Health Poverty Vulnerability and Its Influencing Factors among Rural Residents with Chronic Diseases in Ningxia Hui Autonomous Region in the Post-Poverty Alleviation Era: A Postprint

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Abstract

Background In the post-poverty-alleviation era, in-depth study of health poverty vulnerability among chronic disease patients helps to effectively prevent the recurrence and onset of poverty due to illness from the source. Objective To understand the health poverty vulnerability and its influencing factors among rural chronic disease patients in Ningxia Hui Autonomous Region, and to provide theoretical support and recommendations for formulating more precise and effective health support policies and strategies. Methods From June to July 2022, using a multi-stage stratified cluster random sampling method, survey subjects were selected from four counties in Ningxia Hui Autonomous Region (Yanchi, Haiyuan, Xiji, and Pengyang). The questionnaire was designed by the research team based on literature review and expert consultation, covering residents'demographic characteristics, health status and behaviors, medical security conditions, and household and economic situations. A three-stage Feasible Generalized Least Squares (FGLS) method was used to calculate the health poverty vulnerability index for chronic disease patients, binary Logistic regression was utilized to explore the influencing factors of health poverty vulnerability among chronic disease patients, and Shapley value decomposition was employed to quantify the contribution degree of each influencing factor. Results A total of 4,778 chronic disease patients were ultimately included. Based on the calculated health poverty vulnerability index, a value >0.5 was defined as health poverty vulnerability. The subjects were divided into a health poverty vulnerability group (n=253) and a non-health poverty vulnerability group (n=4,525). Logit regression analysis results showed that age, and most recent healthcare visit at township or county hospitals were risk factors for health poverty vulnerability among chronic disease patients (P<0.05); education level of primary or junior high school, self-rated health status as fair or healthy, longer disease du-

ration, conscious exercise frequency of 6 times or more per week, participation in urban-rural integrated basic medical insurance or urban employee medical insurance, and catastrophic health expenditure were protective factors against health poverty vulnerability (P<0.05). Shapley value decomposition results indicated that individual characteristics contributed the most (43.51%), followed by health status (21.26%) and disease burden (18.81%). Conclusion The health poverty vulnerability of chronic disease patients in Ningxia is at a relatively high level nationwide. Age, catastrophic health expenditure, self-rated health status, weekly conscious exercise frequency, education level, and longest disease duration are key factors influencing health poverty vulnerability among chronic disease patients in Ningxia. The government needs to continuously increase investment, strengthen health education, and carry out health promotion actions; improve the medical service system for chronic disease patients, and strengthen the construction of the medical security system; and medical institutions at all levels should collaborate to build a health poverty vulnerability early warning platform.

Full Text

Study on the Health Poverty Vulnerability and Its Influencing Factors Among Rural Residents with Chronic Diseases in Ningxia Hui Autonomous Region in the Post-Poverty Alleviation Era

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Abstract

Background: In the post-poverty alleviation era, in-depth research on the health poverty vulnerability of chronic disease patients can help effectively prevent the recurrence of poverty or new poverty caused by illness at its root. **Objective**: To understand the health poverty vulnerability and its influencing factors among rural residents with chronic diseases in Ningxia Hui Autonomous Region, and to provide theoretical support and practical suggestions for formulating more precise and effective health support policies and strategies. **Methods**: From June to July 2022, participants were selected from four counties (Yanchi, Haiyuan, Xiji, and Pengyang) in Ningxia using a multistage stratified

cluster random sampling method. The questionnaire, designed based on literature research and expert consultation, covered demographic characteristics, health status and behaviors, medical security, and family economic conditions. The health poverty vulnerability index for chronic disease patients was calculated using the three-stage feasible generalized least squares (FGLS) method. Binary logistic regression was employed to explore influencing factors, and Shapley value decomposition was used to quantify the contribution of each factor. **Results**: A total of 4,778 chronic disease patients were included. Using a threshold of health poverty vulnerability index > 0.5, 253 were classified into the health poverty vulnerable group and 4,525 into the non-vulnerable group. Logit regression showed that age and seeking care at township health centers or county hospitals were risk factors for health poverty vulnerability ($P<0.05$). Protective factors included primary or junior high school education, self-rated general or good health, longer disease duration, 6 conscious exercise sessions per week, participation in urban-rural integrated basic medical insurance or employee medical insurance, and risk-based health expenditures ($P<0.05$). Shapley value decomposition indicated that individual characteristics contributed the most (43.51%), followed by health status (21.26%) and disease burden (18.81%). **Conclusion**: The health poverty vulnerability of chronic disease patients in Ningxia remains relatively high nationwide. Key factors include age, catastrophic health expenditure, self-rated health, weekly exercise frequency, education level, and disease duration. Governments should increase investments, strengthen health education and promotion campaigns, improve medical service systems and healthcare security mechanisms for chronic disease patients, and foster cross-sector collaboration to establish an early warning platform for health poverty vulnerability.

Keywords: Chronic disease; Health poverty vulnerability; Root cause analysis; Rural residents

Introduction

With China' s comprehensive victory in the poverty alleviation campaign, the nation has officially entered the post-poverty alleviation era. In this new period, consolidating poverty alleviation achievements and preventing relapse into poverty are particularly crucial. Examining the history of poverty alleviation efforts in rural areas from the perspective of health and poverty governance reveals that previous approaches primarily focused on static, ex-post measurements of health poverty status, with corresponding remedial measures. However, as rural residents enter a new stage of relative poverty governance and as rural health poverty issues continue to evolve dynamically, this static, ex-post concept of health poverty can no longer match the practical needs of prevention and governance. Consequently, scholars have extended the concept of poverty vulnerability to health poverty vulnerability, which refers to the likelihood that individuals, groups, or organizations will fall into low welfare levels after suffering from health risk factors. This dynamic concept can reflect the probability

of future health poverty and enables dynamic management of health risks while providing strong support for real-time adjustments to anti-poverty policies.

Currently, the prevalence of chronic diseases in China continues to rise, accounting for 89.32% of total deaths. Research indicates that medical expenditures related to chronic diseases occupy a substantial proportion of overall healthcare costs, with four major chronic diseases accounting for over 90% of medical insurance fund expenditures. Studying health poverty vulnerability among chronic disease patients helps accurately identify high-risk families or individuals, enabling the formulation of more precise and effective health support policies and measures while facilitating the construction of a more comprehensive health security system to effectively prevent poverty caused by illness. To more accurately reflect the health poverty issues faced by chronic disease patients in Ningxia, this study focuses on field survey data from 2022 in the southern mountainous region of Ningxia. The unique geographical environment, socioeconomic conditions, and distribution of medical resources in this region make the health poverty problems of chronic disease patients particularly distinctive and complex. Through this research, we aim to provide solid theoretical support and practical recommendations for developing more targeted health support policies and strategies, ultimately contributing to the continuous improvement of health status and quality of life for chronic disease patients in Ningxia and supporting the strategic goals of building a healthy Ningxia and implementing rural revitalization.

Methods

Study Subjects

The study data were derived from a field questionnaire survey conducted in June-July 2022 for a National Natural Science Foundation project, which surveyed 20,821 rural residents. This study selected chronic disease patients from this sample, ultimately including 4,778 chronic disease patients after excluding samples with missing or unclear key variables. Inclusion criteria for chronic disease patients were: (1) diagnosed with chronic disease for more than six months according to diagnostic criteria; (2) aged 18 years and having resided locally for at least one year; (3) possessing adequate communication and comprehension abilities and willing to cooperate with the survey. Exclusion criteria were: (1) unwillingness to cooperate or difficulty with communication; (2) having mental illness or consciousness disorders.

Survey Methods

From June to July 2022, participants were selected using a multistage stratified cluster random sampling method. Based on economic development levels, all administrative villages in townships across the four counties of Yanchi, Haiyuan, Xiji, and Pengyang were stratified into three layers (good, medium, poor). Sample villages were randomly selected from each layer at a 40% ratio

using a random number table. Systematic sampling was then used to select 20-33 households per village as sample households (33 households in 40 villages of Yanchi County, 33 households in 76 villages of Haiyuan County, 20 households in 58 villages of Xiji County, and 20 households in 33 villages of Pengyang County). All permanent residents (local residence 6 months) in each selected household were included as survey subjects.

The questionnaire was designed by the research team based on literature review and expert consultation. The survey was conducted through face-to-face interviews, with surveyors asking questions on-site and recording responses. Immediately after completion, surveyors checked for any missing answers before collecting the questionnaires.

Survey Content

The questionnaire covered: (1) demographic characteristics including gender, age, education level, marital status, and occupation; (2) health status and behaviors including self-rated health status, BMI, chronic disease conditions, and physical exercise; (3) medical security including insurance type, most recent medical institution visited, and whether registered as poverty-alleviation household; (4) family and economic conditions including household consumption, income, and living environment.

Health Poverty Vulnerability Measurement

This study measured health poverty vulnerability based on the Vulnerability as Expected Poverty (VEP) theory proposed by Christiaensen and Subbarao in 2002. The three-stage feasible generalized least squares (FGLS) method was used to calculate health poverty vulnerability among chronic disease patients, with the international poverty line of $3.1 per person per day (equivalent to RMB 20.9 per person per day based on 2022 exchange rates) serving as the standard threshold.

The implementation steps were as follows:

Step 1: Estimate the consumption equation. The health poverty vulnerability of individual i in period t is the probability that their consumption in period t+1 falls below the poverty line. Consumption of individual i in period t+1 can be expressed as a function of characteristic variables (Xi,t) and error terms (ei,t), with residual squares serving as an approximation of consumption variance:

$$\ln Y_{i,t+1} = X_{i,t} + e_{i,t}$$
$$i = Xi + i$$

where Yi,t+ represents consumption level of individual i in period t+1, and Xi,t represents individual or household characteristic variables including education level, self-rated health status, BMI, smoking, alcohol consumption, and risk-based health expenditures.

Step 2: Estimate the expected value and variance of future consumption logarithm:

$\hat{E}[\ln Yi|Xi] = Xi\hat{}$
$\hat{V}[\ln Yi|Xi] = \hat{}^2e,i = Xi\hat{}$

where $Xi\hat{}$ is a consistent estimator of $\hat{}^2e,i$, and $\hat{}$ and $\hat{}$ are feasible generalized least squares regression estimators. $\hat{E}$ and $\hat{V}$ represent the expected value and variance of future consumption logarithm for chronic disease patients.

Step 3: Assuming consumption logarithm follows a normal distribution, estimate health poverty vulnerability according to the standard threshold:

$\hat{}i,t = P(\ln Yi < lnl|Xi) = \phi((lnl - Xi\ ) / Xi\hat{})$

where $\hat{}i,t$ represents the probability of patients falling below the health poverty standard in period t, and lnl is the logarithm of the health poverty standard.

Variable Selection and Assignment

This study referenced the dimensions for measuring health poverty vulnerability proposed by Hu Zhaoyan and Liu Junjun, adjusting indicators according to characteristics of chronic disease patients. Variables were selected from five dimensions: personal characteristics, health status, disease prevention and control, medical security, and disease burden, based on existing database variables that might influence health poverty vulnerability among chronic disease patients in Ningxia. Variable assignments are detailed in .

Quality Control

Before the survey, a detailed training manual was developed and surveyors received centralized training. During the survey, questionnaire content was checked at three levels by surveyors, team leaders, and quality control personnel to ensure completeness and validity. After the survey, double data entry was used for questionnaire data input.

Statistical Analysis

EpiData 3.1 software was used for questionnaire entry, verification, and compilation, while Stata 17.0 software was used for statistical analysis. Non-normally distributed measurement data were described as M(P25, P75) and compared between groups using non-parametric tests. Count data were expressed as relative numbers and compared using ^{2} tests. Binary logistic regression and marginal effects analysis were used to analyze influencing factors of health poverty vulnerability among chronic disease patients. The regression-based Shapley value decomposition method was used to quantify the contribution of each influencing factor, with $P<0.05$ considered statistically significant.

Results

Basic Characteristics of Study Subjects

A total of 4,778 chronic disease patients were included, with ages ranging from 18 to 97 years (median age 61 years). The sample included 2,242 males (46.92%) and 2,536 females (53.08%). The majority were married (4,173, 86.73%), had primary school education or were illiterate (2,221 illiterate, 46.48%; 1,714 primary school, 35.87%), and worked in agriculture (3,248, 68.01%).

Univariate Analysis of Health Poverty Vulnerability by Characteristics

Based on three-stage FGLS calculations, a health poverty vulnerability index > 0.5 was defined as health poverty vulnerability, classifying 253 subjects (5.30%) into the vulnerable group and 4,525 (94.70%) into the non-vulnerable group. Significant differences between groups were observed in age, marital status, education level, self-rated health status, BMI, longest disease duration, smoking, alcohol consumption, weekly conscious exercise frequency, participation in urban-rural integrated basic medical insurance or employee medical insurance, most recent medical institution visited, out-of-pocket medical expenses in the past three months, and risk-based health expenditures ($P<0.05$). Details are shown in .

Logistic Regression Analysis

Binary logistic regression and marginal effects analysis were conducted with health poverty vulnerability (no=0, yes=1) as the dependent variable and 13 variables showing significant differences in univariate analysis as independent variables (assignment methods shown in). Logit regression results showed that age was a risk factor for health poverty vulnerability (OR=1.109, $P<0.05$). Compared with no formal education, primary school and junior high school education were protective factors (OR=0.618 and OR=0.453, $P<0.05$). Compared with poor self-rated health, general and good health status were protective factors (OR=0.507 and OR=0.252, $P<0.05$). Longer disease duration was associated with lower vulnerability (OR=0.966, $P<0.05$). Weekly conscious exercise 6 times was protective compared with no exercise (OR=0.416, $P<0.05$). Participation in urban-rural integrated basic medical insurance or employee medical insurance was a protective factor (OR=0.013, $P<0.05$). Compared with village clinics, seeking care at township health centers or county hospitals was a risk factor (OR=2.519 and OR=7.509, $P<0.05$). Risk-based health expenditure was a protective factor (OR=0.007, $P<0.05$). Results are shown in .

Marginal effects analysis showed positive coefficients for age and most recent medical institution, indicating these factors increase the probability of health poverty vulnerability. Negative coefficients were observed for primary and junior high school education, general and good self-rated health, longer disease duration, weekly exercise 6 times, and risk-based health expenditures, indicating

these factors reduce vulnerability probability.

Shapley Value Decomposition of Influencing Factors

To further explore the contribution of each factor to health poverty vulnerability among chronic disease patients, this study applied Shapley value decomposition. Results showed the explanatory power of each dimension, from highest to lowest, was: personal characteristics (43.51%), health status (21.26%), disease burden (18.81%), disease prevention and control (11.58%), and medical security (4.84%). Among specific factors, age contributed the most (32.94%), followed by risk-based health expenditure (18.81%), self-rated health status (14.66%), and weekly conscious exercise frequency (11.58%). Details are shown in [Figure 1: see original paper].

Discussion

Impact of Personal Characteristics on Health Poverty Vulnerability

Personal characteristics contributed the most to health poverty vulnerability among chronic disease patients in Ningxia, with age showing the highest contribution (32.94%) among all factors. Age positively impacted health poverty vulnerability, consistent with findings from multiple scholars. As age increases, chronic disease patients experience declining physiological functions and weakened immunity, while economic resources and labor capacity become relatively limited, increasing health poverty vulnerability risk. Education levels of primary school and junior high school were protective factors, consistent with research showing that compared with illiterate residents, those with basic education possess fundamental literacy and comprehension skills, enabling better understanding of medical advice, easier acceptance of health education, and reduced risk of disease deterioration, thereby lowering vulnerability.

Impact of Health Status on Health Poverty Vulnerability

Health status contributed the second-largest share to health poverty vulnerability, with self-rated health showing the highest contribution within this dimension. Self-rated health was a protective factor, consistent with relevant studies. Deteriorating health status not only brings physical suffering but also affects individual labor capacity and income, further exacerbating economic difficulties and creating a vicious cycle of long-term poverty. Longer disease duration was negatively correlated with health poverty vulnerability. Patients with longer disease duration experience less fear and worry about their condition, maintain better psychological states, and can actively change unhealthy lifestyle habits, strengthen self-management of chronic diseases, and improve their ability to manage health poverty vulnerability.

Impact of Disease Burden on Health Poverty Vulnerability

Within the disease burden dimension, risk-based health expenditure negatively impacted health poverty vulnerability, consistent with Xiang Qin' s research. This study found that the vulnerable group had lower risk-based health expenditures than the non-vulnerable group, suggesting that in the survey year, these households had smaller medical expenditures but higher other expenses (such as housing construction, weddings, funerals), which reduced health investment for chronic disease patients and increased vulnerability.

Impact of Disease Prevention and Control on Health Poverty Vulnerability

Within the disease prevention and control dimension, smoking and alcohol consumption did not pass significance tests, suggesting the need for larger sample sizes and control of confounding factors like age and gender to explore these relationships. Weekly conscious exercise 6 times was associated with lower health poverty vulnerability. Compared with Liu Junjun' s study, this research found that weekly exercise frequency passed significance testing, further confirming the positive impact of physical exercise on reducing vulnerability. This suggests that developing good exercise habits is crucial for delaying disease progression and reducing health poverty vulnerability.

Impact of Medical Security on Health Poverty Vulnerability

Medical security contributed the fifth-largest share to health poverty vulnerability. Compared with village clinics, chronic disease patients seeking care at township health centers and county hospitals showed higher vulnerability. Research indicates that accessibility is the primary factor affecting residents' medical choices. Chronic disease patients receive lower outpatient reimbursement rates at township and county hospitals compared with village clinics, and these facilities have more examination and treatment items that may increase medical costs, further exacerbating health poverty risk. Participation in urban-rural integrated basic medical insurance or employee medical insurance was a protective factor, as chronic disease patients require long-term treatment and management, including medication, examination, and follow-up costs. Without insurance coverage, these expenses would impose heavy financial pressure on families.

Policy Recommendations

Strengthen Health Education and Promote Health Campaigns

For chronic disease patients with low education levels, health education should emphasize the importance of daily maintenance. The government should allocate appropriate funds to conduct health promotion activities in villages, such as physical exercise check-in programs and experience sharing meetings, to help

chronic disease patients develop exercise habits and healthy lifestyles, effectively improving their quality of life, delaying disease progression, and safeguarding their health.

Improve Medical Service Systems and Strengthen Medical Security

Detailed information about reimbursement procedures and rates should be thoroughly communicated to chronic disease patients to ensure they understand and can fully utilize relevant policies. Primary healthcare institutions, as the frontline for policy implementation, must ensure effective execution to truly benefit patients. Investment in primary-level infrastructure should be increased to enhance service capacity and provide more convenient, efficient medical services. Medical security policies should be further improved to increase protection levels, reduce patients' economic burden, and ensure chronic disease patients can access comprehensive, high-quality medical security services.

Collaborate Across Healthcare Institutions to Build an Early Warning Platform

Healthcare institutions at all levels should work closely together to collect and integrate residents' health information, select appropriate poverty lines, and build a scientific and efficient health poverty vulnerability early warning platform. Such a platform can promptly identify and predict potential health risks, providing decision-making basis for relevant departments to formulate targeted health support policies and measures. Additionally, the early warning platform will strengthen information sharing and communication cooperation among healthcare institutions at all levels to jointly address health poverty challenges.

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Conflict of Interest: The authors declare no conflict of interest.

References: [1]-[28] (as listed in the original text)

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