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Socioeconomic Gradients of Cardiovascular Risk Factors in China and India: Results from the China Health and Retirement Longitudinal Study and Longitudinal Aging Study in India

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Short running head: Socioeconomic gradients of cardiovascular risk factors in China and India

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Abstract

Objectives: Cardiovascular disease has become a major public health challenge in developing countries. The goal of this study is to compare socioeconomic status (SES) gradients of cardiovascular risk factors both within and between China and India.

Methods: We used data from the China Health and Retirement Longitudinal Study (CAHRLS) and the Longitudinal Aging Study in India (LASI) to analyze the associations between cardiovascular risk factors (waist circumference, body mass index, and hypertension) and SES, particularly education attainment and per capita expenditure.

Results: The multivariate logistic regression analyses showed that obesity, defined by either waist circumference or body mass index, was positively correlated with higher education levels in Indian men and women, but inversely associated with education levels among Chinese women. Similar pattern was observed between education attainment and hypertension based on self-reported physician diagnosis and direct blood pressure measurements.

Conclusions: SES is associated with cardiovascular risk factors in both China and India. However, the direction of this relationship varies across these two countries, suggesting that this association is not fixed, but is subjective to time and context-dependent causal pathways.

Key words: socioeconomic status, cardiovascular risk factor, aging, China, India

Introduction

China and India, the two most populous countries that account for one-third of the total world population, are undergoing dramatic demographic, societal, and economic transformations. The rapid population aging accompanied by economic growth in both countries has contributed to a transition in the disease profile from predominantly infectious diseases to chronic diseases, such as cardiovascular disease (CVD), as major causes for mortality, morbidity, and functional impairment among older adults. The Chinese National Center on Cardiovascular Diseases estimated that there are about 230 million patients with CVD in China, including 200 million patients with hypertension, 7 million patients with stroke, 2 million patients with myocardial infarction, and 4.2 million patients with congestive heart failure (Li and Ge 2015). CVD has become the leading cause of mortality in China, accounting for 41% in all deaths. CVD-associated mortality and morbidity are also increasing rapidly in the Indian subcontinent, causing more than 25% of deaths (Gupta 2008). This epidemic has reached its advanced stage even in rural India. A survey conducted in 45 rural villages in India showed that 32% of all deaths were due to CVD, compared to 13% from infectious diseases (Joshi et al. 2006). Furthermore, the onset of cardiovascular disease in developing countries is on average 10 to 15 years earlier than that in developed countries (Yusuf et al. 2004), with coronary heart disease affecting Indians at least 5 to 6 years earlier than their western counterparts (Xavier et al. 2008).

Socioeconomic status (SES) is a known determinant for CVD and related mortality in developed countries (Marmot 1996; González et al. 1998; Cox et al. 2006). However, this SES-CVD association has been less well studied in developing countries such as China and India, mainly due to lack of high quality data. Moreover, the SES gradients may be more complicated in these developing countries, as they are often confounded by varying access to and quality of health care systems and under-diagnosis of CVD. For example, the Global Health Observatory (GHO) data from the World Health Organization showed that in 2011 the density of physicians per 1,000 population was 1.491 in China and 0.743 in India (http://apps.who.int/gho/data/node.main.A1444). China also had 5 times more hospital beds per 1,000 population than India (http://data.worldbank.org/indicator/SH.MED.BEDS.ZS). To illustrate this complexity of SES-CVD association in developing countries, a recent meta-analysis showed that the association between SES and hypertension in rural populations of low- and middle-income countries in Asia may vary according to geographical regions (Busingye et al. 2014). Educational status and hypertension were inversely associated in East Asia, but positively associated in South Asia.

In this study, we used data from the China Health and Retirement Longitudinal Study (CAHRLS) and the Longitudinal Aging Study in India (LASI) to analyze the relationship between cardiovascular risk factors and SES, particularly education attainment and per capita consumption, a preferred indicator of economic status in developing countries. These two studies are conceptually harmonized to the Health and Retirement Study (HRS) in the U.S., thus allowing for examination of not only SES gradients of health measures in each country but also whether the SES gradients of selective health parameters differ significantly between China and India.

Methods

Study design and participants

The China Health and Retirement Longitudinal Study

CHARLS is a longitudinal national survey representative of the middle-aged and elderly population (45 years old and above) in China (Zhao et al. 2014). The CHARLS baseline national survey was fielded between June 2011 and March 2012. The study was a multi-stage, stratified, random sample drawn at the county, neighborhood, and household levels. At the first stage, 150 county-level units were selected randomly out of all county-level units (rural counties or city districts), with probability proportional to population size (PPS), from all provinces except Tibet. The county sample was stratified, by region, urban-rural, and county per capita gross domestic product (GDP). Twenty-eight provinces out of 30 were represented in the selected counties. At the second stage, three administrative villages in rural areas or resident communities in urban areas were randomly selected from each county with PPS sampling, resulting in a total of 450 villages/neighborhoods; these were the primary sampling units (PSU). Households were then sampled from the sampling frame of all dwelling units within a PSU to obtain approximately 20 age eligible households per PSU. Within sampled households, one person aged 45 or older (randomly sampled if there were more than one) became the main respondent. His/her spouse, no matter the age, was also included. A total of 17,708 participants from 10,257 households were interviewed during the baseline survey.

CHARLS questionnaire was conceptually comparable to the one used by the HRS. Information was collected on basic demographics, family, health status, health care, employment, and the household economy. Health-related questions included self-reported health status, previous medical history, lifestyle, health behaviors, and activities of daily living. Anthropometric and other physical measurements were taken, which included height, weight, waist circumference, and blood pressure.

For this analysis, we included 9,947 participants, who had complete data from interview and physical examination.

The Longitudinal Aging Study in India

LASI is a panel survey representative of persons at least 45 years of age in India. Its pilot study was fielded in 2010. To capture regional variations, this pilot study included two northern states (Punjab and Rajasthan) and two southern states (Karnataka and Kerala). The study sample was drawn using a stratified, multistage, area probability sampling design based on the 2001 Indian Census. From each state, the study randomly chose two Census districts and then randomly selected eight primary sampling units (PSU) from each district to match the urban/rural share of the state population. Finally, the study selected 25 community-residing households through random sampling from each PSU. Previous analysis showed that the overall demographic characteristics of LASI pilot sample are congruent with the population characteristics of India (Arokiasamy et al. 2012).

Like CHARLS, the LASI survey instrument has been designed to collect information that is harmonized to the HRS, and includes variables on demographics, family structure and social network, housing and environment, health and health behaviors, health care utilization, work and pension, income, assets, debts, and consumption. LASI also measured anthropometric parameters and physical performance, and collected dried blood spot (DBS) specimens using a standardized protocol (Lee et al. 2015). The analysis in this paper is restricted to 1,460 respondents who were at least 45 years old.

Measures

Socioeconomic status

We used education attainment, per capita household expenditure, and living in rural area as main SES measures. In developed countries, education has been found to be the strongest measure of SES in relation to health (Smith 2007a, 2007b), influencing it through multiple pathways, including health behaviors and access to healthcare (Lee 2011). We categorized education level into four groups: illiterate, literate but less than primary education, primary school, and junior high school or above, based on a respondent's self-reported highest level of attainment. We also include spouse's educational attainment, as for women in China and India, husbands' education might be a better proxy of SES than her own education.

We used per capita household expenditure as another measure of SES. This measure is preferred to income as past studies reveal that consumption is a better indicator of economic status in low-income and rural settings (Strauss et al. 2010). Consumption was measured at the household level, constructed from a sequence of questions that asks about expenses incurred over the previous year. The categories included: food (purchased, home-grown, and meals eaten out), household utilities (e.g., vehicle or home repairs, communications, fuel), fees (taxes, loan repayments, insurance premiums), purchases of durable goods (including clothing), education and health expenditures, discretionary spending items (alcohol and tobacco, entertainment, holiday celebrations, and charitable donations), transit costs, and remittances. The household consumption burden was calculated by taking the total household yearly consumption divided by total household members as a per capita measure. LASI provided imputed data for missing values using a hot deck method, and we control for imputed consumption in the models to adjust for any systematic bias due to missing data for some components of household consumption. CHARLS did not provide imputed data, losing 1424 (14%) observations. In order to compare across the two countries, the measure was converted to US dollars and adjusted by purchasing power parities (PPP) (World Bank 2011).

Cardiovascular risk factors

Waist circumference, weight, and height were measured based on a standardized protocol. For adiposity, we used two related but also independent measures: waist circumference and body mass index (BMI) (Tanamas SK et al. 2015). For waist circumference, we created an indicator for obesity if a male respondent's waist circumference was greater than 102 cm (40 inches) or a female respondent's waist greater than 88 cm (35 inches). BMI was calculated as weight in kilograms divided by height in meters squared. Obesity was defined as BMI equal or greater than 30 kg/m^2.

Information regarding hypertension was obtained in several ways. A binary variable indicating 'self-reported diagnosis of hypertension' was created based on the following question: "Has any health professional ever told you that you have high blood pressure or hypertension?" Another binary variable indicating taking medication to treat or control hypertension was created based on the question: "Are you taking any medication to treat or control your hypertension?" As part of the physical measurements, both CHARLS and LASI field investigators measured blood pressure 3 times, using Omron automatic blood pressure monitors. We created a binary variable for ‘measured hypertension’ if the mean systolic blood pressure was at least 140 mm Hg or mean diastolic blood pressure at least 90 mm Hg. Because under-diagnosis of hypertension may be common in certain Chinese or Indian populations due to low education level or lack of access to health care, we finally defined ‘total hypertension’ as having ever been diagnosed by a health professional, taking medication for hypertension, or hypertensive based on blood pressure readings at the time of the study interview.

Demographic characteristics

We also included information on age and gender in our models.

Statistical methods

We examined gender and country differences across all demographic variables, socioeconomic status measures, and cardiovascular risk factors. The overall and gender-specific descriptive statistics are presented. We accounted for survey design and used survey weights in descriptive inferences. We formally tested first gender differences within country and then gender-specific country differences between China and India. The chi-square test was used to determine statistical significance for these differences.

Next, we performed gender-specific multivariate logistic regression analyses to examine the association between sociodemographic characteristics and cardiovascular risk factors for two countries. The sociodemographic characteristics variables included in multivariate models were age categories (45-59, 60–74, and 75 and older), residency in rural or urban areas, respondent’s education attainment, spousal education level, and per capita expenditure. We converted per capita expenditure values in each country to international dollars using purchase power parity (PPP) rates (drawn from the World Bank, see http://data.worldbank.org/) and did log transformation. To control for possible clustering effect, we also included county dummy variables for CHARLS and state dummy variables for LASI. The cardiovascular risk factors examined were high-risk waist circumference; high body mass index; hypertension based on self-reported physician diagnosis, medication use, or objective blood pressure examination.

Finally, we conducted a sensitivity analysis among LASI respondents to explore whether caste may influence the relationships between sociodemographic characteristics and cardiovascular risk factors in India. Respondents had self-reported information as members of scheduled castes, scheduled tribes, other backward class, and all “others” including “no caste.” Scheduled castes and scheduled tribes are particularly disadvantaged due to a historical legacy of inequality; scheduled tribes often represent more geographically isolated, ethnic minority populations while scheduled castes can generally be characterized as socially segregated by traditional Hindu society, often excluded from education, public spaces (such as wells for drinking water and temples), and most other aspects of civil life in India (Subramanian et al. 2008). Many respondents are considered by the Government of India to be a member of an OBC (other backward class). While less marginalized and stigmatized than scheduled castes or tribes, these individuals also face barriers to economic and educational opportunities (Subramanian et al. 2008). Our sensitivity analysis indicated that caste had no significant effect on the relationships between SES and cardiovascular risk factors, and was thus excluded from our final models. All analyses were done using Stata version 13.1.

Results

Table 1 summarizes the distributions of sociodemographic characteristics and cardiovascular risk factors of CHARLS and LASI participants. CHARLS men and women were older and less likely to reside in rural area than their respective group in LASI, which reflects the population age structures and urban migration status of these two countries. Women were less educated in both countries. CHARLS participants had higher education attainment in general. More than 53% of women in LASI were illiterate. Per capita consumption levels seemed to be higher among CHARLS respondents as well, although the differences were not statistically significant.

The overall prevalence rate of high-risk waist circumference or high-risk BMI was similar between China and India. In both countries, obesity, defined by either waist circumference or BMI, was significantly more common among women than men. Between women in these countries, Chinese were more likely to have high-risk waist circumference, whereas Indians were more likely to have high-risk BMI. The overall prevalence of hypertension was 41.8% in CHARLS and 50.1% in LASI. Further examination of respondents with hypertension showed that men and women in CHARLS had more self-reported diagnosis of hypertension and taking anti-hypertensive medications than those in LASI, but were less likely to have elevated blood pressure on physical examination.

Table 2 shows the multivariate logistic regression analyses of the associations between sociodemographic variables and waist circumference. High-risk waist circumference was positively correlated with selective categories of higher education levels in Indian men and women. However, this association between education and high-risk waist circumference was null among Chines men and inverse among Chinese women with junior high school or higher education. This inverse relationship persisted after adjustment of spousal education levels. Higher per capita expenditure was also positively associated with high-risk waist circumference in Indian women and Chinese men.

The association between education and high-risk BMI had a similar pattern: positive among Indian men and women, but inverse among Chinese women (Table 3). Higher per capita expenditure was also positively associated with high-risk BMI in Indian men and women. In both countries, rural residents had lower prevalence of obesity, based on either waist circumference or BMI.

When hypertension was classified by self-reported diagnosis, use of anti-hypertensive, or high blood pressure readings on physical examination, the disease was more common in older adults in both countries and urban residents in China (Table 4). Higher education attainment was consistently related to prevalent hypertension in both Indian men and women. For CHARLS, the association was again inverse among women. Spouse's educational level shows similar relationship with hypertension. There was no significant association between per capita expenditure and hypertension in CHARLS or LASI sample.

Discussion

This comparative analysis of the relationship between SES and cardiovascular risk factors in China and India indicated that obesity and hypertension are common in both countries. The overall prevalence of high-risk waist circumference was 22.2% in LASI and 22.9% in CHARLS. The prevalence of hypertension was 50.1% and 41.8%, respectively. Obesity, based on either waist circumference or BMI, was positively correlated with higher education levels in Indian men and women, but inversely associated with education levels among Chinese women. Similar pattern was observed for the relationship between education attainment and hypertension. Higher per capita expenditure was associated with high-risk waist circumference among Indian women and Chinese men, and with high-risk BMI among Indian men and women.

Cross-country comparison of socioeconomic inequalities in illness may provide some insight into possible causal explanations and potential interventions. For example, by comparing data from the U.S. HRS and the English Longitudinal Study of Aging (ELSA), Bank et al. showed that even though US residents are much less healthy than their English counterparts and the health differences exist at all points of the SES distribution, the differences between US and English populations cannot be fully explained by universal lifetime health care access in English (Banks et al. 2006). Similarly, comparative analysis of adults 50–75 years old in the United States, England, and 10 European countries suggested that the United States has the worst health levels, as well as generally larger gradients with the disadvantage most marked in the poorest group (Avendano et al. 2009). It was postulated that these observations might be due to survival advantages among US adults with chronic illness, behavioral differences, differences in the health care system, or social policy contexts other than medical care that indirectly impair American health.

Our study is unique in using harmonized high quality survey data to compare SES gradients in cardiovascular risk factors in two large developing countries in the world. The results indicate that education may have different effect on obesity and hypertension, i.e., higher education attainment may be associated with less cardiovascular risk factors in Chinese women, but more risk factors among Indian men and women. These findings are supported by a recent meta-analysis, which also showed that educational status and hypertension were inversely associated in East Asia, but positively associated in South Asia (Busingye et al. 2014). Higher education attainment may have multiple, and possibly opposing effects on cardiovascular risks. On one hand, better education and its associated economic advantage in developing countries may lead to adoption of Western lifestyle, including increased availability of high-energy and processed food. On the other hand, education may increase health awareness, modulate risk behaviors, and provide better access to health care (Busingye et al. 2014).

This complexity in the relationship between education and cardiovascular risk factors may also reflect the possibility that China is further advanced than India along the epidemiological transition from infectious diseases to chronic medical conditions. Even though Chinese and Indian economies are both success stories of globalization and are often treated as broadly similar in their growth potentials, they are different in many aspects, including GDP growth rates in the past two decades, poverty level, and nature of economic inequalities. For example, World Bank data indicate that, during the 20 years from 1995 and 2014, the annual GDP growth rate ranged from 7.3% to 14.2% (average 9.6%) in China and from 3.8% to 10.4%

(average 7.0%) in India (http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG). Poverty rate was 14.7% in 2008 in China, compared to 31.4% in 2009 in India. These two countries also differ in life expectancy, mortality from infectious diseases (e.g. HIV/AIDS and diarrheal diseases), and access to health care (http://www.rand.org/content/dam/rand/pubs/occasional_papers/2008/RAND_OP212.pdf). The mortality rate from infectious diseases was 39 per 100,000 persons in China, compared to 197 per 100,000 persons in India. Our data also showed that Chinese men and women are more likely to report diagnosis of hypertension, take anti-hypertensive medications, and have hypertension controlled than those in India. All these seem to support better access to and higher care quality for hypertension in China. These societal differences may help to explain why the relationship between education attainment and health status varies across these two countries.

Similar variations in SES gradients of health have been observed over time and across countries (Dow and Rehkopf 2010). In the U.S., individuals with higher SES had higher rate of ischemic heart disease before 1950, but started to have lower rate after that time period (Breslow and Buell 1963; Pell and Fayerweather 1985). Therefore, it has been postulated that the aggregate health achievement and/or SES-related health disparities are not fixed, but rather subjective to time and context-dependent causes (Dow & Rehkopf 2010).

LASI data showed that the prevalence of high-risk waist circumference was 22.2% and prevalence of hypertension was 50.1%. These estimates are in general consistent with other reports from India. One study of 6198 subjects living at 11 cities in India indicated that the prevalence of high waist circumference was 35.7% (95% confidence interval: 34.1% - 37.3%) in men and 57.5% (95% confidence interval: 55.6%-59.3%) (Deedwania et al. 2014). Previous studies have also suggested prevalence rates for hypertension in India to be 29-45% in men and 25-38% in women (Bansal et al. 2012). Therefore, LASI pilot sample appears to be similar to the general population in India in health outcomes as well as demographic characteristics.

Our study has several important strengths. First, both CHARLS and LASI are comparable to the HRS in the U.S. and have harmonized SES and health indicators, allowing more accurate cross-country comparisons. Second, both studies have objective measurements of anthropometric and physical parameters. Therefore, our evaluation of cardiovascular risk factors does not entirely depend on self-reported information, which could have severe under-reporting for some disadvantaged populations. Third, CHARLS is a nationally-representative sample. Although LASI pilot study only included four states, the characteristics of LASI pilot sample are congruent with the population characteristics of India.

Some limitations of our study should also be noted. Even though both CHARLS and LASI are designed as longitudinal studies, this analysis is cross-sectional in nature. While it is unlikely that the current status of cardiovascular risks would have an impact on prior education attainment, conditions such as obesity and hypertension could affect expenditure, leading to temporal ambiguity in the association. The clinical diagnosis of hypertension should be made on consistently elevated blood pressure. Given the nature of field survey, neither CHARLS nor LASI was able to ascertain a respondent’s blood pressure levels on a separate occasion. Thus, it is possible that our analytic approach has misclassified a small number of hypertensive cases who were diagnosed based on our physical examination alone.

Despite these limitations, our study indicates that SES is associated with cardiovascular risk factors in both China and India. However, the relationship varies across these two countries. This complexity may suggest different underlying causal pathways linking SES to CVD, which may be related to different stages of socioeconomic development. Longitudinal data from CHARLS and LASI will allow us to further investigate these biological pathways and explore potential interventions to reduce CVD risks in China and India, as these two countries continue their trajectory of rapid economic growth.

References

Arokiasamy, P., Bloom, D., Lee, J., Feeney, K., & Ozolins, M. (2012). Longitudinal Aging Study in India: Vision, design, implementation, and preliminary findings. In J. P. Smith & M. Majmundar (Eds.), *Aging in Asia: Findings from new and emerging data initiatives*. pp 36-74,Washington, DC: The National Academies Press.

Avendano M, Glymour MM, Banks J, Mackenbach JP (2009). Health disadvantage in US adults aged 50 to 74 years: a comparison of the health of rich and poor Americans with that of Europeans. Am J Public Health. Mar;99(3):540-8. doi: 10.2105/AJPH.2008.139469.

Banks J, Marmot M, Oldfield Z, Smith JP (2006). Disease and disadvantage in the United States and in England. JAMA. May 3;295(17):2037-45.

Bansal SK, Saxena V, Kandpal SD, Gray WK, Walker RW, Goel D (2012). The prevalence of hypertension and hypertension risk factors in a rural Indian community: A prospective door-to-door study. J Cardiovasc Dis Res. Apr;3(2):117-23. doi: 10.4103/0975-3583.95365.

Breslow L, Buell P (1960). Mortality from coronary heart disease and physical activity of work in California. J Chronic Dis. April;11:421-44.

Busingye D, Arabshahi S, Subasinghe AK, Evans RG, Riddell MA, Thrift AG (2014). Do the socioeconomic and hypertension gradients in rural populations of low- and middle-income countries differ by geographical region? A systematic review and meta-analysis. Int J Epidemiol. Oct;43(5):1563-77. doi: 10.1093/ije/dyu112.

Cox AM, McKevitt C, Rudd AG, Wolfe CD (2006). Socioeconomic status and stroke. Lancet Neurol. Feb;5(2):181-8.

Deedwania PC, Gupta R, Sharma KK, Achari V, Gupta B, Maheshwari A, Gupta A (2014). High prevalence of metabolic syndrome among urban subjects in India: a multisite study. Diabetes Metab Syndr. Jul-Sep;8(3):156-61. doi: 10.1016/j.dsx.2014.04.033.

Dow WH, Rehkopf DH (2010). Socioeconomic gradients in health in international and historical context. Ann N Y Acad Sci. Feb;1186:24-36. doi: 10.1111/j.1749-6632.2009.

González MA, Rodríguez Artalejo F, Calero JR (1998). Relationship between socioeconomic status and ischaemic heart disease in cohort and case-control studies: 1960-1993. Int J Epidemiol. Jun;27(3):350-8.

Gupta R, Joshi P, Mohan V, Reddy KS, Yusuf S (2008). Epidemiology and causation of coronary heart disease and stroke in India. Heart. Jan;94(1):16-26.

Hu P, Herningtyas EH, Kale V, Crimmins EM, Risbud AR, McCreath H, Lee J, Strauss J, O'Brien JC, Bloom DE, Seeman TE (2015). External quality control for dried blood spot-based

C-reactive protein assay: experience from the indonesia family life survey and the longitudinal aging study in India. Biodemography Soc Biol. 61(1):111-20. doi: 10.1080/19485565.2014.

Joshi R, Cardona M, Iyengar S, Sukumar A, Raju CR, Raju KR, Raju K, Reddy KS, Lopez A, Neal B (2006). Chronic diseases now a leading cause of death in rural India--mortality data from the Andhra Pradesh Rural Health Initiative. Int J Epidemiol. Dec;35(6):1522-9.

Lee J (2011). Pathways from education to depression. J Cross Cult Gerontol.;26(2):121-35.

Lee J, Smith JP (2012). The effect of health promotion on diagnosis and management of diabetes. J Epidemiol Community Health. Apr;66(4):366-71. doi: 10.1136/jech.2009.087304.

Lee J, McGovern ME, Bloom DE, Arokiasamy P, Risbud A, O'Brien J, Kale V, Hu P (2015). Education, gender, and state-level disparities in the health of older Indians: Evidence from biomarker data. Econ Hum Biol. Dec;19:145-56. doi: 10.1016/j.ehb.2015.09.003.

Li H, Ge J (2015). Cardiovascular diseases in China: Current status and future perspectives. IJC Heart & Vasculature. Oct;6:25–31. doi: 10.1016/j.ijcha.2014.10.002.

Marmot MG (1996). Socio-economic factors in cardiovascular disease. J Hypertens Suppl. Dec;14(5):S201-5.

McDade TW, Burhop J, Dohnal J (2004). High-sensitivity enzyme immunoassay for C-reactive protein in dried blood spots. Clin Chem. Mar;50(3):652-4. doi:10.1373/clinchem.2003.029488.

Pell S, Fayerweather WE. Trends in the incidence of myocardial infarction and in associated mortality and morbidity in a large employed population, 1957-1983. N Engl J Med. 1985;312(16):1005-11. doi: 10.1056/NEJM198504183121601.

Smith JP (2007). The impact of socioeconomic status on health over the life course. J Hum Resour. Nov;42(4):739-764. doi: 10.3368/jhr.XLII.4.739.

Smith JP (2007). Nature and causes of trends in male diabetes prevalence, undiagnosed diabetes, and the socioeconomic status health gradient. Proc Natl Acad Sci U S A.;104(33):13225-31. doi: 10.1073/pnas.0611234104.

Stata Corporation. Stata: Release 13.1 Statistical Software. College Station, TX: StataCorp LP:2013.

Strauss J, Lei X, Park A, Shen Y, Smith JP, Yang Z, Zhao Y (2010). Health Outcomes and Socio-Economic Status Among the El Status Among the Elderly in China: Evidence from the CHARLS Pilot. J. Population Ageing. Santa Monica, CA: RAND Corporation.

Subramanian SV, Ackerson LK, Subramanyam MA, Sivaramakrishnan K (2008). Health inequalities in India: The axes of stratification. The Brown Journal of World Affairs.;14(2):127–138.

Tanamas SK, Lean ME, Combet E, Vlassopoulos A, Zimmet PZ, Peeters A (2015). Changing guards: time to move beyond body mass index for population monitoring of excess adiposity. QJM. Jul;109(7):443-6. doi: 10.1093/qjmed/hcv201.

World Bank (2011). International Comparison Program (ICP) 2011 Data, downloaded on March 10, 2015 from http://siteresources.worldbank.org/ICPEXT/Resources/ICP_2011.html

World Health Organization. Preventing Chronic Diseases: A Vital Investment. World Health Organization (2005).

Xavier D, Pais P, Devereaux PJ, Xie C, Prabhakaran D, Reddy KS, Gupta R, et al. (2008). Treatment and outcomes of acute coronary syndromes in India (CREATE): a prospective analysis of registry data. *Lancet*, 371:1435–42.

Yusuf, S., Hawken, S., Ounpuu, S., Dans, T., Avezum, A., et al. (2004). Effects of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): Case-control study, *Lancet*, 364: 937 – 952. Doi: 10.1016/s0140-6736(04)17018-9.

Zhao Y, Hu Y, Smith JP, Strauss J, Yang G (2014). Cohort profile: the China Health and Retirement Longitudinal Study (CHARLS). Int J Epidemiol. Feb;43(1):61-8. doi: 10.1093/ije/dys203.

Table 1. Distribution of sociodemographic characteristics and cardiovascular risk factors by gender and study

	LASI			CHARLS		
	Total	Men	Women	Total	Men	Women
N	1121	538	583	9834	4569	5265
Age, mean (S.D.), years	57.2 (10.3)	57.8 (10.1)	56.8 (10.4)*	60.0 (9.9)	60.5 (9.6)$^{+}$	59.6 (10.1)$^{*+}$
Age categories, %						
45 years – 59 years	61.2	60.0	62.5	53.0	53.0	55.3^{*+}
60 years – 74 years	30.8	31.9	29.7	37.5	37.5^{+}	35.1^{*+}
75 years or over	8.0	8.1	7.8	9.5	9.5^{+}	9.6^{+}
% women	51.6			53.8		
% living in rural area	74.7	76.2	73.2	65.2	66.3^{+}	64.2^{*+}
Education categories, %						
Illiterate	47.4	40.7	53.6*	29.9	13.6^{+}	43.7^{*+}
Literate	11.4	11.7	11.1	19.0	21.1^{+}	17.2^{*+}
Primary school	13.2	14.3	12.3	22.2	27.5^{+}	17.7^{*+}
Junior high school or above	28.0	33.3	23.0*	28.9	37.8^{+}	21.3*
Per capita expenditures in US dollars and adjusted for purchase power parities (median)	1788	1768	1801	2381	2348	2411
Waist circumference >102 cm for male or >88 cm for female	22.2	8.0	35.5*	22.9	4.7^{+}	38.6^{*+}
Body mass index >= 30 kg/m^2	5.1	2.2	7.8*	4.7	2.9^{+}	6.1^{*+}
Hypertension						
(a) Self-reports of doctor-diagnosis	17.3	15.2	19.2*	24.9	23.6^{+}	26.0^{*+}
(b) Taking medication	14.0	11.9	15.9*	19.4	18.2^{+}	20.5^{*+}
(c) Systolic >= 140 mmHg or diastolic >= 90 mmHg	42.8	42.0	43.6	31.7	30.5^{+}	32.7^{+}
(d) Total: (a) or (b) or (c)	50.1	47.5	52.5	41.8	40.4^{+}	43.0^{*+}
Among the total hypertensive (d) **						
% diagnosed and controlled	14.5	11.7	16.9*	24.3	24.7^{+}	24.0^{+}
% diagnosed and uncontrolled	19.8	20.0	19.6	35.1	33.5^{+}	36.3*$^{+}$
% undiagnosed	65.7	68.3	63.5	40.6	41.8^{+}	39.7*$^{+}$

* p<0.05 for testing gender difference within study
+ p<0.05 for testing country difference within same gender
**LASI: total N=580, male N=271, female N=309; CHARLS: total N=4064, male N=1828, female N=2236

Table 2. Gender-specific multivariate logistic regression analysis of the association between sociodemographic characteristics and high-risk waist circumference, by study

High-risk waist circumference	LASI				CHARLS			
	Model 1		Model 2		Model 1		Model 2	
	Men	Women	Men	Women	Men	Women	Men	Women
Age (reference: 45 – 59 years)								
60 – 74 years	1.04(0.48-2.23)	1.05(0.72-1.52)	1.05(0.47-2.33)	1.10(0.75-1.63)	0.90(0.62-1.29)	**1.23(1.05-1.44)**	0.92(0.64-1.34)	**1.27(1.08-1.49)**
75+ years	1.72(0.41-7.20)	1.53(0.59-3.97)	2.23(0.56-8.84)	1.72(0.67-4.39)	0.72(0.34-1.52)	1.12(0.82-1.54)	0.78(0.36-1.68)	1.16(0.84-1.62)
Rural residency (reference: urban)	0.83(0.30-2.27)	**0.50(0.26-0.98**)	0.78(0.29-2.11)	**0.49(0.25-0.99)**	**0.52(0.32-0.86**)	**0.64(0.51-0.79)**	**0.54(0.33-0.90)**	**0.64(0.52-0.80)**
Respondent education (reference: illiterate)								
Literate	2.58(0.60-11.01)	1.18(0.44-3.12)	2.32(0.48-11.15)	1.20(0.43-3.34)	1.05(0.54-2.04)	1.07(0.87-1.31)	1.04(0.53-2.01)	1.05(0.86-1.29)
Primary school	1.65(0.35-7.72)	**2.86(1.36-5.99)**	1.46(0.28-7.55)	**2.76(1.25-6.07)**	1.52(0.80-2.87)	0.86(0.69-1.07)	1.49(0.78-2.83)	0.83(0.67-1.04)
Junior high school+	**4.99(1.77-14.06)**	**3.42(1.66-7.05)**	**4.61(1.41-15.10)**	**2.97(1.30-6.79)**	1.39(0.76-2.55)	**0.74(0.59-0.92)**	1.33(0.72-2.46)	**0.69(0.55-0.87)**
Spouse education (reference: illiterate)								
Literate			1.36(0.37-4.95)	0.37(0.11-1.31)			0.94(0.55-1.60)	1.12(0.84-1.50)
Primary school			0.84(0.17-4.09)	1.19(0.57-2.51)			1.03(0.63-1.68)	1.12(0.85-1.48)
Junior high school+			1.06(0.31-3.59)	1.09(0.58-2.06)			1.14(0.69-1.89)	**1.35(1.03-1.78)**
No spouse			**0.22(0.06-0.87)**	0.65(0.37-1.16)			0.82(0.45-1.50)	1.15(0.85-1.56)
Per capita expenditures in US dollars and adjusted for purchase power parities (log scale)	1.25(0.85-1.84)	**1.53(1.17-2.00)**	1.34(0.94-1.91)	**1.51(1.16-1.97)**	**1.34(1.09-1.65)**	1.09(1.00-1.19)	**1.35(1.09-1.67)**	1.08(0.99-1.18)

* Data are presented as odds ratios (95% confidence intervals). State dummy variables are included in LASI models and county dummy variables are included in the CHARLS model

Table 3. Gender-specific multivariate logistic regression analysis of the association between sociodemographic characteristics and high body mass index (>=30 kg/m^2), by study

High body mass index (>=30 kg/m^2)	LASI				CHARLS			
	Model 1		Model 2		Model 1		Model 2	
	Men	Women	Men	Women	Men	Women	Men	Women
Age (reference: 45 – 59 years)								
60 – 74 years	3.33(0.91-12.18)	1.68(0.67-4.18)	3.29(0.72-14.95)	1.64(0.66-4.07)	**0.57(0.36-0.91)**	0.85(0.63-1.15)	**0.60(0.37-0.96)**	0.93(0.69-1.27)
75+ years	0.86(0.08-9.75)	0.77(0.12-5.01)	1.27(0.11-14.32)	0.72(0.11-4.60)	**0.10(0.01-0.78)**	0.58(0.27-1.25)	**0.11(0.01-0.91)**	0.70(0.32-1.53)
Rural residency (reference: urban)	0.66(0.22-1.95)	0.67(0.41-1.09)	0.56(0.20-1.58)	0.70(0.42-1.15)	**0.49(0.26-0.90)**	0.67(0.43-1.05)	**0.50(0.27-0.92)**	0.68(0.43-1.06)
Respondent education (reference: illiterate)								
Literate	1.77(0.13-24.28)	2.38(0.71-8.04)	1.78(0.11-28.41)	2.36(0.67-8.31)	0.83(0.32-2.16)	0.84(0.57-1.24)	0.79(0.31-2.05)	0.83(0.56-1.23)
Primary school	**6.41(1.16-35.45)**	1.86(0.58-5.97)	**5.84(1.15-29.79)**	1.83(0.55-6.11)	1.26(0.54-2.94)	0.72(0.49-1.08)	1.19(0.52-2.74)	0.70(0.47-1.04)
Junior high school+	1.58(0.32-7.81)	**2.90(1.04-8.08)**	1.55(0.37-6.52)	**2.79(1.01-7.69)**	1.01(0.47-2.20)	**0.64(0.43-0.96)**	0.92(0.42-2.01)	**0.59(0.39-0.89)**
Spouse education (reference: illiterate)								
Literate			1.27(0.09-17.61)	1.02(0.13-8.09)			0.69(0.35-1.34)	1.04(0.55-1.98)
Primary school			0.24(0.02-2.49)	0.47(0.07-3.16)			0.83(0.46-1.52)	0.82(0.44-1.50)
Junior high school+			0.97(0.12-8.01)	1.13(0.34-3.68)			1.07(0.57-2.01)	1.25(0.70-2.24)
No spouse			0.21(0.02-2.23)	1.25(0.50-3.14)			0.39(0.15-1.02)	0.77(0.38-1.57)
Per capita expenditures in US dollars and adjusted for purchase power parities (log scale)	1.72(0.97-3.02)	**1.61(1.16-2.22)**	**1.96(1.03-3.72)**	**1.61(1.15-2.25)**	1.15(0.88-1.49)	1.06(0.91-1.24)	1.18(0.89-1.57	1.07(0.91-1.26)

* Data are presented as odds ratios (95% confidence intervals). State dummy variables are included in LASI models and county dummy variables are included in the CHARLS model

Table 4. Gender-specific multivariate logistic regression analysis of the association between sociodemographic characteristics and hypertension based on either self-report or objective examination, by study

Total hypertensive	LASI				CHARLS			
	Model 1		Model 2		Model 1		Model 2	
	Men	Women	Men	Women	Men	Women	Men	Women
Age (reference: 45 – 59 years)								
60 – 74 years	**2.78(1.78-4.33)**	**2.44(1.51-3.97)**	**2.75(1.75-4.32)**	**2.33(1.44-3.79)**	**2.09(1.78-2.45)**	**2.40(2.03-2.83)**	**2.04(1.73-2.40)**	**2.30(1.94-2.71)**
75+ years	**4.49(1.64-12.30)**	**2.10(1.03-4.26)**	**4.40(1.58-12.23)**	1.85(0.89-3.83)	**3.18(2.36-4.30)**	**4.92(3.60-6.71)**	**2.91(2.14-3.96)**	**4.10(2.95-5.70)**
Rural residency (reference: urban)	1.27(0.73-2.21)	0.73(0.49-1.08)	1.28(0.73-2.24)	0.80(0.54-1.18)	**0.67(0.54-0.85)**	**0.79(0.64-0.98)**	**0.66(0.52-0.83)**	**0.80(0.64-0.99)**
Respondent education (reference: illiterate)								
Literate	2.52(0.87-7.34)	**2.80(1.54-5.07)**	2.57(0.88-7.49)	**2.59(1.40-4.79)**	1.03(0.79-1.35)	**0.81(0.67-1.00)**	1.07(0.82-1.40)	0.83(0.68-1.02)
Primary school	**2.34(1.10-4.97)**	1.66(0.91-3.01)	**2.46(1.07-5.66)**	1.49(0.83-2.71)	1.19(0.92-1.55)	**0.77(0.62-0.97)**	1.24(0.95-1.61)	0.80(0.64-1.01)
Junior high school+	**2.18(1.11-4.31)**	**2.43(1.37-4.31)**	**2.50(1.07-5.83)**	**2.28(1.21-4.30)**	1.02(0.78-1.33)	**0.66(0.52-0.85)**	1.07(0.82-1.40)	**0.66(0.52-0.85)**
Spouse education (reference: illiterate)								
Literate			0.95(0.38-2.40)	1.63(0.74-3.62)			0.89(0.71-1.10)	0.80(0.60-1.06)
Primary school			0.83(0.39-1.80)	**2.02(1.10-3.72)**			1.07(0.85-1.35)	**0.67(0.51-0.89)**
Junior high school+			0.73(0.31-1.70)	2.11(0.93-4.76)			0.93(0.73-1.20)	0.85(0.65-1.12)
No spouse			1.02(0.51-2.05)	**2.73(1.49-4.99)**			**1.36(1.04-1.77)**	1.10(0.81-1.49)
Per capita expenditures in US dollars and adjusted for purchase power parities (log scale)	0.92(0.70-1.22)	1.13(0.89-1.44)	0.93(0.70-1.24)	1.10(0.86-1.40)	1.03(0.94-1.13)	0.97(0.89-1.05)	1.01(0.92-1.11)	0.94(0.86-1.03)

* Data are presented as odds ratios (95% confidence intervals). State dummy variables are included in LASI models and county dummy variables are included in the CHARLS model