behavioral characteristics, interpersonal networks, living and working conditions, and policy environment—to construct a multifactorial Logistic regression model for analyzing the influencing factors of chronic disease multimorbidity.

Results: From 2015 to 2024, the prevalence of chronic disease multimorbidity among rural residents in Ningxia Hui Autonomous Region showed an increasing trend year by year ($P < 0.05$), with the prevalence in 2024 [9.97% (1,599/16,045)] increasing by 5.27 percentage points compared to 2015 [4.70% (977/10,775)]. Among various subgroups, except for those aged 18 to <45 years and those with "very good" self-rated health, the prevalence of chronic disease multimorbidity in all other subgroups showed an increasing trend year by year ($P < 0.05$). Using the Apriori algorithm, 20 strong association rules were obtained, of which 14 were related to hypertension, 10 were related to cerebrovascular disease, intervertebral disc disease, and rheumatoid arthritis, and 9 were related to cardiovascular disease. The results of the multifactorial Logistic regression model showed that the influencing factors for multimorbidity of ≥ 2 chronic diseases and ≥ 3 chronic diseases were basically consistent. An average daily exercise duration of ≥ 30 min and self-rated health being fair/good/very good were protective factors for both multimorbidity patterns ($P < 0.05$), while age ≥ 45 years, BMI ≥ 28.0 kg/m^2, and hospitalization within one year were risk factors for both patterns. Additionally, the absence of depression was a protective factor for multimorbidity of ≥ 2 chronic diseases ($P < 0.05$), and a BMI of 24.0–27.9 kg/m^2 was a risk factor for multimorbidity of ≥ 2 chronic diseases ($P < 0.05$). An average daily sleep duration of 6–8 hours and a distance of 1–5 km to the nearest medical point were protective factors for multimorbidity of ≥ 3 chronic diseases ($P < 0.05$).

Conclusion: The prevalence of chronic disease multimorbidity among rural residents in Ningxia Hui Autonomous Region shows a significant upward trend. Hypertension is the core disease in chronic disease multimorbidity, and multimorbidity among residents is influenced by various factors such as age, behavior and lifestyle, and medical accessibility. It is recommended to use key diseases as an entry point, strengthen health education for residents, and encourage them to prioritize healthy behaviors and lifestyles to achieve the prevention and control of chronic disease multimorbidity.

Full Text

Preamble

Epidemiological Trends and Association Rule Analysis of Chronic Disease Comorbidity among Rural Residents in Ningxia Hui Autonomous Region

Abstract

Objective: To analyze the prevalence, trends, and patterns of chronic disease comorbidity among rural residents in Ningxia Hui Autonomous Region from 2011 to 2019, and to explore the core combinations of comorbid conditions to provide a scientific basis for the integrated management of chronic diseases.

Methods: Data were derived from three waves of the "Ningxia Rural Residents' Health Status and Health Service Utilization Survey" conducted in 2011, 2015, and 2019. A multi-stage stratified cluster random sampling method was employed to collect data from rural residents in the autonomous region. Descriptive statistics were used to analyze the prevalence of chronic diseases and comorbidities across different years and demographic characteristics. Association rule analysis using the Apriori algorithm was applied to identify common patterns and core clusters of comorbid chronic diseases.

Results: The prevalence of chronic diseases among rural residents in Ningxia increased from 18.4% in 2011 to 26.3% in 2019. Correspondingly, the prevalence of comorbidity (the coexistence of two or more chronic conditions in one individual) rose from 4.2% in 2011 to 9.8% in 2019. The prevalence of comorbidity was significantly higher in females than in males and increased significantly with age. Association rule analysis revealed that the most frequent comorbid pairs were hypertension combined with diabetes, and hypertension combined with ischemic heart disease. In 2019, the complexity of comorbidity patterns increased, with new clusters emerging involving cerebrovascular diseases and chronic obstructive pulmonary disease (COPD).

Conclusion: The burden of chronic disease comorbidity among rural residents in Ningxia is increasing. There is a clear clustering effect among metabolic and cardiovascular diseases. Public health strategies should shift from single-disease management to an integrated, patient-centered approach that addresses common risk factors and comorbid clusters.

Introduction

With the acceleration of population aging and changes in lifestyle, chronic non-communicable diseases (NCDs) have become a major public health challenge in China. Unlike single-disease models, comorbidity—defined as the presence of two or more chronic conditions in a single individual—has become the "new

normal" for the elderly and middle-aged populations. Comorbidity is associated with higher mortality

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背景

In recent years, chronic diseases have posed a severe threat to human health, and the prevalence of chronic disease multimorbidity has been increasing annually. Understanding the epidemiological trends and primary disease types among rural residents in the Ningxia Hui Autonomous Region is essential for formulating targeted public health policies and promoting healthy lifestyles. This study aims to investigate the dynamic prevalence trends of chronic disease multimorbidity among rural residents in Ningxia over a 10-year period, identify influential factors and multimorbidity patterns, and reveal the complex associations between potential determinants. These findings provide new insights for the development of chronic disease prevention and control strategies.

The data for this study were derived from a merged dataset combining the Health Follow-up Cohort of Rural Residents in the Ningxia Hui Autonomous Region and National Natural Science Foundation of China project data. This dataset comprises six waves of panel data spanning 15 years. Using the disease counting method, this study selected four waves of population cohorts (2015, 2019, 2022, and 2024) within the 10-year period from 2015 to 2024. The final inclusion criteria focused on age···

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Abstract

This study included 70,667 rural residents aged 18 years and older with complete data on key variables as the research subjects. The χ^2 trend test was employed to analyze prevalence trends. Based on 2024 data, the Apriori algorithm was used to identify patterns of chronic disease multimorbidity. Drawing from the Health Ecology Model, independent variables were selected across five layers—individual traits, behavioral characteristics, interpersonal networks, living and working conditions, and the policy environment—to construct a multivariate logistic regression model for analyzing the influencing factors of chronic disease multimorbidity.

The results indicate that the prevalence of chronic disease multimorbidity among rural residents in the Ningxia Hui Autonomous Region showed a significant upward trend from 2015 to 2024 ($P < 0.05$). The prevalence increased by 5.27 per-

centage points, rising from 4.70% (977/10,775) in 2015 to 9.97% (1,599/16,045) in 2024. Across various subgroups, the prevalence of multimorbidity increased annually ($P < 0.05$), with the exception of individuals aged 18 to <45 years and those who self-rated their health as "excellent."

Using the Apriori algorithm, 20 strong association rules were identified. Among these, 14 rules were associated with hypertension; 10 rules were associated with cerebrovascular disease, intervertebral disc disease, and rheumatoid arthritis; and 9 rules were associated with cardiovascular disease.

The multivariate logistic regression analysis revealed that the influencing factors for multimorbidity involving ≥ 2 chronic diseases and ≥ 3 chronic diseases were largely consistent. An average daily exercise duration of ≥ 30 minutes and self-rated health status of "fair," "good," or "very good" served as protective factors for both multimorbidity patterns ($P < 0.05$). Conversely, older age and hospitalization within the past year were identified as risk factors for both patterns. Additionally, the absence of depression was a protective factor for multimorbidity involving ≥ 2 chronic diseases, while age ≥ 45 years and a BMI ≥ 28.0 kg/m^2 were significant risk factors.

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$P < 0.05$); an average daily sleep duration of 6–8 hours and a distance to the nearest medical facility of 1–5 km were identified as protective factors against having ≥ 3 chronic comorbidities ($P < 0.05$).

($P < 0.05$), and a BMI ranging from 24.0 to 27.9 kg/m^2.

The prevalence of chronic disease comorbidity among rural residents in the Ningxia Hui Autonomous Region shows a significant upward trend. Hypertension serves as the core condition within these comorbidity patterns. The occurrence of multimorbidity among residents is influenced by various factors, including age, behavioral lifestyles, and healthcare accessibility. It is recommended that public health interventions use key diseases as entry points to strengthen health education and encourage residents to prioritize healthy behaviors and lifestyles, thereby achieving effective prevention and control of chronic disease comorbidities.

Keywords: Chronic disease comorbidity; Prevalence; Analysis of influencing factors; Association rule analysis; Ningxia

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The Prevalence Trend and Association Rules of Chronic Disease Comorbidity among Rural Residents in Ningxia CHANG Jianhua, YANG Jian, ZHANG Yongxin[1,2*] *ZHANG Yongxin, Associate Professor* ZHANG Y, CHANG J H, YANG J, et al. The prevalence trend and association rules of chronic disease comorbidity among rural residents in Ningxia[J].

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Background

In recent years, chronic diseases have posed a serious threat to human health, with the prevalence of chronic disease comorbidity also increasing annually. Understanding the epidemiological trends and predominant types of chronic disease comorbidity among rural residents in Ningxia Hui Autonomous Region facilitates the development of targeted public health policies and promotes the adoption of healthy lifestyles.

Objective To examine the dynamic epidemiological trends of chronic disease comorbidity among rural residents in Ningxia Hui Autonomous Region over a 10-year period, identify influencing factors and comorbidity patterns, reveal the complex interrelationships of underlying determinants, and provide new insights for formulating chronic disease prevention and control strategies and measures.

Methods

The data for this study were derived from a merged dataset combining the Ningxia Rural Residents Health Follow-up Cohort and the National Natural Science Foundation of China project data. This dataset comprises six waves of panel data spanning 15 years. Using the disease counting method, this study selected four population cohorts from the aforementioned data spanning the 10-year period from 2015 to 2024 (2015, 2019, 2022, and 2024). Ultimately, 70 667 rural residents aged $ $18 years with clearly defined key variable information tests and trend χ control of chronic disease comorbidity.

Chronic diseases have gradually become a significant issue threatening public health and increasing the economic burden on society. These conditions are characterized by long durations and typically slow progression; they are primarily non-communicable diseases (NCDs) defined by an insidious onset and complex etiologies. In 2008, the World Health Organization (WHO) introduced the concept of multimorbidity, which refers to the coexistence of two or more chronic non-communicable diseases within the same patient. Multimorbidity is not only associated with increased mortality and disability rates, prolonged hospital stays, and higher consumption of medical and health resources, but it also imposes a heavy burden on patients' families and the socioeconomic system.

In recent years, the incidence of chronic diseases in rural areas has risen significantly, and the phenomenon of multimorbidity has become increasingly common. The prevention and control of chronic disease multimorbidity in rural areas face multiple challenges. On one hand, there is a shortage of rural medical resources, with primary healthcare institutions facing "shortcomings"in terms of equipment,

technology, and personnel. On the other hand, rural residents often have weak health literacy and a lack of awareness regarding preventive screening. These factors make it difficult to meet the demands for long-term management of multimorbidity and lead to delayed diagnoses, thereby increasing the difficulty of effective prevention and control [**?**].

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Furthermore, the treatment cycles for multimorbidity are prolonged and the associated costs are high, which frequently leads to rural households "falling into or returning to poverty due to illness." This poses a significant challenge to regional economic and social stability. In response, the state has introduced targeted policies to construct a rural multimorbidity prevention and control network by strengthening primary healthcare institutions and promoting family doctor contracting services, thereby enhancing overall prevention and treatment capabilities [**?**]. These initiatives not only safeguard resident health and alleviate the medical financial burden but also improve the rural public health system, contributing to rural revitalization and social equity. Consequently, these efforts are essential for achieving health equity.

However, existing research possesses certain limitations. Most studies employ cross-sectional designs that focus on the influencing factors of chronic disease multimorbidity among rural residents—such as demographic characteristics and lifestyle habits. There is a notable lack of longitudinal research addressing the long-term dynamic changes and association patterns between diseases. Longitudinal studies, through repeated observational data, can more clearly reveal the temporal patterns and underlying mechanisms of disease progression. Based on these considerations, this study utilizes the Apriori algorithm to mine strong association rules between chronic diseases and identify specific multimorbidity patterns.

2 tests to analyze the prevalence trends of chronic disease

comorbidity. Based on 2024 data, utilized the Apriori algorithm to examine patterns of chronic disease comorbidity. Constructed a multifactorial logistic regression model using variables selected from five spheres—individual traits, behavioral characteristics, interpersonal networks, living and working conditions, and policy environment—grounded in the health ecology model to analyze the determinants of chronic disease comorbidity.

Results

From 2015 to 2024, the prevalence of chronic disease comorbidity among rural residents in Ningxia Hui Autonomous Region showed a year-on-year increasing trend (0.05). The prevalence in 2024 [9.97% (1 599/16 045)] increased by 5.27 percentage points compared to 2015[4.70% (977/10 775)]. Among all subgroups, the prevalence of chronic disease comorbidity showed an annual upward trend in all groups except those aged 18-<45 years and those who self-rated their health

as very good (0.05). The Apriori algorithm yielded 20 strong association rules, of which 14 were related to hypertension, 10 were associated with cerebrovascular disease, intervertebral disc disease, and rheumatoid arthritis, and 9 were linked to cardiovascular disease.

Results

from the multivariable Logistic regression model indicate that the risk factors for $ $2 chronic diseases and $ $3 chronic diseases are largely consistent. Daily exercise duration $ $30 minutes and self- rated health as fair/very good/good serve as protective factors for both comorbidity patterns (0.05). Age $ $45 years, BMI $ $28.0 , and hospitalization within the past year are risk factors for both comorbidity patterns. Additionally, absence of depression was a protective factor for $ $2 chronic disease co-morbidities (0.05), while BMI between 24.0-27.9 kg/m co-morbidities (0.05). Average daily sleep duration of 6–8 hours and distance to nearest healthcare facility within 1-5 km were protective factors for $ $3 chronic disease co-morbidities (0.05).

Conclusion

The prevalence of chronic disease comorbidity among rural residents in Ningxia Hui Autonomous Region shows a marked upward trend, with hypertension being the core disease in chronic disease comorbidity. Resident chronic disease comorbidity is influenced by multiple factors including age, behavioral and lifestyle factors, and healthcare accessibility. It is recommended to focus on key diseases as entry points, strengthen health education for residents, and encourage residents to prioritize healthy behaviors and lifestyles, thereby achieving the prevention and Key words Multiple chronic conditions; Prevalence; Root cause analysis; Association rule analysis; Ningxia

Abstract

This study identifies core diseases within the Chinese general medicine landscape. By integrating follow-up data and employing Logistic regression models, we analyze the influencing factors of comorbidity patterns. This research aims to provide scientifically grounded and feasible strategies for the integrated prevention and control of comorbidities in rural areas, examining the issue through the dual dimensions of disease association and contributing factors.

1. Introduction

The prevalence of multimorbidity—the co-occurrence of two or more chronic conditions in a single individual—presents a significant challenge to public health systems globally, particularly within rural Chinese populations. Understanding the structural relationships between these diseases is essential for developing effective clinical guidelines and public health interventions. While traditional

Figure 1

Figure 1: Figure 1

Figure 1

Figure 2: Figure 1

research often focuses on individual chronic diseases, this study shifts the focus toward "core diseases" and their associated patterns.

2. Methods

2.1 Data Sources and Study Population

The analysis utilizes longitudinal follow-up data from representative rural cohorts. We focused on participants with documented chronic conditions to identify prevalent comorbidity clusters.

2.2 Statistical Analysis

We employed a two-dimensional analytical framework: 1. **Disease Association:** Identifying core diseases and their correlations within the population. 2. **Influencing Factors:** Utilizing Logistic regression models to determine the socio-demographic and behavioral determinants that drive specific comorbidity patterns.

The Logistic regression model is formulated as:

$$\text{logit}(P) = \ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n$$

where P represents the probability of a specific comorbidity pattern occurring, and x_i represents the various independent variables such as age, gender, lifestyle factors, and socioeconomic status.

3. Results

The results indicate that certain cardiovascular and metabolic diseases serve as "hubs" or core diseases within the rural population. The Logistic regression analysis revealed that age and specific dietary habits are significant predictors of complex comorbidity patterns.

As shown in

, the network of disease associations highlights the central role of hypertension and diabetes in driving further complications. The odds ratios (OR) derived from the regression models suggest that individuals in lower socioeconomic brackets are at a higher risk for accumulating multiple chronic conditions.

Figure 1

Figure 3: Figure 1

4. Discussion

Our findings

1.1 研究对象

The data for this study were derived from a merged dataset combining the Ningxia Hui Autonomous Region Rural Residents' Health Follow-up Cohort and National Natural Science Foundation of China project data. This dataset encompasses six waves of panel data spanning 15 years of healthcare reform in the southern mountainous regions of Ningxia. Utilizing the disease counting method, this research selected four waves of population cohorts (2015, 2019, 2022, and 2024) covering the ten-year period from 2015 to 2024 [**?**, **?**].

The survey employed a multi-stage stratified random cluster sampling method to select study participants from Yanchi, Haiyuan, Xiji, and Pengyang counties in the Ningxia Hui Autonomous Region. The specific sampling procedure was as follows: first, all administrative villages within the townships of the four counties were stratified into "good," "medium," and "poor" levels based on their economic development status. Within each stratum, 40% of the villages were selected as sample villages using a random number table. Subsequently, systematic sampling was used to select resident households within these sample villages. Specifically, 33 households were selected from each of the 40 sample villages in Yanchi County; 33 households from each of the 76 sample villages in Haiyuan County; 20 households from each of the 58 sample villages in Xiji County; and 20 households from each of the 33 sample villages in Pengyang County.

All permanent residents (defined as those residing in the household for $\geq$ 6 months) within the sampled households were included in the survey. Exclusion criteria were applied to individuals with severe cognitive impairment, severe mental disorders, or other underlying diseases that would interfere with the investigation, as well as those with language or writing communication difficulties or those unwilling or unable to cooperate with the survey. A total of 109,615 rural residents were initially surveyed. For the purposes of this study, the target population was restricted to adult residents aged $\geq$ 18 years. After removing samples with missing or ambiguous key variables, a final total of 70,667 residents were included in the analysis. The participant screening process is illustrated in

.

Figure 1

Figure 4: Figure 1

1.2.1 确定纳入分析的慢性病种类

We analyzed the types of chronic diseases among rural residents in the Ningxia Hui Autonomous Region as recorded in the database. For each period of the database, we ultimately included the top 12 chronic diseases based on prevalence. These conditions include hypertension, diabetes, intervertebral disc disease, cerebrovascular disease, chronic gastroenteritis, cardiovascular disease, rheumatoid arthritis, chronic obstructive pulmonary disease (COPD), radiotherapy or drug treatment for malignant tumors, liver cirrhosis, chronic kidney disease, and bronchial asthma.

1.2.2 基于健康生态学模型选取影响因素

The health ecology model places individual health within a multi-layered, complex ecosystem, comprehensively analyzing various health determinants across five distinct spheres: individual traits, behavioral characteristics, interpersonal networks, living and working conditions, and the policy environment. This model aligns well with the multifaceted nature of chronic disease comorbidity in rural areas, where various factors are intricately intertwined. It provides a systematic framework for examining the mechanisms through which factors at different levels influence chronic disease comorbidity, making it highly suitable for the present study.

In this study, variables were selected based on a questionnaire customized by the research group, with reference to the characteristics of each sphere within the model. While some variables lack direct support from existing literature, they were included based on the inclusion criteria of their respective ecological spheres.

1.1 Individual Traits

This layer includes demographic characteristics such as gender, age, and Body Mass Index (BMI).

1.2 Study Population and Data Collection

The longitudinal data collection process for the study population is summarized as follows:

- **2015 Cohort:** Out of 20,775 individuals aged 18 and over, 686 individuals were included based on similarities in basic household conditions.
- **2019 Cohort:** Out of 17,213 individuals aged 18 and over, 1,600 individuals were included based on similarities in basic household conditions.

Figure 2

Figure 5: Figure 2

During the interval between 2015 and 2019, 4,198 individuals were excluded due to death or being lost to follow-up.

- **2022 Cohort:** Out of 16,634 individuals aged 18 and over, 193 individuals were included based on similarities in basic household conditions. Similar to the previous period, 4,198 individuals were recorded as lost to follow-up or deceased.
- **Final Sample:** The study ultimately included a total population of 70,667 individuals across the study periods for comprehensive analysis.

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Loss to follow-up or death; 16,045 individuals over the age of 18 in 2022. Flowchart for screening research subjects [**?**]. (2) Behavioral characteristics layer: Smoking, alcohol consumption, depression, self-rated health, average daily exercise duration, and average daily sleep duration have been confirmed by previous studies to be associated with the incidence of chronic diseases and are core confounding factors in numerous health studies [**?**, **?**]. Two indicators—whether a physical examination was conducted within one year and whether hospitalization occurred within one year—directly reflect individual medical behavior and proactive health management; these align with the characteristics of this layer and were included based on the inclusion criteria. (3) Interpersonal network layer: Marital status and social activities significantly impact individual mental health and the acquisition of social support, which in turn affects the risk of chronic disease. (4) Living and working conditions layer: Educational level, employment status, and annual household income reflect an individual' s socioeconomic status and are closely related to the acquisition of health resources and the formation of health behaviors. Two indicators—whether the kitchen is separated from the living area and the distance to the nearest medical point—pertain to the healthiness of the living environment and the accessibility of medical services; these were included in this layer according to the inclusion criteria. (5) Policy environment layer: Medical insurance directly affects the medical cost burden and healthcare utilization of rural residents, serving as a key policy-level factor influencing chronic disease prevention and control, as shown in

.

Statistical Methods

Data entry was performed using EpiData 3.1 software, and data screening and cleaning were conducted using SPSS 27.0. Categorical data are described using frequencies and percentages. Comparisons of chronic disease prevalence among

residents with different characteristics were performed using the χ^2 test.

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Fisher' s exact test was employed for categorical data analysis. Trends in the prevalence of chronic diseases over the years were evaluated using the χ^2 test for trend. To identify the influencing factors of chronic disease multimorbidity, unconditional multivariable logistic regression analysis was performed. The goodness-of-fit of the model was assessed using the Hosmer-Lemeshow test. Statistical significance was defined at a threshold of $P < 0.05$.

Using the Apriori algorithm from the `arules` package in R 4.4.2 software, we conducted an association rule analysis to identify patterns of chronic disease multimorbidity. Association rules are utilized to discover latent relationships and co-occurrence patterns within large datasets.

In this study, we defined the presence of specific chronic conditions as "items" and individual patient profiles as "transactions."The Apriori algorithm identifies frequent itemsets—combinations of diseases that occur together more often than expected—based on predefined thresholds for support, confidence, and lift.

The primary metrics used to evaluate the strength and significance of these multimorbidity patterns are defined as follows:

1. **Support**: This represents the prevalence of a specific combination of diseases within the total study population. For a rule $A \Rightarrow B$, support is calculated as:
$$Support(A \Rightarrow B) = P(A \cap B)$$

2. **Confidence**: This measures the conditional probability that a patient has disease B given that they already have disease A. It indicates the reliability of the association:
$$Confidence(A \Rightarrow B) = \frac{P(A \cap B)}{P(A)}$$

3. **Lift**: This metric assesses the strength of the association by comparing the observed frequency of the co-occurrence to the frequency expected if the diseases were independent. A lift value greater than 1 indicates a positive correlation between the conditions:
$$Lift(A \Rightarrow B) = \frac{P(A \cap B)}{P(A)P(B)}$$

By applying these criteria, we filtered and visualized the most significant multimorbidity clusters, providing insights into the complex interactions between chronic conditions in the clinical population.

Association rule mining is a data analysis method used to discover potential relationships between different items within a dataset. It is typically expressed in the form $X \Rightarrow Y$, where X and Y are disjoint itemsets. A "frequent itemset" refers to a set of items with a support value greater than or equal to a specified minimum support threshold, reflecting combinations of items that frequently occur together in the data.

The Apriori algorithm is based on the downward closure property of frequent itemsets (i.e., all non-empty subsets of a frequent itemset must also be frequent). By scanning the dataset multiple times, the algorithm incrementally generates frequent itemsets starting from individual items. Consequently, this study employs the Apriori method to explore the intrinsic associations between chronic disease comorbidities. Support, confidence, and lift are the standard metrics used to evaluate these associations [**?**].

1.1 Support

Support represents the probability that both itemset X and itemset Y appear simultaneously in the total number of transactions. It measures the frequency of the association rule within the entire dataset. The formula is expressed as:

$$Support(X \Rightarrow Y) = P(X \cup Y) = \frac{\text{count}(X \cup Y)}{N}$$

Where N represents the total number of samples.

(1) **Support**: This refers to the ratio of the number of transactions containing both itemsets A and B to the total number of transactions in the dataset, denoted as $Support(A \rightarrow B)$. It represents the frequency with which itemsets appear together in the dataset; the higher the support, the more significant the association rule.

(2) **Confidence**: This refers to the ratio of the number of transactions containing both itemsets A and B to the number of transactions containing itemset A, denoted as $Confidence(A \rightarrow B)$. It measures the conditional probability of B occurring given that A has occurred; the higher the confidence, the more reliable the association rule.

(3) **Lift**: This refers to the ratio of the confidence of the rule to the support of itemset B, denoted as $Lift(A \rightarrow B)$. It is used to measure the degree of influence that the occurrence of A has on the occurrence of B (i.e., the effectiveness of the association rule). When the lift is greater than 1.000, a higher value indicates a stronger positive correlation for the rule $A \rightarrow B$.

Sensitivity analysis was employed to evaluate the impact of Apriori algorithm parameters on the results of association rule mining. Specifically, the system analyzed rule generation under various parameter combinations by setting support thresholds at 0.005, 0.010, and 0.050, confidence thresholds at 0.3, 0.5, and 0.7, and a minimum itemset length of 2.

The evaluation metrics included the total number of rules, the distribution of support and confidence, lift (where Lift > 1), and domain-specific plausibility. For each set of parameters, association rules were first generated using the `arules` package. Subsequently, the `subset` function was utilized to filter for strong rules, and the resulting rule structures were visualized using network diagrams.

2.1 居民的基本情况

The study included 20,775 residents in 2015, consisting of 10,718 males (51.59%) and 10,057 females (48.41%); age distribution showed 11,457 (55.15%) aged 18–44, 5,480 (26.38%) aged 45–59, and 3,838 (18.47%) aged 60 and older. In 2019, 17,213 residents were included, with 9,006 males (52.32%) and 8,207 females (47.68%); the age groups 18–44, 45–59, and 60+ accounted for 8,647 (50.24%), 4,919 (28.58%), and 3,647 (17.55%) participants, respectively. The 2022 cohort comprised 16,634 residents, including 8,700 males (52.30%) and 7,934 females (47.70%), with 7,305 (43.91%), 4,970 (29.88%), and 4,359 (26.21%) in the respective age categories. Finally, in 2024, 16,045 residents were included, with 8,380 males (52.23%) and 7,665 females (47.77%), distributed across age groups as 6,450 (40.20%) aged 18–44, 4,587 (28.59%) aged 45–59, and 5,008 (31.21%) aged 60 and older.

Regarding the prevalence of chronic disease multimorbidity among residents with different characteristics, the prevalence rates for rural residents in the Ningxia Hui Autonomous Region in 2015, 2019, 2022, and 2024 were 4.70% (977/20,775), 7.89% (1,358/17,213), 9.04% (1,503/16,634), and 9.97% (1,599/16,045), respectively. Compared to 2015, the prevalence in 2024 increased by 5.27 percentage points. The prevalence showed a significant upward trend over the years ($\chi^2 = 385.14, P < 0.001$).

Statistically significant differences were observed in the prevalence of chronic disease multimorbidity when compared across gender, age, self-rated health status, marital status, educational level, employment status, and annual household income ($P < 0.05$). Within the subgroups, the prevalence of multimorbidity exhibited a year-on-year increasing trend ($P < 0.05$) for all categories except for those aged 18–44 and those with "excellent" self-rated health. In 2024, hypertension was the most prevalent chronic disease, followed by intervertebral disc disease, diabetes, and cerebrovascular disease. The prevalence of multimorbidity involving hypertension and at least one other chronic disease was 7.95% (1,276/16,045), while the multimorbidity rates for all other specific chronic diseases were below 3.00% (see).

Between 2015 and 2024, the five chronic diseases with the highest prevalence of multimorbidity were hypertension, intervertebral disc disease, diabetes, rheumatoid arthritis, and cardiovascular disease. Overall, the proportion of patients suffering from only a single chronic disease showed a downward trend, while the proportion of those with comorbid conditions increased accordingly. Specifically,

Figure 3

Figure 6: Figure 3

the proportion of hypertensive patients with comorbidities rose from 27.36% (572/2,091) in 2015 to 42.10% (1,276/3,031) in 2024. For diabetes, this proportion increased from 43.48% (120/276) in 2015 to 70.21% (469/668) in 2024. Similarly, the proportion of rheumatoid arthritis patients with comorbidities rose from 33.20% (170/512) to 64.91% (320/493), intervertebral disc disease from 35.69% (101/283) to 57.35% (476/830), and cardiovascular disease from 47.60% (99/208) to 70.16% over the same period.

Chinese General Practice: Comparison of the prevalence of chronic disease multimorbidity among residents with different characteristics from 2015 to 2024. Prevalence [n (%)].

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Annual household income

2 值

Chinese General Practice, (301/429), as shown in Figure 3

. Association rule analysis of chronic disease multimorbidity patterns identified a total of 20 association rules. These included 5 binary pattern rules, 5 ternary pattern rules, and 10 quaternary pattern rules.

Among these, 14 association rules were related to hypertension, while 10 rules were associated with cerebrovascular

[n (%)] Detection rates of chronic diseases and their multimorbidity among rural residents in Ningxia, 2024

Chronic disease multimorbidity

Afflicted with 2 chronic diseases; Afflicted with ≥ 3 chronic diseases; Total

Radiotherapy for malignant tumors or vascular diseases, intervertebral disc disease, and rheumatoid arthritis were involved in several rules, while 9 association rules were related to cardiovascular disease. The top two association rules by support were "diabetes + hypertension" and "cerebrovascular disease + hypertension." The top three rules by confidence were "intervertebral disc disease, cerebrovascular disease, cardiovascular disease + hypertension," "diabetes, cerebrovascular disease, cardiovascular disease + hypertension," and "diabetes + hypertension." The top three rules by lift were "chronic gastroenteritis, cardiovascular disease + rheumatoid arthritis," "hypertension, cerebrovascular disease, rheumatoid arthritis + cardiovascular disease," and "cerebrovascular disease, rheumatoid arthritis + cardiovascular disease," as shown in Table 3 .

Figure 4

Figure 7: Figure 4

By incrementally adjusting the support, confidence, and lift values, an association rule network diagram was generated, as shown in Figure 4

. The results indicate that hypertension serves as the core node, exhibiting strong associations with diabetes, cardiovascular disease, and cerebrovascular disease. Furthermore, cerebrovascular disease is associated with intervertebral disc disease and rheumatoid arthritis (Figure 4A), while chronic gastroenteritis shows a strong association with intervertebral disc disease and rheumatoid arthritis (Figure 4B).

Analysis of factors influencing multimorbidity

2.6.1 单因素分析

There were statistically significant differences in the prevalence rates of multimorbidity (defined as having ≥ 2 or ≥ 3 chronic diseases) across various demographic and socioeconomic factors, including gender, age, BMI, smoking status, depression, self-rated health, average daily exercise duration, average daily sleep duration, hospitalization within the past year, educational level, employment status, and annual household income ($P < 0.05$). Furthermore, statistically significant differences were observed in the prevalence of ≥ 2 chronic diseases based on alcohol consumption and physical examination status within the past year ($P < 0.05$). These findings are detailed in the study titled "Distribution of major types of chronic diseases and chronic disease multimorbidity among adult residents in rural areas of Ningxia, 2015-2024."

According to the "Chronic disease co-morbidity association rules for adult residents in rural areas of Ningxia in 2024" published in *Chinese General Practice*, the association rules were evaluated based on support (%), confidence (%), and lift (%). The analysis included the total number of patients (cases) for each rule. Specifically, for the visualization in Figure A, the parameters were set at a support level of 5.0%, a confidence level of 30.0%, and a lift greater than 1.2. For Figure B, the parameters were set at a support level of 1.0%, a confidence level of 50.0%, and a lift greater than 1.0.

The network graph of association rules for chronic diseases with high prevalence rates further illustrates these relationships. Statistically significant differences were found in the prevalence of ≥ 2 chronic diseases among residents based on their specific demographic profiles ($P < 0.05$). Additionally, the distance to the nearest medical facility was significantly associated with the prevalence rate of ≥ 3 chronic diseases ($P < 0.05$).

2.6.2 多因素 Logistic 回归分析

Using the prevalence of multimorbidity—defined respectively as the presence of ≥ 2 chronic diseases and ≥ 3 chronic diseases—as the dependent variables (assigned values: No = 0, Yes = 1), we incorporated five distinct dimensions of social environmental factors as independent variables. These dimensions include the physical environment, service environment, social cohesion, social participation, and neighborhood security.

To account for potential confounding factors, we adjusted for individual-level covariates, including gender, age, education level, marital status, and place of residence. We then constructed a series of multilevel logistic regression models to analyze the data. Specifically, Model 1 was a null model (intercept-only) used to calculate the Intra-class Correlation Coefficient (ICC) and determine whether there was significant clustering at the community level. Model 2 introduced the individual-level demographic covariates. Finally, Model 3 integrated the five dimensions of the social environment to examine their independent associations with the risk of multimorbidity. All statistical analyses were performed using appropriate software, with significance levels set at $P < 0.05$.

A multi-factor logistic regression analysis was conducted using the 19 indicators from the layer as independent variables. The Hosmer-Lemeshow test yielded p-values of 0.770 and 0.518, respectively. Since these values are greater than 0.05, they indicate that the model demonstrates a good fit and possesses significant reference value for further analysis.

The results indicate that age, BMI, depression status, self-rated health, average daily exercise duration, and whether the individual had been hospitalized within the past year are significant influencing factors for the presence of two or more chronic comorbidities among residents ($P < 0.05$). Furthermore, age, BMI, self-rated health, average daily exercise duration, average daily sleep duration, and hospitalization history within the past year were also identified as key factors.

Chinese General Practice https Comparison of the prevalence of comorbidity of chronic diseases among rural adult residents with different characteristics in Ningxia Region

Multimorbidity of ≥ 2 chronic conditions; Multimorbidity of ≥ 3 chronic conditions

2 值

Individual Characteristics Layer

≥ 60 years old: 2,942; 1,149 (39.01%); 339 (11.52%)

< 18.5 kg/m^2; 18.5 ∼ 23.9 kg/m^2; 24.0 ∼ 27.9 kg/m^2; ≥ 28.0 kg/m^2; Behavioral Characteristics Layer

60 min 663 200 (30.17) 36 (5.43)

Figure 5

Figure 8: Figure 5

<6 h 864 363 (42.01) 127 (14.70)

8 h 338 115 (34.02) 36 (10.65)

Chinese General Practice (Table 4 continued) Interpersonal Network Level; Living and Working Conditions Level

The distance to the nearest medical facility is a significant factor influencing the prevalence of multimorbidity (defined as having ≥ 3 chronic diseases) among residents ($P < 0.05$), as illustrated in Figure 5

.

2.7 敏感性分析

2.7.1 Impact of Parameter Variations on Rule Quantity

(1) Impact of Support: When the confidence level is fixed at 0.3 and the support increases from 0.001 to 0.010, the number of rules decreases sharply from 231 to 6. This indicates that higher support requirements filter out low-frequency itemsets, leading to an exponential decline in the number of rules. (2) Impact of Confidence: With the support fixed at 0.005, increasing the confidence from 0.1 to 0.7 results in the number of rules decreasing from 160 to 22. Raising the confidence threshold significantly tightens the reliability criteria, ensuring that only rules with high certainty are retained.

2.7.2 Determination and Significance of Optimal Parameters

By synthesizing the quantity and quality of the generated rules, the optimal parameters were ultimately selected as support = 0.005 and confidence = 0.5.

Comorbidity of ≥ 2 chronic diseases; Comorbidity of ≥ 3 chronic diseases.

2 值

Confidence = 0.3 and lift = 1 were selected as the core analysis parameters for the following reasons: (1) This configuration yields a moderate number of rules (51 in total), effectively avoiding the redundancy associated with lower parameter thresholds and the sparsity caused by excessively high parameters. (2) According to the support-confidence heatmap, the rule distribution is most concentrated within the support range of 0.001 to 0.010 and the confidence range of 0.1 to 0.3

. This region represents the "sweet spot" for parameter optimization.

Figure 6

Figure 9: Figure 6

3.1 慢性病共病的流行趋势

This study focuses on the prevalence trends of chronic disease multimorbidity in the rural areas of the Ningxia Hui Autonomous Region over the ten-year period from 2015 to 2024. The results indicate a significant upward trend in the prevalence of multimorbidity. Furthermore, chronic diseases are no longer exclusively "diseases of the elderly" but are increasingly affecting younger populations, posing a severe challenge to the public health system. The study found that while the prevalence of single chronic conditions has declined, the prevalence of multimorbidity has risen annually [**?**]. This trend is closely related to the geographical location of the Ningxia Hui Autonomous Region in the Northwest.

< 10,000 RMB: 964; 379 (39.32%); 114 (11.83%)

50,000 RMB: 669; 203 (30.34%); 51 (7.62%)

<1 km 1 515 528 (34.85) 154 (10.17)

5 km 271 104 (38.38) 44 (16.24)

1 587 (34.09) 435 (9.34) 12 (37.5) 4 (12.5)

Chinese General Practice https

- P< 0.05,

** P< 0.01,

These factors are closely related to relatively lagging economic development, a predominantly agricultural workforce, a high proportion of "empty-nest" elderly individuals in rural areas, significant distances to the nearest medical facilities, and generally lower educational levels resulting in limited health literacy regarding chronic diseases. Furthermore, the rise in consumer spending and shifts in lifestyle over the past decade have led to a marked increase in average Body Mass Index (BMI). Consequently, the prevalence of cardiovascular and cerebrovascular diseases, hypertension, and diabetes has shown a steady year-on-year growth.

Patterns of chronic disease multimorbidity

3.2.1 高血压共病模式

The prevalence of hypertension in China is increasing annually, and the incidence of comorbid diabetes and coronary heart disease among hypertensive patients is significantly higher than in the general population. Research based on 2018 CHARLS data, utilizing the Apriori algorithm to analyze comorbidity patterns across 14 chronic diseases, indicates that the most common patterns

Figure 1

Figure 10: Figure 1

involve hypertension combined with heart disease, dyslipidemia, and diabetes. The results of the present study demonstrate that hypertension serves as the core condition within chronic disease comorbidities. Furthermore, our investigation revealed that due to the high prevalence of hypertension, increasing the support threshold in association rule analysis results in hypertension appearing as the consequent in nearly all rule sets. Therefore, to better explore the patterns of other chronic disease comorbidities, this study appropriately lowered the support threshold. Currently, the etiology of hypertension remains not fully understood, though it is primarily associated with unhealthy lifestyle habits, genetics, environmental factors, and other chronic conditions. In the visual representation (where $P < 0.001$), the blue sections denote comorbidities of ≥ 2 chronic diseases, while the red sections represent comorbidities of ≥ 2 and ≥ 3 chronic diseases.

Forest plot of factors influencing chronic disease comorbidities among adult rural residents in the Ningxia Hui Autonomous Region based on the Health Ecology Model.

Heat map of the number of association rules with different support and confidence levels.

Research indicates that among rural residents in the Ningxia Hui Autonomous Region, the binary comorbidity patterns of hypertension with diabetes, and cerebrovascular disease with hypertension, are the most prevalent; these findings are consistent with previous studies [**?**, **?**]. Common comorbidity patterns for diabetes include diabetes with hypertension, diabetes with cerebrovascular disease, and cardiovascular disease (including hypertension), which also aligns with existing research conclusions [**?**]. Some studies have found that chronic inflammation and oxidative stress serve as the shared pathological basis for these conditions. The chronic inflammatory state in diabetic patients accelerates atherosclerosis, thereby increasing the risk of cardiovascular disease.

3.2.2 其他共病模式

Research has confirmed at the genetic level that chronic gastroenteritis and cardiovascular diseases are closely associated with rheumatoid arthritis (RA). Furthermore, the incidence of gastroparesis in patients with RA is 36% higher than that in the general population. Additionally, when high-risk arthritis patients take non-steroidal anti-inflammatory drugs (NSAIDs), gastrointestinal complications remain difficult to avoid even when co-administered with gastroprotective agents; in some cases, this may even increase the risk of gastrointestinal disease. In summary, genetic factors and the use of specific medications may strengthen the latent association between arthritis and gastrointestinal dis-

orders.

This study also found that comorbidity patterns involving intervertebral disc disease are more prevalent in the rural areas of the Ningxia Hui Autonomous Region. This finding differs from previous research results, leading to the hypothesis that because the study subjects are predominantly rural residents engaged in farming, the high intensity of physical labor contributes to the prevalence of both intervertebral disc disease and rheumatoid arthritis.

Influencing Factors of Chronic Disease Comorbidity

[The following section would analyze the specific determinants contributing to these patterns···]

3.3.1 个人特质层

In this study, the prevalence of chronic disease multimorbidity among individuals aged 60 and older was 22.92%, which is lower than the 66.3% prevalence reported for Chinese older adults in the fifth wave of the China Health and Retirement Longitudinal Study (CHARLS). Numerous studies have demonstrated that age and obesity are positively correlated with the risk of chronic disease multimorbidity. On one hand, chronic diseases often have long latency periods, leading to a higher risk of onset among the elderly population. On the other hand, obesity significantly increases the risk of multimorbidity for conditions such as type 2 diabetes. Furthermore, obesity and being overweight can lead to insulin resistance, which subsequently increases the risk of developing diabetes while simultaneously raising the incidence of cardiovascular disease.

3.3.2 行为特征层

Regarding physical activity, high-intensity exercise can reduce the risk of chronic conditions such as heart disease, though it may increase the risk of arthritis and kidney disease. In contrast, regular exercise significantly lowers the incidence and mortality rates of cardiovascular disease and type 2 diabetes [**?**]. In this study, 52.4% of participants over the age of 60 exercised for more than 30 minutes per day on average, and their multimorbidity rate was lower than the overall average. However, the detected prevalence of multimorbidity among smokers and drinkers was lower than that among non-smokers and non-drinkers, which contradicts some previous research findings [**?**]. In the rural areas of the Ningxia Hui Autonomous Region, individuals who can sustain the consumption of tobacco and alcohol may possess relatively better economic conditions, thereby enjoying advantages in areas such as dietary nutrition and healthcare (e.g., regular physical examinations).

For instance, individuals with better economic status may detect and manage multimorbidity earlier. Conversely, non-smokers and non-drinkers with poorer

economic status might neglect health management, leading to more severe disease progression and paradoxically higher detection rates. From the perspective of survivor bias, medical resources in rural Ningxia are relatively limited; individuals who smoke or drink heavily and have already developed severe illnesses may have been excluded from the survey sample due to premature death or disability. The remaining sample likely consists of "healthy survivors" who are more tolerant of tobacco and alcohol or have not yet developed obvious diseases, leading to an underestimation of multimorbidity prevalence. Furthermore, the survey identified a large number of individuals who had quit smoking or drinking. This group may include many individuals who proactively quit due to existing illnesses (such as respiratory or liver diseases), suggesting a "reverse causality" —where the disease preceded the cessation behavior, resulting in a higher multimorbidity rate within this group. Existing research has shown that moderate alcohol consumption (1–2 glasses/day) follows a "J-shaped" curve in reducing the risk of cardiovascular and cerebrovascular diseases. Compared to those with better self-rated health, individuals with poor self-rated health face a higher risk of chronic multimorbidity; however, this conclusion may be influenced by the reverse effect of "chronic disease leading to a decline in self-rated health." Direct research on the reverse causality between self-rated health and multimorbidity is relatively scarce. Existing literature primarily explores the impact of self-rated health on chronic disease prognosis and quality of life, or the impact of chronic diseases on self-rated health. Studies have found that reverse causality bias may exist between self-rated health and specific chronic diseases, rather than across all chronic diseases or multimorbidity patterns [**?**]. Patients with depression exhibit higher multimorbidity rates because depression not only increases disease risk by affecting neuroendocrine, immune, and metabolic systems, but its associated unhealthy lifestyles also exacerbate chronic conditions. Using "hospitalization within the past year" as a risk factor emphasizes the long-term health risk effects that the hospitalization experience itself exerts on populations not yet diagnosed with the target chronic diseases through multidimensional mechanisms. Hospitalization is not a direct "cause" of chronic disease; rather, it indirectly increases the risk of subsequent chronic diseases by altering an individual' s physiological state, health behavior patterns, or accessibility to medical resources. Clinical data indicate that the number and severity of chronic comorbidities are closely related to the frequency and duration of hospitalization. For example, patients with comorbidities involving COPD, cardiovascular disease, and diabetes have a higher risk of hospitalization than those with a single disease [**?**], which is consistent with the results of this study.

3.3.3 人际网络层

The association between marital status and cardiovascular disease has been extensively studied. Systematic reviews and meta-analyses have demonstrated that unmarried individuals face a significantly higher risk of developing cardiovascular disease, coronary heart disease, and stroke; furthermore, they exhibit higher mortality rates following myocardial infarction.

In addition, social and psychological factors are closely interrelated. Patients with depression may experience a diminished capacity for chronic disease self-management or an increased risk of comorbid mortality due to a lack of social support and high levels of psychological stress.

3.3.4 生活和工作条件层

Individuals with higher educational attainment, stable employment, and an annual average income exceeding 50,000 RMB exhibit a relatively lower prevalence of chronic disease multimorbidity. Furthermore, the distance to medical facilities exerts a significant influence on chronic disease management. Patients residing far from medical points face difficulties in conducting regular check-ups and follow-ups due to the inconvenience of travel, making it challenging to receive timely and effective interventions, which ultimately weakens the efficacy of chronic disease management.

The finding that a geographical accessibility of 1–5 km serves as a protective factor against multimorbidity is primarily due to the establishment of a "screening-treatment-management" health service loop. This distance range facilitates regular physical examinations and disease follow-ups, enabling the early detection of chronic conditions such as hypertension and diabetes, thereby preventing the progression from a single disease to multiple comorbidities. Moreover, reducing travel time enhances patient compliance with follow-up visits and medication adherence. Crucially, the 1–5 km radius typically encompasses community pharmacies, rehabilitation centers, and family doctor studios. As the contracting rate for family doctors increases, a "prevention-treatment-rehabilitation" one-stop management system is formed. This provides patients with multimorbidity with continuous health interventions, fundamentally reducing the risk of developing multiple concurrent diseases.

3.3.5 政策环境层

Health insurance participation significantly influences the utilization of medical services among patients with chronic disease comorbidities. Insured patients with comorbidities exhibit markedly higher frequencies of outpatient visits and hospitalizations compared to those without insurance. This suggests that health insurance plays a critical role in the occurrence, management, and cost control of chronic disease comorbidities.

Future research and public health policies should focus on the impact of health insurance on chronic disease comorbidities to optimize management strategies and improve patient prognoses. A limitation of this study is that the data source is limited to self-reported information collected via questionnaires, without incorporating objective indicators obtained from biological sample testing.

On one hand, questionnaire data are susceptible to factors such as subjective cognitive bias and recall bias, whereas biological variables provide a more ob-

jective quantitative basis; the absence of the latter may reduce the robustness of the research findings. On the other hand, the lack of biological evidence makes it difficult for this study to reveal the underlying biological mechanisms of the associations between variables, limiting the analysis to descriptions at the behavioral or cognitive levels.

This limitation may affect the depth and scope of the study' s conclusions. Author Contributions: Zhang Fan was responsible for the conception and design of the article, data analysis, and manuscript writing; Chang Jianhua was responsible for data cleaning and organization; Yang Juan was responsible for literature search, organization, and summarization; Qiao Hui and Xie Yongxin were responsible for polishing and revising the manuscript and are responsible for the overall content.

The authors declare no conflicts of interest.

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60 岁以上老年人群的慢性病患病情

Ma, W. J., Tong, Y., Wang, Y. F., et al. Research on the association between health-related behaviors and chronic disease comorbidity among the elderly liv-

ing alone in China [J]. *Modern Preventive Medicine*, 2024, 51(7): 1277-1283.

Research on the Association Between Health-Related Behaviors and Chronic Disease Comorbidity Among the Elderly Living Alone in China

Abstract

As the aging population in China intensifies, the health status of elderly individuals living alone has become a critical public health concern. This study investigates the prevalence of chronic disease comorbidity among this demographic and analyzes the specific health-related behaviors that influence these outcomes. By utilizing large-scale survey data, we explore the complex interplay between lifestyle factors—such as physical activity, dietary habits, smoking, and alcohol consumption—and the accumulation of multiple chronic conditions. Our findings aim to provide a scientific basis for targeted interventions and policy-making to improve the quality of life for the solitary elderly population.

1. Introduction

The demographic transition in China is characterized by a rapid increase in the proportion of elderly citizens, accompanied by a rising trend in "empty nest" households and individuals living alone. Chronic disease comorbidity, defined as the coexistence of two or more chronic conditions in a single individual, poses a significant challenge to the healthcare system due to increased clinical complexity and healthcare costs. For the elderly living alone, the lack of immediate social support may exacerbate the risks associated with poor health behaviors. Understanding the correlation between these behaviors and comorbidity is essential for developing effective preventive strategies.

2. Methods

This study utilizes data from a national longitudinal survey. The sample focuses specifically on individuals aged 60 and above who report living alone. Chronic disease status was determined through self-reported medical diagnoses of common conditions, including hypertension, diabetes, cardiovascular diseases, and chronic respiratory diseases. Health-related behaviors were categorized into several dimensions: smoking status, alcohol consumption, physical exercise frequency, and sleep duration. Statistical analyses, including multivariable logistic regression, were employed to identify the associations between these behaviors and the presence of chronic disease comorbidity.

3. Results

The analysis reveals a high prevalence of chronic disease comorbidity among the elderly living alone in China. Preliminary data suggest that a significant percentage of this population suffers from at least two chronic conditions.

The results indicate that certain health-related

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Association between self-rated health and risks of all-cause and cardiovascular disease mortality among adults in 10 regions of China

Dong Wenhong, Wu Jing, Yu Canqing, et al. Association between self-rated health and risks of all-cause and cardiovascular disease mortality among adults in 10 regions of China [J]. Chinese Journal of Epidemiology, 2021, 42(5): 763-770.

Abstract

Objective: To investigate the association between self-rated health (SRH) and the risk of all-cause mortality and cardiovascular disease (CVD) mortality among adults in 10 regions of China.

Methods: This study utilized data from the China Kadoorie Biobank (CKB). After excluding participants with a history of heart disease, stroke, or cancer at baseline, a total of 487,198 participants were included in the analysis. SRH was categorized into four levels: "excellent," "good," "fair," and "poor." Cox proportional hazards regression models were employed to estimate the hazard ratios (HR) and 95% confidence intervals (CI) for the association between SRH and mortality risks.

Results: During a median follow-up period of 10 years, 33,846 deaths were recorded, including 12,963 deaths from CVD. After adjusting for age, sex, region, socioeconomic status, and lifestyle factors, compared to those reporting "excellent" health, the HRs (95% CI) for all-cause mortality were 1.10 (1.05-1.15) for "good," 1.34 (1.28-1.40) for "fair," and 1.88 (1.78-1.98) for "poor" health ($P_{trend} < 0.001$). For CVD mortality, the corresponding HRs (95% CI) were 1.13 (1.05-1.22), 1.45 (1.35-1.56), and 2.15 (1.98-2.34), respectively ($P_{trend} < 0.001$). These associations remained statistically significant even after further adjustment for baseline physical health indicators (such as hypertension and diabetes) and

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Figures

Figure 7

Figure 11: Figure 7