SSM - Population Health 25 (2024) 101601

Contents lists available at ScienceDirect

SSM - Population Health

journal homepage: www.elsevier.com/locate/ssmph

# Gender differences in the relationship between income inequality and health in China: Evidence from the China Health and Nutrition Survey data

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ARTICLE INFO

*Keywords:*
Income inequality
Self-reported health
Health-compromising behaviours
Gender differences
China

ABSTRACT

This study examines gender differences in the relationship between income inequality and health in China. Multilevel regression models were used to analyse data from the most recent five waves (2004–2015) across 12 provinces in the China Health and Nutrition Survey (CHNS). The findings remain robust when considering alternative measures of health outcomes and income inequality. Men showed greater sensitivity to income inequality in terms of adverse health outcomes. When individuals experienced the same level of changes in income inequality, men had a higher risk of reporting poor health status, higher BMI, higher systolic blood pressure, and a higher risk of smoking cigarettes and drinking alcohol than women. Despite missing data and causal inference challenges, this study highlights gender differences in the relationship between income inequality and health in China, potentially attributed to cultural gender norms. Double standards regarding weight and health-compromising behaviours based on gender roles and stereotypes are more intensive in China, particularly in areas with higher income inequality. One policy implication of this study is that reducing income inequality could enhance individual health outcomes, with a more notable impact on men's health compared to women's.

## 1. Introduction

China has experienced rapid economic growth during the last four decades, however, this was accompanied by growing income inequality. Nevertheless, the Chinese government has given priority to economic development and regarded the increasing income inequality as an unfortunate but necessary consequence of economic growth (Bakkeli, 2020). Consequently, growing income inequality resulted in various social issues, including challenges in public health. China's health performance has significantly declined when compared to the rates before economic reforms (Pei & Rodriguez, 2006). Following China's rising income inequality, the rising prevalence of chronic diseases among the Chinese population and the gaps in health provision have posed significant challenges to public health in China (Shi et al., 2008; Zhao, 2012). Given the rise of income inequality and health problems, it has become increasingly important to explore the relationship between income inequality and health in China.

Studies indicate that income inequality may cause poor health outcomes, and countries with higher income inequality may experience a worse level of population health (Lynch & Kaplan, 1997; Pickett & Wilkinson, 2015; Wilkinson & Pickett, 2006). The negative relationship between income inequality and health was first proposed for wealthy countries that have passed through the "epidemiological transition", which refers to the phenomenon of chronic diseases replacing infectious diseases as the main cause of mortality (Deaton, 2003). Specifically, before the epidemiological transition, income determines health outcomes, while afterward, income inequality determines health outcomes (ibid.). Despite the lack of consensus on mechanisms and affected groups, a growing body of empirical studies supports the hypothesis that income inequality might be positively associated with poor health outcomes. Wilkinson and Pickett (2006) conducted a thorough review regarding evidence on the relationship between income inequality and population health. They concluded that 70 percent (among 155 papers containing 168 separate analyses identified on the subject) support the hypothesis that high levels of income inequality led to poor population health. Kondo (2012) conducted a meta-analysis on nine cohort studies and 19 cross-sectional studies, which suggested that income inequality might have adverse impacts on individual health. The geographic scale could be an important reason why some studies have little or no evidence for the negative relationship between income inequality and

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https://doi.org/10.1016/j.ssmph.2024.101601
Received 23 October 2023; Received in revised form 25 December 2023; Accepted 3 January 2024
Available online 4 January 2024

health (Subramanian & Kawachi, 2004; Wilkinson & Pickett, 2006). This relationship could be more effectively examined when the geographic units are large enough to show the inequality level.

Income inequality could be negatively associated with health at both individual and aggregate levels, but most empirical evidence still concentrates on developed countries (Adjaye-Gbewonyo & Kawachi, 2012; Deaton, 2003; Wilkinson & Pickett, 2006). Particularly, evidence from the United States has been examined in many studies, including across states and in metropolitan areas (Kawachi & Kennedy, 1997; Kennedy et al., 1998; Mellor & Milyo, 2002; Subramanyam et al., 2009). However, evidence from developing countries is relatively limited, and there is no consensus about the relationship between income inequality and health according to empirical tests.

Studies that examined the relationship between income inequality and health in China using the China Health and Nutrition Survey (CHNS) data have presented different findings. Pei and Rodriguez (2006) argue that people living in provinces with greater income inequality have an increased risk of 10–15% on fair or poor self-reported health. In addition, some studies indicate that income inequality negatively impacts the health of specific groups of people, or at least has a more significant impact on them. For example, Chen and Meltzer (2008) successfully examined the hypothesis that income inequality has a negative influence on individual health in China for rural residents. However, the relationship between income inequality and health is not strong among urban residents. Fang and Rizzo (2012) argue that income inequality harms individual health more among low-income households than their counterparts. Yang and Kanavos (2012) state that income-related health inequalities are more pronounced among urban populations than rural counterparts. However, Bakkeli (2016) suggests that income inequality does not have a significant influence on the risks of having health problems.

In developed countries, income inequality may play a greater role in women's health than men's health, regarding factors such as women's Body Mass Index (BMI), self-reported health status, health-related behaviours, and mortality (Montez et al., 2016; Robert & Reither, 2004; Stafford et al., 2005). Specifically, Patel et al. (2018) report a statistically significant positive relationship between income inequality and the risk of depression in high-income countries, emphasising the greater effects of income inequality on women and low-income populations. In addition, Diez-Roux et al. (2000) examine the relationship between state income inequality and four cardiovascular disease risk factors (BMI, hypertension, sedentary lifestyles, and smoking) within the US. Indeed, the authors found the associations between income inequality and three (BMI, hypertension, and smoking) of four factors were only statistically significant in women. In general, women are more vulnerable to socioeconomic inequality and more disadvantaged in terms of using healthcare systems (Montez et al., 2016). However, very few studies focus on the gender differences in the relationship between income inequality and health in developing countries, and the same applies to China in this regard. To address this research gap, it is important to examine the gender disparities in the relationship between income inequality and health within the context of China.

This study aims to examine the following research questions: What is the relationship between income inequality and health in China, and do gender differences exist in this relationship? If the results are the same as developed countries, why are women more vulnerable to income inequality in terms of poor health outcomes? If not, what explains the difference in results compared to developed countries? To address these three research questions, multilevel regression models were used to analyse data from the most recent five waves (2004–2015) across 12 provinces in the China Health and Nutrition Survey.

## 2. Methods

### 2.1. Data

This research employs a longitudinal dataset from the China Health and Nutrition Survey (CHNS) from 2004 to 2015. Specifically, the CHNS is an ongoing cohort and international collaborative project, which was designed to examine the effects of health, nutrition, and family planning policies in China to see how the social and economic transformation of Chinese society is affecting the health and nutritional status of its population. CHNS is a longitudinal survey with 10 waves from 1989 to 2015. This study used the most recent five waves (2004, 2006, 2009, 2011, and 2015) data, drawing a sample from 12 provinces that are substantially diverse in geography, economic development, public resources, and health indicators. These five waves represent the most recent available data, and the individual health outcomes data has only been available since 2004. According to the CHNS, since 2004, all questions have been related to individual activities, lifestyle, health status, and body shape, allowing this research to examine the relationship between income inequality and individual health.

### 2.2. Variables

The key causal variable of interest is *income inequality*. The Gini coefficient is the most commonly used measure of income inequality in studies that examine the relationship between income inequality and health. In constructing the Gini coefficient, it is necessary to choose a level of aggregation to define a market area. For example, in the context of China, Pei and Rodriguez (2006) apply the provincial-level income inequality; Fang and Rizzo (2012) and Bakkeli (2016) apply the city/county-level income inequality. In this study, the Gini coefficient is calculated at the county level each year, and the term 'county' is used here for both counties/townships in rural areas, and cities in urban areas. This study focuses on county-level income inequality to allow a larger variation of income inequality in the sample. The second key variable of interest is household income per capita which measures the absolute income.

The dependent variable is *health outcome*, measured by self-reported health status. Additionally, physical health indicators (BMI and systolic blood pressure) and health-compromising behaviours (smoking and drinking) were used as alternative health outcomes dependent variables. Self-reported health can reflect the states of the human body and mind and it is a more inclusive and accurate measure of health status and health risk factors (Idler & Benyamini, 1997; Jylhä, 2009). Specifically, self-reported health (or self-assessed health, self-rated health) status (SRHS) is one of the most commonly used individual health measures. It is based on a single question such as 'How is your health in general' with five options provided. The original 5-value scale SRHS employs 0–5 to indicate "very good", "good", "fair", "bad", and "very bad" health status respectively. In a dichotomised format in this study, 1 stands for the overall poor health status (fair, poor, and very poor) while 0 stands for the overall good health status (very good and good). The World Health Organisation has emphasised the importance of using SRHS for monitoring the population health (de Bruin et al., 1996). There are advantages to using SRHS: First, it is simple, short, and global (Jylhä, 2009); Second, it has been widely accepted that self-reported health is an important indicator or predictor of mortality in many studies (Burstrom, 2001).

Control variables include age, years of education, household income, ethnicity, household size, hukou and the possession of medical insurance. Important variables and their descriptions are listed in Table 1 below, categorised into the following aspects: health outcomes, income inequality, demographic characteristics, and socioeconomic characteristics.

**Table 1**
Variables and descriptions.

| Variables | Descriptions |
|---|---|
| *Health Outcomes* | |
| Self-reported health status (SRHS) | Excellent, good, fair, poor (1: poor health; 0: excellent, good and fair health) |
| Physical health indicators | BMI; systolic blood pressure |
| Health-compromising behaviours | |
| Smoking | Have you ever smoked cigarettes (including hand-rolled or device-rolled)? |
| Drinking | Did you drink beer or any other alcoholic beverage last year? |
| *Income inequality* | County-level Gini coefficient |
| *Demographic characteristics* | |
| Age | Only include 18 above |
| Ethnicity | Han (majority); Ethnic minorities |
| Hukou | Rural; Urban |
| Province | Beijing, Chongqing, Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, Shandong, Shanghai |
| *Socioeconomic characteristics* | |
| Per capita annual household income | In RMB |
| Education | Years of education |
| Medical insurance | Have; Not have |
| Household size | – |

### 2.3. Analytic strategy

When examining the relationship between income inequality and SRHS and health-compromising behaviours, considering the binary character of the dependent variable and the high proportion of positive outcomes, it is common to employ a non-linear modelling approach. Thus, logistic regression models are applied for dichotomised health outcomes, such as SRHS and health-compromising behaviours. For individual i in time t, estimating equations of the logistic models are:

$$prob(y_{it}=1|\alpha_i,\beta)=\frac{\exp(\alpha_i+x_{it}\beta)}{1+\exp(\alpha_i+x_{it}\beta)} \quad (1)$$

$\alpha_i$ is the incidental parameter and β is the structural parameter.

When examining the relationship between income inequality and physical indicators (BMI and systolic blood pressure), this study applied the fixed-effect OLS model by adding county-level indicators and year indicators to control for county and year heterogeneity. The advantage of fixed-effects estimation is that it allows for additive, unobserved heterogeneity that can be freely correlated with the time-varying covariates (Wooldridge, 2005). In addition, it reduces the problem of self-selection and omitted-variable bias. By applying this, the model could capture variations in health that occur over time, as well as control for time-constant and potentially confounding characteristics within counties. In all models, two-way cluster-robust standard errors are applied on individual units to avoid serial correlation. Although it is ideal to use instrumental variables to correct the endogeneity, there is little evidence from previous studies on qualified instrumental variables in the context of the relationship between income inequality and health.

When county-level indicators and year indicators are included to control for county and year heterogeneity, the equation for the fixed-effects model is:

$$H_{ipt}=\alpha+\beta_1 Inequality_{pt}+\beta_2 Lnhhinc\_pc+\gamma_1 X_{ipt}+\gamma_2 T_t+\varepsilon_p+\nu_t+\eta_{ipt} \quad (2)$$

$H_{ipt}$ represents the individual's health outcome in a specific county and time, while inequality stands for the Gini coefficient. In addition, *lnhhinc_pc* stands for the logarithm of household income per capita. $X$ is a vector of individual control variables and includes additional explanatory variables that may affect health outcomes. $T$ is a vector of year dummies, $\varepsilon_p$ is the unknown intercept for each county unit, $\nu_t$ is the error for year dummies, $\eta_{ipt}$ is the error disturbance term.

Table 2 presents the descriptive statistics of the data used in this study. All variables are categorised into three parts according to their characteristics: socio-demographic, income inequality, and health outcomes. Specifically, the individual's socio-demographic characteristics include age, years of education, household income, ethnicity, household size, Hukou, and whether they have medical insurance.

## 3. Results

### 3.1. Baseline models

Table 3 displays results for three logistic models using panel data from three different years (2004, 2006, 2015) since self-reported health

**Table 2**
Descriptive statistics.

| | Men | | Women | |
|---|---|---|---|---|
| | *N (%)* | *Mean (SD)* | *N (%)* | *Mean (SD)* |
| **Socio-demographic** | | | | |
| Age | | 43.87 (19.24) | | 45.57 (18.80) |
| Years of education | | 9.77 (3.81) | | 8.32 (4.50) |
| Annual household income per capita | | 13963.91 (24764.7) | | 13436.36 (23154.97) |
| Ethnicity | | | | |
| Majority Han | 25,677 (88.9%) | | 27,074 (88.7%) | |
| Minority | 3194 (11.1%) | | 3460 (11.3%) | |
| Household size | | 3.75 (1.56) | | 3.72 (1.61) |
| Hukou | | | | |
| Urban | 10,427 (36%) | | 11,431 (37.32) | |
| Rural | 18,534 (64%) | | 19,196 (62.68) | |
| Medical insurance | | | | |
| Have | 10,011 (38.5%) | | 10,973 (38.4%) | |
| Not have | 16,001 (61.5%) | | 17,586 (61.6%) | |
| **Income Inequality** | | | | |
| Gini | | 0.43 (0.08) | | 0.43 (0.08) |
| Theil T | | 0.41 (0.17) | | 0.41 (0.17) |
| Theil L | | 0.37 (0.20) | | 0.37 (0.20) |
| **Health Outcomes** | | | | |
| Self-reported health (1/0) | | | | |
| Poor | 6111 (37.5%) | | 7559 (43.8%) | |
| Not poor | 10,206 (62.5%) | | 9711 (56.2%) | |
| BMI | | 22.99 (4.42) | | 23.05 (4.46) |
| Systolic blood pressure | | 123.14 (18.51) | | 120.84 (20.01) |
| Drank alcohol last year (1/0) | | | | |
| Yes | 1,4452 (55.44%) | | 2360 (8.37%) | |
| No | 1,1615 (44.56%) | | 2,5832 (91.63%) | |
| Ever smoked cigarettes (1/0) | | | | |
| Yes | 14,748 (56.3%) | | 932 (3.29%) | |
| No | 11,446 (43.7%) | | 27,404 (96.71%) | |

[a]Data from five waves 2004, 2006, 2009, 2011, and 2015; 'self-reported health' was not collected in 2009 and 2011.

**Table 3**
Logistic regression measuring the effects of income inequality on SRHS.

| | Model 1 (N = 33587) | Model 2 (N = 33587) | Model 3* (N = 30318) |
|---|---|---|---|
| Dependent variable: SRHS (1 poor; 0 not poor) | | | |
| Gini | 2.579*** | 2.319*** | 1.831*** |
| | (5.74) | (5.09) | (3.23) |
| ln (household income) | | 0.935*** | 0.949*** |
| | | (-6.47) | (-4.25) |
| constant | 0.405*** | 0.775** | 0.254*** |
| | (-11.95) | (-2.03) | (-7.46) |

* Exponentiated coefficients (odds ratio); *t* statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; data from 2004, 2006, 2015 (SRHS was not collected in 2009 and 2011); Model 3 includes age, years of education, household size, ethnicity, Hukou and possession of medical insurance.

status data was not collected in the 2009 and 2011 waves. In all three models, the dependent variable is self-reported health status. Three base models respond to the common critique that household income and socio-demographic characteristics may confound estimates of the effects of income inequality. Model 1 focuses on the effect of income inequality alone (Gini coefficients); model 2 estimates the effect of income inequality independent of household income and vice versa; while model 3 additionally adjusts for other key characteristics.

For all models, a high level of income inequality (high Gini coefficients) is strongly associated with poor health (odds ratio 1.831, $p < 0.01$) after adjusting for other socio-demographic key characteristics (Model 3). The odds of reporting poor health were 1.831 for each 1 increase in the Gini coefficient and 1.062 for each 0.1 increase in the Gini coefficient, holding all other covariates constant. That is, individuals living in areas with higher income inequality, characterized by a 0.1 increase in the Gini coefficient, faced a 6.2% greater risk of reporting poor health. In addition, higher household income, more years of education, and being a minor ethnicity were associated with a lower risk of reporting poor health, while age and having medical insurance were positively related to reporting poor health status.

Table 4 compares samples of men and women after adjusting for socio-demographic key characteristics. Income inequality and self-reported poor health status were positively related ($p < 0.05$) for both men and women, and men were more sensitive to income inequality. That is, individuals living in areas with higher income inequality were more likely to report poor health status, and this likelihood was higher for men compared to women.

**Table 4**
Logistic regression measuring the effects of income inequality on SRHS by gender.

| | All sample (N = 30318) | Men (N = 14423) | Women (N = 15895) |
|---|---|---|---|
| Dependent variable: SRHS | | | |
| Gini | 1.831*** | 1.933** | 1.737** |
| | (3.23) | (2.43) | (2.15) |
| ln (household income) | 0.949*** | 0.974 | 0.923*** |
| | (-4.25) | (-1.47) | (-4.67) |
| constant | 0.254*** | 0.185*** | 0.313*** |
| | (-7.46) | (-6.26) | (-4.62) |

* Exponentiated coefficients (odds ratio); *t* statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; data from 2004, 2006, 2015 (SRHS was not collected in 2009 and 2011); all regressions include age, years of education, household size, ethnicity, Hukou and possession of medical insurance.

### 3.2. Robustness checks

Alternative models and alternative income inequality measures are considered for robustness checks. The results of the robustness checks are as follows: First, base models were changed from logistic models to OLS models and were augmented with fixed effects (Table 5). Specifically, there was a 0.012 unit increase in self-reported poor health for men ($p < 0.05$) and a 0.009 unit for women ($p < 0.1$) living in higher income inequality areas with a 0.1 increase in the Gini coefficients. In line with the base models, the Gini coefficient and self-reported poor health were positively related, and men were more sensitive to the Gini coefficient in terms of self-reported poor health status.

Second, Gini coefficients were replaced by Theil indices (Table 6). Generalized Entropy (Theil) indices and the Gini coefficient are complementary income inequality measures. Specifically, the Gini coefficient is particularly sensitive to changes at middle-income levels. Theil's T is also known as the Theil index and is sensitive to changes in upper-income levels, while Theil's L (mean logarithm deviation) is sensitive to changes at the bottom income levels (Bakkeli, 2016). Specifically, the odds of men reporting poor health were 1.809 ($p < 0.01$) for each 1 increase in Theil's T index and 1.061 ($p < 0.01$) for each 0.1 increase in Theil's T index, holding all other covariates constant. That is, for men living in areas with higher income inequality, a 0.1 increase in Theil's T index was linked to a 6.1% greater risk of reporting poor health. Accordingly, the risk for women counterparts was 4.3% ($p < 0.01$). Thus, after conducting the robustness checks, the positive relationship between income inequality and self-reported poor health status persisted for both men and women, indicating robust results.

### 3.3. Other health outcomes

To measure health outcomes from diverse aspects, objective health indicators are applied as dependent variables, such as physical indicators (BMI and systolic blood pressure) and health-compromising behaviours (smoking and drinking). Smoking behaviour is measured by the CHNS question: Have you ever smoked cigarettes (including hand-rolled or device-rolled)? (0: never smoked; 1: yes). In addition, drinking behaviour is measured by the CHNS question: Did you drink beer or any other alcoholic beverage last year? (0: no; 1: yes). All these

**Table 5**
Robustness analysis: OLS (FE) as alternative regression models.

| | All sample (N = 30318) | Men (N = 14423) | Women (N = 15895) |
|---|---|---|---|
| Dependent variable: SRHS | | | |
| Gini | 0.102*** | 0.115** | 0.0927* |
| | (2.83) | (2.19) | (1.86) |
| ln (household income) | −0.0120*** | −0.00724** | −0.0171*** |
| | (-5.03) | (-2.10) | (-5.15) |
| constant | 0.271*** | 0.210*** | 0.305*** |
| | (7.85) | (4.17) | (6.40) |
| R2 | 0.101 | 0.0883 | 0.111 |

**t* statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; data from 2004, 2006, 2015 (SRHS was not collected in 2009 and 2011); all regressions include age, years of education, household size, ethnicity, Hukou and possession of medical insurance.

**Table 6**
Robustness analysis: Theil's T and Theil's L as alternative income inequality measures.

| | All sample (N = 30318) | Men (N = 14423) | Women (N = 15895) |
|---|---|---|---|
| Dependent variable: SRHS | | | |
| a. alternative income inequality measures: Theil's T | | | |
| Theil's T | 1.651*** | 1.809*** | 1.520*** |
| | (5.90) | (4.84) | (3.57) |
| ln (household income) | 0.946*** | 0.970* | 0.922*** |
| | (-4.47) | (-1.69) | (-4.78) |
| constant | 0.278*** | 0.202*** | 0.342*** |
| | (-7.51) | (-6.41) | (-4.59) |
| b. alternative income inequality measures: Theil's L | | | |
| Theil's L | 1.309*** | 1.305*** | 1.312*** |
| | (3.97) | (2.75) | (2.86) |
| ln (household income) | 0.947*** | 0.973 | 0.922*** |
| | (-4.38) | (-1.55) | (-4.77) |
| constant | 0.300*** | 0.224*** | 0.362*** |
| | (-7.11) | (-6.04) | (-4.38) |

* Exponentiated coefficients (odds ratio); *t* statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; data from 2004, 2006, 2015 (SRHS was not collected in 2009 and 2011); all regressions include age, years of education, household size, ethnicity, Hukou and possession of medical insurance.

health indicators are collected in all five survey waves from 2004 to 2015.

When applying objective health outcomes, BMI ($p < 0.05$) and systolic blood pressure ($p < 0.01$) were positively related to the Gini coefficients (Table 7). That is, individuals living in areas with higher income inequality were more likely to have higher BMI and higher systolic blood pressure. As for the health-compromising behaviours (Table 8), the Gini coefficient and smoking were negatively related with no statistical significance ($p > 0.1$), while drinking and self-reported poor health status were negatively related ($p < 0.1$). That is, individuals living in areas with higher income inequality were less likely to smoke cigarettes and drink alcohol. In addition, similar to the results from SRHS, men displayed greater sensitivity to income inequality compared to women concerning their physical health outcomes.

Specifically, when comparing individuals living in areas with a difference of one unit in the level of income inequality, men showed higher BMI and systolic blood pressure than women. For instance, a 0.1 unit increase in the Gini coefficient corresponded to a 0.112 unit increase in men's BMI, whereas women's BMI increased by 0.109 units. In addition, a 0.1 unit increase in the Gini coefficient was associated with a 0.772 unit increase in men's systolic blood pressure, whereas women's systolic blood pressure increased by 0.593 units. However, Women exhibited greater sensitivity to changes in income inequality concerning their health-compromising behaviours. Specifically, in areas with higher income inequality, a 0.1 increase in the Gini coefficient was associated with a 2.8% lower likelihood of smoking cigarettes for men and a 3.7% lower likelihood for women. This suggests that women were less inclined to smoke when individuals faced the same level of income inequality in their residential areas. A similar trend was observed in drinking behaviours for both men and women.

To conclude, income inequality appears to have a more adverse effect on men compared to women. Specifically, when facing a similar change in income inequality, men tend to report worse health outcomes (poorer self-reported health, higher BMI, higher blood pressure) and a higher risk of engaging in adverse health-compromising behaviours (smoking cigarettes and drinking alcohol) compared to women.

**Table 7**
OLS (FE) models: objective health outcomes.

| | All sample | men | women |
|---|---|---|---|
| **Physical health** | | | |
| a. dependent variable: BMI | | | |
| Gini | 1.046*** | 1.120** | 1.090** |
| | (3.30) | (2.43) | (2.53) |
| ln (household income) | 0.203*** | 0.294*** | 0.108*** |
| | (11.91) | (11.85) | (4.64) |
| constant | 15.83*** | 14.31*** | 16.78*** |
| | (48.75) | (30.23) | (38.02) |
| County and year fixed effects | YES | YES | YES |
| N | 50389 | 23684 | 26705 |
| R2 | 0.186 | 0.199 | 0.197 |
| b. dependent variable: systolic blood pressure | | | |
| Gini | 6.472*** | 7.716*** | 5.928*** |
| | (5.10) | (4.29) | (3.36) |
| ln (household income) | 0.256*** | 0.332*** | 0.195** |
| | (3.71) | (3.39) | (2.03) |
| constant | 88.73*** | 88.60*** | 89.10*** |
| | (67.50) | (47.79) | (48.59) |
| County and year fixed effects | YES | YES | YES |
| N | 47448 | 22133 | 25315 |
| R2 | 0.333 | 0.332 | 0.350 |

*$t$ statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; data from 2004, 2006, 2009, 2011, and 2015; all regressions include age, years of education, household size, ethnicity, Hukou and possession of medical insurance.

## 4. Conclusion

Income inequality, as measured by county-level Gini coefficients, showed positive relationships with self-reported poor health, BMI, and systolic blood pressure, after accounting for individuals' socio-demographic characteristics. However, income inequality showed negative associations with both smoking cigarettes and drinking alcohol. That is, individuals living in areas with higher income inequality had a higher risk of reporting poor health, higher BMI and systolic blood pressure, and a lower risk of smoking cigarettes and drinking alcohol. These results remain robust even after undergoing a series of robustness checks, which involved the change of regression models from logistic to OLS models, as well as the substitution of Gini coefficients with Theil's index to measure income inequality.

There were gender disparities in the relationship between income inequality and health outcomes. Men showed greater sensitivity to income inequality in terms of SRHS, while women showed greater sensitivity regarding health-compromising behaviours. As income inequality was positively associated with adverse health outcomes, men faced a higher risk of reporting poor health outcomes. Conversely, income inequality had a negative relationship with health-compromising behaviours, making women more likely to prevent such behaviours. Overall, when individuals lived in areas with the same level of income inequality, men had a higher risk of reporting poor health status, higher BMI, and systolic blood pressure, and a higher risk of smoking cigarettes and drinking alcohol than women.

**Table 8**
Logistic regressions: health-compromising behaviours.

| | All sample | men | women |
|---|---|---|---|
| **Health behaviours** | | | |
| a. dependent variable: smoke (0: no smoke 1: smoke) | | | |
| Gini | 0.661 | 0.755 | 0.683 |
| | (-1.27) | (-0.81) | (-0.42) |
| ln (household income) | 0.902*** | 0.942** | 0.877** |
| | (-4.54) | (-2.44) | (-2.33) |
| constant | 0.000590*** | 0.235*** | 0.000969*** |
| | (-18.10) | (-3.81) | (-7.04) |
| N | 49593 | 23303 | 26290 |
| b. dependent variable: drink (0: no drink 1: drink) | | | |
| Gini | 0.484*** | 0.600* | 0.478* |
| | (-2.91) | (-1.77) | (-1.86) |
| ln (household income) | 0.966** | 1.029 | 0.975 |
| | (-2.01) | (1.43) | (-0.89) |
| constant | 0.0190*** | 0.224*** | 0.0908*** |
| | (-14.57) | (-4.93) | (-6.26) |
| N | 49319 | 23171 | 26148 |

* Exponentiated coefficients (odds ratio); *t* statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; data from 2004, 2006, 2009, 2011, and 2015; all regressions include age, years of education, household size, ethnicity, Hukou and possession of medical insurance.

## 5. Discussion

The positive relationship between income inequality and poor health outcomes could be explained by behavioural and psychosocial mechanisms. High BMI and systolic blood pressure may be related to food intake, and the increasing income inequality could diminish informal social control over unhealthy behaviours such as the consumption of high-caloric foods (Kawachi, 2000). In addition, increased nutritional problems which may result in obesity (high BMI) and hypertension (high systolic blood pressure) may be a consequence of the psychosocial impact of living in a more hierarchical society (Pickett, 2005). Moreover, the findings may be partly because of region-specific cultural features of diet in China where salt intake remains high. Sodium intake is decreasing in China but remains double the Institute of Medicine recommendations (Du et al., 2014).

Limitations of this study include the potential biases introduced by missing data and causal inference challenges in studying the relationship between income inequality and health. Deaton (2003) argues the effects between income inequality and health that run in both directions could not be neglectable. This dual causal causality between income inequality and health is a difficult issue for the research. As a potential solution, Bakkeli (2020) replaced missing income with the lowest 5% decile in income distribution. In addition, Li and Zhu (2006) attempted to partially address the causal effect by replacing the income and income inequality measures with lagged values, which enables to identify the causal effect from inequality to health, as current health status should not affect past income levels or past income inequality. Future studies should take these limitations and potential solutions into consideration. In addition, the relationship between income inequality and health outcomes is complex and may be influenced by numerous confounding factors. This study may have not considered some confounding factors, which may have an influence on both income inequality and health.

Moreover, the category of gender is deployed naively only as a demographic variable. Simandan (2021) argues that gender should also be framed as an epistemological sensibility and as an ontological conundrum in the field of population health. Future studies should acknowledge this complexification of the category "gender". As another limitation of the research design, this study presents a static perception of the association between income inequality and health outcomes. However, social class and social mobility impact health and well-being (Simandan, 2018). Thus, this non-static, highly dynamic phenomenon ("social mobility") is important to be considered. Nonetheless, this study highlights the gender differences in the association between income inequality and health, especially focusing on the sources of these gender differences within the context of China.

One of the important reasons for different results between developed countries and China may be because of the double standards of weight and health-compromising behaviours (smoking cigarettes and drinking alcohol) across genders based on gender roles and stereotypes is more intensive in China, particularly in areas with higher income inequality. On the one hand, Chinese women would have a very negative view of their bodies and experience higher levels of body image dissatisfaction (Stojcic et al., 2020). The idea of “thinness equals beauty” has become a popular social trend in recent years in China (Sun et al., 2022). As a result, in areas with higher income inequality, women may be more likely to experience perceived weight stigma and weight-based discrimination than men. On the other hand, greater alcohol drinking among men is associated with stereotypical masculine qualities while traditional feminine associated with less drinking (Nolen-Hoeksema, 2004). Rolfe et al. (2009) also suggest that individuals drink for self-medication, pleasure, and leisure, while women need to justify their drinking and protect their moral status as “good women”. Bo and Jaccard (2020) particularly indicate the double standards of drinking across genders are prominent in China, where Chinese women are discouraged from drinking by Chinese cultural gender norms.

In addition, women have a much lower smoking rate in China compared to other developed countries, while the male smoking rate is one of the highest in the world. According to Hagen et al. (2016), female smoking prevalence is dramatically lower in developing countries (3.1%) than in developed countries (17.2%), whereas male smoking is similar (32% *vs.* 30.1%) in 2012. In China, male smoking prevalence is among the highest in the world at 52.9%, while only 2.4% of adult women are current smokers (Sansone et al., 2015). In addition, Female smoking has generally been seen as less socially acceptable than male smoking, two-thirds of adult men and one-third of adult women think it is unacceptable for women to smoke (*ibid.*).

Indicating the cultural gender norms in China may contribute to explaining the different findings from developed countries regarding gender differences in the relationship between income inequality and health. Compared to developed countries, China may uphold stricter moral standards for women and show less tolerance for behaviours considered less traditionally feminine, such as alcohol consumption and smoking. While this study emphasises gender differences in the relationship between income inequality and health in the Chinese context, its findings may not be directly applicable to other countries or regions. When beyond China’s specific socio-economic and cultural context, the findings that income inequality may result in a higher risk of adverse health outcomes for men than for women could also be framed as an expected result within the logic of evolutionary psychology. For example, men are more likely to participate in risky behaviours for status-seeking and mating competition, which could pose a danger to health (Charlton, 1996). Male status-seeking is related to fitness gains and male social status has strong fitness consequences (von Rueden, Gurven, & Kaplan, 2010).

Understanding gender differences in the relationship between income inequality and health may provide potential explanations for the mixed findings in the previous studies. As gender composition of the sample may influence the relationship between income inequality and health. A policy implication of this study is that reducing income

inequality could improve individual health, as income inequality adversely affects individual health. Previous policies often targeted socio-economically vulnerable individuals and groups, such as women and the old population. However, this study shows that reducing income inequality could enhance individual health outcomes, with a more notable impact on men's health compared to women's. Thus, it is important for the Chinese government to reduce income inequality, even though some efforts have been made. Policy designs need to consider the balance between efficiency and equity; for example, further reducing regional income inequality between the poorer western regions and wealthier central regions, and between rural and urban areas.

## CRediT authorship contribution statement

**Lin Li:** Conceptualization, Data curation, Formal analysis, Methodology, Software, Validation, Writing – original draft, Writing – review & editing.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

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