# Health-related quality of life and its influencing factors in individuals with high cardiovascular disease risk: a cross-sectional study based on EQ-5D utility scores in Inner Mongolia, China

**Ning Cao**
Inner Mongolia Medical University
**Yunfeng Xi**
Inner Mongolia Center for Disease Control and Prevention
**Yumin Gao**
Inner Mongolia Medical University
**Hailing Li**
Inner Mongolia Medical University
**Yanchao Liu**
Inner Mongolia Medical University
**Liwei Niu**
Inner Mongolia Medical University
**Nan Zhang**
Inner Mongolia Medical University
**Hao Zhu**
Inner Mongolia Medical University
**Han Bao**
Inner Mongolia Medical University
**Liying Qiao**
Inner Mongolia Center for Disease Control and Prevention
**Tao Yan**
Inner Mongolia Medical University
**Xin Fang**
Inner Mongolia Medical University
**Xiaoqian Xu**
Inner Mongolia Medical University
**Lehui Li**
Inner Mongolia Medical University
**Yuan Xia**
Inner Mongolia Medical University

**Xiong Su**
Inner Mongolia Medical University
**Wenrui Wang**
Inner Mongolia Medical University
**Xingguang Zhang** ( zxg311@126.com )
Inner Mongolia Medical University https://orcid.org/0000-0002-3295-0890

---

**Research**

**Keywords:** Keywords Cardiovascular disease, high-risk individuals, health-related quality of life, EQ-5D, Tobit regression model

**Posted Date:** April 5th, 2021

**DOI:** https://doi.org/10.21203/rs.3.rs-386347/v1



---

## Abstract

# Background

The high risk of cardiovascular disease (CVD) being associated with impaired Health-related quality of life (HRQoL). However, few studies have assessed the HRQoL of individuals with a high risk of CVD in Inner Mongolia, or even in China. We aimed to assess health-related quality of life (HRQoL) among individuals in Inner Mongolia with a high risk of CVD and its risk factors, to provide a reference to improve HRQoL in individuals with high CVD risk.

# Methods

From 2015 to 2017, residents of six villages or communities in Inner Mongolia, selected using a multi-stage stratified cluster random sampling method, were invited to complete a questionnaire and undergo physical examination and laboratory testing. We selected participants whose predicted 10-year risk for CVD exceeded 10% as those with high CVD risk. HRQoL in individuals with high CVD risk was investigated based on the EuroQol-5 Dimension (EQ-5D) scale. The Chinese utility value integral system was used to calculate EQ-5D utility scores, and the Tobit regression model were used to analyze the influencing factors of HRQoL among individuals with high CVD risk.

# Results

Of 13,359 participants with high CVD risk, 65.63% reported no problems in any of the five dimensions; the most frequently reported difficulty was pain/discomfort. The mean utility score was 1.000 (0.869, 1.000). Tobit regression analysis showed that sex, age, education level, residence area, household income, physical activity, hypertension, and dyslipidemia were influencing factors of HRQoL.

# Conclusion

We found that female sex, older age, living in an urban area, lower education level, lower household income, and lower physical activity levels were associated with reduced HRQoL. People with a high risk of CVD should maintain their blood glucose and lipid levels within the normal range.


## Background

Cardiovascular disease (CVD) is the leading cause of morbidity and mortality worldwide. An estimated 17.9 million deaths due to CVD occurred in 2016, equivalent to 31% of all deaths[1]. CVD creates a considerable public health burden in China. There are an estimated 290 million patients with CVD in China, and the disease accounted for more than 40% of all deaths in China in 2016[2]. In 2013, the standardized mortality rate of men and women in Inner Mongolia was higher than that in China [3], and

the burden of CVD is also higher[4, 5], with disability-adjusted life-years due to stroke and ischemic heart disease in Inner Mongolia much higher than those in China in 2017.

CVD is characterized by a high disability rate and long course of disease. Therefore, health-related quality of life (HRQoL) has gained increased attention as a critical indicator in the evaluation of CVD[6]. HRQoL is a multifactorial concept that includes physical and mental health, symptoms, functional status, and overall health perception[7–9]. Studies have revealed that CVD is significantly associated with impaired HRQoL[10–13].

Some studies have focused on HRQoL among individuals with a high CVD risk. A study in eight European countries showed that patients at risk of CVD had impaired HRQoL [6]. A South Korean study found that a 10-year CVD risk exceeding 20% is an independent predictor of impaired HRQoL[14]. These results indicate that HRQoL measurement is necessary for individuals with a high CVD risk. However, few studies have assessed the HRQoL of individuals with a high risk of CVD in Inner Mongolia, or even in China. In this study, we aimed to assess HRQoL among individuals with a high risk of CVD and its risk factors in Inner Mongolia using the EuroQol-5 Dimension (EQ-5D) scale, to provide a reference for improving HRQoL among individuals with high CVD risk and in primary prevention of CVD.

# Methods

### Study participants

From 2015 to 2017, residents living in six villages or communities in Inner Mongolia, selected using a multi-stage stratified cluster random sampling method, were invited to complete a questionnaire and to undergo physical examination and laboratory testing, which have been described previously[15]. Briefly, the sampling process was stratified according to socioeconomic status, geographic region, and urbanization. In the first sampling, we selected cities from different geographic regions. The next stage was to select city districts from among the cities and rural townships from among counties. In the final stage, we selected street districts from among city districts and rural villages from among townships for the local population base. The six selected street or villages were in Hollinger County in Hohhot City, Haibowan District in Wuhai City, Zhungeer Banner in Erdos City, Aohan Banner in Chifeng City, Horqin Right Front Banner in Hinggan League, and Manzhouli in Hulunbeier City. In total, we included 70,380 permanent residents of Inner Mongolia.

The questionnaire included sociodemographic characteristics (sex, age, ethnicity, annual household income, educational level, marital status, residence area, medical insurance), lifestyle, and disease history. Physical examination and laboratory testing included measurement of blood pressure, blood glucose, lipid levels, height, weight, and waist circumference. Blood pressure was measured twice on the right upper arm using an electronic blood pressure monitor (Omron HEM-7430; Omron Corporation, Kyoto, Japan) after 5 minutes of rest, with the participant in a seated position. We took the average blood pressure value of the two readings as the final value. Blood glucose was measured by a glucose analyser (BeneCheck PD-G001-2, Taiwan, China). Blood lipid test was measured by a rapid lipid analyser

(CardioChek PA Analyzer; Polymer Technology Systems, Indianapolis, Indiana, USA). Height, weight, and waist circumference were measured with participants wearing light clothing and no shoes.

According to the questionnaire responses and results of physical examination and laboratory testing, we selected participants whose predicted 10-year risk for CVD exceeded 10% as those with a high CVD risk. This criterion was calculated based on age, sex, smoking status, systolic blood pressure, the presence of diabetes, and total cholesterol level using risk prediction charts of the Chinese Guideline for the Prevention of Cardiovascular Disease[16]. Participants were excluded if they had a history of CVD, including myocardial infarction, percutaneous coronary intervention, coronary artery bypass grafting, or stroke. Finally, 13,359 participants with a high risk of CVD were included in the study.

### Measurement of health-related quality of life (HRQoL)

Participants with a high CVD risk were assessed using questionnaires designed to evaluate their cardiovascular status in detail, including physical activity, dietary information, and other lifestyle factors, family history, menstrual history, and HRQoL. We used the EQ-5D scale to evaluate HRQoL. This scale is an essential tool for evaluating HRQoL with the advantages of simplicity, ease of operation, and high reliability. The EQ-5D-3L scale contains five dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression); each dimension has three levels of response or severity: no problems, some/moderate problems, and severe problems[14,7].

For this study, the EQ-5D utility scores were calculated based on the Chinese utility value integral system (Table 1)[17,18]. If all five dimensions are at the first level, this indicates a state of complete health, and the utility score is 1. If all five dimensions are at the third level, this indicates the worst state of health, and the utility score is −0.149. Therefore, the range of EQ-5D scores is −0.149 to 1.000.

Table 1. Chinese utility values for EQ-5D health states

| dimension | Mobility | Self-care | Usual activities | Pain/discomfort | Anxiety/depression |
|---|---|---|---|---|---|
| No problems | 0 | 0 | 0 | 0 | 0 |
| Some/moderate problems | 0.099 | 0.105 | 0.074 | 0.092 | 0.086 |
| Severe problems | 0.246 | 0.208 | 0.193 | 0.236 | 0.205 |
| C | 0.039 | | | | |
| N3 | 0.022 | | | | |

### Definition of covariates

The main risk factors of CVD include hypertension, diabetes, dyslipidemia, obesity, and smoking. Body mass index (BMI) was calculated as weight in kilograms divided by height (in meters) squared. Obesity

was defined as a BMI of at least 28 kg/m² and overweight as BMI 24.0–27.9 kg/m$^2$[13]. Hypertension was defined as an average systolic blood pressure of 140 mm Hg or higher, or average diastolic blood pressure of 90 mm Hg or higher, or self-reported use of antihypertensive drugs over the previous 2 weeks[19]. Diabetes was defined as fasting blood glucose of 7.0 mmol/L or higher, or self-reported diabetes, or self-reported use of a hypoglycemic agent or insulin injections in the previous 2 weeks. Dyslipidemia was described as total cholesterol of 6.2 mmol/L or higher, or low-density lipoprotein cholesterol of 4.14 mmol/L or higher, or high-density lipoprotein cholesterol of 1.0 mmol/L or lower, or triglyceride level of 2.3 mmol/L or higher, or use of lipid-lowering drugs in the previous 2 weeks[20]. Risk factors that were not under control were defined as those in which treatment goals had not been achieved (smoking, BMI ≥28, and blood pressure, blood sugar, or lipids higher than normal levels). The assigned values of each variable are shown in Table 2.

Table 2. Variable assignments

| Variables | Assignments |
|---|---|
| Sex | Male=0; Female=1 |
| Age | 35~44=0、45~54=1、55~64=2、65~75:3 |
| Ethnic group | Han people=0; Mongolian=1; The other=2 |
| Education level | Primary school=0; Middle or high school=1; College=2 |
| Occupation | Not a farmer=0; Farmer=1 |
| Marital status | Single=0; married=1 |
| Household income(￥/year) | ≤50000(￥/year)=0; >50000(￥/year)=1 |
| Medical insurance | No=0; Yes=1 |
| Smoking status | Non-smoker=0; Smoker=1 |
| BMI | Normal and thinnish=0; overweight=1; obesity=2 |
| Hypertension | No=0; Yes=1 |
| Diabetes | No=0; Yes=1 |
| Dyslipidemia | No=0; Yes=1 |
| Number of uncontrolled risk factors* | None=0; 1 uncontrolled risk factor=1;<br>2 uncontrolled risk factors=2; 3 uncontrolled risk factors=3;<br>≧4 uncontrolled risk factors=4 |

*Risk factors of cardiovascular disease include hypertension, diabetes, dyslipidemia, obesity, smoking.

BMI, body mass index.

### Statistical analysis

Descriptive statistics were used to summarize the utility scores of EQ-5D. As the utility score distribution was skewed and censored at 1, the median and 25th and 75th percentiles [$M$ ($P_{25}$, $P_{75}$)] was used. Kruskal–Wallis tests or Wilcoxon rank-sum tests were used to detect the differences in EQ-5D scores among the various subgroups. The Tobit regression model was used to assess the influencing factors of EQ-5D utility scores. Statistical analyses were performed using IBM SPSS version 25.0 (IBM Corp., Armonk, NY, US) and Stata version 16.0 (Stata Corp LLC, College Station, TX, USA). Two-sided $p<0.05$ was considered statistically significant.

## Results

### Characteristics of individuals with high CVD risk

We included 13,359 participants in Inner Mongolia with a high risk of CVD. The mean age of participants was 56.57±8.94 years, with 5,885 men (mean age 55.75 ± 9.43 years) and 7,474 women (mean age 57.22±8.48 years). Demographic and clinical characteristics of the 13,359 participants are presented in Table 3.

Table 3. Demographic characteristics of individuals with high risk of cardiovascular disease

| | Male | Female | Total | $\chi^2$ | $p$ |
|---|---|---|---|---|---|
| | *n* (%) | *n* (%) | *N* (%) | | |
| Ethnic group | | | | 3.311 | 0.191 |
| Han | 5308(90.2) | 6819(91.1) | 12118(90.7) | | |
| Mongol | 563(9.6 | 648(8.7) | 1211(9.1) | | |
| Other | 14(0.2) | 16(0.2) | 30(0.2) | | |
| Education level | | | | 958.975 | <0.001 |
| Primary school | 1759(29.9) | 4147(55.5) | 5906(44.2) | | |
| Middle or high school | 3149(53.5) | 2823(37.8) | 5972(44.7) | | |
| College | 977(16.6) | 504(6.7) | 1481(11.1) | | |
| Residence region | | | | 10.596 | 0.001 |
| Rural | 4116(69.9) | 5419(72.5) | 9535(71.4) | | |
| Urban | 1769(30.1) | 2055(27.5) | 3824(28.6) | | |
| Marital status | | | | 94.106 | <0.001 |
| Single | 232(3.9) | 600(8.0) | 832(6.2) | | |
| Married | 5653(96.1) | 6874(92.0) | 12527(93.8) | | |
| Household income | | | | 130.571 | <0.001 |
| ≤50000(￥/year) | 4952(84.1) | 6774(90.6) | 11726(87.8) | | |
| >50000(￥/year) | 933(15.9) | 700(9.4) | 1633(12.2) | | |
| Medical insurance | | | | 0.080 | 0.777 |
| No | 528(9.0) | 666(8.9) | 1194(8.9) | | |
| Yes | 5357(91.0) | 6808(91.1) | 12165(91.1) | | |
| Smoking status | | | | 3086.579 | <0.001 |
| No | 3039(51.6) | 6990(93.5) | 10029(75.1) | | |
| Yes | 2846(48.4) | 484(6.5) | 3330(24.9) | | |
| Drinking status | | | | 3163.620 | <0.001 |
| No | 3151(53.5) | 7098(95.0) | 10249(76.7) | | |
| Yes | 2734(46.5) | 376(5.0) | 3110(23.3) | | |
| Physical activity | | | | 1.301 | 0.254 |

| | | | | | |
|---|---|---|---|---|---|
| No | 4262(72.4) | 5346(71.5) | 9608(71.9) | | |
| Yes | 1623 (27.6) | 2128(28.5) | 3751(28.1) | | |
| BMI | | | | 2.084 | 0.353 |
| Normal and thinnish | 1233(21.0) | 1635(22.0) | 2868(21.5) | | |
| Overweight | 2597(44.2) | 3274(44.0) | 5871(44.1) | | |
| Obesity | 2047(34.8) | 2535(34.1) | 4582(34.4) | | |
| Hypertension | | | | 33.172 | <0.001 |
| No | 581(9.9) | 508(6.8) | 1089(8.2) | | |
| Yes | 5304(90.1) | 6966(93.2) | 12270(91.8) | | |
| Diabetes | | | | 10.605 | 0.001 |
| No | 4205(71.5) | 5529(74.0) | 9734(72.9) | | |
| Yes | 1680(28.5) | 1945(26.0) | 3625(27.1) | | |
| Dyslipidemia | | | | 4.237 | 0.040 |
| No | 2686(45.6 | 3545(47.4) | 6231(46.6) | | |
| Yes | 3199(54.4) | 3929(52.6) | 7128(53.4) | | |
| Number of uncontrolled risk factors* | | | | 813.138 | <0.001 |
| None | 138(1.0) | 325(2.4) | 463(3.5) | | |
| 1 uncontrolled risk factor | 1544(26.2) | 3357(44.9) | 4901(36.7) | | |
| 2 uncontrolled risk factors | 2644(44.9) | 2907(38.9) | 5551(41.6) | | |
| 3 uncontrolled risk factors | 1309(22.2) | 830(11.1) | 2139(16.0) | | |
| ≧4 uncontrolled risk factors | 250(4.1) | 55(0.7) | 305(2.3) | | |

*Risk factors of cardiovascular disease include hypertension, diabetes, dyslipidemia, obesity, and smoking.

**Distribution of self-reported health states among individuals with high CVD risk**

Table 4 summarizes the percentage of participants with a high risk of CVD and self-reported problems (no, moderate, or severe problems) on the EQ-5D questionnaire. In total, 8768 individuals reported no problems in any of the five dimensions (65.63%). Across the five dimensions, problems in the pain/discomfort dimension were the most frequently reported (30.9%), followed by anxiety/depression (24.4%). Problems in the self-care dimension were the least reported (0.4%).

Table 4. Distribution of EQ-5D self-reported health states among individuals with high risk of cardiovascular disease [*n* (%)]

| | No problem | Moderate problem | Extreme problem |
|---|---|---|---|
| Mobility | 13199(98.8) | 155(1.2) | 5(0.0) |
| Self-care | 13298(99.6) | 54(0.4) | 6(0.0) |
| Usual activities | 13199(98.8) | 155(1.2) | 5(0.0) |
| Pain/discomfort | 9233(69.1) | 4093(30.7) | 33(0.2) |
| Anxiety/depression | 10104(75.6) | 3247(24.3) | 8(0.1) |

**EQ-5D utility scores among individuals with high CVD risk**

The EQ-5D utility score among individuals with high CVD risk in Inner Mongolia was 1.000 (0.869,1.000), which indicated that more than 50% of individuals with high CVD risk had no problems in any of the five dimensions of the EQ-5D. This also reflected the ceiling effect of the EQ-5D scale, that is, the test questions are too easy, leading to generally high scores among most individuals. EQ-5D utility scores among participants with high CVD risk, according to different characteristics, are shown in Table 5. We found statistically significant differences in utility scores by sex, age group, ethnic group, education level, residence area, household income, medical insurance status, physical activity level, the presence or absence of hypertension, diabetes, dyslipidemia, and the number of uncontrolled risk factors (all $p<0.05$). There was no significant difference in utility scores according to marital status, smoking, drinking, and different BMI groups (all $p>0.05$).

Table 5. Comparison of EQ-5D utility scores among individuals with high risk of cardiovascular disease

| Variables | *n* | The EQ-5D utility scores $M(P_{25}, P_{75})$ | $Z/\chi^2$ | *p* |
|---|---|---|---|---|
| Gender | | | -7.571 | <0.001 |
| Male | 5885 | 1.000□0.869,1.000□ | | |
| Female | 7474 | 1.000□0.869,1.000□ | | |
| Age | | | 39.774 | <0.001 |
| 35-44 | 1394 | 1.000□0.875,1.000□ | | |
| 45-54 | 4133 | 1.000□0.869,1.000□ | | |
| 55-64 | 5116 | 1.000□0.869,1.000□ | | |
| 65-75 | 2716 | 1.000□0.869,1.000□ | | |
| Ethnic group | | | 7.166 | 0.028 |
| Han | 12118 | 1.000□0.869,1.000□ | | |
| Mongol | 1211 | 1.000□0.869,1.000□ | | |
| Other | 30 | 1.000□0.874,1.000□ | | |
| Education level | | | 14.997 | 0.001 |
| Primary school | 5906 | 1.000□0.869,1.000□ | | |
| Middle or high school | 5972 | 1.000□0.869,1.000□ | | |
| College | 1481 | 1.000□0.869,1.000□ | | |
| Residence region | | | 13.491 | <0.001 |
| Rural | 9535 | 1.000□0.869,1.000□ | | |
| Urban | 3824 | 1.000□0.783,1.000□ | | |
| Marital status | | | -1.535 | 0.125 |
| Single | 832 | 1.000□0.869,1.000□ | | |
| Married | 12527 | 1.000□0.869,1.000□ | | |
| Household income | | | -4.220 | <0.001 |
| ≤50000(□/year) | 11726 | 1.000□0.869,1.000□ | | |
| >50000(□/year) | 1633 | 1.000□0.869,1.000□ | | |
| Medical insurance | | | -2.223 | 0.026 |
| No | 1194 | 1.000□0.783,1.000□ | | |

| | | | | |
|---|---|---|---|---|
| Yes | 12165 | 1.000(0.869,1.000) | | |
| Smoking status | | | -1.274 | 0.203 |
| Non-smoker | 10029 | 1.000(0.869,1.000) | | |
| Smoker | 3330 | 1.000(0.869,1.000) | | |
| Drinking status | | | -1.326 | 0.185 |
| No | 10249 | 1.000(0.869,1.000) | | |
| Yes | 3110 | 1.000(0.869,1.000) | | |
| Physical activity | | | -13.689 | <0.001 |
| No | 9608 | 1.000(0.783,1.000) | | |
| Yes | 3751 | 1.000(0.869,1.000) | | |
| BMI | | | 0.893 | 0.640 |
| Normal and thinnish | 2874 | 1.000(0.869,1.000) | | |
| Overweight | 5871 | 1.000(0.869,1.000) | | |
| Obesity | 4614 | 1.000(0.869,1.000) | | |
| Hypertension | | | -5.722 | <0.001 |
| No | 1089 | 1.000(0.869,1.000) | | |
| Yes | 12270 | 1.000(0.783,1.000) | | |
| Diabetes | | | -2.669 | 0.008 |
| No | 9734 | 1.000(0.869,1.000) | | |
| Yes | 3625 | 1.000(0.869,1.000) | | |
| Dyslipidemia | | | -5.662 | <0.001 |
| No | 6231 | 1.000(0.869,1.000) | | |
| Yes | 7128 | 1.000(0.869,1.000) | | |
| Number of uncontrolled risk factors* | | | 22.998 | <0.001 |
| None | 463 | 1.000(0.783,1.000) | | |
| 1 uncontrolled risk factor | 4901 | 1.000(0.869,1.000) | | |
| 2 uncontrolled risk factors | 5551 | 1.000(0.869,1.000) | | |
| 3 uncontrolled risk factors | 2139 | 1.000(0.869,1.000) | | |
| ≧4 uncontrolled risk factors | 305 | 1.000(0.869,1.000) | | |

*Risk factors of cardiovascular disease include hypertension, diabetes, dyslipidemia, obesity, and smoking.

### Influencing factors of HRQoL in individuals with high CVD risk

Regression coefficients obtained in the Tobit regression model are shown in Table 6. Except for ethnic group, diabetes, and the number of uncontrolled risk factors, all other factors were influencing factors of HRQoL among individuals with high CVD risk in our study population. The EQ-5D utility scores of women were lower than those of men ($p<0.05$). Older people had lower scores than younger people ($p<0.05$). Individuals with higher education levels, medical insurance, high household income, and those who engaged in physical activity had significantly higher utility scores ($p<0.05$). Individuals living in rural areas had higher scores than those living in urban areas ($p<0.05$). Individuals with hypertension and dyslipidemia had significantly lower utility scores than individuals without them (all $p<0.05$).

Table 6. Influencing factors of health-related quality of life in patients with cardiovascular disease

| Variables | Coef. | 95%*CI* | SE | *t* | *p* |
|---|---|---|---|---|---|
| Gender (ref. = male) | | | | | |
| Female | -0.0089 | (-0.0124, -0.0054) | 0.0018 | -4.93 | <0.001 |
| Age (ref. =35~44) | | | | | |
| 45~54 | -0.0116 | (-0.0174, -0.0058) | 0.0030 | -3.92 | <0.001 |
| 55~64 | -0.0133 | (-0.0191, -0.0074) | 0.0030 | -4.48 | <0.001 |
| 65~75 | -0.0092 | (-0.0157, -0.0028) | 0.0033 | -2.81 | 0.005 |
| Ethnic group (ref. = Han people) | | | | | |
| Mongolian | -0.0005 | (-0.0057, 0.0056) | 0.0030 | -0.02 | 0.985 |
| The other | 0.0121 | (-0.0220, 0.0458) | 0.0172 | 0.70 | 0.484 |
| Education level (ref.=Primary school) | | | | | |
| Middle or high school | 0.0140 | (0.0102, 0.0178) | 0.0020 | 7.26 | <0.001 |
| College | 0.0109 | (0.0042, 0.0170) | 0.0032 | 3.26 | 0.001 |
| Residence region (ref.= Rural) | | | | | |
| Urban | -0.0296 | (-0.0335, -0.0256) | 0.0020 | -14.75 | <0.001 |
| Household income (ref.= ≤50000(□/year) | | | | | |
| >50000(□/year) | 0.0140 | (0.0102, 0.0178) | 0.0027 | 5.01 | <0.001 |
| Medical insurance (ref.= Uninsured) | | | | | |
| Insured | 0.0015 | (0.0091,0.0208) | 0.0030 | 5.05 | <0.001 |
| Physical activity(ref.=No) | | | | | |
| Yes | 0.0147 | (0.0070, 0.0223) | 0.0039 | 3.76 | <0.001 |
| Hypertension (ref.=No) | | | | | |
| Yes | -0.201 | □-0.024□-0.0164□ | 0.0019 | -10.68 | <0.001 |
| Diabetes(ref.=No) | | | | | |
| Yes | -0.0016 | (-0.0061, 0.0028) | 0.0023 | -0.72 | 0.474 |

| | | | | | |
|---|---|---|---|---|---|
| Dyslipidemia(ref.=No) | | | | | |
| Yes | -0.0045 | (-0.0080, -0.0012) | 0.0017 | -2.64 | 0.008 |
| Number of uncontrolled risk factors(ref.=No) | | | | | |
| 1 uncontrolled risk factor | 0.0035 | (-0.0074,0.0143) | 0.0056 | 0.63 | 0.530 |
| 2 uncontrolled risk factors | 0.0001 | (-0.0111,0.0116) | 0.0058 | 0.03 | 0.974 |
| 3 uncontrolled risk factors | -0.0007 | (-0.0133,0.0118) | 0.0064 | -0.12 | 0.906 |
| ≧4 uncontrolled risk factors | 0.0003 | (-0.0162,0.0168) | 0.0084 | 0.04 | 0.972 |

*CI*, confidence interval; SE, standard error.

# Discussion

In the prevention and treatment of CVD, HRQoL of individuals with a high CVD risk has not attracted sufficient attention, despite the high risk of CVD being associated with impaired HRQoL in previous studies. In the present large-scale study in Inner Mongolia, we evaluated patients' HRQoL using the EQ-5D scale. Moreover, we identified the following influencing factors on HRQoL in individuals with high CVD risk: female sex, older age, lower education level, living in urban areas, lower household income, low physical activity levels, and the presence of hypertension and dyslipidemia were associated with lower EQ-5D utility scores. These findings are critical in the primary prevention of CVD.

The common scales used for HRQoL study are the EQ-5D scale and the short form 36 health survey questionnaire (SF-36). The EQ-5D scale has a clear structure and is easy to operate, while the SF-36 questionnaire has too many question items, making the survey more time-consuming and laborious. Additionally, EQ-5D is more suitable for people with poor health[21], while the sample investigated in this study is a high-risk population of CVD, so the health status is not very good, and the EQ-5D scale was proved more friendly to with lower education levels[22]. Due to the ceiling effect of the EQ-5D scale, the EQ-5D utility score was a censored variable, and the Tobit regression model used in this study is suitable for the study of censored data analysis.

We found that 65.63% of individuals with high CVD risk reported no problems in any of the five dimensions of the EQ-5D, which was better than the results of an HRQoL survey among Chinese and Australian patients with CVD[23–25]. However, it is inappropriate to compare the quality of health-related quality of life between different countries through absolute numbers. Although health-related quality of life can reflect objective health conditions to a certain extent, it differs from other objective indicators in that subjects with similar health conditions do not necessarily think that their own health-related quality of life is similar. Health-related quality of life is affected by cultural background, education level, and personal experience. Pain/discomfort was the most commonly reported problem, followed by

anxiety/depression, which is consistent with results of 2008 and 2013 national health services surveys[26]. This reveals that harm to the physical and mental health of individuals with a high risk of CVD occurs to different degrees. Our finding also suggests that psychological problems should not be neglected in these patients, and we should strengthen the intervention of psychological problems by providing timely counseling, to reduce their psychological burden [27].

According to Tobit regression model analysis, older age and female sex were associated with worse HRQoL, which is consistent with previous research among individuals with a high risk of CVD in other regions[6, 7]. One reason for this finding is likely that physiological functioning of the organism declines with increased age. Our finding also emphasizes the importance of strengthening self-health management education and health management services for older individuals. Individuals with a high risk of CVD who had higher levels of education, household income, and physical activity had higher EQ-5D utility scores, which is consistent with previous research among individuals with a high risk of CVD in other regions and patients with established CVD in China[6, 7, 23, 28]. Patients with higher education levels have a more comprehensive and correct understanding of physical health and can master more health-related knowledge than those with lower levels of education. Patients with higher incomes may have better access to health care. From another viewpoint, there is an unbalanced distribution of health status among individuals with high CVD risk. Attention is needed in populations with lower income and education levels. People living in rural areas had higher utility scores than those living in urban areas, although it is generally believed that urban areas have better conditions for medical care, urban areas may gather more patients with higher CVD risk, resulting in poorer HRQol of urban residents. In addition, the research object of this study is permanent residents, the results of this study will not confused due to people who have lived in urban areas for short periods for medical treatment. Individuals with a high CVD risk who regularly engaged in physical exercise had better HRQoL, indicating that regular exercise is necessary for individuals with a high risk of CVD.

Hypertension and dyslipidemia are known risk factors for CVD. Our results also revealed that individuals with a high CVD risk who had hypertension or dyslipidemia had significantly lower EQ-5D utility scores than individuals without them, consistent with previous research in patients with hypertension or dyslipidemia[29–32]. The previous study revealed that CVD patients with hypertension reported more often suffering from problems with Mobility and Usual activities dimensions[24], it may be the same in people at high risk of CVD. This suggested that people with a high risk of CVD should maintain their blood pressure and lipid levels within the normal range, to improve their HRQoL. However, a serious problem exists of poor treatment and control rates in people with a high risk of CVD in China, as reported previously[33, 34]. Therefore, the focus of reducing blood pressure and blood lipid levels in people at high risk of CVD should be to improve treatment and control rates.

Our study had several limitations. First, as this study was conducted using cross-sectional data, it was not possible to assess the causal relationship between HRQoL and its influencing factors. Taking the “physical activity” factor as an example, although it was possible that individuals with a high CVD risk who regularly engaged in the physical exercise had better HRQoL, there was also a possibility that

individuals who were hard in "action", "self-care", and "daily activities" dimension could not perform adequate physical exercise. Second, there was a noticeable ceiling effect in the EQ-5D-3L scale used in this study than EQ-5D-5L.

# Conclusion

Among individuals with a high CVD risk in Inner Mongolia, pain/discomfort was the most commonly reported problem. The main influencing factors of HRQoL included sex, age, education level, residence area, household income, physical activity, and hypertension and dyslipidemia. Medical and health services need to pay greater attention to individuals with a high risk of CVD including women, elderly people, those living in urban areas, and people with lower levels of education, household income, and physical activity. People with a high risk of CVD should maintain their blood glucose and lipid levels within the normal range.

# Abbreviations

CVD**:** Cardiovascular disease; HRQoL: health-related quality of life; EQ-5D: EuroQol-5 Dimension scale, EQ-5D-3L: EuroQOL-5 Dimension scale with 3 levels; BMI: Body mass index; *CI*: confidence interval; SE:standard error. SF-36: the short form 36 health survey questionnaire; EQ-5D-5L: EuroQOL-5 Dimension scale with 5 levels;

# Declarations

### Ethics approval and Consent to participate

This project was approved by the ethics committee of Fuwai Hospital Chinese Academy of Medical Sciences (approval number: 2014-574). Written informed consent was obtained from all individual participants included in the study.

**Consent for publication** Not applicable.

### Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available due to municipal database.

### Competing interests

The authors declare that they have no competing interests in relation to this manuscript.

### Funding

The study was supported by the Ministry of Finance of China and National Health and Family Planning Commission of China; the Inner Mongolia Autonomous Region Health and Family Planning Commission Research Project (grant number 201701041); the Natural Science Foundation Program of Inner Mongolia Autonomous Region (grant number 2020MS08048); the Youth Innovation Fund Project of Inner Mongolia Medical University (grant number YKD2020QNCX035).

### Authors' contributions

Wenrui Wang and Yunfeng Xi participated in study design, researched data. Ning Cao and Liwei Niu carried out data analysis and drafted the manuscript. XG Zhang assisted with data acquisition and interpretation, reviewed the manuscript and made revision of the manuscript. Nan Zhang, Hao Zhu, Han Bao, Liying Qiao, Tao Yan, Xin Fang, Xiaoqian Xu, Lehui Li, Yan Liu and Yuan Xia researched data. All authors read and approved the final manuscript.

### Acknowledgment

We thank Analisa Avila, ELS, of Liwen Bianji, Edanz Group China (www.liwenbianji.cn/ac), for editing the English text of a draft of this manuscript.

## References

1.WHO. World health statistics 2020: monitoring health for the SDGs, sustainable development goals. Geneva: World Health Organization; 2020.

2.Shengshou H, Runlin G, Lisheng L, Manlu Z, Wen W, Yongjun W et al. Summary of the 2018 Report on Cardiovascular Diseases in China. Chinese Circulation Journal. 2019;34(03):209-20

3.Zhou M, Wang H, Zhu J, Chen W, Wang L, Liu S et al. Cause-specific mortality for 240 causes in China during 1990-2013: a systematic subnational analysis for the Global Burden of Disease Study 2013. LANCET. 2016;387(10015):251-72. 'doi:'10.1016/S0140-6736(15)00551-6.

4.Pu H, Li J, Wang P, Cui L, Wang H. The death of the circulatory system diseases in China: provincial socioeconomic and environmental perspective. Environ Sci Pollut Res Int. 2017;24(11):10381-90. 'doi:'10.1007/s11356-017-8677-2.

5.Zhou M, Wang H, Zeng X, Yin P, Zhu J, Chen W et al. Mortality, morbidity, and risk factors in China and its provinces, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. LANCET. 2019;394(10204):1145-58. 'doi:'10.1016/S0140-6736(19)30427-1.

6.Ludt S, Wensing M, Szecsenyi J, van Lieshout J, Rochon J, Freund T et al. Predictors of health-related quality of life in patients at risk for cardiovascular disease in European primary care. PLOS ONE. 2011;6(12):e29334. 'doi:'10.1371/journal.pone.0029334.

7.Petek D, Petek-Ster M, Tusek-Bunc K. Health Behavior and Health-related Quality of Life in Patients with a High Risk of Cardiovascular Disease. Zdr Varst. 2018;57(1):39-46. 'doi:'10.2478/sjph-2018-0006.

8.The World Health Organization Quality of Life Assessment (WHOQOL): development and general psychometric properties. The World Health Organization Quality of Life Assessment (WHOQOL): development and general psychometric properties. SOC SCI MED. 1998;46(12):1569-85. 'doi:'10.1016/s0277-9536(98)00009-4.

9.Carr AJ, Gibson B, Robinson PG. Measuring quality of life: Is quality of life determined by expectations or experience? BMJ. 2001;322(7296):1240-3. 'doi:'10.1136/bmj.322.7296.1240.

10.Dyer MT, Goldsmith KA, Sharples LS, Buxton MJ. A review of health utilities using the EQ-5D in studies of cardiovascular disease. Health Qual Life Outcomes. 2010; 8:13. 'doi:'10.1186/1477-7525-8-13.

11.Westin L, Nilstun T, Carlsson R, Erhardt L. Patients with ischemic heart disease: quality of life predicts long-term mortality. SCAND CARDIOVASC J. 2005;39(1-2):50-4. 'doi:'10.1080/14017430410003903.

12.Xie J, Wu EQ, Zheng ZJ, Sullivan PW, Zhan L, Labarthe DR. Patient-reported health status in coronary heart disease in the United States: age, sex, racial, and ethnic differences. CIRCULATION. 2008;118(5):491-7. 'doi:'10.1161/CIRCULATIONAHA.107.752006.

13.Tran BX, Moir MP, Thai T, Nguyen LH, Ha GH, Nguyen T et al. Socioeconomic Inequalities in Health-Related Quality of Life among Patients with Cardiovascular Diseases in Vietnam. BIOMED RES INT. 2018;2018:2643814. 'doi:'10.1155/2018/2643814.

14.Ko H, Lee J, Shin J, Jo E. Health-Related Quality of Life and Cardiovascular Disease Risk in Korean Adults. Korean Journal of Family Medicine. 2015;36(6):349. 'doi:'10.4082/kjfm.2015.36.6.349.

15.Xi Y, Bao H, Han K, Qiao L, Xu X, Zhu H et al. Evaluating the treatment and control of modifiable cardiovascular disease risk factors among patients with diabetes in the Inner Mongolia, China: A cross-sectional study. PREV MED. 2020; 139:106174. 'doi:'10.1016/j.ypmed.2020.106174.

16. Chinese Cardiovascular Disease Prevention Guidelines (2017) Writing Group, Editorial Board of Chinese Journal of Cardiovascular Diseases. 2017 Chinese guideline for the prevention of cardiovascular disease. Chinese Journal of Cardiology. 2018;46(01):10-25

17.Liu GG, Wu H, Li M, Gao C, Luo N. Chinese time trade-off values for EQ-5D health states. VALUE HEALTH. 2014;17(5):597-604. 'doi:'10.1016/j.jval.2014.05.007.

18.Shiyuan D, Xinyue G, Anqi C, Aijun X. Health-related quality of life in patients with chronic diseases based on EQ-5D utility score system. Modern Preventive Medicine. 2020;47(06):1067-70

19. China Hypertension Prevention Guidelines Revision Committee Hypertension Alliance, Chinese Medical Association Cardiovascular Branch, Professional Committee of Hypertension of Chinese, Medical

Doctor Association, Hypertension Branch of China Association for the Promotion of International Health Care, China Senior Citizens, Medical Association Hypertension Branch. 2018 Chinese guidelines for the management of hypertension. Chin J Cardiovasc Med. 2019;24(01):24-56

20. China Joint Committee for the Revision of Adult Dyslipidemia Prevention Guidelines. Chinese guidelines on prevention and treatment of dyslipidemia in adults. Chinese Journal of Circulation. 2016;31(10):937-53

21.Minhong L, Xijing F, Peng G, Wentao Z. Comparative Analysis on EuroQol-5 Dimensions and ShortForm6D in Quality of Life Scale. Chinese health economy. 2014;33(03):9-11

22.Wang C, Lang J, Xuan L, Li X, Zhang L. The effect of health literacy and self-management efficacy on the health-related quality of life of hypertensive patients in a western rural area of China: a cross-sectional study. INT J EQUITY HEALTH. 2017;16(1). 'doi:'10.1186/s12939-017-0551-9.

23.Qingwen D, Wenbin L. Multilevel analysis of health-related quality of life of patients with

cardiovascular disease and its determinants. Journal Of Shandong University( Health Science). 2020;58(07):115-21

24.Mei YX, Wu H, Zhang HY, Hou J, Zhang ZX, Liao W et al. Health-related quality of life and its related factors in coronary heart disease patients: results from the Henan Rural Cohort study. Sci Rep. 2021;11(1):5011. 'doi:'10.1038/s41598-021-84554-6.

25.McCaffrey N, Kaambwa B, Currow DC, Ratcliffe J. Health-related quality of life measured using the EQ-5D-5L: South Australian population norms. Health Qual Life Outcomes. 2016;14(1):133. 'doi:'10.1186/s12955-016-0537-0.

26.Yao Q, Liu C, Zhang Y, Xu L. Changes in health-related quality of life of Chinese populations measured by the EQ-5D-3 L: a comparison of the 2008 and 2013 National Health Services Surveys. Health Qual Life Outcomes. 2019;17(1):43. 'doi:'10.1186/s12955-019-1109-x.

27.Duoer Y, Shaoliang T. Health-related Quality of Life and Its Influencing Factors in Patients with Chronic Diseases in Sichuan□Hebei and

Gansu Based on Tobit Model. Chinese General Practice. 2018;21(28):3459-66

28.Xiao-Nan W, Li W, Kun F, Hang-Ying Q, Jia Z, Yan-Ping □ et al. Health□related quality of life and its influencing factors in stroke patients in

rural areas of Western China: a survey based on EQ□5D scale. Chin J Mult Organ Dis Elderly. 2020;19(09):641-5

29.Wong E, Xu RH, Cheung A. Health-related quality of life among patients with hypertension: population-based survey using EQ-5D-5L in Hong Kong SAR, China. BMJ OPEN. 2019;9(9):e32544. 'doi:'10.1136/bmjopen-2019-032544.

30.Liang Z, Zhang T, Lin T, Liu L, Wang B, Fu AZ et al. Health-related quality of life among rural men and women with hypertension: assessment by the EQ-5D-5L in Jiangsu, China. QUAL LIFE RES. 2019;28(8):2069-80. 'doi:'10.1007/s11136-019-02139-3.

31.Wu H, Li H, Li H, Ding Y, Wang C, Zhang G et al. Evaluation of health-related quality of life in adults with and without dyslipidemia in rural areas of central China. QUAL LIFE RES. 2020;29(4):925-39. 'doi:'10.1007/s11136-019-02336-0.

32.Zhang Y, Zhou Z, Gao J, Wang D, Zhang Q, Zhou Z et al. Health-related quality of life and its influencing factors for patients with hypertension: evidence from the urban and rural areas of Shaanxi Province, China. BMC HEALTH SERV RES. 2016; 16:277. 'doi:'10.1186/s12913-016-1536-x.

33.Lu J, Lu Y, Yang H, Bilige W, Li Y, Schulz W et al. Characteristics of High Cardiovascular Risk in 1.7 Million Chinese Adults. ANN INTERN MED. 2019;170(5):298-308. 'doi:'10.7326/M18-1932.

34.Lu J, Lu Y, Wang X, Li X, Linderman GC, Wu C et al. Prevalence, awareness, treatment, and control of hypertension in China: data from 1.7 million adults in a population-based screening study (China PEACE Million Persons Project). LANCET. 2017;390(10112):2549-58. 'doi:'10.1016/S0140-6736(17)32478-9.