

Gender-specific differences in associations between economic status and systolic blood pressure or diastolic blood pressure

Jun Li¹, Rui-Hua Feng², Yan-Na Mao³, Xiao-Wan Wang²

¹Department of Human Resources, Peking Union Medical College Hospital, Beijing 100730, China;

²Department of Health Economics, Institute of Medical Information, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing 100020, China;

³School of Health Services Management, Southern Medical University, Guangzhou, Guangdong 510515, China.

Hypertension is a significant contributor to cardiovascular diseases. When controlled ineffectively, hypertension can lead to heart diseases and stroke, which together constitutes the leading causes of global premature death and disability. According to a national cross-sectional survey in China, the prevalence of hypertension among adults aged ≥ 18 years was 23.2% in 2015.^[1]

Presently, increasing numbers of studies have examined the social determinants of health. Due to structural disadvantages in the social context, a low socioeconomic status may influence blood pressure (BP) regulation unfavorably. In recent years, a growing body of literature has described the relationship between socioeconomic status and BP and/or the prevalence of hypertension. However, relatively few studies have investigated gender differences in the association between low income and elevated BP. Gender and economic status can potentially influence our access to personal, material, social, and psychological resources. Moreover, females and males may react differently to poverty. According to the current scientific literature, little research has examined the gender differences in BP and economic status among Chinese adults. Therefore, this observational study investigated the association of income and BP and addressed whether gender affects the impact of economic status on BP profile.

A cross-sectional survey was conducted to collect information on the prevalence and risk factors of chronic diseases among residents in the county-level city of Huanghua located in Hebei Province in east China, from September to November 2018. The sample size ($n = 6474$) was estimated according to the sampling rate estimation formula, using the prevalence of diabetes in Hebei Province (12.9%) as the reference value for calculation. The sample

size was increased by 10% to cover for possible incomplete information.

All physical and laboratory examinations and standardized in-person interviews were conducted in a village clinic/community health center by licensed healthcare professionals from township/community health centers. A simplified “China Chronic Disease and Risk Factor Surveillance Questionnaire” developed by the Chinese Center for Disease Control and Prevention was used. Physical and laboratory examinations included BP, weight, height, waist size, fasting glucose, and blood lipids (triglyceride, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, and total cholesterol). Trained healthcare professionals administered fully standardized physical and laboratory examinations. In all, 6705 questionnaires were collected with a 94.2% response rate.

According to the World Health Organization’s definition, smoking one or more cigarettes in the previous month and drinking any alcohol in the previous year were defined as smoking and alcohol consumption, respectively. High-intensity physical activities involved long-distance running, fast swimming, football, basketball, skipping, aerobics, and so on, at least once a week. “Salty taste” was determined using a self-report qualitative question. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m^2). We categorized BMI based on the “Chinese adult guidelines for the prevention and control of overweight and obesity,” and those with $BMI \geq 24 \text{ kg/m}^2$ and $BMI \geq 28 \text{ kg/m}^2$ were considered overweight and obese, respectively. Mean values of systolic BP (SBP) and diastolic BP (DBP) in three times were calculated. Abnormal blood lipids were defined as

Access this article online

Quick Response Code:



Website:

www.cmj.org

DOI:

10.1097/CM9.0000000000000953

Correspondence to: Dr. Rui-Hua Feng, Department of Health Economics, Institute of Medical Information, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing 100020, China
E-Mail: feng.ruihua@imicams.ac.cn

Copyright © 2020 The Chinese Medical Association, produced by Wolters Kluwer, Inc. under the CC-BY-NC-ND license. This is an open access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

Chinese Medical Journal 2020;133(14)

Received: 25-03-2020 Edited by: Ning-Ning Wang

Table 1: The adjusted associations between socioeconomic status and SBP/DBP stratified by gender.

Variable	β (95% CI)	
	Reference of adjusting variable: females	Reference of adjusting variable: males
SBP		
Annual household income per capita	-1.33 (-1.91, -0.74)*	-0.32 (-0.76, 0.13)
Gender	-0.94 (-2.23, 0.35)	0.94 (-0.35, 2.23)
Annual household income per capita \times gender	1.01 (0.29, 1.73)*	-1.01 (-1.73, -0.29)*
DBP		
Annual household income per capita	-0.62 (-1.02, -0.22)*	-0.15 (-0.44, 0.15)
Gender	0.28 (-0.59, 1.15)	-0.28 (-1.15, 0.59)
Annual household income per capita \times gender	0.47 (-0.01, 0.96)	-0.47 (-0.96, 0.01)

Adjusted confounders: Place of residence, age group, educational attainment, marital status, ethnicity, body mass index, smoking, alcohol intake, salty taste, high-intensity physical activity, diabetes mellitus, and abnormal blood lipids. * $P < 0.05$. DBP: Diastolic blood pressures; SBP: Systolic blood pressures; CI: Confidence interval.

increased total cholesterol, triglycerides, or low-density lipoprotein cholesterol, or decreased high-density lipoprotein cholesterol. Diabetes mellitus was characterized by fasting blood glucose >7.0 mmol/L or 126 mg/dL.

In this study, the sub-database set was selected from the cross-sectional survey database to analyze gender-specific differences in the associations of economic status with SBP and DBP. Multiple linear regression analysis was performed to estimate the impact of annual household income per capita on SBP/DBP. Additionally, multiple variables were controlled, including place of residence, gender, age, educational attainment, marital status, ethnicity, BMI, smoking, drinking, salty taste, physical activity, diabetes mellitus, and abnormal blood lipids. Anti-hypertensive medication intake could significantly influence the BP level. BP levels required adjustment when the participants took anti-hypertensive drugs before the analysis. Therefore, SBP and DBP were increased by 15 mmHg in participants who took anti-hypertensive medication daily, and they were increased by 10 mmHg in participants who took anti-hypertensive medication occasionally or when necessary. The interaction effect between gender and income was considered in the multiple linear regression models (SBP/DBP = $\alpha + \beta_1$ Income + β_2 Gender + β_3 Income \times Gender + . . . + $\beta_n X_n$); the interaction term in the equation was the product of Income \times Gender, reflecting the change in the effect of economic status on SBP/DBP according to gender. The t test for the coefficient of the interaction term reflects whether the interaction effect exists. The coefficient of income estimates the effect of income on SBP/DBP when Gender = 0. Statistical significance was set at $P < 0.05$. All statistical analyses were performed using Stata14.0 (StataCorp LP, College Station, TX, USA).

The study sample comprised 2991 men (44.6%) and 3714 women (55.4%). The mean SBP and DBP were 128.8 and 83.1 mmHg, respectively (129.5/83.8 mmHg for males and 128.3/82.6 mmHg for females). Annual household income was RMB 12,000 Yuan and RMB 10,000 Yuan for males and females, respectively.

We conducted a univariate analysis of related risk factors of SBP and DBP stratified by gender. The annual household

income was significantly associated with SBP/DBP for females ($\beta = -2.10$, 95% confidence interval [CI]: -2.79, -1.42); $\beta = -1.14$, 95% CI: -1.58, -0.69) but not for males.

As shown in Table 1, stratified multivariate analysis by gender revealed the effect of economic status on SBP and DBP. In SBP and DBP models, the variance inflation factors of independent variables were between 1.01 and 3.68. Generally, the variance inflation factor should not be greater than 5. Adjusted for confounding variables, the annual household income per capita was significantly associated with SBP ($\beta = -1.33$, 95% CI: -1.91, -0.74) and DBP ($\beta = -0.62$, 95% CI: -1.02, -0.22) for females. The coefficients of annual household income per capita were -1.33 and -0.62, indicating that SBP and DBP decreased by 1.33 and 0.62 units, respectively, when income increased by 10,000 Chinese Yuan. However, there was no statistically significant difference in males for SBP or DBP.

The result of t test demonstrated that interaction terms (annual household income per capita \times gender) were significant in the SBP models but insignificant in the DBP models ($P_{\text{interaction}} = 0.006$ for SBP; $P_{\text{interaction}} = 0.056$ for DBP), suggesting that the relationship between income and SBP differed significantly by gender but the relationship between income and DBP did not. Specifically, gender modified the associations of economic status with SBP.

This study revealed a positive association of economic status with SBP and DBP among females. Additionally, the interaction analysis indicated that gender may act as a modifier between economic status and SBP in our study population. Specifically, females and economic status had a synergy effect on SBP.

Although the results reveal that poor economic status played an independent role in elevated BP, the exact pathways and mechanisms between income and BP are unclear. This may stem from two aspects of intermediary causes: individual health behaviors and/or risk factors, and accessibility and affordability of healthcare relevant to income-level inequities.

One possible explanation for the “gender/income” interaction effect on SBP could be that the different adaptation to stressors and allostatic load by gender may affect SBP regulation. Stress is a major risk factor for hypertension.^[2] Chronic stress is more common in low-income than high-income communities.^[3] Furthermore, a Danish study on 1160 adults from a deprived neighborhood indicated that women experienced more psychological distress than men.^[4] Regarding its principle, chronic and pervasive stress from poverty may up-regulate the hypothalamic-pituitary-adrenal system, which may increase allostatic load and stress-coping behaviors^[5] and cause reduced efficiency of BP regulatory mechanisms. Similar to Danish research, poverty may pressurize Chinese women more than men, resulting in elevated SBP only in females.

The present study demonstrates that the influence of low economic status on elevated BP is both gender specific and income specific, and women with poor income are at a greater risk of elevated BP. If these gender differences in susceptibility to poverty are robust, then interventions for precise health poverty alleviation may require adjustment according to gender, and prevention of hypertension should emphasize females with low income.

Declaration of participants consent

The authors certify that they have obtained all appropriate patient consent forms. All participants provided their

consent for all physical and laboratory examinations and standardized in-person interviews.

Conflicts of interest

None.

References

1. Wang ZW, Chen Z, Zhang LF, Wang X, Hao G, Zhang ZG, *et al.* Status of hypertension in China: results from the china hypertension survey, 2012-2015. *Circulation* 2018;137:2344-2356. doi: 10.1161/CIRCULATIONAHA.117.032380.
2. Liu MY, Yang YA, Zhang LJ, Pu LH, He DF, Liu JY, *et al.* Potential predictors for mental stress-induced myocardial ischemia in patients with coronary artery disease. *Chin Med J* 2019;132:1390-1399. doi: 10.1097/CM9.0000000000000260.
3. Evans GW. The environment of childhood poverty. *Am Psychol* 2004;59:77-92. doi: 10.1037/0003-066X.59.2.77.
4. Bak CK, Tanggaard Andersen P, Bacher I, Draghiciu Bancila D. The association between socio-demographic characteristics and perceived stress among residents in a deprived neighbourhood in Denmark. *Eur J Public Health* 2012;22:787-792. doi: 10.1093/eurpub/cks004.
5. Seeman M, Stein Merkin S, Karlamangla A, Koretz B, Seeman T. Social status and biological dysregulation: the “status syndrome” and allostatic load. *Soc Sci Med* 2014;118:143-151. doi: 10.1016/j.socscimed.2014.08.002.

How to cite this article: Li J, Feng RH, Mao YN, Wang XW. Gender-specific differences in associations of economic status with systolic blood pressure and diastolic blood pressure: a cross-sectional study. *Chin Med J* 2020;133:1722-1724. doi: 10.1097/CM9.0000000000000953