BMJ Open

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-014402
Article Type:	Research
Date Submitted by the Author:	21-Sep-2016
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Primary Subject Heading:	Public health
Secondary Subject Heading:	Sociology
Keywords:	PUBLIC HEALTH, SOCIAL MEDICINE, INTERNAL MEDICINE

Socioeconomic Status and Prevalence of Chronic Non-communicable Diseases in Chinese Women

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Word count of text: 3094.

Keywords: chronic non-communicable diseases; socioeconomic status; Chinese women

Objective: To investigates the role of socioeconomic status (SES) in chronic non-communicable diseases (NCDs), and offer theory evidence for prevention and control of NCDs.

Design: Cross-section survey and data analysis by structural equation model (SEM).

Setting: Nationwide.

Participants: Participation in this study was restricted to women aged 15 years and older who were investigated in 2008 National Health Services Survey (NHSS) in China.

Outcome measures: Two health outcomes were used including number of NCDs and self-reported health. Individual annual income, education, occupation and medical insurance were used to measure SES. In addition, there was a behavioral indicator, smoking.

Results: In Chinese women, except for education, other factors associated with SES increased the risk for NCDs. Education played the biggest protective role in SES (-0.115). Occupation affected NCDs mostly indirectly. The effects of SES on NCDs were more significant than smoking. Medical insurance, smoking and self-reported health mediated the correlation between SES with NCDs.

Conclusions: In China, socioeconomic disparities associated with the prevalence of NCDs exist among women. Educational and social interventions are needed to mitigate the negative health outcomes in Chinese women.

Strengths and limitations of this study

- In this study, we used SEM in data analysis which has advantage in constructing complex model of multiple causes and effects, hence we can explore the more precise and distinct impacts of SES on NCDs.
- We determined that how the SES influenced NCDs exactly considering the interaction of SES with other factors and found the key and mediate SES, then created theory foundation for prevention and control of Chinese women.
- In this study, it was regrettable that we analyzed the NCDs condition only for women.

BACKGROUND

Chronic non-communicable diseases (NCDs) are the leading cause of death worldwide [1, 2], and most patients afflicted with NCDs live in low- and middle-income countries (LMICs) [3, 4].A study of23 LMICs revealed that NCDs accounted for 50% of the total disease burdenandapproximately80% of mortality in 2005 [5]. Unfortunately, the growing threat of NCDs for the social and economic development of LMICs is often under-appreciated [3].

Many lifestyle and behavioral risk factors are associated with NCDs [6-9] and are closely linked to socioeconomic status (SES) [10].Empirical evidence shows that SES is inversely correlated with NCDs in industrialized Western countries [11]. However, studies have failed to replicate such findings in developing or transitional countries [12].

The mechanism underlying the role of SES in NCDs is largely unknown. Several SES factors probably affect NCDs via SES and/or behavioral factors. Previous studies have often failed to delineate the indirect effects. A few studies used an SES index, incorporating several indicators[13]. Other studies selected a single SES indicator [14, 15]. The former approach prevented researchers from further exploration of indirect effects, while the latter skewed the conclusions. Studies using multiple SES indicators have also been reported [16, 17]. However, each SES indicator was usually treated as an independent entity.

This study adopts a structural equation model (SEM), which facilitated analysis of the interaction between multiple variables (e.g., SES, behavioral risks and NCDs), as well as the role of a single variable on multiple parameters.

METHODS

Participants

Over the past decades, China experienced rapid economic growth, but with enormous wealth inequalities. NCDs have started to attract increasing concerns [18-21] as they account for an estimated 80% of deaths and 70% of disability-adjusted life-years lost in China [22].

Participants in this study were restricted to women aged 15 years and older since women are more likely to suffer from NCDs than men. Since the founding of People's Republic of China, the social status of Chinese women improved under the leadership of Chairman Mao, who advocated gender equality. However, increased workforce participation does not exempt women from fulfilling their traditional household duties, leading to serious problems in work-life balance [23, 24]. It is believed that Chinese women are more vulnerable to NCDs. The 2008 National Health Services Survey (NHSS) in China revealed a higher prevalence of cancer, diabetes, heart disease, hypertension, and mental illness in Chinese women compared with Chinese men [25].Further, the association between SES and NCDs is gender-dependent. For example, hypertension was found to be inversely associated with SES in women, but positively associated with SES in men [15, 16, 26]. In addition, women are more likely to experience socioeconomic difficulties than their male counterparts [27].

Sampling methods

Data used for this study were derived from the 2008 National Health Services Survey (NHSS) organized by the Ministry of Health, China. Participants were selected using a multi-stage stratified random sampling strategy.

First, 90 cities/counties were proportionately and randomly selected and classified into five groups based on10socioeconomic indicators. Second, five districts/townships were selected from each of these cities/counties using a simple random approach. In the third stage, the participating communities were narrowed down to two neighborhoods/villages randomly from each district/township. Finally, 60 households were randomly selected from each selected community. Health and health services of all the members of the selected households were recorded using questionnaires. A total of 66,500 women were found eligible to participate in this study.

Data collection

The survey was undertaken through face-to-face interviews. When a household member was absent, a proxy respondent was considered. In total, less than 30% of questionnaires were completed by proxy participants.

The interviews were conducted by community health workers, with supervision from medical doctors. Training was provided to all the interviewers and supervisors prior to the survey. Each supervisor was required to visit 5% of the households under his/her supervision to examine the accuracy of data recorded in the questionnaires. Fourteen questions were repeated during the supervisor visits in the absence of the interviewers. A consistency rate of

91% to 97% was recorded.

Variables

Two health outcomes (Y) were used for the data analysis to develop the structural equation model (SEM).

- Number of NCDs: NCD was defined as a chronic medical condition diagnosed by a physician at least six months before the survey, for which either the symptom(s) persisted or relevant medical treatment continued. Participants were first asked whether they experienced one or more NCDs over the past six months. If the answer was "yes", the specific diagnoses were recorded. The NCDs were then recorded. The diagnoses were also used to confirm the health condition and accuracy of data. The main NCDs reported by the participants included cancer, heart disease, cerebrovascular disease, respiratory disease, endocrine disorders, and nutrition and metabolic disease.
- Self-reported health: It was measured using a health rating scale ranging from 0 (worst) to 100 (best).

The following SES indicators were collected in the 2008 NHSS:

- Educational attainment was measured by years of study based on a scale of 1 to 4, with 1 suggesting no formal education; 2 indicating education up to middle school; 3 denoting high school level; and 4 standing for college and university level education;
- Individual annual income was classified into five groups: 1 (≤2500 Yuan); 2 (2501-3999 Yuan); 3 (4000-5999 Yuan); 4 (6000-10000 Yuan); highest (>10000 Yuan).
- Occupation was classified into five groups, based on employment and role of manual labor: 1 (no paid job); 2 (manual, such as farming); 3 (semi-manual); 4 (skilled); 5 (management).
- Medical insurance was coded according to the level of security covered by the government-sponsored social health insurance schemes: 1,no insurance coverage; 2, New Rural Cooperative Medical Scheme (NCMS) and Medical Insurance for Urban residents (MIUR); and 3,Free Medical Care (FMC) and Medical Insurance for Urban Employees (MIUE).

Behavioral risk factors of NCDs measured in the 2008 NHSS included smoking, alcohol consumption, physical activity, and preventive medical examination. However, only smoking and physical activity were found to be associated with NCDs. The association between physical activity and NCDs was not linear: Moderate physical exercise reduced NCDs, whereas, vigorous exercise increased NCDs. Therefore, only smoking was incorporated in the SEM. We tested four measures of smoking in the SEM: smoking as a dichotomous variable (yes or no); frequency of smoking; volume of cigarette consumption; and a latent variable incorporating both frequency and volume of cigarette consumption. The dichotomous measurement of smoking produced the best fit of model.

Data analysis

We used SPSS (version 16) for descriptive analyses and AMOS 17 for SEM.

The SEM analyses were performed to test the relationship between health outcomes, SES, and NCDs risk factors. SEM facilitates multiple interactions between variables. The SEM approach scored over the traditional regression method. In this study, education, income, occupation and medical insurance were belong to SES indicators, so we constructed a measurement model with a latent variable named SES and several observed variables including above all SES indicators firstly, but the results of goodness of fit test were not acceptable. The cause of such consequences was the directions of impact of SES indicator on NCDs were different, some were protective factors and others were risk factors. Moreover, these SES indicators influenced between each other. To analyze the mechanism of action among NCDs, SES and behavior clearly and intensively, we used path analysis with observed variables (PA-OV) to construct SEM only containing observed variables. And we test the significance of every factor on NCDs by bootstrap (the number of bootstrap samples was 5000), and analyzed their effect on NCDs.

Five SEM models were developed to test the hypotheses. All variables including education, individual annual income, occupation, medical insurance, smoking, self-reported health, NCDs, were involved in all SEM model. Figure 1 was the Base Model for NCDs, SES, and other factors. Model A added education→ income on the basis of Base Model, Model B introduced income→ medical insurance basing on Model A, Model C added education→ smoking on the base of Model B, finally Model D introduced income→smoking on the basis of Model C.

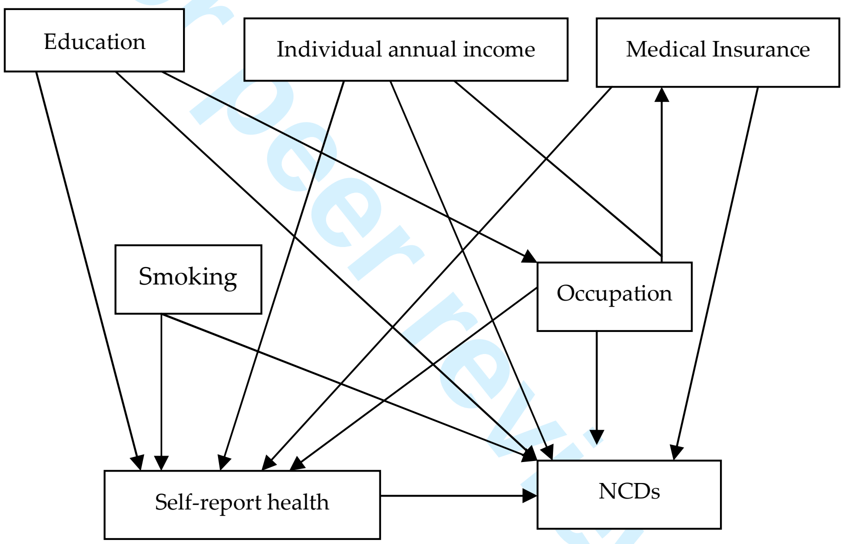

Figure 1. Base Model of SES, NCDs, and other factors in Chinese women

Goodness-of-fit testing provided additional evidence to support the mediation hypotheses. We evaluated the SEM using a number of model fit indices. A non-significant chi-square indicates a good fit. However, chi-square statistics are inflated by the large sample size. Therefore, we also examined goodness-of-fit index (GFI) and adjusted goodness-of-fit index (AGFI), root mean square error of approximation (RMSEA) and root mean square residual (RMR). These indices range from 0 to 1, with a value ≥0.90 for GFI and AGFI, ≤0.06 for RMSEA, and ≤0.08 for RMR indicating a good fit.

RESULTS

Participant profile

The majority (73%) of participants completed middle or high school education. Their personal income distribution varied evenly across five ranges. Approximately, more than 50% of all the participants engaged in manual labor. The low entitlement insurance schemes (NCMS/MIUR) covered over 70% of participants. Less than 3% of participants were smoking at the time of the survey (Table 1).

NCDs and SES, self-reported health

Nearly2.98% participants reported suffering from two NCDs, while 0.7% reported three or more NCDs. The participants reported an average score of 80.02 (SD=14.23) out of 100 in terms of perceived overall health.

NCDs were found to be associated with education, individual annual income, occupation, medical insurance, and smoking (Table 1). A lower prevalence of NCDs was associated with higher educational attainment, lower income, and absence of smoking (p<0.0001).

Table 1 Variation of NCDs with SES

Characteristics of participants	N (%)	NCDs, n (%)				*P*-value
		0	1	2	3	
Education						
1 No formal education	13836(20.81)	9736(70.37)	3248(23.47)	703(5.08)	149(1.08)	
2 Up to middle school	39027(58.69)	32927(84.37)	4884(12.51)	983(2.52)	233(0.60)	<0.001
3 Up to high school	9756(14.67)	8595(88.10)	879(9.01)	223(2.29)	59(0.60)	
4 College/university	3881(5.84)	3535(91.08)	254(6.54)	70(1.80)	22(0.57)	
Individual annual income						
1 ～2500	14515(21.83)	12186(83.95)	1935(13.33)	326(2.25)	68(0.47)	
2 ～4000	13519(20.33)	11388(84.24)	1771(13.10)	308(2.28)	52(0.38)	
3 ～6000	12328(18.54)	10332(83.81)	1609(13.05)	325(2.64)	62(0.50)	<0.001
4 ～10000	14052(21.13)	11653(82.93)	1883(13.40)	423(3.01)	93(0.66)	
5 >10000	12086(18.17)	9234(76.40)	2067(17.10)	597(4.94)	188(1.56)	
Occupation						
1 No paid job	17969(27.02)	14437(80.34)	2753(15.32)	642(3.57)	137(0.76)	
2 Manual (farmer)	34310(51.59)	29413(85.73)	4176(12.17)	617(1.80)	104(0.30)	
3 Semi-manual	7062(10.62)	5524(78.22)	1104(15.63)	333(4.72)	101(1.43)	<0.001
4 Skilled	4634(6.97)	3549(76.59)	770(16.62)	239(5.16)	76(1.64)	
5 Management	2525(3.80)	1870(74.06)	462(18.30)	148(5.86)	45(1.78)	
Medical Insurance						
1 No insurance	8704(13.09)	7440(85.48)	1020(11.72)	194(2.23)	50(0.57)	
2 NCMS/ MIUR	47232(71.03)	39698(84.05)	6212(13.15)	1120(2.37)	202(0.43)	<0.001
3 MIUE/ FMC	10564(15.89)	7655(72.46)	2033(19.24)	665(6.29)	211(2.00)	
Smoking						
1 No	64801(97.45)	53596(82.71)	8892(13.72)	1875(2.89)	438(0.68)	<0.001
2 Yes	1699(2.55)	1197(70.45)	373(21.95)	104(6.12)	25(1.47)	

Note: All *P*−values are two-tailed.

A gradient relationship between self-reported health and NCDs conditions was found, with better perceived health in participants without NCDs (82.70±12.36), intermediate health score in those with one NCD (68.88±15.19), and worse perceived health in those with two (62.98±15.73) and three or more (58.50±17.08) NCDs (F=4644.30, p<0.0001).

Model fit

The base model showed poor model fit, with chi-square statistics, RMR and RMSEA failing to reach the cut-off criteria indicating the need for mediators. Indeed, the model fit improved with the addition of mediators. Model D, which incorporated all the three mediator hypotheses, produced the best fit (Table 2).

Table 2. Model fit indices: Base Model and other competitive models

Model	Chi-square	df	P	RMR	GFI	AGFI	RMSEA
Base Model	5112.503	7	<0.001	0.220	0.979	0.916	0.105
Model A	1214.684	6	<0.001	0.043	0.995	0.976	0.055
Model B	330.820	5	<0.001	0.069	0.999	0.992	0.031
Model C	47.797	4	<0.001	0.006	1.000	0.999	0.013
Model D	0.774	3	0.856	0.002	1.000	1.000	0.000

Note. All P values are two-tailed. df: degree of freedom.

Estimates of regression weights in model D

Model D (Fig.2) was the only tested model that met all of the model fit criteria, including the chi-square statistics. It showed that higher educational attainment and self-reported health were protecting factors for NCDs. Smoking, higher individual annual income, occupations with less manuallabor, and higher levels of medical insurance entitlement were risk factors for NCDs. By contrast, self-reported health was positively associated with higher educational attainment and higher individual annual income, and negatively associated with smoking, occupations with less manuallabor, and higher levels of medical insurance entitlement (Fig.2).

Model D confirmed significant correlation between smoking and SES, and between SES indicators. Smoking was negatively correlated with educational attainment, and positively correlated with individual annual income levels. Individual annual income of the participants increased with higher educational attainments. Higher individual annual income was also correlated with higher levels of medical insurance entitlement (p<0.001; Fig.2).

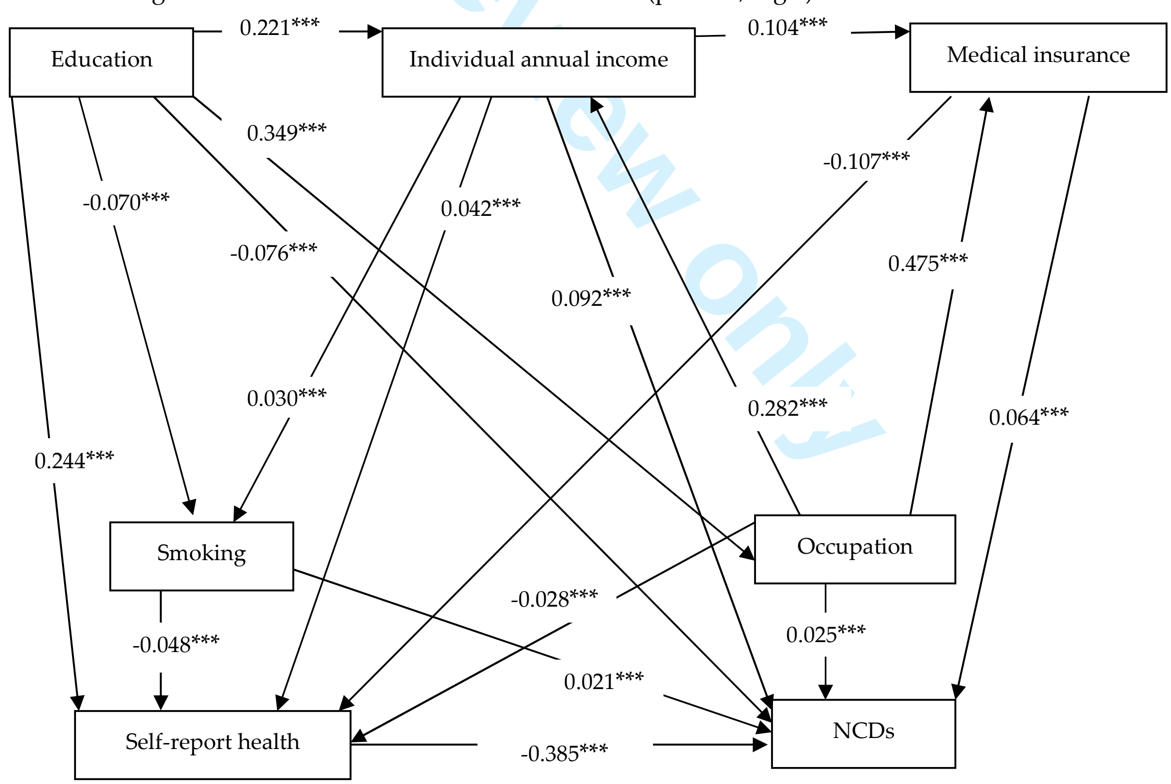

Figure 2. Model D of SES, NCDs, and other factors in Chinese Women

The numbers above the "→" were standardized regression weights. ***P<0.001(two-tailed test).

Estimates of direct and indirect effects

Overall, self-reported health had the greatest total effect on NCDs (r'=-0.385), followed by education (r'=-0.115). Education and medical insurance affected NCDs, directly (Table 3).The direct effect of individual annual income on NCDs was much greater than its indirect effect. The likelihood of income influencing NCDs via mediators (such as medical insurance and smoking) was minimal because its indirect effect was close to zero (Table3).The indirect effect of occupation on NCDs was greater than its direct effect. A partial mediator effect was confirmed, which suggests that occupation affected NCDs mainly through mediators such as individual annual income and medical insurance (Table 3).Smoking had a weak effect on NCDs, but remained low compared with the SES factors (Table 3).

Table 3. Direct and indirect effects of variables on NCDs

	Total	Direct	Indirect
Individual annual income	0.088***	0.092***	-0.004*
Occupation	0.110***	0.025***	0.086***
Medical Insurance	0.105***	0.064***	0.041***
Education	-0.115***	-0.076***	-0.039***
Smoking	0.040***	0.021***	0.018***
Self-reported Health	-0.385***	-0.385***	0.000

Note: All the effects were standardized. *P<0.05(two-tailed test). ***P<0.001(two-tailed test). "0" indicated that self-reported health did not affect NCDs indirectly.

DISCUSSION

We developed the SEM model D for NCDs with excellent fit. The model suggested that NCDs were associated with a complex network of risk factors. Education and self-reported health are the two most important predictors of NCDs in the model. Poor perception of health, lower educational attainment, higher individual annual income, higher levels of entitlement with medical insurance, and smoking are associated with higher risk of NCDs. Occupations with limited manuallabor also contributed to a higher risk for NCDs, although mainly through mediators such as individual annual income and medical insurance.

Education has been widely accepted as a protective SES factors for NCDs[28-31]. Our findings were consistent with several studies[30, 31] suggesting that education was the most important SES determinant in NCDs. Kimbro et al found that education not only had a strong direct impact on health, but was also a strong predictor of smoking incidence[32]. Over the past decades, China made great efforts and progress in reducing literacy gap between men and women. However, educational disparities also exist among women due to unbalanced socioeconomic development, for example, between urban and rural populations. The results of the 2010 population census of the People's Republic of China showed that the illiteracy rate in urban women aged above 15 years was 3.03%, compared with those living in towns and country at5.90% and 10.66%, respectively[33].

The effect of individual annual income on NCDs is controversial. We found that women with higher individual annual income were more likely to suffer from NCDs, similar to findings from other low- and middle-income countries[34-37], and in most high-income countries[38-40]. It is important to acknowledge that women in China have been encouraged to participate in workforce. Despite increased income, women are still under great pressure to fulfill their traditional duties in the family. The dual pressure (social and family) rendered working women more vulnerable to physical and mental health problems than men[24, 25, 27, 41-43]. Meanwhile, higher income has increased the adoption of sedentary lifestyles and excessive calorie intake, imposing a higher risk for NCDs. According to the Chinese National Nutrition and Health Survey in 2002, nearly 300 million Chinese people were overweight or obese. Nearly, 18.6% (160 million) of Chinese adults manifest abnormal blood lipids[44].

Higher levels of medical insurance are associated with higher risk of NCDs. Its impact is minimal since individuals are not entitled to select from the different schemes available and over 87.1% insurance coverage was achieved recently[25]. Social and medical insurance schemes in China are tied to residency and occupational enrollment. The association between medical insurance and NCDs partially reflects occupational and urban-rural disparities. However, we cannot exclude the possibility of reporting bias. In this study, NCDs were defined as a diagnostic condition. FMC/MIUE enrollees were more likely to visit doctors and seek hospital services than NCMS/MIUR enrollees and those without insurance coverage[25]. Therefore, they are more likely to report NCDs.

The effect of occupation on NCDs is partially mediated by individual annual income and medical insurance. Indeed, manual and labor-intensive jobs involve a high level of physical activity, which may mitigate lifestyle risk factors such as physical inactivity[45]. Occupations with limited manual labor are associated with additional risk factors. A study in Beijing found that 65.4% urban employees frequently worked overtime; 47.1% felt "overloaded" and 29% felt "exhausted"[46]. The "White Book on Urban White-collar Health in China" released by the Chinese medical professional bodies in 2010 reported that 76% of the urban white-collar workers were in a subclinical health condition, with nearly six in ten complaining of fatigue. Obviously, higher income and medical insurance entitlement does not improve individual health automatically. Instead, their NCD conditions may have been further exacerbated by higher income and medical insurance entitlement.

Surprisingly, smoking appeared to be a weak predictor of NCDs in this study, probably due to the low level of smoking rate (2.55%) among the participants and high level (72.4%) of exposure to passive smoking[47]. However, smoking remains one of the top five risk factors threatening women's health in China. China is the world's largest tobacco producer and consumer. The total number of adult smokers in China has exceeded 300 million, including 10 million women. Furthermore, tobacco control is a huge challenge[48], especially when smoking is combined with socioeconomic factors[49-51]. The SEM results indicate that smoking was positively associated with income and negatively associated with education. Given the financial sensitivity of tobacco consumption, the tobacco levy introduced in China recently, may become an effective instrument for tobacco control.

Self-reported health played an important role in the SEM model, although it was not the main focus of this study. The effect of self-reported health on NCDs is profound (r'=-0.385). Self-reported health is also closely associated with SES[52-54], and mediates effects on NCDs. A few researchers believe that self-reported health reflects physiological, mental and social indices[55, 56]. Empirical evidence suggests that self-reported health is a reliable predictor of morbidity and mortality[57-60].

Socioeconomic disparities associated with the prevalence of NCDs exist among women in China. High educational attainment is associated with a low risk of NCDs. However, economic development is unlikely to reduce NCDs. High individual annual income is associated with increased risk of NCDs, as well as increased smoking rate. The effect of occupation on NCDs is mainly mediated by income and medical insurance. People engaged in less manuallaborare more likely to live in urban areas, earning a high income, and enjoy high levels of entitlement with medical insurance, which in turn increases their risk of NCDs. In conclusion, China is facing a serious challenge during the current socioeconomic transition. Economic development has been accompanied by increasing burden of NCDs. Education and social interventions are needed to mitigate such negative consequences.

There were limitations in this study. The status of NCDs was self-reported, and therefore, the findings may not reflect true behaviors. Another potential limitation relates to the cross-sectional nature of the data. Therefore, no definitive statements can be made about causal relationship between SES, behavior and NCDs. It was regretting that the study focused on Chinese females alone, it could not illustrate the situation of NCDs for whole Chinese.

Acknowledgments: The authors thank the National Natural Science Fund (grant number: 71403074 and 71333003) for the funding of the research. The authors also appreciated two reviewers of this article for their very constructive comments and suggestions.

Author contributions: Dr. Qunhong Wu had full access to all the study data and is responsible for the integrity of the data and the accuracy of data analysis. Study concept and design: Qunhong Wu, Yanhua Hao, Limin Wang, Libo Liang; Acquisition, analysis, or interpretation of data: Hui Yin, Yu Cui, Yuchun Tao; Draft of the manuscript: Hui Yin; Critical revision of the manuscript for important intellectual content: Hui Yin, Yu Cui, Qunhong Wu, Yanhua Hao, Chaojie Liu; Statistical analysis: Hui Yin, Yu Cui, Ye Li, Libo Liang.

Funding: This research was supported by the National Natural Science Fund (grant number: 71403074 and 71333003).

Declaration of competing interests: None declared.

Data sharing statement: No additional data are available.

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Figure legends:

Figure 1: Base Model of SES, NCDs, and other factors in Chinese women
The figure 1 is the base model of NCDs and factors, and describes the complex relationship between all variables. In figure 1, “X→Y” means that X influences Y.

Figure 2. Model D of SES, NCDs, and other factors in Chinese Women
The figure 2 is the most fitness model of NCDs and factors, and describes the mechanism how SES and other factors affect NCDs including direction and size. “X→Y” means that X influences Y. The numbers above the “→” were standardized regression weight.
***P<0.001(two-tailed test).

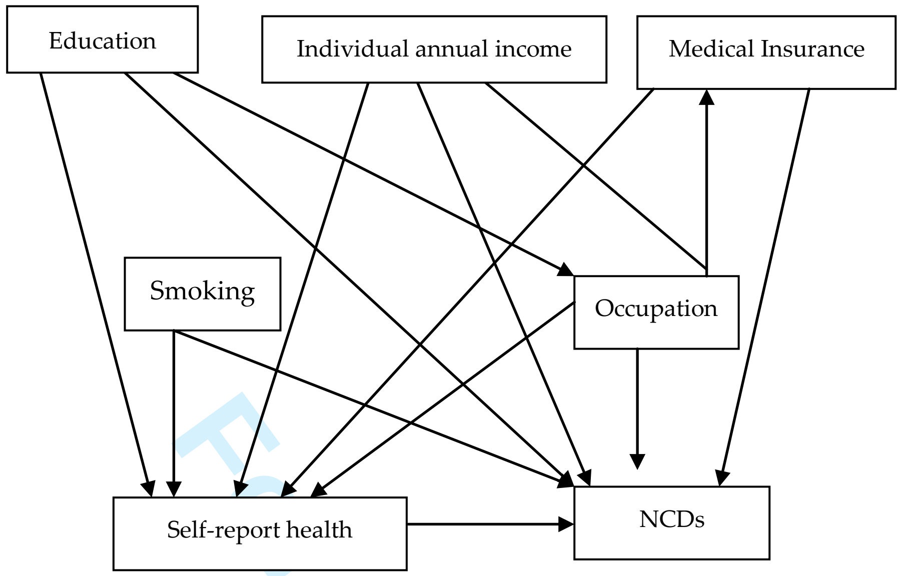

Figure 1. Base Model of SES, NCDs, and other factors in Chinese women

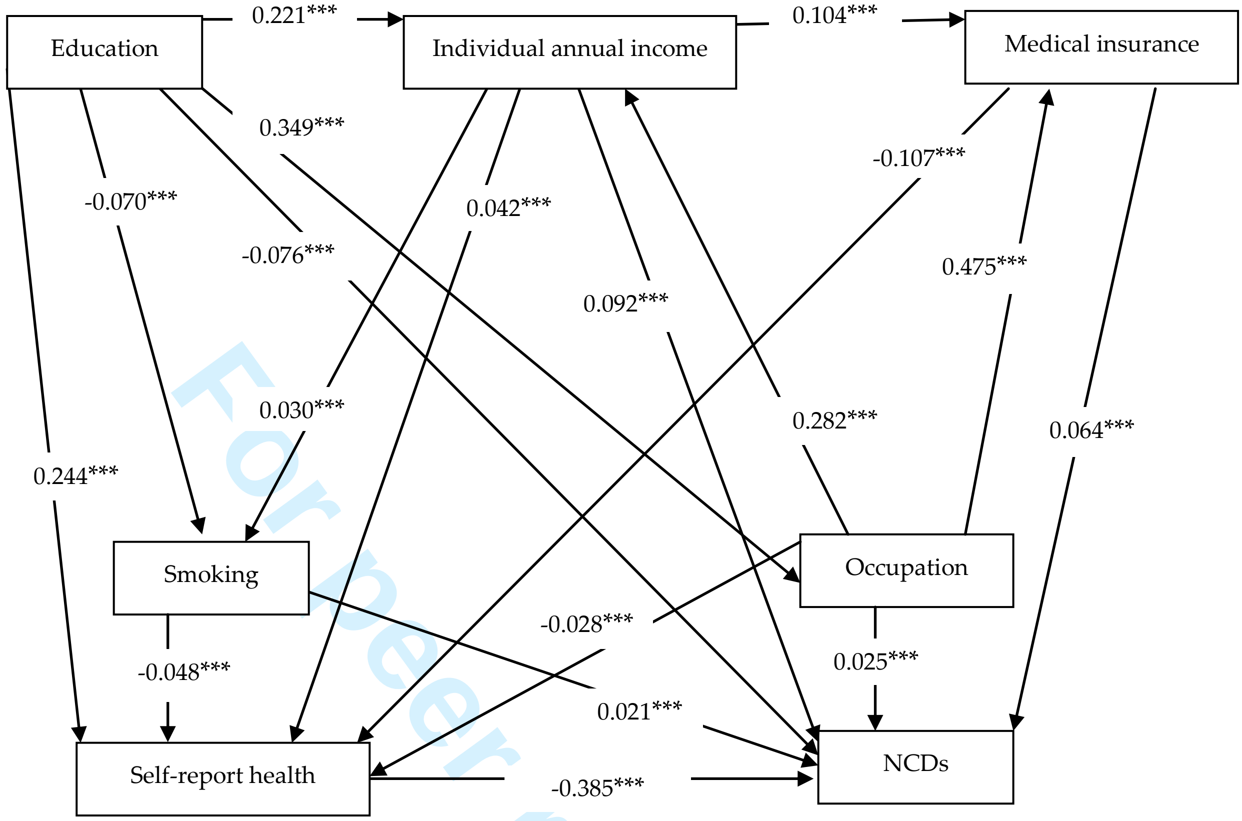

Figure 2. Model D of SES, NCDs, and other factors in Chinese Women

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BMJ Open

Socioeconomic Status and Prevalence of Chronic Non-communicable Diseases in Chinese Women: a Structural Equation Modeling Approach

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-014402.R1
Article Type:	Research
Date Submitted by the Author:	20-Dec-2016
Complete List of Authors:	Yin, Hui; Publich Health School in Harbin Medical University , Health educaiton Wu, Qunhong; Harbin Medical University, Social Medicine Cui, Yu; Harbin Medical University, School of Public Health Hao, Yanhua; Harbin Medical University, Social Medicine Liu, Chaojie; La Trobe University Li, Ye; Harbin Medical University, School of Public Health Liang, Libo; Harbin Medical University, School of Public Health Wang, Limin; School of Public Health, Harbin Medical University Tao, Yuchun; Shcool of Public Health, Harbin Medical University
Primary Subject Heading:	Public health
Secondary Subject Heading:	Sociology
Keywords:	PUBLIC HEALTH, SOCIAL MEDICINE, INTERNAL MEDICINE

Socioeconomic Status and Prevalence of Chronic Non-communicable Diseases in Chinese Women: a Structural Equation Modeling Approach

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Word count of text: 3872.

Keywords: chronic non-communicable diseases; socioeconomic status; Chinese women

ABSTRACT

Objective: To investigate the role of socioeconomic status (SES) in chronic non-communicable diseases (NCDs), and offer theoretical evidence for the prevention and control of NCDs.

Design: Cross-sectional survey and structural equation modeling (SEM).

Setting: Nationwide, China.

Participants: Female participants in the 2008 National Health Services Survey (NHSS) in China who were 15 years and older.

Outcome Measures: Number of NCDs and self-reported health and their associations with SES. SES was measured by annual individual income, educational attainment, occupation, and medical insurance. Smoking served as a behavioral risk indicator.

Results: SES factors were associated with the increased risk of NCDs in Chinese women. Education played the biggest protective role in SES (-0.115).Occupation mainly affected NCDs indirectly. The effects of SES on NCDs were more significant than that of smoking. Medical insurance, smoking, and self-reported health play a mediating role in the correlations between SES and NCDs.

Conclusions: In China, socioeconomic disparities associated with the prevalence of NCDs exist among women. Educational and social interventions are needed to mitigate their negative consequences on health outcomes in Chinese women.

Strengths and limitations of this study

- We used SEM in data analysis which is a powerful tool for developing complex and sophisticated theoretical models. SEM can enhance our understanding of the relationships between multiple factors.
- SEM possesses direct implications for the development of NCDs treatment and intervention programs, because it can improve our understanding of the impact of SES on NCDs and the interactions between SES factors and between SES and other factors.
- The NHSS is a cross-sectional survey, which prevents us from making any causal conclusions in the present study.
- The present analysis was restricted to women.

BACKGROUND

Chronic non-communicable diseases (NCDs) are the leading cause of death worldwide[1, 2], and most patients with NCDs live in low- and middle-income countries (LMICs)[3]. A study of23 LMICs revealed that NCDs accounted for 50% of the total disease burdenandapproximately80% of mortality in 2005[4]. Unfortunately, the growing threat of NCDs on social and economic development is often under-appreciated in LMICs[3].

Many lifestyle and behavioral risk factors are associated with NCDs[5,6] and are closely linked to socioeconomic status (SES)[7]. Empirical evidence shows that high SES is inversely correlated with NCDs in industrialized Western countries[8]. However, some studies failed to replicate such findings in developing or transitional countries[9].

NCDs were impacted by all kinds of variables. Except of biological factors, there is SES gradient in NCDs[10]. The mechanism underlying the role of SES in NCDs is largely unknown. Medical insurance is one of SES factors[11], and the prevalence of multiple chronic conditions varies from different health insurance coverage[12]. Smoking belonged to human behavior is risk for chronic diseases including cancer, cardiovascular disease, lung diseases, kidney diseases, digestive diseases, diabetes, urinary diseases, and so on[13]. In addition, self-rated health is subjective perception for health by respondents themselves, it is a strong predictor of subsequent mortality with SES gradient[14]. Self-rated health is negatively associated to depressed mood[15]. Depression may affect physical health problems, particularly chronic diseases[16]. Moreover, life style factors mediate on relationship between socioeconomic status and self-rated health[17]. Several SES factors probably affect NCDs via behavioral risk factors. It is remarkable that World Health Organization (WHO) put forward the Commission on Social Determinants of Health Conceptual Framework (CSDH) in 2009[7]. In CSDH, SES factors are social structural drivers which impact on daily living conditions including behavior, social cohesion, psychosocial factors, and so on, then health and distribution of health and well-being are influenced by them. In other words, the human behavior like smoking is a mediator in the relationship between SES and health.

Moreover, previous studies have often failed to delineate the indirect effects. A few studies used an SES index to incorporate several indicators[18]. Other studies selected a single SES indicator [19,20]. The former approach prevented researchers from further exploring the indirect effects of SES, while the latter skewed the conclusions. Studies using multiple SES indicators have also been reported[21,22]. However, each SES indicator was usually treated as an independent entity.

This study adopted a structural equation model (SEM) approach to investigate the associations of SES factors with NCDs, which enabled us to explore interactions between multiple variables (e.g., SES, behavioral risks and NCDs), as well as the role of a single variable on multiple parameters. And supply the implications for development of NCDs treatment and intervention programs in Chinese Women.

METHODS

Study design

The 2008 NHSS in China is nationwide cross-sectional survey.

Participants and Sampling methods

The participants of this study were female and aged 15 years and older who were from the 2008 NHSS in China.

Data used for this study were derived from the 2008 NHSS, which was organized by the Ministry of Health, China. The NHSS participants were selected using a multi-stage stratified random sampling strategy.

Firstly, 90 cities/counties were proportionately and randomly selected and classified into five groups based on10socioeconomic indicators. Secondly, five districts/townships were randomly selected from each of these cities/counties. In the third stage, the participating communities were narrowed down to two neighborhoods/villages randomly from each district/township of the selected cities/counties. Finally, 60 households were randomly selected from each selected community. The health status and use of health services of the members of the selected households were recorded in a questionnaire. A total of 66,500 women met the eligibility criteria of this study.

After the survey, the Health Statistical Center of the Ministry of Health of China (MOH) has made a systematic test and evaluation on the quality and representativeness of the survey data, the representative of the original sample showed a good representation to the overall population. Myer's Index was 3.48, which showed no age bias existed.

Variables

Two health outcomes (Y) were calculated in the development of the SEM.

- Number of NCDs: NCD was defined as a chronic medical condition diagnosed by a physician at least six months before the survey, for which either the symptom(s) persisted or relevant medical treatment continued. Participants were first asked whether they had experienced one or more NCDs over the past six months. If the answer was "yes", the specific diagnoses were recorded. The main NCDs reported by the participants included cancer, heart disease, cerebrovascular disease, respiratory disease, endocrine disorders, and nutrition and metabolic disease.
- Self-reported health: This was measured using a health rating scale ranging from 0 (worst) to 100 (best).

The following SES indicators were collected in the 2008 NHSS:

- Educational attainment was measured by years of study based on a scale of 1 to 4, with 1 indicating no formal education; 2 indicating education up to middle school; 3 indicating high school level; and 4 indicating college and university level education;
- Individual annual income was classified into five groups: 1 (≤2500 Yuan); 2 (2501-3999 Yuan); 3 (4000-5999 Yuan); 4 (6000-10000 Yuan); 5(>10000 Yuan).
- Occupation was classified into five groups: 1 (no paid job); 2 (manual, such as farming); 3 (semi-manual); 4 (skilled); 5 (management).
- Medical insurance was coded according to the level of security covered by the government-sponsored social health insurance schemes: 1,no insurance coverage; 2, New Rural Cooperative Medical Scheme (NCMS) and Medical Insurance for Urban residents (MIUR); and 3, Medical Insurance for Urban Employees (MIUE) and Free Medical Care (FMC).

Behavioral risk factors of NCDs measured in the 2008 NHSS included smoking, alcohol consumption, physical activity, and preventive medical examination. However, only smoking and physical activity were found to be associated with NCDs. The association between physical activity and NCDs was not linear: moderate physical exercise reduced NCDs, whereas, vigorous exercise increased NCDs. Therefore, only smoking was incorporated in the SEM. We tested four measures of smoking in the SEM: smoking as a dichotomous variable (yes or no); frequency of smoking; volume of cigarette consumption; and a latent variable incorporating both frequency and volume of cigarette consumption. The dichotomous measurement of smoking produced the best fit of the model.

Data collection

A questionnaire survey was undertaken through face-to-face interviews. When a household member was absent, a proxy respondent was considered. In total, less than 30% of questionnaires were completed by proxy respondents.

The interviews were conducted by community health workers with supervision from medical doctors. Training was provided to all of the interviewers and supervisors prior to the survey. Each supervisor was required to visit 5% of the households under his/her supervision to examine the accuracy of the data recorded in the questionnaires. Fourteen questions were repeated during the supervisor visits in the absence of the interviewers. A consistency rate of 91% to 97% was recorded.

Data analysis

We used SPSS (version 16) for the descriptive analyses and AMOS 17forSEM. The SEM is a statistical methodology that takes a confirmatory approach to the analysis of a structural theory bearing on some phenomenon[23]. SEM can analyze multiple independent variables and multiple dependent variables[24].Using SEM procedures, model can be developed to indentify factors that may be important to consider in developing effective interventions designed to improve the lives of individuals with disabilities and chronic illness[25]. SEM usually is applied into researches of Social Psychology and Behavioral Medicine, now it gradually is used extensively in various areas of Medicine. It is to be noted that more and more studies on NCDs have used SEM[26,27], and there were some researchers to analyzed the relationship between SES and NCDs by SEM[27].

The SEM analyses were performed to test the relationships between health outcomes, SES, and behavioral risk factors. SEM tests multiple interactions between variables. The SEM approach scored over the traditional regression method. In this study, SES was measured by education, income, occupation and medical insurance. We constructed a latent variable incorporating all of the above SES indicators firstly. But the results of goodness of fit test for the SEM were not acceptable, simply because the directions of impact of the SES indicators on NCDs were different: some were protective factors but others were risk factors. Moreover, these SES indicators influenced each other. Therefore, we used path analysis with observed variables (PA-OV) to construct the SEM in which only observed variables were contained. We tested the significance of each factor on NCDs by bootstrap (the number of bootstrap samples was 5000), and analyzed their effects on NCDs. Besides, the robustness check will be carried out using generalized linear model, and the results will supply in supplementary materials.

Five SEM models were developed to test the hypotheses, all including educational attainment, individual annual income, occupation, medical insurance, smoking, self-reported health, and NCDs. Figure 1 depicts the Base Model. Model A added education→ income on the basis of the Base Model. Model B introduced income→medical insurance based on Model A. Model C added education→smoking on the basis of Model B. Finally, Model D introduced income→smoking on the basis of Model C.

Goodness-of-fit testing provided additional evidence to support the mediation hypotheses. We evaluated the SEM using a number of model fit indices. A non-significant chi-square indicates a good fit. However, chi-square statistics are inflated by the large sample size. Therefore, we also examined the goodness-of-fit index (GFI) and the adjusted goodness-of-fit index (AGFI), root mean square error of approximation (RMSEA) and root mean square residual (RMR). These indices ranged from 0 to 1, with a value ≥0.90 for GFI and AGFI, ≤0.06 for RMSEA, and ≤0.08 for RMR indicating a good fit of models.

RESULTS

Participant profile

The majority (73%) of participants had completed middle or high school education. Their personal income was distributed evenly across the five ranges. More than 50% of all the participants engaged in manual labor. The low entitlement insurance schemes (NCMS/MIUR) covered over 70% of participants. Less than 3% of participants were smoking at the time of the survey (Table 1).

NCDs and SES, self-reported health

Nearly2.98% of participants suffered from two NCDs, while 0.7% suffered from three or more NCDs. The participants reported an average score of 80.02 (SD=14.23) out of 100 for perceived overall health.

Education, income, occupation, medical insurance, and smoking were associated with NCDs (Table 1). Higher educational attainment, lower income, and absence of smoking were associated with lower prevalence of NCDs (p<0.0001).

Table 1 SES and prevalence of NCDs

Characteristics of participants	N(%)	NCDs, n (%)				*P*-value
		0	1	2	3	
Education						
1 No formal education	13836(20.81)	9736(70.37)	3248(23.47)	703(5.08)	149(1.08)	<0.001
2 Up to middle school	39027(58.69)	32927(84.37)	4884(12.51)	983(2.52)	233(0.60)	
3 Up to high school	9756(14.67)	8595(88.10)	879(9.01)	223(2.29)	59(0.60)	
4 College/university	3881(5.84)	3535(91.08)	254(6.54)	70(1.80)	22(0.57)	
Individual annual income						
1 ～2500	14515(21.83)	12186(83.95)	1935(13.33)	326(2.25)	68(0.47)	<0.001
2 ～4000	13519(20.33)	11388(84.24)	1771(13.10)	308(2.28)	52(0.38)	
3 ～6000	12328(18.54)	10332(83.81)	1609(13.05)	325(2.64)	62(0.50)	
4 ～10000	14052(21.13)	11653(82.93)	1883(13.40)	423(3.01)	93(0.66)	
5 >10000	12086(18.17)	9234(76.40)	2067(17.10)	597(4.94)	188(1.56)	
Occupation						
1 No paid job	17969(27.02)	14437(80.34)	2753(15.32)	642(3.57)	137(0.76)	<0.001
2 Manual (farmer)	34310(51.59)	29413(85.73)	4176(12.17)	617(1.80)	104(0.30)	
3 Semi-manual	7062(10.62)	5524(78.22)	1104(15.63)	333(4.72)	101(1.43)	
4 Skilled	4634(6.97)	3549(76.59)	770(16.62)	239(5.16)	76(1.64)	
5 Management	2525(3.80)	1870(74.06)	462(18.30)	148(5.86)	45(1.78)	
Medical Insurance						
1 No insurance	8704(13.09)	7440(85.48)	1020(11.72)	194(2.23)	50(0.57)	<0.001
2 NCMS/ MIUR	47232(71.03)	39698(84.05)	6212(13.15)	1120(2.37)	202(0.43)	
3 MIUE/ FMC	10564(15.89)	7655(72.46)	2033(19.24)	665(6.29)	211(2.00)	
Smoking						
1 No	64801(97.45)	53596(82.71)	8892(13.72)	1875(2.89)	438(0.68)	<0.001
2 Yes	1699(2.55)	1197(70.45)	373(21.95)	104(6.12)	25(1.47)	

Note: All *P*−values are two-tailed.

A gradient relationship between self-reported health and NCDs conditions was found: best perceived health in those without NCDs (82.70±12.36), intermediate health score in those with one NCDs (68.88±15.19), and worst perceived health in those with two (62.98±15.73) and three or more (58.50±17.08) NCDs (F=4644.30, p<0.0001).

Model fit

The base model showed poor model fit, with chi-square statistics, RMR and RMSEA failing to reach the cut-off criteria. The model fit improved with the addition of mediators. Model D, incorporating all the three mediator hypotheses, produced the best fit (Table 2).

Table 2. Model fit indices: Base Model and other competitive models

Model	Chi-square	df	P	RMR	GFI	AGFI	RMSEA
Base Model	5112.503	7	<0.001	0.220	0.979	0.916	0.105
Model A	1214.684	6	<0.001	0.043	0.995	0.976	0.055
Model B	330.820	5	<0.001	0.069	0.999	0.992	0.031
Model C	47.797	4	<0.001	0.006	1.000	0.999	0.013
Model D	0.774	3	0.856	0.002	1.000	1.000	0.000

Note. All P values are two-tailed. df: degree of freedom.

Estimates of regression weights in model D

Model D (Fig.2) was the only tested model that met all of the model fit criteria including the chi-square statistics. It showed that higher educational attainment and self-reported health were protective factors for NCDs. Smoking, higher income, occupations with less manuallabor, and higher levels of medical insurance entitlement were risk factors for NCDs. Self-reported health was positively associated with higher educational attainment and higher income, and negatively associated with smoking, occupations with less manuallabor, and higher levels of medical insurance entitlement (Fig.2).

Model D confirmed the significant correlation between smoking and SES, and between SES indicators. Smoking was negatively correlated with educational attainment, and positively correlated with income levels. The income of the participants increased with higher educational attainments. Higher income was also correlated with higher levels of medical insurance entitlement ($p<0.001$; Fig.2).

Estimates of direct and indirect effects

Overall, self-reported health had the greatest total effect on NCDs (r'=-0.385), followed by education (r'=-0.115). Education and medical insurance affected NCDs directly (Table 3).The direct effect of income on NCDs was much greater than its indirect effect. The likelihood of income influencing NCDs via mediators (such as medical insurance and smoking) was minimal because its indirect effect was close to zero (Table3).The indirect effect of occupation on NCDs was greater than its direct effect. A partial mediator effect was confirmed, which suggested that occupation affected NCDs mainly through mediators such as income and medical insurance (Table 3).Smoking had a weak effect on NCDs compared with the SES factors (Table 3).

Table 3. Direct and indirect effects of variables on NCDs

	Total	Direct	Indirect
Individual annual income	0.088***	0.092***	-0.004*
Occupation	0.110***	0.025***	0.086***
Medical Insurance	0.105***	0.064***	0.041***
Education	-0.115***	-0.076***	-0.039***
Smoking	0.040***	0.021***	0.018***
Self-reported Health	-0.385***	-0.385***	0.000

Note: All the effects are standardized. *P<0.05(two-tailed test). ***P<0.001(two-tailed test). "0" indicates that self-reported health does not affect NCDs indirectly.

DISCUSSION

Over the past decades, China experienced rapid economic growth, but with enormous wealth inequalities. NCDs have started to attract increasing concerns[28,29] as they account for an estimated 80% of deaths and 70% of disability-adjusted life-years lost in China[30]. Chinese women are more vulnerable to NCDs than men. With the founding of the People's Republic of China, the social status of Chinese women improved under the leadership of Chairman Mao, who advocated gender equality. However, increased workforce participation does not exempt women from their traditional household duties, which leads to serious problems in work-lifebalance[31]. The 2008 NHSS in China revealed a higher prevalence of cancer, diabetes, heart disease, hypertension, and mental illness in Chinese women compared with Chinese men[32]. In addition, the association between SES and NCDs is gender-dependent. For example, hypertension was found to be inversely associated with SES in women, but positively associated with SES in men[20,21]. Moreover, women are more likely to experience socioeconomic difficulties than their male counterparts[33]. So this study focused on Chinese women.

We developed a SEM (model D) for NCDs with excellent fit. The model suggests that a complex network of risk factors is associated with NCDs. Education and self-reported health are the two most important predictors of NCDs in the model. Poor perceived health, lower educational attainment, higher income, higher levels of entitlement with medical insurance, and smoking are associated with a higher risk of NCDs. Occupations with limited manuallabor also contribute to a higher risk of NCDs, although mainly through mediators such as income and medical insurance.

Education has been widely accepted as a protective SES factor for NCDs[34-36]. Our findings are consistent with those in several studies[35,36], which suggest that education is the most important SES determinant in NCDs. Kimbro et al. found that education not only has a strong direct impact on health, but also is a strong predictor of smoking incidence[37]. Over the past decades, China has made great efforts and progress in reducing the literacy gap between men and women. However, educational disparities still exist among women due to unbalanced socioeconomic development, such as those between urban and rural communities. The results of the 2010 population census of China showed that the illiteracy rate of urban women aged 15 years and above was 3.03%, but the illiteracy rate of those living in rural towns and countieswas5.90% and 10.66%, respectively[38]. The effect of income on NCDs is controversial. We found that women with higher incomes are more likely to suffer from NCDs, similar to the findings from other low- and middle-income countries[39] and in most high-income countries[40]. It is important to acknowledge that women in China have been encouraged to participate in the workforce. Despite their increased income, women are still under great pressure to fulfill their traditional duties in the family. The dualpressure (social and family) rendersworking women more vulnerable to physical and mental health problems than men[32,33,41,42]. Meanwhile, higher income has increased the adoption of sedentary lifestyles and excessive calorie intake, imposing a higher risk for NCDs. According to the Chinese National Nutrition and Health Survey in 2002, nearly 300 million Chinese people were overweight or obese. Around 18.6% (160 million) of Chinese adults manifested abnormal blood lipids[43]. Higher levels of medical insurance entitlement are associated with a higher risk of NCDs. Its impact is minimal since individuals are not entitled to select from the different schemes available[32]. Social health insurance schemes in China are tied to residency and occupation. The association between medical insurance and NCDs partially reflects occupational and urban-rural disparities. However, we cannot exclude the possibility of reporting bias. In this study, NCDs were defined as a diagnostic condition. FMC/MIUE enrollees were more likely to visit doctors and seek hospital services than NCMS/MIUR enrollees[32]. Therefore, they are more likely to report NCDs. The effect of occupation on NCDs is partially mediated by income and medical insurance. Indeed, manual and labor-intensive jobs involve a high level of physical activity, which may mitigate lifestyle risk factors such as physical inactivity[44]. Occupations with limited manual labor are associated with additional risk factors. A study conducted in Beijing found that 65.4% of urban employees frequently worked overtime; 47.1% felt "overloaded" and 29% felt "exhausted"[45]. The "White Book on Urban White-collar Health in China" released by the Chinese medical professional bodies in 2010 reported that 76% of the urban white-collar workers were in a subclinical health condition, with nearly six in ten complaining of fatigue. Clearly, higher income and medical insurance entitlement does not improve individual health automatically. Instead, their NCD conditions may have been further exacerbated by higher income and medical insurance entitlement.

Surprisingly, smoking appeared to be a weak predictor of NCDs in this study, probably due to the low smoking rate (2.55%) among the participants and the high level (72.4%) of exposure to passive smoking[46]. However, smoking remains one of the top five risk factors threatening women's health in China. China is the world's largest tobacco producer and consumer. The total number of adult smokers in China has exceeded 300 million, including 10 million women. Furthermore, tobacco control is a huge challenge[47], especially when smoking is combined with socioeconomic factors[48]. The SEM results indicate that smoking is positively associated with income and negatively associated with education. Given the financial sensitivity of tobacco consumption, the tobacco levy introduced in China recently may become an effective instrument for tobacco control.

Self-reported health played an important role in the SEM model, although it was not the main focus on this study. The effect of self-reported health on NCDs is profound (r'=-0.385). Self-reported health is also closely associated with SES[49-51], and plays a mediating role. A few researchers believe that self-reported health reflects physiological, mental and social indices[52]. Empirical evidence suggests shat self-reported health is a reliable predictor of morbidity and mortality[53,54].

Socioeconomic disparities associated with the prevalence of NCDs exist among women in China. High educational attainment is associated with a low risk of NCDs. However, economic development is unlikely to reduce NCDs. High income is associated with an increased risk of NCDs, as well as increased smoking rate. The effect of occupation on NCDs is mainly mediated by income and medical insurance. People engaged in less manuallaborare more likely to live in urban areas, earn a high income, and enjoy high levels of entitlement with medical insurance, which in turn increases their risk of NCDs. In conclusion, China is facing a serious challenge during the current socioeconomic transition. Economic development has been accompanied by the increasing burden of NCDs. Educational and social interventions are needed to mitigate such negative consequences.

World Health Organization (WHO) launched a report about socioeconomic inequalities and chronic disease in several counties, and the report showed that high prevalence of obesity, high blood pressure, high cholesterol, high fasting blood glucose exists in lower education and higher income in Chinese Women[55]. Moreover, there was study in socioeconomic inequality in NCDs in rural population of LMICs, which indicated having higher income, household assets or social class was associated with hypertension in South Asia, and compared with other occupation, farmers or manual labourers were associated with a lower risk for hypertension in all countries of this study[56]. The summary of this study in the above paragraph was consistent with these studies mostly. This study testified these research findings, and enriched the connotation of relationship between SES and NCDs in LMICs. And what's more, the results of this study will offer important implications for prevention and control of NCDs in Chinese Women.

There were several limitations in this study. The status of NCDs was self-reported, and therefore, the findings are subject to recall bias. Another potential limitation relates to the cross-sectional nature of the data. No definitive statements can be made about the causal relationships between SES, risk behaviors and NCDs. Although the data from NHSS is the most authoritative data of health in China, the survey is cross section design which prevents us from making any causal conclusions in the present study. The study focused on Chinese women, which does not illustrate the situation of NCDs for the entire Chinese population.

Acknowledgments: The authors thank the National Natural Science Fund (grant number: 71403074 and 71333003) for funding this research. The authors also appreciate two reviewers of this article for their very constructive comments and suggestions.

Author contributions: Dr. Qunhong Wu has full access to all the study data and is responsible for the integrity of the data and the accuracy of data analysis. Study concept and design: Qunhong Wu, YanhuaHao, Limin Wang, LiboLiang. Acquisition, analysis, and interpretation of data: Hui Yin, Yu Cui, YuchunTao. Draft of the manuscript: HuiYin.Critical revision of the manuscript for important intellectual content: Hui Yin, Yu Cui, Qunhong Wu, YanhuaHao, ChaojieLiu. Statistical analysis: Hui Yin, Yu Cui, Ye Li, Libo Liang.

Funding: This research was supported by the National Natural Science Fund (grant number: 71403074 and 71333003).

Declaration of competing interests: None declared.

Ethics approval: The research was approved by the Medical Ethics Committee of Harbin Medical University (Daqing).

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Figure legends:

Figure 1:Base SEM Model

Figure 1 is the base model describing the complex relationships between all variables. In figure 1, "X→Y" means that X influences Y.

Figure 2. SEM Model D

Figure 2 is the SEM model D with best fit, which describes the mechanisms involved in the relationships between SES and NCDs including their direction and size. "X→Y" means that X influences Y. The numbers above the "→"are standardized regression weight.

***P<0.001(two-tailed test).

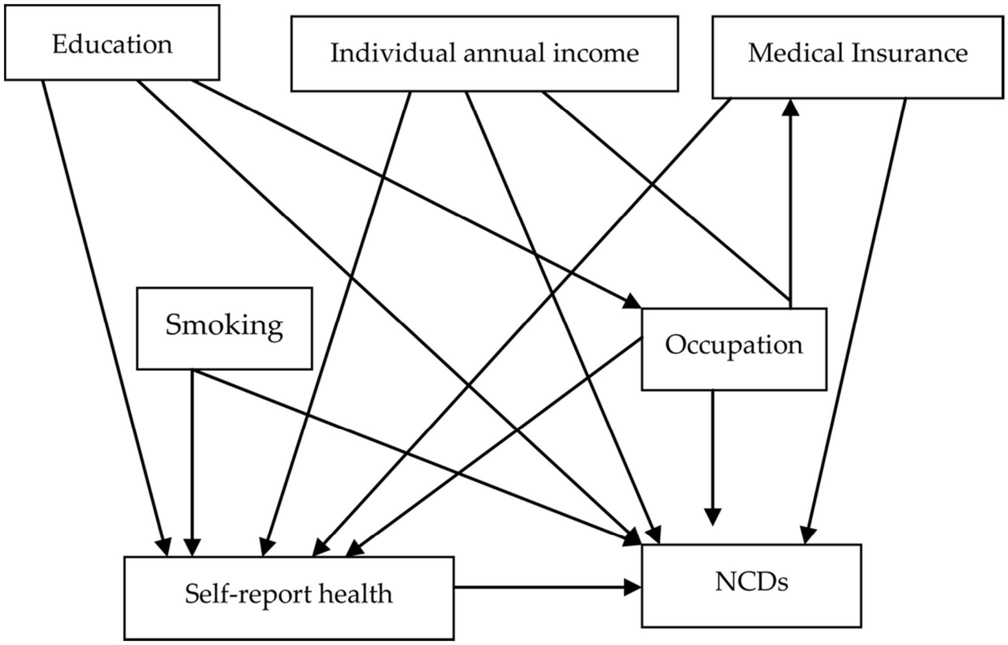


Figure 1:Base SEM Model
Figure 1 is the base model describing the complex relationships between all variables. In figure 1, “X→Y” means that X influences Y.

106x67mm (300 x 300 DPI)

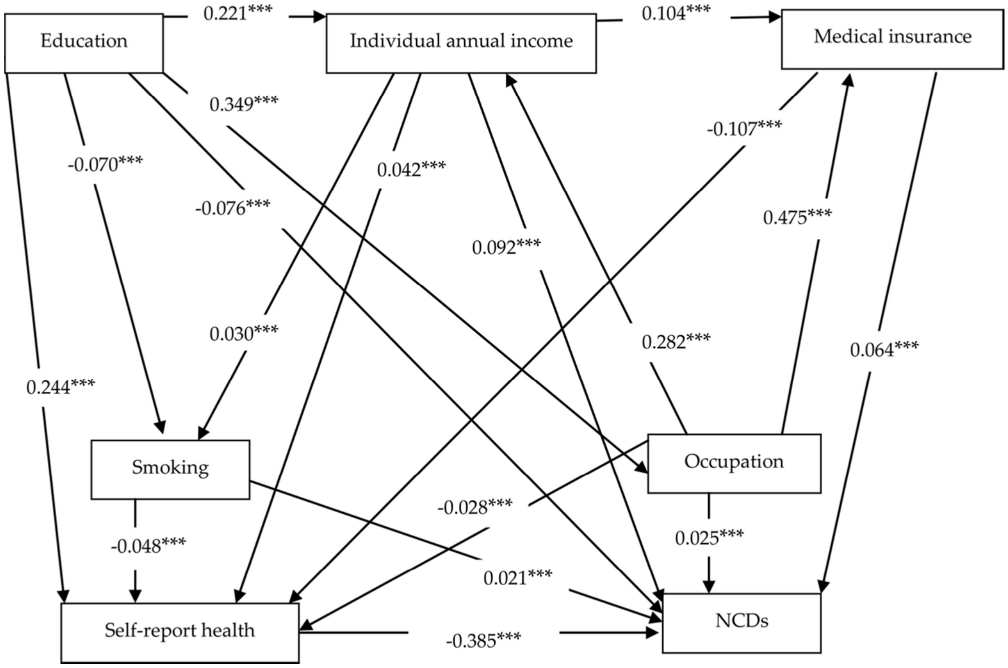


Figure 2. SEM Model D
Figure 2 is the SEM model D with best fit, which describes the mechanisms involved in the relationships between SES and NCDs including their direction and size. "X→Y" means that X influences Y. The numbers above the "→"are standardized regression weight. ***P<0.001(two-tailed test).

112x74mm (300 x 300 DPI)

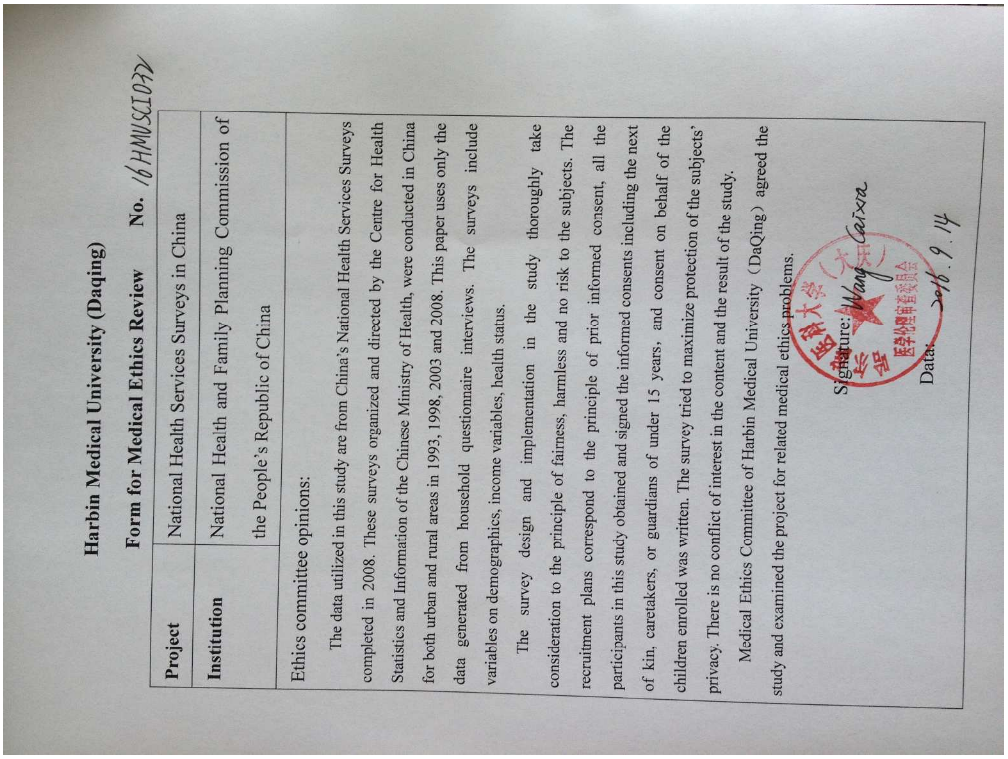
STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract P1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found P2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported P2-3
Objectives	3	State specific objectives, including any prespecified hypotheses P3
Methods		
Study design	4	Present key elements of study design early in the paper P3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection P3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants P3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable P4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group P4
Bias	9	Describe any efforts to address potential sources of bias P4
Study size	10	Explain how the study size was arrived at P3
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why P4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding P5
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed P4
		(*d*) If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders P6
		(b) Indicate number of participants with missing data for each variable of interest
Outcome data	15*	Report numbers of outcome events or summary measures P6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included P5-7
		(*b*) Report category boundaries when continuous variables were categorized P6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

Discussion			
Key results	18	Summarise key results with reference to study objectives	P8-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	P9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	P9
Generalisability	21	Discuss the generalisability (external validity) of the study results	P9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	P10

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.



Harbin Medical University (Daqing)

Form for Medical Ethics Review No. 16HMUSC1037

Project	National Health Services Surveys in China
Institution	National Health and Family Planning Commission of the People's Republic of China

Ethics committee opinions:

The data utilized in this study are from China's National Health Services Surveys completed in 2008. These surveys organized and directed by the Centre for Health Statistics and Information of the Chinese Ministry of Health, were conducted in China for both urban and rural areas in 1993, 1998, 2003 and 2008. This paper uses only the data generated from household questionnaire interviews. The surveys include variables on demographics, income variables, health status.

The survey design and implementation in the study thoroughly take consideration to the principle of fairness, harmless and no risk to the subjects. The recruitment plans correspond to the principle of prior informed consent, all the participants in this study obtained and signed the informed consents including the next of kin, caretakers, or guardians of under 15 years, and consent on behalf of the children enrolled was written. The survey tried to maximize protection of the subjects' privacy. There is no conflict of interest in the content and the result of the study.

Medical Ethics Committee of Harbin Medical University（DaQing）agreed the study and examined the project for related medical ethics problems.

Signature: Wang Caixia

Data: 2016.9.14

Ethics approval

1151x863mm (72 x 72 DPI)

Robustness check

In this study, we used two multiple linear regressions to check the Robustness.

1. Influencing factors of NCDs

The first multiple linear regression was to analyze the effects of individual annual income, education, occupation, medical insurance, smoking and self-reported health on NCDs (Table 1).

Table 1 The effects of individual annual income, education, occupation, medical insurance, smoking and self-reported health on NCDs by multiple linear regression

Independent	B	ß	*P*	95% CI	
				lower	upper
intercept	1.211		0.000	1.185	1.236
individual annual income	0.035	0.096	0.000	0.032	0.038
education	-0.053	-0.077	0.000	-0.058	-0.048
occupation	0.012	0.022	0.000	0.007	0.016
medical insurance	0.060	0.062	0.000	0.053	0.068
smoking	0.066	0.020	0.000	0.043	0.089
self-reported health	-0.014	-0.388	0.000	-0.015	-0.014

Note: "B" was un standardized regression coefficient; *ß was* standardized regression coefficient.

As table 1 showed that all of factors were relation with NCDs, and education and self-reported health were protective factors for NCDs, others were risk. The results were consistent with SEM.

2. Influencing factors of self-reported health

The second multiple linear regression was to analyze the effects of individual annual income, education, occupation, medical insurance, smoking on self-reported health (Table 2).

Table 2 The effects of individual annual income, education, occupation, medical insurance, smoking on self-reported health by multiple linear regression

Independent	B	ß	*P*	95% CI	
				lower	upper
intercept	75.151		0.000	74.687	75.616
individual annual income	0.280	0.028	0.000	0.200	0.360
education	5.161	0.277	0.000	5.013	5.308
occupation	-0.400	-0.028	0.000	-0.528	-0.272
medical insurance	-2.786	-0.105	0.000	-3.011	-2.561
smoking	-4.575	-0.051	0.000	-5.233	-3.917

Note: "B" was un standardized regression coefficient; *ß was* standardized regression coefficient.

As table 1 showed that effects of individual annual income, education, occupation, medical insurance, smoking were significant. Individual annual income and education had positive correlation to self-reported health, and others had negative correlation with self-reported health. This results were consistent with SEM, too.

BMJ Open

Socioeconomic Status and Prevalence of Chronic Non-communicable Diseases in Chinese Women: a Structural Equation Modeling Approach

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-014402.R2
Article Type:	Research
Date Submitted by the Author:	08-Feb-2017

Complete List of Authors:	Yin, Hui; Publich Health School in Harbin Medical University , Health educaiton Wu, Qunhong; Harbin Medical University, Social Medicine Cui, Yu; Harbin Medical University, School of Public Health Hao, Yanhua; Harbin Medical University, Social Medicine Liu, Chaojie; La Trobe University Li, Ye; Harbin Medical University, School of Public Health Liang, Libo; Harbin Medical University, School of Public Health Wang, Limin; School of Public Health, Harbin Medical University Tao, Yuchun; Shcool of Public Health, Harbin Medical University

Primary Subject Heading:	Public health
Secondary Subject Heading:	Sociology
Keywords:	PUBLIC HEALTH, SOCIAL MEDICINE, INTERNAL MEDICINE

Socioeconomic Status and Prevalence of Chronic Non-communicable Diseases in Chinese Women: a Structural Equation Modeling Approach

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Word count of text: 3843.

Keywords: chronic non-communicable diseases; socioeconomic status; Chinese women

ABSTRACT

Objective: To investigate the role of socioeconomic status (SES) in chronic non-communicable diseases (NCDs), and offer theoretical evidence for the prevention and control of NCDs.

Design: Cross-sectional survey and structural equation modeling (SEM).

Setting: Nationwide, China.

Participants: Female participants in the 2008 National Health Services Survey (NHSS) in China who were 15 years and older.

Outcome Measures: Number of NCDs and self-reported health and their associations with SES. SES was measured by annual individual income, educational attainment, occupation, and medical insurance. Smoking served as a behavioral risk indicator.

Results: SES factors were associated with the increased risk of NCDs in Chinese women. Education was identified as the most important factor with a protective role (factor loading=-0.115) for NCDs. Income mainly affected NCDs directly; whereas, occupation mainly affected NCDs indirectly. The effects of SES on NCDs were more significant than that of smoking. Medical insurance, smoking, and self-reported health played a mediating role in the correlations between those SES factors and NCDs.

Conclusions: In China, socioeconomic disparities associated with the prevalence of NCDs exist among women. Educational and social interventions are needed to mitigate their negative consequences on health outcomes in Chinese women.

Strengths and limitations of this study

- We used SEM in data analysis which is a powerful tool for developing complex and sophisticated theoretical models that involve a large number of linear equations. SEM can enhance our understanding of the relationships between multiple factors, such as the relative contributions of SES factors and other factors related to NCDs and the correlations between SES and other factors.
- Like all statistical models, SEM presents approximations of reality. Variables included in the SEM models are subject to the restrictions of data availability. Further studies with additional variables may help improve the model fit with reality.
- The NHSS is a cross-sectional survey, which prevents us from making any causal conclusions in the present study.

BACKGROUND

Chronic non-communicable diseases (NCDs) are the leading cause of death worldwide[1, 2], and most patients with NCDs live in low- and middle-income countries (LMICs)[3]. A study of 23 LMICs revealed that NCDs accounted for 50% of the total disease burden and approximately 80% of mortality in 2005[4]. Unfortunately, the growing threat of NCDs on social and economic development is often under-appreciated in LMICs[3]. Empirical evidence shows that high SES (e.g. high levels of education and income) is inversely correlated with NCDs in industrialized Western countries[5]. However, some studies failed to replicate such findings in developing or transitional countries[6].

The mechanism underlying the role of SES in NCDs is largely unknown. Several SES factors, such as income, education and occupation, probably affect NCDs[7]. Medical insurance is also widely considered as one of the SES indicators[8], which may be associated with NCDs [9]. Many lifestyle and behavioral risk factors are associated with NCDs[10,11] and are closely linked to SES[12]. For example, smoking is associated with cancer, diabetes, cardiovascular disease, lung disease, kidney disease, digestive disease, and urinary disease[13]. Lifestyle and behavioral factors have been found to mediate the relationship between SES and self-rated health[14], which is a strong predictor of NCDs and mortality with SES gradient[15,16]. Self-rated health is negatively associated with depressed mood, which may affect physical health problems, particularly chronic diseases[17]. The World Health Organization (WHO) Commission on Social Determinants of Health (CSDH)[12] considers SES as a structural driver impacts on people's daily lives and activities, which in turn, influence people's health and well-being.

Previous studies have often failed to delineate the indirect effects of SES. A few studies used an SES index to incorporate several indicators[18]. Other studies selected a single SES indicator [19,20]. The former approach prevented researchers from further exploring the indirect effects of SES, while the latter skewed the conclusions. Studies using multiple SES indicators have also been reported[21,22]. However, each SES indicator was usually treated as an independent entity.

This study adopted a structural equation model (SEM) approach to investigate the associations of SES factors with NCDs, which enabled us to explore associations between multiple variables (e.g. SES, behavioral risks and NCDs), as well as the role of a single variable on multiple parameters. Such a study has policy implications for the development of NCD treatment and intervention programs, because it can improve our understanding of the impact of SES on NCDs.

METHODS

Study design

Data used for this study were derived from the 2008 NHSS, which was a nationwide cross-sectional survey organized by the Ministry of Health, China.

Participants and Sampling methods

The participants of this study were restricted to the female participants of the 2008 NHSS in China who were aged 15 years and older.

The NHSS participants were selected using a multi-stage stratified random sampling strategy. Firstly, 90 cities/counties were proportionately and randomly selected and classified into five groups based on10socioeconomic indicators. Secondly, five districts/townships were randomly selected from each of these cities/counties. In the third stage, the participating communities were narrowed down to two neighborhoods/villages randomly from each district/township of the selected cities/counties. Finally, 60 households were randomly selected from each selected community. The health status and use of health services of the members of the selected households were recorded in a questionnaire. A total of 66,500 women met the eligibility criteria of this study. The representativeness and quality of data collected in the NHSS were assessed by the National Health Statistical Center. A Myer's Index of 3.48 was found, showing no age bias.

Variables

Two health outcomes (Y) were calculated in the development of the SEM.

- Number of NCDs: NCD was defined as a chronic medical condition diagnosed by a physician at least six months before the survey, for which either the symptom(s) persisted or relevant medical treatment continued. Participants were first asked whether they had experienced one or more NCDs over the past six months. If the answer was "yes", the specific diagnoses were recorded. The main NCDs reported by the participants included cancer, heart disease, cerebrovascular disease, respiratory disease, endocrine disorders, and nutrition and metabolic disease.
- Self-reported health: This was measured using a health rating scale ranging from 0 (worst) to 100 (best).

The following SES indicators were collected in the 2008 NHSS:

- Educational attainment was measured by years of study based on a scale of 1 to 4, with 1 indicating no formal education; 2 indicating education up to middle school; 3 indicating high school level; and 4 indicating college and university level education.
- Individual annual income was classified into five groups: 1 (≤2500 Yuan); 2 (2501-3999 Yuan); 3 (4000-5999 Yuan); 4 (6000-10000 Yuan); 5(>10000 Yuan).
- Occupation was classified into five groups: 1 (no paid job); 2 (manual, such as farming); 3 (semi-manual); 4 (skilled); 5 (management).
- Medical insurance was coded according to the level of security covered by the government-sponsored social health insurance schemes: 1,no insurance coverage; 2, New Rural Cooperative Medical Scheme (NCMS) and Medical Insurance for Urban residents (MIUR); and 3, Medical Insurance for Urban Employees (MIUE) and Free Medical Care (FMC).

Behavioral risk factors of NCDs measured in the 2008 NHSS included smoking, alcohol consumption, physical activity, and preventive medical examination. However, only smoking and physical activity were found to be associated with NCDs. The association between physical activity and NCDs was not linear: moderate physical exercise reduced NCDs, whereas, vigorous exercise increased NCDs. Therefore, only smoking was incorporated in the SEM. We tested four measures of smoking in the SEM: smoking as a dichotomous variable (yes or no); frequency of smoking; volume of cigarette consumption; and a latent variable incorporating both frequency and volume of cigarette consumption. The dichotomous measurement of smoking produced the best fit of the model.

Data collection

A questionnaire survey was undertaken through face-to-face interviews. When a household member was absent, a proxy respondent was considered. In total, less than 30% of questionnaires were completed by proxy respondents.

The interviews were conducted by community health workers with supervision from medical doctors. Training was provided to all of the interviewers and supervisors prior to the survey. Each supervisor was required to visit 5% of the households under his/her supervision to examine the accuracy of the data recorded in the questionnaires. Fourteen questions were repeated during the supervisor visits in the absence of the interviewers. A consistency rate of 91% to 97% was recorded.

Data analysis

We used SPSS (version 16) for the descriptive and regression (linear and logistic) analyses and AMOS 17 for SEM. We transformed the NCDs variable into dichotomous (yes=1, no=0) and performed logistic regression analyses to explore its associations with various SES and behavioral variables (including interactions between some of those variables). We also performed linear regression analyses considering the number of NCD conditions as a continuous measurement. The major findings are consistent with the SEM results. To simply reporting, this article only presents the SEM results. Details about the regression analyses can be found in the supplementary materials.

The SEM analyses were performed to test the relationships between health outcomes, SES, and behavioral risk factors. SEM is a statistical method that takes a confirmatory approach to the analysis of a structural theory[23]. It allows analyses of multiple independent variables and multiple dependent variables in one model[24]. SEM has been widely applied in studies related to social psychology and behavioral medicine. It has also been increasingly used in NCDs studies, including identification of effective interventions designed to improve the lives of individuals with disabilities and chronic illness[25-27].This study contained two health outcomes (dependent variables) and multiple independent variables (SES and behavioral factors). The SEM approach scored over the traditional regression method.

In this study, SES was measured by education, individual annual income, occupation and medical insurance. We constructed a latent variable incorporating all of the above SES indicators firstly. But the results of goodness of fit test for the SEM were not acceptable, simply because the directions of impact of the SES indicators on NCDs were different: some were protective factors but others were risk factors. Moreover, these SES indicators influenced each other. Therefore, we used path analysis with observed variables (PA-OV) to construct the SEM in which only observed variables were contained. We tested the significance of each factor on NCDs by bootstrap (the number of bootstrap samples was 5000), and analyzed their effects on NCDs. The robustness of the SEM models was confirmed by logistic regression and linear regression analyses (results were supplied in the supplementary materials).

Five SEM models were developed to test the hypotheses, all including education, individual annual income, occupation, medical insurance, smoking, self-reported health, and NCDs. Figure 1 depicts the Base Model. Model A added education→individual annual income on the basis of the Base Model. Model B introduced individual annual income→ medical insurance based on Model A. Model C added education→smoking on the basis of Model B. Finally, Model D introduced individual annual income→smoking on the basis of Model C.

Goodness-of-fit testing provided additional evidence to support the mediation hypotheses. We evaluated the SEM using a number of model fit indices. A non-significant chi-square indicates a good fit. However, chi-square statistics are inflated by the large sample size. Therefore, we also examined the goodness-of-fit index (GFI) and the adjusted goodness-of-fit index (AGFI), root mean square error of approximation (RMSEA) and root mean square residual (RMR). These indices ranged from 0 to 1, with a value ≥0.90 for GFI and AGFI, ≤0.06 for RMSEA, and ≤0.08 for RMR indicating a good fit of models.

RESULTS

Participant profile

The majority (73%) of participants had completed middle or high school education. Their personal income was distributed evenly across the five ranges. More than 50% of all the participants engaged in manual labor. The low entitlement insurance schemes (NCMS/MIUR) covered over 70% of participants. Less than 3% of participants were smoking at the time of the survey (Table 1).

NCDs and SES, self-reported health

Nearly2.98% of participants suffered from two NCDs, while 0.7% suffered from three or more NCDs. The participants reported an average score of 80.02 (SD=14.23) out of 100 for perceived overall health.

Education, individual annual income, occupation, medical insurance, and smoking were associated with NCDs (Table 1). Higher educational attainment, lower income, and absence of smoking were associated with lower prevalence of NCDs (p<0.0001).

Table 1 SES and prevalence of NCDs

Characteristics of participants	N(%)	NCDs, n (%)				*P*-value
		0	1	2	3	
Education						
1 No formal education	13836(20.81)	9736(70.37)	3248(23.47)	703(5.08)	149(1.08)	
2 Up to middle school	39027(58.69)	32927(84.37)	4884(12.51)	983(2.52)	233(0.60)	<0.001
3 Up to high school	9756(14.67)	8595(88.10)	879(9.01)	223(2.29)	59(0.60)	
4 College/university	3881(5.84)	3535(91.08)	254(6.54)	70(1.80)	22(0.57)	
Individual annual income						
1 ～2500	14515(21.83)	12186(83.95)	1935(13.33)	326(2.25)	68(0.47)	
2 ～4000	13519(20.33)	11388(84.24)	1771(13.10)	308(2.28)	52(0.38)	
3 ～6000	12328(18.54)	10332(83.81)	1609(13.05)	325(2.64)	62(0.50)	<0.001
4 ～10000	14052(21.13)	11653(82.93)	1883(13.40)	423(3.01)	93(0.66)	
5 >10000	12086(18.17)	9234(76.40)	2067(17.10)	597(4.94)	188(1.56)	
Occupation						
1 No paid job	17969(27.02)	14437(80.34)	2753(15.32)	642(3.57)	137(0.76)	
2 Manual (farmer)	34310(51.59)	29413(85.73)	4176(12.17)	617(1.80)	104(0.30)	
3 Semi-manual	7062(10.62)	5524(78.22)	1104(15.63)	333(4.72)	101(1.43)	<0.001
4 Skilled	4634(6.97)	3549(76.59)	770(16.62)	239(5.16)	76(1.64)	
5 Management	2525(3.80)	1870(74.06)	462(18.30)	148(5.86)	45(1.78)	
Medical Insurance						
1 No insurance	8704(13.09)	7440(85.48)	1020(11.72)	194(2.23)	50(0.57)	
2 NCMS/ MIUR	47232(71.03)	39698(84.05)	6212(13.15)	1120(2.37)	202(0.43)	<0.001
3 MIUE/ FMC	10564(15.89)	7655(72.46)	2033(19.24)	665(6.29)	211(2.00)	
Smoking						
1 No	64801(97.45)	53596(82.71)	8892(13.72)	1875(2.89)	438(0.68)	<0.001
2 Yes	1699(2.55)	1197(70.45)	373(21.95)	104(6.12)	25(1.47)	

Note: All *P*−values were two-tailed.

A gradient relationship between self-reported health and NCDs conditions was found: best perceived health in those without NCDs (82.70±12.36), intermediate health score in those with one NCD (68.88±15.19), and worst perceived health in those with two (62.98±15.73) and three or more (58.50±17.08) NCDs (F=4644.30, p<0.0001).

Model fit

The base model showed poor model fit, with chi-square statistics, RMR and RMSEA failing to reach the cut-off criteria. The model fit improved with the addition of mediators. Model D, incorporating all the three mediator hypotheses, produced the best fit (Table 2).

Table 2 Model fit indices: Base Model and other competitive models

Model	Chi-square	df	P	RMR	GFI	AGFI	RMSEA
Base Model	5112.503	7	<0.001	0.220	0.979	0.916	0.105
Model A	1214.684	6	<0.001	0.043	0.995	0.976	0.055
Model B	330.820	5	<0.001	0.069	0.999	0.992	0.031
Model C	47.797	4	<0.001	0.006	1.000	0.999	0.013
Model D	0.774	3	0.856	0.002	1.000	1.000	0.000

Note: All *P*- values were two-tailed. df: degree of freedom.

Estimates of regression weights in model D

Model D (Fig.2) was the only tested model that met all of the model fit criteria including the chi-square statistics. It showed that higher educational attainment and self-reported health were protective factors for NCDs. Smoking, higher income, occupations with less manuallabor, and higher levels of medical insurance entitlement were risk factors for NCDs. Self-reported health was positively associated with higher educational attainment and higher income, and negatively associated with smoking, occupations with less manuallabor, and higher levels of medical insurance entitlement (Fig.2).

Model D confirmed the significant correlation between smoking and SES, and between SES indicators. Smoking was negatively correlated with educational attainment, and positively correlated with income levels. The income of the participants increased with higher educational attainments. Higher income was also correlated with higher levels of medical insurance entitlement (p<0.001; Fig.2).

Estimates of direct and indirect effects

Overall, self-reported health had the greatest total effect on NCDs (r'=-0.385), followed by education (r'=-0.115). Education and medical insurance affected NCDs both directly and indirectly (Table 3). The direct effect of income on NCDs was much greater than its indirect effect. The likelihood of income influencing NCDs via mediators (such as medical insurance and smoking) was minimal because its indirect effect was close to zero (Table3). The indirect effect of occupation on NCDs was greater than its direct effect. A partial mediator effect was confirmed, which suggested that occupation affected NCDs mainly through mediators such as income and medical insurance (Table 3). Smoking had a weak effect on NCDs compared with the SES factors (Table 3).

Table 3 Direct and indirect effects of variables on NCDs

	Total	Direct	Indirect
Individual annual income	0.088***	0.092***	-0.004*
Occupation	0.110***	0.025***	0.086***
Medical Insurance	0.105***	0.064***	0.041***
Education	-0.115***	-0.076***	-0.039***
Smoking	0.040***	0.021***	0.018***
Self-reported Health	-0.385***	-0.385***	0.000

Note: All the effects were standardized. **P*<0.05(two-tailed test). ****P*<0.001(two-tailed test). "0" indicates that self-reported health did not affect NCDs indirectly.

DISCUSSION

Over the past decades, China experienced rapid economic growth, but with enormous wealth inequalities. NCDs have started to attract increasing concerns[28,29] as they account for an estimated 80% of deaths and 70% of disability-adjusted life-years lost in China[30]. Chinese women are more vulnerable to NCDs than men. With the founding of the People's Republic of China, the social status of Chinese women improved under the leadership of Chairman Mao, who advocated gender equality. However, increased workforce participation does not exempt women from their traditional household duties, which leads to serious problems in work-lifebalance[31]. The 2008 NHSS in China revealed a higher prevalence of cancer, diabetes, heart disease, hypertension, and mental illness in Chinese women compared with Chinese men[32]. In addition, the association between SES and NCDs is gender-dependent. For example, hypertension was found to be inversely associated with SES in women, but positively associated with SES in men[20,21]. Moreover, women are more likely to experience socioeconomic difficulties than their male counterparts[33]. So this study focused on Chinese women.

Education has been widely accepted as a protective SES factor for NCDs[34-38]. Our findings are consistent with those in several studies[30,31], which suggest that education is the most important SES determinant in NCDs. The 2002-2004 World Health Survey (WHS) reported that education was inversely correlated with chronic diseases except for diabetes in LMICs[37]. Cois et al. discovered that higher education predicts lower prevalence of hypertension in South Africa[27]. The WHO also reported a link between higher education and lower prevalence of NCDs in China[38]. We found that the effects of education on NCDs involved both direct and indirect effects, and they were mediated by smoking and other SES factors. Indeed, education is a strong predictor of smoking incidence[39]. Over the past decades, China has made great efforts and progress in reducing the literacy gap between men and women. However, educational disparities still exist among women due to unbalanced socioeconomic development, such as those between urban and rural communities. The results of the 2010 population census of China showed that the illiteracy rate of urban women aged 15 years and above was 3.03%, but the illiteracy rate of those living in rural towns and counties was 5.90% and 10.66%, respectively[40].

In this study, we found that women with higher incomes are more likely to suffer from NCDs, similar to findings from other studies in China[38] and other LMICs[41]. However, several studies reached a different conclusion: Cois et al. found that higher income predicts lower blood pressure in South Africa[27]; the 2002-2004 WHS revealed a positive correlation between wealth and NCDs only for diabetes in LMICs[37]**.** It is important to acknowledge that women in China have been encouraged to participate in the workforce. Despite their increased income, women are still under great pressure to fulfill their traditional duties in the family. The dualpressure (social and family) rendersworking women more vulnerable to physical and mental health problems than men[32,33,42,43]. Meanwhile, higher income has increased the adoption of sedentary lifestyles and excessive calorie intake, imposing a higher risk of NCDs. According to the Chinese National Nutrition and Health Survey in 2002, nearly 300 million Chinese people were overweight or obese. Around 18.6% (160 million) of Chinese adults manifested abnormal blood lipids[44].

We found that higher levels of medical insurance entitlement are associated with a higher risk of NCDs. This result is consistent with findings of a survey in six middle-income countries including China, which reported a higher prevalence of hypertension in people with mandatory medical insurance compared with those without insurance[45]. However, another study in LMICs revealed a negative association between medical insurance and depression[46]. Medical insurance may influence health through various channels. A lack of medical insurance limits access to preventive services, including cancer screening, vaccination, and medications for preventive purposes[47]. In China, individuals are not entitled to select from the different insurance schemes available[32]. Social health insurance schemes in China are tied to residency and occupation. The association between medical insurance and NCDs partially reflects occupational and urban-rural disparities. We cannot exclude the possibility of reporting bias either. In this study, NCDs were defined as a diagnostic condition. FMC/MIUE enrollees are more likely to visit doctors and seek hospital services than NCMS/MIUR enrollees[32]. Therefore, they may be more likely to report NCDs.

The link between manual labor and lower risk of NCDs demonstrated in this study is consistent with other studies. A systematic review and meta-analysis concluded that farmers and manual laborers have lower risk of hypertension than other workers[48]. This may reflect higher levels of physical activities in these laborers[48,49]. Occupations with limited manual labor are associated with additional NCD risks. A study conducted in Beijing found that 65.4% of urban employees frequently worked overtime; 47.1% felt “overloaded” and 29% felt “exhausted”[50]. The “White Book on Urban White-collar Health in China” released by Chinese medical professional bodies in 2010 reported that 76% of urban white-collar workers were in a subclinical health condition, with nearly six in ten complaining of fatigue. Clearly, higher income and medical insurance entitlement does not improve individual health automatically. Instead, their NCD conditions may have been further exacerbated by higher income and medical insurance entitlement. Indeed, we found that the effect of occupation on NCDs is partially mediated by income and medical insurance.

Surprisingly, smoking appeared to be a weak predictor of NCDs in this study, probably due to the low smoking rate (2.55%) among the participants and the high level (72.4%) of exposure to passive smoking[51]. Nonetheless, smoking remains one of the top five risk factors threatening women’s health in China. China is the world’s largest tobacco producer and consumer. The total number of adult smokers in China has exceeded 300 million, including 10 million women. Furthermore, tobacco control is a huge challenge[52], especially when smoking is combined with socioeconomic factors[53]. Our SEM results demonstrated a positive association between smoking and income and a negative association between smoking and education. A survey in 48 LMICs showed that wealth is not associated with smoking in Chinese women although this is not the case in 19 countries where richer women are more likely to smoke than the poor[54]. Given the financial sensitivity of tobacco consumption, the tobacco levy introduced in China recently may become an effective instrument for tobacco control.

Self-reported health played an important role in the SEM model, although it was not the main focus on this study. The effect of self-reported health on NCDs is profound (r’=-0.385). Self-reported health is also closely associated with SES, and plays a mediating role. These findings are consistent with studies undertaken elsewhere [55-58]. A study in East Asia reported a positive association between income and self-reported health in Chinese women, but failed to establish an association between occupation and self-reported health in those women[55]. A few researchers believe that self-reported health reflects physiological, mental and social indices[59]. Empirical evidence suggests that self-reported health is a reliable predictor of morbidity and mortality1[15,,60].

In conclusion, China is facing a serious challenge during the current socioeconomic transition. A complex network of risk factors is associated with NCDs. Socioeconomic disparities associated with the prevalence of NCDs exist among women in China. High educational attainment is associated with a low risk of NCDs. However, the robust economic development has failed to translate into reduced risks of NCDs. Like the cases in many developing countries, high income is associated with an increased risk of NCDs, as well as increased smoking rate. The effect of occupation on NCDs is also mediated by income and economic development. People engaged in less manual labor are more likely to live in urban areas, earn a high income, and enjoy high levels of entitlement with medical insurance, which in turn increases their risks of NCDs. China’s economic development has been accompanied by many social challenges, including the increasing burden of NCDs. Educational and social interventions are needed to mitigate such negative consequences. Unlike most previous studies which examined the relationships between SES and NCDs in high-income countries, this study expands our understanding of such relationships to the contexts of developing and transitional economies. The findings have policy implications for establishing responsive intervention strategies targeting NCDs in developing economies. Data of this study were drawn from a nationwide household survey, one of the largest and most representative data sets currently available in China.

However, caution needs to be taken in drawing conclusions. The cross-sectional design of this study prevents us from making any causal conclusions between SES, risk behaviors and NCDs. There were several other limitations in this study. The status of NCDs was self-reported, and therefore, the findings are subject to recall bias. Although the major findings of the SEM were confirmed by the results of regression analyses, several interaction effects failed to achieve statistical significance in the regression analyses. Finally, the study focused on Chinese women, which did not illustrate the situation of NCDs for the entire Chinese population.

Acknowledgments: The authors thank the National Natural Science Fund (grant number: 71403074 and 71333003) for funding this research. The authors also appreciate two reviewers of this article for their very constructive comments and suggestions. Ms. Michele Mooney provided editing and proofreading services.

Author contributions: Dr. Qunhong Wu has full access to all the study data and is responsible for the integrity of the data and the accuracy of data analysis. Study concept and design: Qunhong Wu, Yanhua Hao, Limin Wang, Libo Liang. Acquisition, analysis, and interpretation of data: Hui Yin, Yu Cui, Yuchun Tao. Draft of the manuscript: Hui Yin. Critical revision of the manuscript for important intellectual content: Hui Yin, Yu Cui, Qunhong Wu, Yanhua Hao, Chaojie Liu. Statistical analysis: Hui Yin, Yu Cui, Ye Li, Libo Liang.

Funding: This research was supported by the National Natural Science Fund (grant number: 71403074 and 71333003).

Declaration of competing interests: None declared.

Ethics approval: The research was approved by the Medical Ethics Committee of Harbin Medical University (Daqing).

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Figure legends:

Figure 1. Base SEM Model

Figure 1 was the base model describing the complex relationships between all variables. In figure 1, "X→Y" meant X influenced Y.

Figure 2. SEM Model D

Figure 2 was the SEM model D with best fit, which describes the mechanisms involved in the relationships between SES and NCDs including their direction and size. "X→Y" meant X influenced Y. The numbers above the "→"were standardized regression weights.

***P<0.001(two-tailed test).

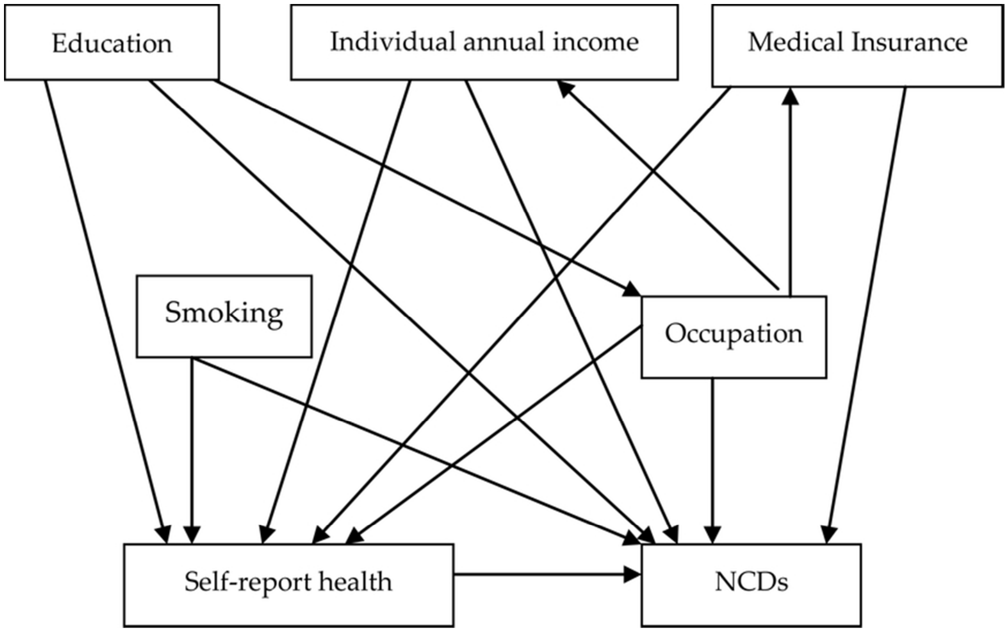

Figure 1. Base SEM Model
Figure 1 was the base model describing the complex relationships between all variables. In figure 1, "X→Y" meant X influenced Y.

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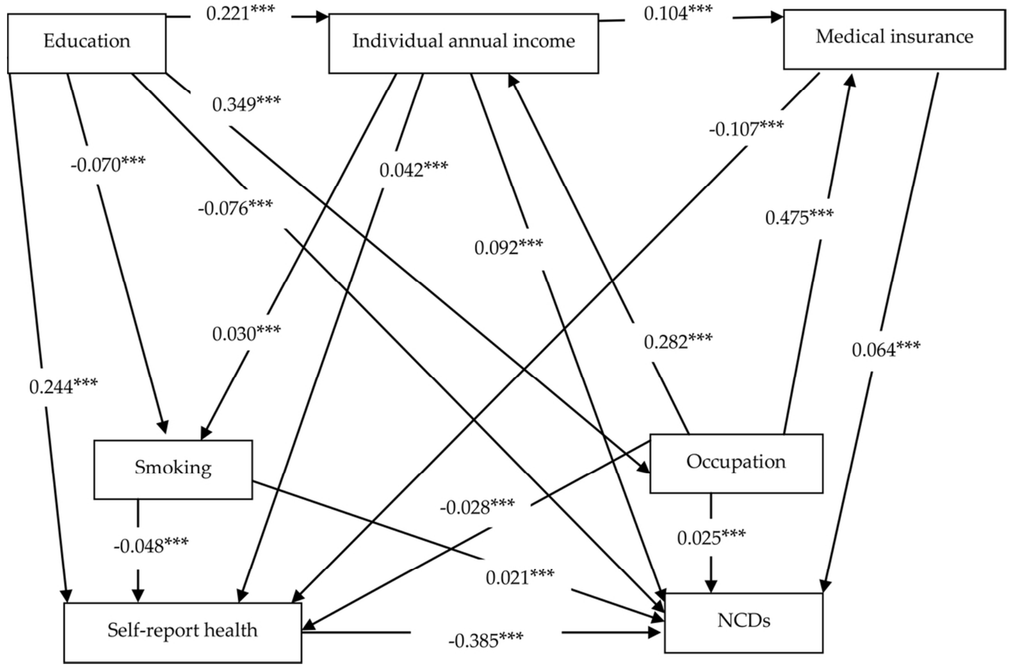

Figure 2. SEM Model D
Figure 2 was the SEM model D with best fit, which describes the mechanisms involved in the relationships between SES and NCDs including their direction and size. "X→Y" meant X influenced Y. The numbers above the "→"were standardized regression weights. ***P<0.001(two-tailed test).

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Robustness check

In this study, we used bivariate logistic regressions and multiple linear regressions to check the Robustness.

1. Influencing factors of NCDs

The f bivariate logistic regressions was to analyze the effects of individual annual income, education, occupation, medical insurance, smoking, self-reported health and interaction of these factors on NCDs (Table 1).

Table 1 The effects of individual annual income, education, occupation, medical insurance, smoking and self-reported health and interaction on NCDs by bivariate logistic regression

Independent Variable	B	SE	*P*
Model 1			
Self-reported health	-0.070	0.001	<0.001
Smoking	0.271	0.062	<0.001
Education	-0.449	0.018	<0.001
Individual annual income	0.207	0.009	<0.001
Occupation	0.085	0.014	<0.001
Medical Insurance	0.354	0.026	<0.001
Model 2			
self-reported health	-0.070	0.001	<0.001
Smoking	-0.198	0.165	>0.05
Education	-0.458	0.018	<0.001
Individual annual income	0.207	0.009	<0.001
Occupation	0.085	0.014	<0.001
Medical Insurance	0.355	0.026	<0.001
Education*smoking	0.278	0.090	<0.01
Model 3			
self-reported health	-0.058	0.002	<0.001
Smoking	0.273	0.062	<0.001
Education	-0.448	0.018	<0.001
Individual annual income	0.491	0.042	<0.001
Occupation	0.084	0.014	<0.001
Medical Insurance	0.352	0.026	<0.001
Individual annual income* self-reported health	-0.004	0.001	<0.001

Note: The dependent variable was NCDs with 0=did not suffer NCDs and 1=suffered NCDs.

Continued:

Independent Variable	B	SE	*P*
Model 4			
Self-reported health	-0.081	0.003	<0.001
Smoking	0.267	0.062	<0.001
Education	-0.450	0.018	<0.001
Individual annual income	0.207	0.009	<0.001
Occupation	0.085	0.014	<0.001
Medical Insurance	-0.025	0.117	>0.05
Medical Insurance * Self-reported health	0.005	0.002	0.001
Model 5			
Self-reported health	-0.069	0.001	<0.001
Smoking	0.267	0.062	<0.001
Education	-0.587	0.025	<0.001
Individual annual income	0.161	0.011	<0.001
Occupation	-0.044	0.022	>0.05
Medical Insurance	0.331	0.026	<0.001
Occupation * Education* Individual annual income	0.013	0.002	<0.001
Model 6			
Self-reported health	-0.070	0.001	<0.001
Smoking	0.161	0.081	<0.05
Education	-0.451	0.018	<0.001
Individual annual income	0.206	0.009	<0.001
Occupation	0.083	0.014	<0.001
Medical Insurance	0.354	0.026	<0.001
Education*Occupation * Individual annual income*smoking	0.008	0.004	<0.05

Note: The dependent variable was NCDs with 0=did not suffer NCDs and 1=suffered NCDs.

As table 1 showed that all of factors were relation with NCDs, and education and self-reported health were protective factors for NCDs, others were risk. Furthermore, five interactions were examined significantly. The results were consistent with SEM.

2. Influencing factors of self-reported health

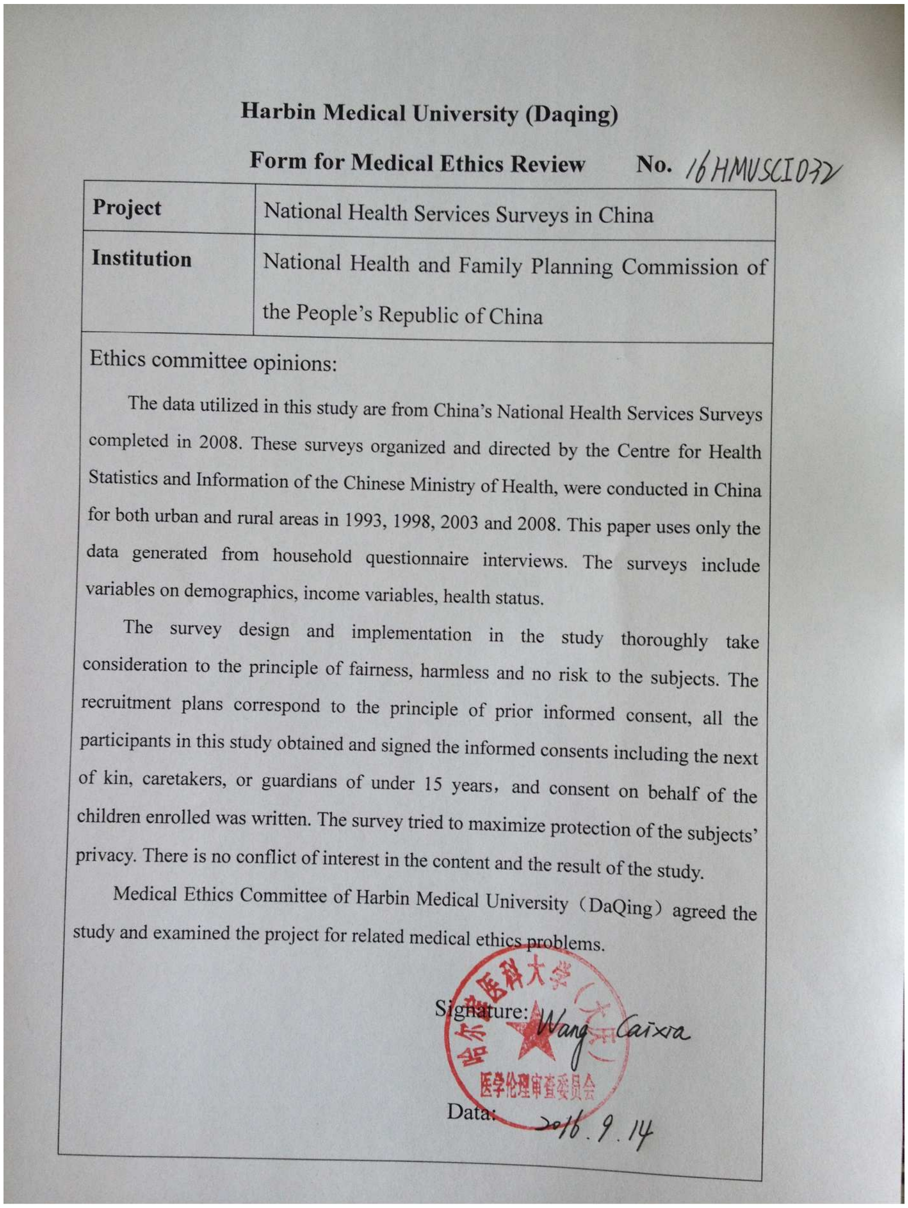
The multiple linear regressions was to analyze the effects of individual annual income, education, occupation, medical insurance, smoking on self-reported health (Table 2).

Table 2 The effects of individual annual income, education, occupation, medical insurance, smoking on self-reported health by multiple linear regression

Independent Variable	B	*β*	*P*
Individual annual income	0.280	0.028	0.000
Education	5.161	0.277	0.000
Occupation	-0.400	-0.028	0.000
Medical insurance	-2.786	-0.105	0.000
Smoking	-4.575	-0.051	0.000

Note: "B" was unstandardized regression coefficient; "*β*" was standardized regression coefficient.

As table 2 showed that effects of individual annual income, education, occupation, medical insurance, smoking were significant. Individual annual income and education had positive correlation to self-reported health, and others had negative correlation with self-reported health. The results were consistent with SEM, too.



Harbin Medical University (Daqing)

Form for Medical Ethics Review **No.** 16HMUSCI032

Project	National Health Services Surveys in China
Institution	National Health and Family Planning Commission of the People's Republic of China

Ethics committee opinions:

The data utilized in this study are from China's National Health Services Surveys completed in 2008. These surveys organized and directed by the Centre for Health Statistics and Information of the Chinese Ministry of Health, were conducted in China for both urban and rural areas in 1993, 1998, 2003 and 2008. This paper uses only the data generated from household questionnaire interviews. The surveys include variables on demographics, income variables, health status.

The survey design and implementation in the study thoroughly take consideration to the principle of fairness, harmless and no risk to the subjects. The recruitment plans correspond to the principle of prior informed consent, all the participants in this study obtained and signed the informed consents including the next of kin, caretakers, or guardians of under 15 years, and consent on behalf of the children enrolled was written. The survey tried to maximize protection of the subjects' privacy. There is no conflict of interest in the content and the result of the study.

Medical Ethics Committee of Harbin Medical University（DaQing）agreed the study and examined the project for related medical ethics problems.

医学伦理审查委员会

Signature: Wang Caixia

Data: 2016.9.14

Ethics approval

226x302mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	P1–2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	P2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	P2–3
Objectives	3	State specific objectives, including any prespecified hypotheses	P3
Methods			
Study design	4	Present key elements of study design early in the paper	P3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	P3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	P3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	P4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	P4
Bias	9	Describe any efforts to address potential sources of bias	P4
Study size	10	Explain how the study size was arrived at	P3
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	P4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	P5
		(*b*) Describe any methods used to examine subgroups and interactions	P5
		(*c*) Explain how missing data were addressed	P4
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	None
		(*e*) Describe any sensitivity analyses	P5
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	P3
		(b) Give reasons for non-participation at each stage	None
		(c) Consider use of a flow diagram	None
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	P6
		(b) Indicate number of participants with missing data for each variable of interest	None
Outcome data	15*	Report numbers of outcome events or summary measures	P6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	P5–7
		(*b*) Report category boundaries when continuous variables were categorized	P6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	None
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	supplementary materials

Discussion			
Key results	18	Summarise key results with reference to study objectives	P8−10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	P10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	P9−10
Generalisability	21	Discuss the generalisability (external validity) of the study results	P10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	P10

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Socioeconomic Status and Prevalence of Chronic Non-communicable Diseases in Chinese Women: a Structural Equation Modeling Approach

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-014402.R3
Article Type:	Research
Date Submitted by the Author:	13-Mar-2017
Complete List of Authors:	Yin, Hui; Publich Health School in Harbin Medical University , Health educaiton Wu, Qunhong; Harbin Medical University, Social Medicine Cui, Yu; Harbin Medical University, School of Public Health Hao, Yanhua; Harbin Medical University, Social Medicine Liu, Chaojie; La Trobe University Li, Ye; Harbin Medical University, School of Public Health Liang, Libo; Harbin Medical University, School of Public Health Wang, Limin; School of Public Health, Harbin Medical University Tao, Yuchun; Shcool of Public Health, Harbin Medical University
Primary Subject Heading:	Public health
Secondary Subject Heading:	Sociology
Keywords:	PUBLIC HEALTH, SOCIAL MEDICINE, INTERNAL MEDICINE

Socioeconomic Status and Prevalence of Chronic Non-communicable Diseases in Chinese Women: a Structural Equation Modeling Approach

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Word count of text: 3969.

Keywords: chronic non-communicable diseases; socioeconomic status; Chinese women

ABSTRACT

Objective: To investigate the role of socioeconomic status (SES) in chronic non-communicable diseases (NCDs), and offer theoretical evidence for the prevention and control of NCDs.

Design: Cross-sectional survey and structural equation modeling (SEM).

Setting: Nationwide, China.

Participants: Female participants in the 2008 National Health Services Survey (NHSS) in China who were 15 years and older.

Outcome Measures: Number of NCDs and self-reported health and their associations with SES. SES was measured by annual individual income, educational attainment, occupation, and medical insurance. Smoking served as a behavioral risk indicator.

Results: SES factors were associated with the increased risk of NCDs in Chinese women. Education was identified as the most important factor with a protective role (factor loading=-0.115) for NCDs. Income mainly affected NCDs directly; whereas, occupation mainly affected NCDs indirectly. The effects of SES on NCDs were more significant than that of smoking. Medical insurance, smoking, and self-reported health played a mediating role in the correlations between those SES factors and NCDs.

Conclusions: In China, socioeconomic disparities associated with the prevalence of NCDs exist among women. Educational and social interventions are needed to mitigate their negative consequences on health outcomes in Chinese women.

Strengths and limitations of this study

- We used SEM in data analysis which is a powerful tool for developing complex and sophisticated theoretical models that involve a large number of linear equations. SEM can enhance our understanding of the relationships between multiple factors, such as the relative contributions of SES factors and other factors related to NCDs and the correlations between SES and other factors.

- Like all statistical models, SEM presents approximations of reality. Variables included in the SEM models are subject to the restrictions of data availability. Further studies with additional variables may help improve the model fit with reality.

- The NHSS is a cross-sectional survey, which prevents us from making any causal conclusions in the present study.

BACKGROUND

Chronic non-communicable diseases (NCDs) are the leading cause of death worldwide[1, 2], and most patients with NCDs live in low- and middle-income countries (LMICs) [3]. A study of 23 LMICs revealed that NCDs accounted for 50% of the total disease burden and approximately 80% of mortality in 2005[4]. Unfortunately, the growing threat of NCDs on social and economic development is often under-appreciated inLMICs[3]. Empirical evidence shows that high SES is inversely correlated with NCDs in industrialized Western countries[5].

However, some studies failed to replicate such findings in developing or transitional countries[6].

The mechanism underlying the role of SES in NCDs is largely unknown. Several SES factors, such as income, education and occupation, probably affect NCDs[7]. Medical insurance is also widely considered as one of the SES indicators[8], which may be associated with NCDs [9]. Many lifestyle and behavioral risk factors are associated with NCDs[10,11,12] and are closely linked to SES[13]. Lifestyle and behavioral factors have been found to mediate the relationship between SES and self-rated health[14], which is a strong predictor of NCDs and mortality with SES gradient[15, 16]. Self-rated health is negatively associated with depressed mood, which may affect physical health problems, particularly NCDs[17]. The World Health Organization (WHO) Commission on Social Determinants of Health (CSDH)[13] considers SES as a structural driver impacts on people's daily lives and activities, which in turn, influence people's health and well-being.

Previous studies have often failed to delineate the indirect effects of SES. A few studies used an SES index to incorporate several indicators[18]. Other studies selected a single SES indicator[19,20]. The former approach prevented researchers from further exploring the indirect effects of SES, while the latter skewed the conclusions. Studies using multiple SES indicators have also been reported[21,22]. However, each SES indicator was usually treated as an independent entity.

This study adopted a structural equation model (SEM) approach to investigate the associations of SES factors with NCDs, which enabled us to explore associations between multiple variables, as well as the role of a single variable on multiple parameters. Such a study has policy implications for the development of NCDs treatment and intervention programs, because it can improve our understanding of the impact of SES on NCDs.

METHODS

Study design

Data used for this study were derived from the 2008 NHSS, which was a nationwide cross-sectional survey organized by the Ministry of Health, China.

Participants and Sampling methods

The participants of this study were restricted to the female participants of the 2008 NHSS in China who were aged 15 years and older.

The NHSS participants were selected using a multi-stage stratified random sampling strategy. Firstly, 90 cities/counties were proportionately and randomly selected and classified into five groups based on 10 socioeconomic indicators. Secondly, five districts/townships were randomly selected from each of these cities/counties. In the third stage, the participating communities were narrowed down to two neighborhoods/villages randomly from each district/township of the selected cities/counties. Finally, 60 households were randomly selected from each selected community. The health status of the members of the selected households was recorded in a questionnaire. A total of 66,500 women met the eligibility criteria of this study. The representativeness and quality of data collected in the NHSS were assessed by the National Health Statistical Center. A Myer's Index of 3.48 was found, showing no age bias.

Variables

Two health outcomes (Y) were calculated in the development of the SEM.

- Number of NCDs: NCDs was defined as a chronic medical condition diagnosed by a physician at least six months before the survey. Participants were first asked whether they had experienced one or more NCDs over the past six months. If the answer was "yes", the specific diagnoses were recorded. The main NCDs reported by the participants included cancer, heart disease, cerebrovascular disease, respiratory disease, endocrine disorders, and nutrition and metabolic disease.
- Self-reported health: This was measured using a health rating scale ranging from 0 (worst) to 100 (best).

The following SES indicators were collected in the 2008 NHSS:

- Educational attainment was measured by years of study based on a scale of 1 to 4, with 1indicating no formal education; 2 indicating education up to middle school; 3 indicating high school level; and 4 indicating college and university level education.
- Individual annual income was classified into five groups: 1 (≤2500 Yuan); 2 (2501-3999 Yuan); 3 (4000-5999 Yuan); 4 (6000-10000 Yuan);5(>10000 Yuan).
- Occupation was classified into five groups: 1 (no paid job); 2 (manual, such as farming); 3 (semi-manual); 4 (skilled); 5 (management).
- Medical insurance was coded according to the level of security covered by the government-sponsored social health insurance schemes: 1,no insurance coverage; 2, New Rural Cooperative Medical Scheme (NCMS) and Medical Insurance for Urban residents (MIUR); and 3, Medical Insurance for Urban Employees (MIUE) and Free Medical Care (FMC).

Behavioral risk factors of NCDs measured in the 2008 NHSS included smoking, alcohol consumption, physical activity, and preventive medical examination. However, only smoking and physical activity were found to be associated with NCDs. The association between physical activity and NCDs was not linear: moderate physical exercise reduced NCDs, whereas, vigorous exercise increased NCDs. Therefore, only smoking was incorporated in the SEM. We tested four measures of smoking in the SEM: smoking as a dichotomous variable (yes or no); frequency of smoking; volume of cigarette consumption; and a latent variable incorporating both frequency and volume of cigarette consumption. The dichotomous measurement of smoking produced the best fit of the model.

Data collection

A questionnaire survey was undertaken through face-to-face interviews, with a response rate of 83%. When a household member was absent, a proxy respondent was considered. In total, less than 30% of questionnaires were completed by proxy respondents.

The interviews were conducted by community health workers with supervision from medical doctors. Training was provided to all of the interviewers and supervisors prior to the survey. Each supervisor was required to visit 5% of the households under his/her supervision to examine the accuracy of the data recorded in the questionnaires. Fourteen questions were repeated during the supervisor visits in the absence of the interviewers. A consistency rate of 91% to 97% was recorded.

Data analysis

We used SPSS (version 16) for the descriptive and regression (linear and logistic) analyses and AMOS 17 for SEM. We transformed the NCDs variable into dichotomous (yes=1, no=0) and performed logistic regression analyses to explore its associations with various SES and behavioral variables (including interactions between some of those variables). We also performed linear regression analyses considering the number of NCDs conditions as a continuous measurement. The major findings are consistent with the SEM results. To simplify reporting, this article only presents the SEM results. Details about the regression analyses can be found in the supplementary materials.

The SEM analyses were performed to test the relationships between health outcomes, SES, and behavioral risk factors. SEM is a statistical method that takes a confirmatory approach to the analysis of a structural theory[23]. It allows analyses of multiple independent variables and multiple dependent variables in one model[24]. SEM has been widely applied in studies related to social psychology and behavioral medicine. It has also been increasingly used in NCDs studies, including identification of effective interventions designed to improve the lives of individuals with disabilities and chronic illness[25-27]. This study contained two health outcomes (dependent variables) and multiple independent variables (SES and behavioral factors). The SEM approach scored over the traditional regression method.

In this study, SES was measured by education, individual annual income, occupation and medical insurance. We constructed a latent variable incorporating all of the above SES indicators firstly. But the results of goodness of fit test for the SEM were not acceptable, simply because the directions of impact of the SES indicators on NCDs were different: some were protective factors but others were risk factors. Moreover, these SES indicators influenced each other. Therefore, we used path analysis with observed variables (PA-OV) to construct the SEM in which only observed variables were contained. We tested the significance of each factor on NCDs by bootstrap (the number of bootstrap samples was 5000), and analyzed their effects on NCDs. The robustness of the SEM models was confirmed by logistic regression and linear regression analyses (results were supplied in the supplementary materials).

Five SEM models were developed to test the hypotheses, all including education, individual annual income, occupation, medical insurance, smoking, self-reported health, and NCDs. Figure 1 depicts the Base Model. Model A added education→individual annual income on the basis of the Base Model. Model B introduced individual annual income→ medical insurance based on Model A. Model C added education→smoking on the basis of Model B. Finally, Model D introduced individual annual income→smoking on the basis of Model C.

Goodness-of-fit testing provided additional evidence to support the mediation hypotheses. We evaluated the SEM using a number of model fit indices. A non-significant chi-square indicates a good fit. We also examined the goodness-of-fit index (GFI) and the adjusted goodness-of-fit index (AGFI), root mean square error of approximation (RMSEA) and root mean square residual (RMR). These indices ranged from 0 to 1, with a value ≥0.90 for GFI and AGFI, ≤0.06 for RMSEA, and ≤0.08 for RMR indicating a good fit of models.

RESULTS

Participant profile

The majority (73%) of participants had completed middle or high school education. Their personal income was distributed evenly across the five ranges. More than 50% of all the participants engaged in manual labor. The low entitlement insurance schemes (NCMS/MIUR) covered over 70% of participants. Less than 3% of participants were smoking at the time of the survey (Table 1).

NCDs and SES, self-reported health

Nearly 2.98% of participants suffered from two NCDs, while 0.7% suffered from three or more NCDs. The participants reported an average score of 80.02 (SD=14.23) out of 100 for perceived overall health.

Education, individual annual income, occupation, medical insurance, and smoking were associated with NCDs (Table 1). Higher educational attainment, lower income, and absence of smoking were associated with lower prevalence of NCDs (p<0.0001).

Table 1 SES and prevalence of NCDs

Characteristics of participants	N(%)	NCDs, n (%)				*P*-value
		0	1	2	3	
Education						
1 No formal education	13836(20.81)	9736(70.37)	3248(23.47)	703(5.08)	149(1.08)	
2 Up to middle school	39027(58.69)	32927(84.37)	4884(12.51)	983(2.52)	233(0.60)	<0.001
3 Up to high school	9756(14.67)	8595(88.10)	879(9.01)	223(2.29)	59(0.60)	
4 College/university	3881(5.84)	3535(91.08)	254(6.54)	70(1.80)	22(0.57)	
Individual annual income						
1 ～2500	14515(21.83)	12186(83.95)	1935(13.33)	326(2.25)	68(0.47)	
2 ～4000	13519(20.33)	11388(84.24)	1771(13.10)	308(2.28)	52(0.38)	
3 ～6000	12328(18.54)	10332(83.81)	1609(13.05)	325(2.64)	62(0.50)	<0.001
4 ～10000	14052(21.13)	11653(82.93)	1883(13.40)	423(3.01)	93(0.66)	
5 >10000	12086(18.17)	9234(76.40)	2067(17.10)	597(4.94)	188(1.56)	
Occupation						
1 No paid job	17969(27.02)	14437(80.34)	2753(15.32)	642(3.57)	137(0.76)	
2 Manual (farmer)	34310(51.59)	29413(85.73)	4176(12.17)	617(1.80)	104(0.30)	
3 Semi-manual	7062(10.62)	5524(78.22)	1104(15.63)	333(4.72)	101(1.43)	<0.001
4 Skilled	4634(6.97)	3549(76.59)	770(16.62)	239(5.16)	76(1.64)	
5 Management	2525(3.80)	1870(74.06)	462(18.30)	148(5.86)	45(1.78)	
Medical Insurance						
1 No insurance	8704(13.09)	7440(85.48)	1020(11.72)	194(2.23)	50(0.57)	
2 NCMS/ MIUR	47232(71.03)	39698(84.05)	6212(13.15)	1120(2.37)	202(0.43)	<0.001
3 MIUE/ FMC	10564(15.89)	7655(72.46)	2033(19.24)	665(6.29)	211(2.00)	
Smoking						
1 No	64801(97.45)	53596(82.71)	8892(13.72)	1875(2.89)	438(0.68)	<0.001
2 Yes	1699(2.55)	1197(70.45)	373(21.95)	104(6.12)	25(1.47)	

Note: All *P*−values were two-tailed.

A gradient relationship between self-reported health and NCDs conditions was found: best perceived health in those without NCDs (82.70 ± 12.36), intermediate health score in those with one NCD (68.88 ± 15.19), and worst perceived health in those with two (62.98 ± 15.73) and three or more (58.50 ± 17.08) NCDs (F=4644.30, p<0.0001).

Model fit

The base model showed poor model fit, with chi-square statistics, RMR and RMSEA failing to reach the cut-off criteria. The model fit improved with the addition of mediators. Model D, incorporating all the three mediator hypotheses, produced the best fit (Table 2).

Table 2 Model fit indices: Base Model and other competitive models

Model	Chi-square	df	P	RMR	GFI	AGFI	RMSEA
Base Model	5112.503	7	<0.001	0.220	0.979	0.916	0.105

Model A	1214.684	6	<0.001	0.043	0.995	0.976	0.055
Model B	330.820	5	<0.001	0.069	0.999	0.992	0.031
Model C	47.797	4	<0.001	0.006	1.000	0.999	0.013
Model D	0.774	3	0.856	0.002	1.000	1.000	0.000

Note: All *P*- values were two-tailed. df: degree of freedom.

Estimates of regression weights in model D

Model D (Fig.2) was the only tested model that met all of the model fit criteria including the chi-square statistics. It showed that higher educational attainment and self-reported health were protective factors for NCDs. Smoking, higher income, occupations with less manuallabor, and higher levels of medical insurance entitlement were risk factors for NCDs. Self-reported health was positively associated with higher educational attainment and higher income, and negatively associated with smoking, occupations with less manuallabor, and higher levels of medical insurance entitlement (Fig.2).

Model D confirmed the significant correlation between smoking and SES, and between SES indicators. Smoking was negatively correlated with educational attainment, and positively correlated with income levels. The income of the participants increased with higher educational attainments. Higher income was also correlated with higher levels of medical insurance entitlement (p<0.001; Fig.2).

Estimates of direct and indirect effects

Overall, self-reported health had the greatest total effect on NCDs (r'=-0.385), followed by education (r'=-0.115). Education and medical insurance affected NCDs both directly and indirectly (Table 3).The direct effect of income on NCDs was much greater than its indirect effect. The likelihood of income influencing NCDs via mediators (such as medical insurance and smoking) was minimal because its indirect effect was close to zero (Table3).The indirect effect of occupation on NCDs was greater than its direct effect. A partial mediator effect was confirmed, which suggested that occupation affected NCDs mainly through mediators such as income and medical insurance (Table 3).Smoking had a weak effect on NCDs compared with the SES factors (Table 3).

Table 3 Direct and indirect effects of variables on NCDs

	Total	Direct	Indirect
Individual annual income	0.088***	0.092***	-0.004*
Occupation	0.110***	0.025***	0.086***
Medical Insurance	0.105***	0.064***	0.041***
Education	-0.115***	-0.076***	-0.039***
Smoking	0.040***	0.021***	0.018***
Self-reported Health	-0.385***	-0.385***	0.000

Note: All the effects were standardized. *P<0.05(two-tailed test). ***P<0.001(two-tailed test). "0" indicates that self-reported health did not affect NCDs indirectly.

DISCUSSION

Chinese women are exposed to high levels of SES risk factors for NCDs. This study identified low levels of education, higher income, and occupations with less manual labor as major predictors of NCDs. Meanwhile, medical insurance, smoking, and self-reported health played a mediating role in the correlations between those SES factors and NCDs.

One of the strengths of this study is that we used SEM in data analysis which is a powerful tool for developing complex and sophisticated theoretical models that involve a large number of linear equations. SEM can enhance our understanding of the relationships between multiple factors, such as the relative contributions of SES factors and other factors related to NCDs and the correlations between SES and other factors. Furthermore, data of this study were drawn from a nationwide household survey, one of the largest and most representative data sets currently available in China. However, like all statistical models, SEM presents approximations of reality. The NHSS is a cross-sectional survey, which prevents us from making any causal conclusions in the present study.

Unlike most previous studies which examined the relationships between SES and NCDs in high-income countries, this study expands our understanding of such relationships to the contexts of developing and transitional economies. Over the past decades, China experienced rapid economic growth, but with enormous wealth inequalities. NCDs have started to attract increasing concerns[28,29] as they account for an estimated 80% of deaths and 70% of disability-adjusted life-years lost in China[30]. But there is paucity in studies focusing on Chinese women. Chinese women are more vulnerable to NCDs than men. With the founding of the People's Republic of China, the social status of Chinese women improved under the leadership of Chairman Mao, who advocated gender equality. However, increased workforce participation does not exempt women from their traditional household duties, which leads to serious problems in work-lifebalance[31]. The 2008 NHSS in China revealed a higher prevalence of many NCDs in Chinese women compared with Chinese men[32]. In addition, the association between SES and NCDs is gender-dependent. For example, hypertension was found to be inversely associated with SES in women, but positively associated with SES in men[20,21]. Moreover, women are more likely to experience socioeconomic difficulties than their male counterparts[33].

This study found that education is the most important SES determinant of NCDs for Chinese women. Education has been widely accepted as a protective SES factor for NCDs[34-38].The 2002-2004 World Health Survey (WHS) reported that education was inversely correlated with chronic diseases except for diabetes in LMICs[37]. Cois et al. discovered that higher education predicts lower prevalence of hypertension in South Africa[27]. The WHO also reported a link between higher education and lower prevalence of NCDs in China[38]. We found that the effects of education on NCDs involved both direct and indirect effects, and they were mediated by smoking and other SES factors. Indeed, education is a strong predictor of smoking incidence[39]. Educational disparities exist among Chinese women due to unbalanced socioeconomic development, such as those between urban and rural communities. The results of the 2010 population census of China showed that the illiteracy rate of urban women aged 15 years and above was 3.03%, but the illiteracy rate of those living in rural towns and counties was 5.90% and 10.66%, respectively[40].

In this study, we found that women with higher incomes are more likely to suffer from NCDs, similar to findings from other studies in China[38] and other LMICs[41]. However, several studies reached a different conclusion: Cois et al. found that higher income predicts lower blood pressure in South Africa[27]; the 2002-2004 WHS revealed a positive correlation between wealth and NCDs only for diabetes in LMICs[37]**.** It is important to acknowledge that women in China have been encouraged to participate in the workforce. Despite their increased income, women are still under great pressure to fulfill their traditional duties in the family. The dualpressure (social and family) renders working women more vulnerable to health problems than men[32,33,42,43]. Meanwhile, higher income has increased the adoption of sedentary lifestyles and excessive calorie intake, imposing a higher risk of NCDs. According to the Chinese National Nutrition and Health Survey in 2002, nearly 300 million Chinese people were overweight or obese. Around 18.6% of Chinese adults manifested abnormal blood lipids[44].

We found that higher levels of medical insurance entitlement are associated with a higher risk of NCDs. This result is consistent with findings of a survey in six middle-income countries including China, which reported a higher prevalence of hypertension in people with mandatory medical insurance compared with those without insurance[45]. However, another study in LMICs revealed a negative association between medical insurance and depression[46]. Medical insurance may influence health through various channels. A lack of medical insurance limits access to preventive services[47]. In China, individuals are not entitled to select from the different insurance schemes available[32]. Social health insurance schemes in China are tied to residency and occupation. The association between medical insurance and NCDs partially reflects occupational and urban-rural disparities. We cannot exclude the possibility of reporting bias either. In this study, NCDs were defined as a diagnostic condition. FMC/MIUE enrollees are more likely to visit doctors and seek hospital services than NCMS/MIUR enrollees[32]. Therefore, they may be more likely to report NCDs.

The link between manual labor and lower risk of NCDs demonstrated in this study is consistent with other studies. A systematic review and meta-analysis concluded that farmers and manual laborers have lower risk of hypertension than other workers[48]. This may reflect higher levels of physical activities in these laborers[48,49]. Occupations with limited manual labor are associated with additional NCDs risks. A study conducted in Beijing found that 65.4% of urban employees frequently worked overtime; 47.1% felt "overloaded" and 29% felt "exhausted"[50]. The "White Book on Urban White-collar Health in China" released by Chinese medical professional bodies in 2010 reported that 76% of urban white-collar workers were in a subclinical health condition, with nearly six in ten complaining of fatigue. Clearly, higher income and medical insurance entitlement does not improve individual health automatically. Instead, their NCDs conditions may have been further exacerbated by higher income and medical insurance entitlement. Indeed, we found that the effect of occupation on NCDs is partially mediated by income and medical insurance.

Surprisingly, smoking appeared to be a weak predictor of NCDs in this study, probably due to the low smoking rate (2.55%) among the participants and the high level (72.4%) of exposure to passive smoking[51]. Nonetheless, smoking remains one of the top five risk factors threatening women's health in China. China is the world's largest tobacco producer and consumer. The total number of adult smokers in China has exceeded 300 million, including 10 million women. Furthermore, tobacco control is a huge challenge[52], especially when smoking is combined with socioeconomic factors[53]. Our SEM results demonstrated a positive association between smoking and income and a negative association between smoking and education. A survey in 48 LMICs showed that wealth is not associated with smoking in Chinese women although this is not the case in 19 countries where richer women are more likely to smoke than the poor[54]. Given the financial sensitivity of tobacco consumption, the tobacco levy introduced in China recently may become an effective instrument for tobacco control.

Self-reported health played an important role in the SEM model, the effect of self-reported health on NCDs is profound (r'=-0.385). Self-reported health is also closely associated with SES, and plays a mediating role. These findings are consistent with studies undertaken elsewhere [55-58]. A study in East Asia reported a positive association between income and self-reported health in Chinese women, but failed to establish an association between occupation and self-reported health in those women[55]. A few researchers believe that self-reported health reflects physiological, mental and social indices[59]. Empirical evidence suggests that self-reported health is a reliable predictor of morbidity and mortality1[15, 60].

In conclusion, China is facing a serious challenge during the current socioeconomic transition. A complex network of risk factors is associated with NCDs. Socioeconomic disparities associated with the prevalence of NCDs exist among women in China. High educational attainment is associated with a low risk of NCDs. However, the robust economic development has failed to translate into reduced risks of NCDs. Like the cases in many developing countries, high income is associated with an increased risk of NCDs, as well as increased smoking rate. The effect of occupation on NCDs is also mediated by income and economic development. People engaged in less manual labor are more likely to live in urban areas, earn a high income, and enjoy high levels of entitlement with medical insurance, which in turn increases their risks of NCDs.

The findings of this study have policy implications for establishing responsive intervention strategies targeting NCDs in developing economies. Economic development in many developing countries, such as China, has been accompanied by many social challenges, including the increasing burden of NCDs. It is important to note that women are likely to suffer disproportional risks of NCDs due to gender inequalities in SES. Education may hold the key to mitigating such negative consequences. However, generalization of the findings to other countries needs to be cautious, because the SES of women varies across countries. The SES risk factors for NCDs may be contexts dependent.

There were several limitations in this study. The status of NCDs was self-reported, and therefore, the findings are subject to recall bias. Although the major findings of the SEM were confirmed by the results of regression analyses, several interaction effects failed to achieve statistical significance in the regression analyses. Finally, the study focused on Chinese women, which did not illustrate the situation of NCDs for the entire Chinese population. Further studies are needed to answer the following questions: (1)are there differences between men and women in relation to SES risk factors for NCDs; (2)what are the underlining reasons for the gender differences in SES risk factors for NCDs; (3)what difference (effect size) will education make to reduce gender inequalities in NCDs.

Acknowledgments: The authors thank the National Natural Science Fund (grant number: 71403074 and 71333003) for funding this research. The authors also appreciate two reviewers of this article for their very constructive comments and suggestions. Ms. Michele Mooney provided editing and proofreading services.

Author contributions: Dr. Qunhong Wu has full access to all the study data and is responsible for the integrity of the data and the accuracy of data analysis. Study concept and design: Qunhong Wu, Yanhua Hao, Limin Wang, Libo Liang. Acquisition, analysis, and interpretation of data: Hui Yin, Yu Cui, Yuchun Tao. Draft of the manuscript: Hui Yin. Critical revision of the manuscript for important intellectual content: Hui Yin, Yu Cui, Qunhong Wu, Yanhua Hao, Chaojie Liu. Statistical analysis: Hui Yin, Yu Cui, Ye Li, Libo Liang.

Funding: This research was supported by the National Natural Science Fund (grant number: 71403074 and 71333003).

Declaration of competing interests: None declared.

Ethics approval: The research was approved by the Medical Ethics Committee of Harbin Medical University (Daqing).

Data share statement: There are not additional unpublished data from this study.

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Figure legends:

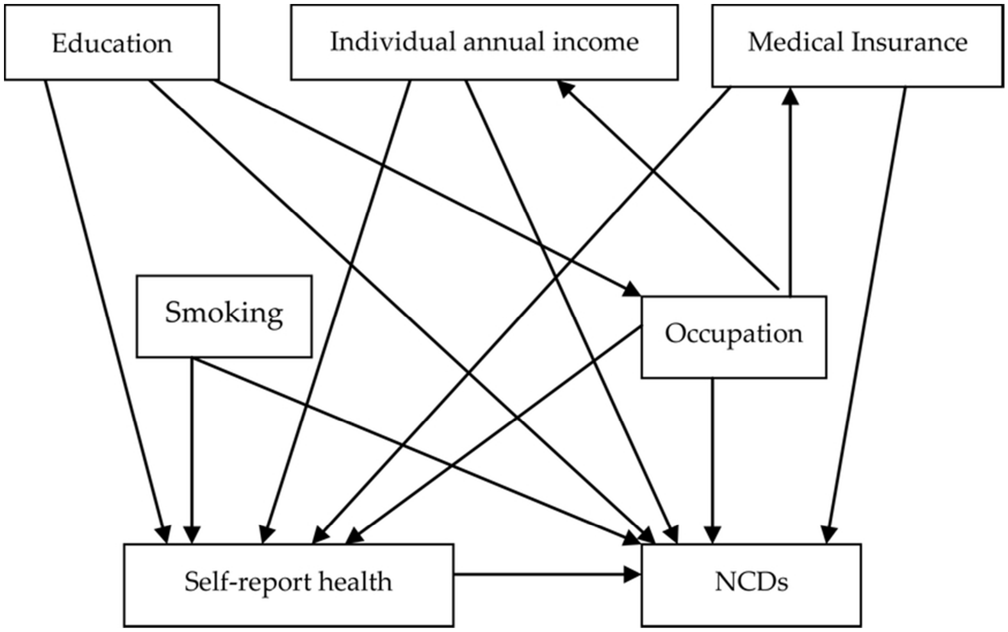
Figure 1. Base SEM Model

Figure 1 was the base model describing the complex relationships between all variables. In figure 1, "X→Y" meant X influenced Y.

Figure 2. SEM Model D

Figure 2 was the SEM model D with best fit, which describes the mechanisms involved in the relationships between SES and NCDs including their direction and size. "X→Y" meant X influenced Y. The numbers above the "→"were standardized regression weights.

***P<0.001(two-tailed test).



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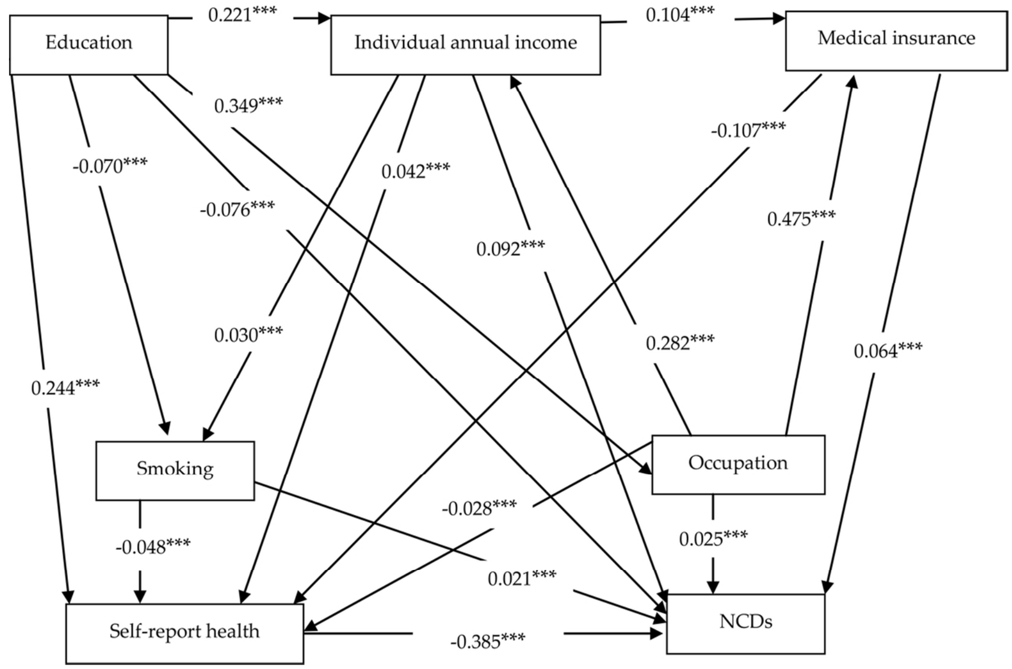
73x45mm (300 x 300 DPI)



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109x72mm (300 x 300 DPI)

Robustness check

In this study, we used bivariate logistic regressions and multiple linear regressions to check the Robustness.

1. Influencing factors of NCDs

The f bivariate logistic regressions was to analyze the effects of individual annual income, education, occupation, medical insurance, smoking, self-reported health and interaction of these factors on NCDs (Table 1).

Table 1 The effects of individual annual income, education, occupation, medical insurance, smoking and self-reported health and interaction on NCDs by bivariate logistic regression

Independent Variable	B	SE	*P*
Model 1			
Self-reported health	-0.070	0.001	<0.001
Smoking	0.271	0.062	<0.001
Education	-0.449	0.018	<0.001
Individual annual income	0.207	0.009	<0.001
Occupation	0.085	0.014	<0.001
Medical Insurance	0.354	0.026	<0.001
Model 2			
self-reported health	-0.070	0.001	<0.001
Smoking	-0.198	0.165	>0.05
Education	-0.458	0.018	<0.001
Individual annual income	0.207	0.009	<0.001
Occupation	0.085	0.014	<0.001
Medical Insurance	0.355	0.026	<0.001
Education*smoking	0.278	0.090	<0.01
Model 3			
self-reported health	-0.058	0.002	<0.001
Smoking	0.273	0.062	<0.001
Education	-0.448	0.018	<0.001
Individual annual income	0.491	0.042	<0.001
Occupation	0.084	0.014	<0.001
Medical Insurance	0.352	0.026	<0.001
Individual annual income* self-reported health	-0.004	0.001	<0.001

Note: The dependent variable was NCDs with 0=did not suffer NCDs and 1=suffered NCDs.

Continued:

Independent Variable	B	SE	*P*
Model 4			
Self-reported health	-0.081	0.003	<0.001
Smoking	0.267	0.062	<0.001
Education	-0.450	0.018	<0.001
Individual annual income	0.207	0.009	<0.001
Occupation	0.085	0.014	<0.001
Medical Insurance	-0.025	0.117	>0.05
Medical Insurance * Self-reported health	0.005	0.002	0.001
Model 5			
Self-reported health	-0.069	0.001	<0.001
Smoking	0.267	0.062	<0.001
Education	-0.587	0.025	<0.001
Individual annual income	0.161	0.011	<0.001
Occupation	-0.044	0.022	>0.05
Medical Insurance	0.331	0.026	<0.001
Occupation * Education* Individual annual income	0.013	0.002	<0.001
Model 6			
Self-reported health	-0.070	0.001	<0.001
Smoking	0.161	0.081	<0.05
Education	-0.451	0.018	<0.001
Individual annual income	0.206	0.009	<0.001
Occupation	0.083	0.014	<0.001
Medical Insurance	0.354	0.026	<0.001
Education*Occupation * Individual annual income*smoking	0.008	0.004	<0.05

Note: The dependent variable was NCDs with 0=did not suffer NCDs and 1=suffered NCDs.

As table 1 showed that all of factors were relation with NCDs, and education and self-reported health were protective factors for NCDs, others were risk. Furthermore, five interactions were examined significantly. The results were consistent with SEM.

2. Influencing factors of self-reported health

The multiple linear regressions was to analyze the effects of individual annual income, education, occupation, medical insurance, smoking on self-reported health (Table 2).

Table 2 The effects of individual annual income, education, occupation, medical insurance, smoking on self-reported health by multiple linear regression

Independent Variable	B	*β*	*P*
Individual annual income	0.280	0.028	0.000
Education	5.161	0.277	0.000
Occupation	-0.400	-0.028	0.000
Medical insurance	-2.786	-0.105	0.000
Smoking	-4.575	-0.051	0.000

Note: "B" was unstandardized regression coefficient; "*β*" was standardized regression coefficient.

As table 2 showed that effects of individual annual income, education, occupation, medical insurance, smoking were significant. Individual annual income and education had positive correlation to self-reported health, and others had negative correlation with self-reported health. The results were consistent with SEM, too.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract P1-2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found P2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported P2-3
Objectives	3	State specific objectives, including any prespecified hypotheses P3
Methods		
Study design	4	Present key elements of study design early in the paper P3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection P3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants P3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable P4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group P4
Bias	9	Describe any efforts to address potential sources of bias P4
Study size	10	Explain how the study size was arrived at P3
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why P4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding P5
		(*b*) Describe any methods used to examine subgroups and interactions P5
		(*c*) Explain how missing data were addressed P4
		(*d*) If applicable, describe analytical methods taking account of sampling strategy None
		(*e*) Describe any sensitivity analyses P5
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed P3
		(b) Give reasons for non-participation at each stage None
		(c) Consider use of a flow diagram None
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders P6
		(b) Indicate number of participants with missing data for each variable of interest None
Outcome data	15*	Report numbers of outcome events or summary measures P6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included P5-7
		(*b*) Report category boundaries when continuous variables were categorized P6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period None
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses supplementary materials

Discussion			
Key results	18	Summarise key results with reference to study objectives	P7
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	P8, P10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	P8, P9, P10
Generalisability	21	Discuss the generalisability (external validity) of the study results	P8
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	P10

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.