Influencing Factors of Chronic Disease Multimorbidity among Middle-aged and Elderly Adults in Ningxia Based on Social Determinants of Health: Postprint

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Date: 2023-10-24T00:00:00+00:00

Abstract

Background The population aging process is accelerating, and health issues among middle-aged and elderly individuals are becoming increasingly prominent. Chronic disease multimorbidity seriously threatens the health and quality of life of middle-aged and elderly populations, hindering the progress of the Healthy China Initiative. Investigating its relationship with social determinants of health has positive significance. Objective To understand the status of chronic disease multimorbidity and social determinants of health among middle-aged and elderly people in Ningxia, analyze the association between social determinants of health and chronic disease multimorbidity in this population, and provide references for health management and intervention strategies for middle-aged and elderly patients with chronic disease multimorbidity. Methods Using a multi-stage stratified random sampling method, health-related data were collected from 1,997 middle-aged and elderly individuals in 10 districts/counties of Shizuishan, Yinchuan, and Guyuan cities in Ningxia between June 27, 2022 and August 27, 2022. The Apriori algorithm was applied to analyze multimorbidity patterns among middle-aged and elderly people in the Ningxia region, and unconditional logistic regression analysis was used to explore the association between chronic disease multimorbidity and social determinants of health in this population. Results Among middle-aged and elderly people in the Ningxia region, 418 individuals had multimorbidity, with a chronic disease multimorbidity rate of 20.9%. The association rule results showed 14 multimorbidity patterns, of which 11 were related to coronary heart disease, 9 were related to hypertension, and 9 were related to diabetes. The unconditional logistic regression analysis results indicated that middle-aged and elderly individuals aged $ $60 years, with 2–3 children, with established family health records, with retired or unemployed work status, and with resident pension insurance had higher rates of chronic

disease multimorbidity (P<0.05). Those with nighttime sleep duration of 7–8 hours and >8 hours, and with college-level education or above had lower rates of chronic disease multimorbidity (P<0.05). Conclusion The influencing factors of chronic disease multimorbidity among middle-aged and elderly individuals involve various aspects at the individual, community, and societal levels. It is recommended to intervene with chronic disease multimorbidity patients from multiple dimensions to improve population health levels.

Full Text

Preamble

Influencing Factors of Chronic Comorbidities among Middle-aged and Elderly People in Ningxia based on Social Determinants of Health

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Abstract

Background: With the acceleration of population aging, the health problems of middle-aged and elderly people have become increasingly prominent. Chronic comorbidities seriously threaten the health and quality of life of middle-aged and elderly individuals, hindering the progress of the Healthy China Initiative. Exploring the relationship between chronic comorbidities and social determinants of health is of positive significance.

Objective: To understand the prevalence of chronic comorbidities and the status of social determinants of health among middle-aged and elderly people in Ningxia, and to analyze the association between social determinants of health and chronic comorbidities, so as to provide reference for health management and intervention strategies for this population.

Methods: A multi-stage stratified random sampling method was used to investigate health-related data from 1,997 middle-aged and elderly individuals in 10 districts/counties of Shizuishan City, Yinchuan City, and Guyuan City in Ningxia from June 27, 2022, to August 27, 2022. The Apriori algorithm was applied to analyze comorbidity patterns, and unconditional Logistic regression analysis was used to explore the association between chronic comorbidities and social determinants of health.

Results: Among the participants, 418 individuals had chronic comorbidities, yielding a prevalence rate of 20.9%. Association rule analysis identified 14 comorbidity patterns, of which 11 were related to coronary heart disease, 9 to hypertension, and 9 to diabetes. Unconditional Logistic regression analysis revealed that age $ $60 years, having 2-3 children, established family health records, retired or unemployed status, and resident pension insurance were associated with

higher rates of chronic comorbidities (P<0.05). In contrast, nighttime sleep duration of 7-8 hours or >8 hours, and education level of college or above were associated with lower rates of chronic comorbidities (P<0.05).

Conclusion: The influencing factors of chronic comorbidities among middle-aged and elderly people involve individual, community, and social dimensions. Multidimensional interventions for patients with chronic comorbidities are recommended to improve population health.

Keywords: Multiple chronic conditions; Middle-aged and elderly people; Social determinants of health; Association rules; Root cause analysis

Funding: Ningxia Natural Science Foundation Project (2022AAC03212)

Citation: MA C F, TANG R, YANG X H, et al. Influencing factors of chronic comorbidities among middle-aged and elderly people in Ningxia based on social determinants of health[J]. Chinese General Practice, 2024. [Epub ahead of print].

Introduction

The "Healthy China 2030" Planning Outline indicates that deaths due to chronic diseases already account for 85% of total mortality, making chronic disease management the primary task for improving national health[1]. Due to their complex etiology, insidious onset, long course, and low cure rates, chronic diseases often lead to patients suffering from multiple conditions simultaneously[2]. The WHO defines this as chronic comorbidity—an individual having two or more chronic non-communicable diseases[3]. Studies show that over one-quarter of Singapore' s population has chronic comorbidities, with 50% among those aged 60 and above[4]. By 2020, 157 million people in the United States had one or more chronic diseases[5]. In the UK, the chronic comorbidity rate was 54% in 2015, projected to increase to 67.8% by 2035[6]. In China, approximately 180 million elderly people have chronic diseases, with over one-third having two or more chronic conditions[7-8].

Chronic comorbidities have seriously impacted population health and hindered the progress of the Healthy China Initiative. In the 1940s, the WHO proposed that "health is a state of complete physical, mental, and social well-being," laying the ideological foundation for the Social Determinants of Health (SDH) theory. SDH represents the root causes determining people' s health and disease, encompassing all social environmental characteristics from birth, growth, living, working to aging[9]. Galea et al.[10] believe that SDH is inextricably linked to human health outcomes. Based on this, our study examines the influencing factors and patterns of chronic comorbidities from an SDH perspective, aiming to

provide reference for health management and intervention measures for patients with chronic comorbidities.

Methods

Data Source

This study utilized data from the Ningxia Natural Science Foundation Project—"Research on the Impact Mechanism of Disease Economic Burden and Economic Risk for Chronic Disease Residents" (2022AAC03212). A multi-stage stratified random sampling method was employed to conduct questionnaire surveys in 10 districts/counties of Shizuishan City, Yinchuan City, and Guyuan City in Ningxia from June 27, 2022, to August 27, 2022. The sample size was calculated using the formula: $n = Z\alpha^2 \times p(1\text{-}p)/d^2 \times deff$, where α=0.05, $Z\alpha$=1.96, d=5% (sampling error), and p=0.2455 (the incidence of catastrophic health expenditure in Ningxia chronic disease households in 2015[11]). The calculated total sample size was 1,710. Considering potential invalid questionnaires, 2,000 questionnaires were distributed, yielding 1,997 valid questionnaires (99.85% response rate).

Inclusion criteria: (1) age $ $45 years; (2) local residence $ $6 months; (3) no understanding or communication barriers; (4) signed informed consent and voluntary participation. After systematic review, 12 chronic diseases were included: hypertension, diabetes, coronary heart disease, hyperlipidemia, liver disease, stroke, arthritis or rheumatism, malignant tumor, chronic obstructive pulmonary disease, stomach or digestive system disease, lumbar spine disease, and memory-related diseases. This study was approved by the Ningxia Medical University Ethics Review Committee (Ethics No. 2021-1397).

Variables

Dependent variable: The occurrence of chronic comorbidities was included as the dependent variable. Non-comorbid patients were assigned a value of 0, and comorbid patients were assigned a value of 1. Individuals with $ $2 chronic diseases were defined as having chronic comorbidities; those with only one or no chronic disease were defined as non-comorbid.

Independent variables: Based on the SDH model, five dimensions were established. The first dimension represents individual genetics, with variables including sex and age. The second dimension represents individual behavior and lifestyle, including smoking status, alcohol consumption, nap duration, nighttime sleep duration, and weekly exercise frequency. The third dimension represents social and community influences, including number of children, marital status, and whether a health record was established. The fourth dimension represents social structural factors, including average monthly household income, education level, living situation, employment status, and residential area. The

fifth dimension represents macro socioeconomic, cultural, and environmental factors, with pension insurance type as the variable.

Following WHO definitions, 45-59 years was defined as middle-aged and $ $60 years as elderly. Based on self-reported times and WHO recommendations for optimal nap and nighttime sleep duration, nap time was categorized as <30 min, 30-60 min, and >60 min, while nighttime sleep duration was categorized as <7 h, 7-8 h, and >8 h[12-13].

Statistical Analysis

Data were processed using Microsoft Excel and imported into SPSS 25.0 for analysis. Normally distributed measurement data were expressed as ($\bar{x}\pm s$), and count data were expressed as percentages. Inter-group comparisons used ^{2} tests or Fisher' s exact test. Unconditional Logistic regression analysis was used to explore the relationship between SDH and chronic comorbidities among middle-aged and elderly people in Ningxia, with $P<0.05$ considered statistically significant. The Hosmer-Lemeshow goodness-of-fit test was used to assess model fit. The Apriori algorithm was applied to analyze comorbidity patterns among middle-aged and elderly people in Ningxia. The Apriori algorithm uses prior knowledge of frequent itemset properties and a layer-by-layer search iteration method to explore (K+1)-itemsets using K-itemsets, exhaustively identifying all frequent itemsets in the dataset and reflecting associations between different items. Support, confidence, and lift are commonly used metrics[14]:

- **Support:** Support(A→B) = Num(A B)/W = P(A B), representing the probability of A and B occurring simultaneously in database W. Higher support indicates more important association rules.
- **Confidence:** Confidence(A→B) = Support(A→B)/Support(A) = P(B|A), representing the proportion of cases where A and B occur simultaneously among cases where only A occurs. Higher confidence indicates more credible association rules.
- **Lift:** Lift(A→B) = P(B|A)/P(B), representing the ratio of the conditional probability of B occurring given A to the unconditional probability of B. Lift reflects the correlation between A and B in the association rule; when lift >1 and higher, it indicates stronger positive correlation of A→B.

Results

Basic Characteristics of Middle-aged and Elderly People in Ningxia

Among the 1,997 included participants, 418 had chronic comorbidities, yielding a prevalence rate of 20.9%, while 1,579 did not have comorbidities. The sample included 989 males, of whom 205 (20.7%) had chronic comorbidities with a mean age of $67.09\$\pm 9.88 years, and 784 (79.3\pm 10.58 years. Among 1,008 females, 213 (21.1\pm 9.43 years, and 795 (78.9\pm 10$

$59 agegroup (n = 883), 91 (10.3 \pm 4.68 years, while 792 (89.7 \pm \$4.45$ years. In the $\$ 60 agegroup (n = 1,114), 327 (29.4 \pm 6.78 years, while 787 (70.6 \pm \$6.90$ years.

Comparison of Chronic Disease Prevalence Across Different Characteristics

Significant differences were found in the distribution of chronic disease prevalence across age groups, sex, smoking status, alcohol consumption, nap duration, nighttime sleep duration, weekly exercise frequency, number of children, marital status, health record establishment, average monthly income, education level, and living situation ($P<0.05$). No significant differences were observed in chronic disease distribution across residential areas or pension insurance types ($P>0.05$). See Table 1 .

Common Comorbidity Patterns and Association Analysis Among Elderly People in Ningxia

Based on previous research, support was set at 1.0%, minimum confidence at 50%, and lift at 1[15]. Fourteen association rules were identified, including 2 binary patterns, 6 ternary patterns, and 6 quaternary patterns. Eleven rules were related to coronary heart disease, 9 to hypertension, and 9 to diabetes. See Table 2 .

The top 3 association rules by support were: (1) hypertension and diabetes; (2) hypertension, hyperlipidemia, and coronary heart disease; (3) coronary heart disease, stroke, arthritis or rheumatism, and hypertension. The top 3 by confidence were: (1) hypertension, stroke, arthritis or rheumatism, and coronary heart disease; (2) hypertension, arthritis or rheumatism, diabetes, and coronary heart disease; (3) hypertension, hyperlipidemia, and coronary heart disease. The top 3 by lift were: (1) diabetes, liver disease, coronary heart disease, and hypertension; (2) coronary heart disease, liver disease, diabetes, and hypertension; (3) arthritis or rheumatism and memory-related diseases.

Association Analysis Between SDH and Chronic Comorbidities Among Middle-aged and Elderly People in Ningxia

Using comorbidity status as the dependent variable (assignment: 1=yes, 0=no) and the included variables as independent variables, unconditional Logistic regression analysis was performed. The Hosmer-Lemeshow test yielded P=0.305, indicating good model fit and reference value. Results showed that age $ $60 years, having 2-3 children, established family health records, retired or unemployed status, and resident pension insurance were associated with higher chronic comorbidity rates ($P<0.05$), while nighttime sleep duration of 7-8 hours or >8 hours, and college-level or higher education were associated with lower chronic comorbidity rates ($P<0.05$). See Table 3 .

Discussion

Chronic comorbidities have become a major public health problem affecting the health of elderly populations in China, with a trend toward younger onset. Preventing chronic comorbidities and promoting health among middle-aged and elderly people is particularly important. Our association rule analysis revealed complex comorbidity patterns, with most involving coronary heart disease, hypertension, and diabetes. Coronary heart disease was the most frequent condition in these patterns, followed by hypertension and diabetes. This differs slightly from He et al.[16], who found most patterns involved hypertension, coronary heart disease, and asthma, with hypertension being most frequent. Therefore, in chronic disease prevention and management, blood pressure monitoring should be combined with attention to cardiac function and blood glucose to reduce risk factors for coronary heart disease, hypertension, and diabetes. Health management should also focus on patients with these conditions, implementing early management and intervention to prevent comorbidity development. Standardized management protocols should be developed for both single chronic diseases and different comorbidity patterns to meet health management needs, enabling early detection, diagnosis, and treatment to prevent adverse consequences[17].

Regarding individual genetic factors, age $ $60 years was a significant risk factor for chronic comorbidities (OR=2.644), consistent with Qi et al.[18]. This may be because chronic diseases have long courses and complex etiologies requiring prolonged accumulation, making older individuals with declining physiological function and weaker resistance more susceptible to multiple conditions.

In terms of individual behavior and lifestyle, middle-aged and elderly people with nighttime sleep duration of 7-8 hours or >8 hours had lower comorbidity risk. Research shows that sleep disorders are associated with poorer health status[19-21]. Sleep is a fundamental physiological need, and sleep disorders affect physical, mental, and emotional well-being, reducing quality of life. Our finding that 7-8 hours or more of sleep is protective suggests that maintaining adequate sleep is an effective preventive measure against chronic comorbidities.

At the social and community level, having 2-3 children and established health records were associated with higher comorbidity rates. Previous studies indicate that increased number of children has significant negative effects on elderly health, with poor health outcomes resulting not only from aging but also from insufficient emotional support and overwork[22]. In rural areas, middle-aged and elderly individuals generally have lower education levels and inadequate postpartum care, leading to varying degrees of physical and psychological damage with increased childbirth[23]. The association between established family health records and higher comorbidity may reflect that individuals with records pay more attention to health monitoring and thus have better awareness of their chronic disease status.

Regarding social structural factors, college-level or higher education was asso-

ciated with lower comorbidity rates, consistent with Liu et al.[24]. Higher education is associated with lower chronic disease risk, likely due to better health literacy and self-care awareness[25-26]. Our study also found that retired or unemployed status was associated with higher comorbidity rates. Research shows that good social support is protective for quality of life and promotes mental and physical health[27]. Unemployed and retired elderly individuals are more prone to negative emotions such as loneliness and helplessness, harming physical and mental health.

At the macro socioeconomic, cultural, and environmental level, resident pension insurance was associated with higher comorbidity rates. This may be because resident pension insurance covers urban and rural residents who are not state organ or public institution employees and are not covered by employee basic pension insurance[28]. This population generally has lower education and income levels, poorer quality of life compared to those with employee or commercial medical insurance, leading to poorer health status and increased chronic comorbidity risk.

Chronic comorbidities reduce quality of life, increase treatment difficulty, and impose heavier economic burdens. Therefore, understanding not only pathogenic factors but also individual health-related behaviors and other factors is essential. From an SDH perspective, this study multidimensionally explored factors influencing chronic comorbidity rates among middle-aged and elderly people, proposing targeted interventions based on different dimensions to provide insights for health management and reduce comorbidity incidence. However, this study included limited variables; future research should more comprehensively examine influencing factors to provide a more solid scientific basis for chronic comorbidity prevention and control.

Author Contributions: MA Chunfang was responsible for study conception and design, statistical analysis, and drafting the manuscript. YANG Xiaohua and LI Yue participated in manuscript revision. TANG Rong was responsible for quality control and overall accountability.

Conflict of Interest: None declared.

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References

[1] WANG Longde. Opportunities and challenges of "Healthy China 2030" [J]. Science and Technology Review, 2018, 36(22): 8-11.

[2] YAN Zeyu, CHEN Dafang. Research progress on chronic disease comorbidity patterns[J]. Chinese Journal of Disease Control, 2023, 27(4): 471-475. DOI:

10.16462/j.cnki.zhjbkz.2023.04.017.

[3] ZHAO Y, ATUN R, OLDENBURG B, et al. Physical multimorbidity, health service use, and catastrophic health expenditure by socioeconomic groups in China: an analysis of population-based panel data[J]. Lancet Glob Health, 2020, 8(6): e840-849. DOI: 10.1016/S2214-109X(20)30127-3.

[4] LOW L L, KWAN Y H, KO M S M, et al. Epidemiologic characteristics of multimorbidity and sociodemographic factors associated with multimorbidity in a rapidly aging Asian country[J]. JAMA Netw Open, 2019, 2(11): e1915245. DOI: 10.1001/jamanetworkopen.2019.15245.

[5] KING D E, XIANG J, PILKERTON C S. Multimorbidity trends in United States adults, 1988-2014[J]. J Am Board Fam Med, 2018, 31(4): 503-513. DOI: 10.3122/jabfm.2018.04.180008.

[6] KINGSTON A, ROBINSON L, BOOTH H, et al. Projections of multi-morbidity in the older population in England to 2035: estimates from the Population Ageing and Care Simulation (PACSim) model[J]. Age Ageing, 2018, 47(3): 374-380. DOI: 10.1093/ageing/afx201.

[7] FAN Li, ZOU Xiao. The significance of chronic disease management and preventive care for the elderly in China[J]. Chinese Journal of Clinical Healthcare, 2020, 23(2): 145-147. DOI: 10.3969/J.issn.1672-6790.2020.02.001.

[8] WANG Limin, CHEN Zhihua, ZHANG Mei, et al. Study on the prevalence and disease burden of chronic diseases among the elderly population in China[J]. Chinese Journal of Epidemiology, 2019, 40(3): 277-283. DOI: 10.3760/cma.j.issn.0254-6450.2019.03.005.

[9] GOLDSTEIN S P, TOVAR A, ESPEL-HUYNH H M, et al. Applying a social determinants of health framework to guide digital innovations that reduce disparities in chronic disease[J]. Psychosom Med, 2023, 85(7): 659-669. DOI: 10.1097/PSY.0000000000001176.

[10] GALEA S, FACTOR S H, PALERMO A G, et al. Access to resources for substance users in Harlem, New York City: service provider and client perspectives[J]. Heath Educ Behav, 2002, 29(3): 296-311. DOI: 10.1177/109019810202900303.

[11] LI Qin, YANG Biao, CHEN Yanan, et al. Analysis of chronic disease prevalence and equity among middle-aged and elderly people in Yanchi County, Ningxia[J]. Modern Preventive Medicine, 2019, 46(15): 2776-2779, 2794.

[12] YOKOYAMA E, KANEITA Y, SAITO Y, et al. Association between depression and insomnia subtypes: a longitudinal study on the elderly in Japan[J]. Sleep, 2010, 33(12): 1693-1702. DOI: 10.1093/sleep/33.12.1693.

[13] WU Yiting. Seven hours of daily sleep can promote physical and mental health in middle-aged and elderly people—Fudan research team reveals for the

first time the genetic neural mechanism of optimal sleep duration in middle-aged and elderly people[N]. Shanghai Science and Technology News, 2022-05-06(4).

[14] GUAN Peixia, LI Zhiqiang, MAO Qian, et al. Association analysis between fatty liver and five chronic metabolic diseases based on association rules[J]. Modern Preventive Medicine, 2021, 48(17): 3242-3246, 3253.

[15] XU Xiaobing, LI Di, SUN Yang, et al. Analysis of chronic disease comorbidities among Chinese elderly based on association rules[J]. Chinese Journal of Prevention and Control of Chronic Diseases, 2021, 29(11): 808-812. DOI: 10.16386/j.cjpccd.issn.1004-6194.2021.11.002.

[16] HE Yuzheng, YU Jiqing, ZHENG Jianzhong, et al. Association analysis between health promotion behaviors and chronic disease comorbidities among elderly people in Ningxia[J/OL]. Chinese General Practice, 2023: 1-9. (2023-01-31). https://kns.cnki.net/kcms/detail/13.1222.R.20230130.1519.007.html.

[17] GENG Ye, JIE Wan, ZHANG Sijia, et al. Research progress on the epidemiological status and prevention of chronic disease comorbidities[J]. Chinese Journal of Prevention and Control of Chronic Diseases, 2023, 31(1): 71-75. DOI: 10.16386/j.cjpccd.issn.1004-6194.2023.01.016.

[18] QI Yuantao, LIU Yan, DU Jin, et al. Study on influencing factors of chronic disease comorbidities among Chinese elderly based on the health ecology model[J]. Chinese General Practice, 2023, 26(1): 50-57. DOI: 10.12114/j.issn.1007-9572.2022.0458.

[19] YOU Xiaomei, SUN Yulian, ZHANG Huiyin. Analysis of causes and nursing interventions for sleep disorders in elderly diabetic patients[J]. China Medical Guide, 2022, 20(36): 136-138. DOI: 10.15912/j.cnki.gocm.2022.36.022.

[20] YU Liya, PENG Lei, LUO Ting, et al. Study on the relationship between sleep disorders and EEG activity, neuropsychological indicators, and health-related quality of life in Parkinson' s disease patients[J]. Modern Biomedical Progress, 2022, 22(20): 3863-3867. DOI: 10.13241/j.cnki.pmb.2022.20.012.

[21] HUANG Xin, LI Suning, YIN Junxiang, et al. Current status and recommendations for sleep disorder prevention and control research in China[J]. Journal of Sichuan University: Medical Science Edition, 2023, 54(2): 226-230.

[22] SONG Jiawen, JING Zaifang. Main impact of number of children on mental health of middle-aged and elderly people in rural families—deep analysis of the "three-child" policy and farmers' fertility intentions[J]. Journal of Shenyang Agricultural University: Social Science Edition, 2022, 24(4): 397-404.

[23] TAN Lei, WANG Nan, LIU Lu. Analysis of the promoting effect of postpartum health care on maternal physical and psychological recovery[J]. Psychological Month, 2022, 17(23): 93-95. DOI: 10.19738/j.cnki.psy.2022.23.028.

[24] LIU Beibei, TIAN Qingfeng, GUO Jinling. Analysis of the prevalence status and comorbidity patterns of chronic diseases among middle-aged and

elderly people in China[J]. Medicine and Society, 2022, 35(8): 58-61, 66. DOI: 10.13723/j.yxysh.2022.08.011.

[25] FU Xin' ai, TANG Meiling. Effect of solution-focused approach on elderly hypertensive patients with low education levels in primary care[J]. Psychological Month, 2022, 17(15): 133-135. DOI: 10.19738/j.cnki.psy.2022.15.043.

[26] NAN Lin, ZOU Yuanwu, SHI Erli, et al. Analysis of the prevalence status and influencing factors of chronic diseases among residents in Ali Prefecture, Tibet in 2021[J]. Journal of Xi' an Jiaotong University: Medical Science, 2023, 44(2): 300-308. DOI: 10.7652/jdyxb202302023.

[27] HE Jia. A comparative study on mental health status of re-employed and non-employed elderly in Xi' an[D]. Yan' an: Yan' an University, 2020.

[28] LIU Jianing. Brief analysis of the development of China' s pension insurance system[J]. Cooperative Economy and Science, 2023(1): 173-175. DOI: 10.13665/j.cnki.hzjjykj.2023.01.047.

(Received: May 9, 2023; Revised: October 6, 2023) (Edited by: WANG Shiyue)

Note: Figure translations are in progress. See original paper for figures.