HHS Public Access
Author manuscript
Int J Public Health. Author manuscript; available in PMC 2018 September 01.

Published in final edited form as:
Int J Public Health. 2017 September ; 62(7): 763–773. doi:10.1007/s00038-017-0968-3.

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

Peifeng Hu, MD, PhD[1], **Serena Wang**[2], and **Jinkook Lee, PhD**[2]

[1]Division of Geriatric Medicine, David Geffen School of Medicine at UCLA, Los Angeles, CA

[2]Center for Economic and Social Research, University of Southern California, Los Angeles, CA

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 (CVRF) both within and between China and India.

Methods—We used multivariable logistic regression models to examine the associations between SES and CVRF, using data from the China Health and Retirement Longitudinal Study (CHARLS) and the Longitudinal Aging Study in India (LASI).

Results—The results showed that, compared to illiteracy, the odds ratios of completing junior high school for high-risk waist circumference were 4.99 (95% confidence interval: 1.77-14.06) among Indian men, 3.42 (95% confidence interval: 1.66-7.05) among Indian women, but 0.74 (95% confidence interval: 0.59-0.92) among Chinese women. Similar patterns were observed between educational attainment and high-risk body mass index, and between education and hypertension, based on self-reported physician diagnosis and direct blood pressure measurements.

Conclusions—SES is associated with CVRF in both China and India. However, this relationship showed opposite patterns across two countries, suggesting that this association is not fixed, but is subjective to underlying causal pathways, such as patterns of risky health behaviors and different social and health policies.

Keywords

socioeconomic status; cardiovascular risk factor; ageing; China; India

Address correspondence to Peifeng Hu, MD, PhD, Division of Geriatric Medicine, David Geffen School of Medicine at UCLA, 10945 Le Conte Avenue, Suite 2339, Los Angeles, CA 90095-1687; telephone: 310-825-8253; phu@mednet.ucla.edu.

Conflict of Interest: the authors declare that they have no conflict of interest.

Compliance with Ethical Standards: Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

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 (United Nations 2015). 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 (Dummer and Cook 2008). 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% of all deaths (Li and Ge 2015). 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 an 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 10 to 15 years earlier on average 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 (Reddy KS 2004). 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 (World Health Organization 2016). China also had 5 times more hospital beds per 1,000 population than India (World Bank 2016a). 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 (CHARLS) and the Longitudinal Aging Study in India (LASI) to analyze the relationship between cardiovascular risk factors (CVRF) and SES, particularly education attainment and per capita consumption, a preferred indicator of economic status in developing countries. Our main aims are to examine SES gradients of CVRF in China and India, and enumerate how the SES gradients of selective health parameters differ significantly between the two countries. These cross-country variations may help to shed light on different underlying causal pathways in national contexts.

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. The details of this study have been described elsewhere (Zhao et al. 2014). Briefly, the CHARLS baseline national survey was a multi-stage, stratified, random sample drawn at the county, neighborhood, and household levels. A total of 17,708 participants from 10,257 households were interviewed during the baseline survey.

The 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 the interview and the physical examination. The CHARLS study was approved by the ethical committee of Beijing University.

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 (Arokiasamy et al. 2012). 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. Previous analysis showed that the overall demographic characteristics of the 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 harmonizable 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. The LASI pilot study was approved by the ethical committee of the International Institute of Population Sciences (IIPS), Mumbai.

Measures

Socioeconomic status—We used education attainment and per capita household expenditure as the 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 health 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, because 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, and was 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 in STATA (Chien et al. 2013), and we control for impute 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. Therefore, we imputed household expenditure for 1,424 (14%) participants with missing data. For the imputation process, the unit of observation was the individual. Statistics were weighted using respondent-level cross-sectional weights, which accounted for household and individual non-response. Total household consumption included imputed values using a similar hot-deck imputation procedure to LASI (Chien et al. 2013). In order to compare consumption across the two countries, the measure was converted to US dollars and adjusted by purchasing power parities (PPP) (World Bank 2011).

There are significant rural-urban differences in SES and health status in both China and India. Therefore, we included rural residency in our models to control for its potential confounding effects.

Cardiovascular risk factors—Waist circumference (in centimeters), weight (in kilograms), and height (in centimeters) were measured based on a standardized protocol. For adiposity, we used two related but 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 was 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 to 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 was 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 defined ‘total hypertension’ as either 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.

Statistical methods

We examined sex and country differences in age, SES measures, and CVRF. The overall and sex-specific descriptive statistics are presented. We accounted for survey design and used survey weights in descriptive inferences. First, we formally tested sex differences within the countries, and then tested sex-specific country differences between China and India. The chi-squared test was used to determine statistical significance for these differences.

Next, we performed sex-specific multivariable logistic regression analyses to examine the association between sociodemographic characteristics and CVRF for the two countries. The sociodemographic variables included in multivariable Model 1 were age categories (45-59, 60–74, and 75 and older), residency in rural or urban areas, respondent's education attainment, and per capita expenditure. We converted per capita expenditure values in each country to international dollars using purchase power parity (PPP) rates (World Bank 2011) and performed a log transformation. To control for possible clustering effects, 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, and hypertension based on self-reported physician diagnosis, medication use, or objective blood pressure examination. In Model 2, we also included spousal education attainment, in addition to the variables in Model 1.

Finally, we conducted a sensitivity analysis among LASI respondents to explore whether caste may influence the relationships between SES and CVRF in India. Respondents had self-reported membership in scheduled castes, scheduled tribes, other backward class, or 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 are generally 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 other backward class (OBC). While less marginalized and stigmatized than scheduled castes or tribes, these individuals also face barriers to economic and educational opportunities (Subramanian et al. 2008). Approximately 65% of LASI participants belonged to a scheduled caste, scheduled tribe, or OBC. Our sensitivity analysis indicated that caste had no significant effect on the relationships between SES and CVRF. Because our sample size had 95% power to detect an effect size of 1.5, we excluded caste from our final models. All analyses were done using Stata version 13.1.

Results

Table 1 summarizes the distributions of sociodemographic characteristics and of cardiovascular risk factors for CHARLS and LASI participants. CHARLS men and women were older and less likely to reside in a rural area than their counterparts 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. After accounting for purchasing power parity, the difference of per capita consumption levels between the countries was 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 a high-risk waist circumference, whereas Indians were more likely to have a 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 higher levels of self-reported diagnosis of hypertension and of taking anti-hypertensive medications than those in LASI, but were less likely to have elevated blood pressure from the physical examination.

Table 2 shows the multivariable logistic regression analyses of the associations between sociodemographic variables and waist circumference. For high-risk waist circumference, compared to participants who were illiterate, the odds ratios for completing junior high school were 4.99 (95% confidence interval: 1.77-14.06) among Indian men, 3.42 (95% confidence interval: 1.66-7.05) among Indian women, but 0.74 (95% confidence interval: 0.59-0.92) among Chinese women. However, this association between education and high-risk waist circumference was not significant among Chinese men. After adjustment for spousal education levels (Model 2), the odds ratios were 4.61 (95% confidence interval: 1.41-15.10) for Indian men, 2.97 (95% confidence interval: 1.30-6.79) for Indian women, and 0.69 (95% confidence interval: 0.55-0.87) for Chinese women. Higher per capita expenditure was also positively associated with high-risk waist circumference among Indians and Chinese men, but not among Chinese women.

The association between education and high-risk BMI had a similar pattern. After adjustment for spousal education (Model 2), the odds ratios for completing junior high school were 2.79 (95% confidence interval: 1.01-7.69) among Indian women, but 0.59 (95% confidence interval: 0.39-0.89) 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.

Hypertension 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 inverted among women, whereas there were no significant results among Chinese men. Higher spousal education level was also associated with a lower likelihood of having hypertension among women. There was no significant association between per capita expenditure and hypertension in the CHARLS or LASI samples.

Discussion

This comparative analysis of the relationship between SES and cardiovascular risk factors in China and India indicated that significant heterogeneity exists between sexes and between countries. 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. A similar pattern was observed for the relationship between education attainment and hypertension, with a positive association in Indian men and women, and an inverse association in Chinese women. Higher per capita expenditure was associated with high-risk waist circumference among Indians and Chinese men, and with high-risk BMI among Indian men and women.

A 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 England (Banks et al. 2006). A similar analysis between China and India in the future would be integral in further elucidating the role of SES and access to care in health outcomes.

Our study is unique in using harmonized high quality survey data to compare SES gradients in CVRF in the two most populous developing countries in the world, which are both undergoing rapid economic transition but are at different levels of development. The results indicate that education may have different effects on obesity and hypertension by country and sex, 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 the adoption of a 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 CVRF may also reflect the possibility that China is further advanced than India in economic development and the epidemiological transition from infectious diseases to chronic medical conditions (Dummer and Cook 2008). 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 the nature of economic inequalities. For example, World Bank data indicate that, during the 20 years from 1995 to 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 (World Bank 2016b). The 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 (Ma and Sood 2008). The age-adjusted mortality rate from communicable diseases was 86 per 100,000 persons in China, compared to 377 per 100,000 persons in India (World Health Organization 2010). Our data also showed that Chinese men and women are more likely to report a diagnosis of hypertension, to take anti-hypertensive medications, and to have hypertension controlled than those in India. All these indicators 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 rates of ischemic heart disease before 1950, but started to have lower rates 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, such as patterns of risky health behaviors and different social and health policies (Dow and Rehkopf 2010). For example, unlike Chinese smokers, 46% of Indian men smoke bidi (Barik et al 2016), which may be more harmful than other forms of tobacco consumption (Rahman and Fukui 2000).

Our data showed an inverse association between SES and CVRF among Chinese women, but not among Chinese men. The exact reasons are not clear. It has been postulated that women with low SES experience more psychosocial disadvantage than men because of a higher likelihood of being unemployed and/or depressed, and thus they may be more at risk for the development of cardiovascular diseases due to the relationship between low SES and stress-related neuroendocrine dysfunction (Chichlowska et al 2009).

LASI data showed that the prevalence of high-risk waist circumference was 22.2% and the prevalence of hypertension was 50.1%. These estimates are generally consistent with other reports from India. One study of 6,198 subjects living in 11 cities in India indicated that the prevalence of high waist circumference was 35.7% in men and 57.5% in women (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, the LASI pilot sample appears to be similar to the general population in India in health outcomes as well as in 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 for 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 suffer from severe under-reporting for some disadvantaged populations. Third, CHARLS is a nationally-representative sample with a large sample size. Although the LASI pilot study only included four states, the characteristics of the LASI pilot sample are congruent with the population characteristics of India. Power calculations indicated that the LASI sample had adequate power to detect at least a moderate effect size.

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 based on consistently elevated blood pressure. Given the nature of the field survey, neither CHARLS nor LASI was able to ascertain a respondent's blood pressure level 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. Lastly, there are significant rural-urban differences in SES and health status in both China and India. Although we have tried to control for the effects of rural residency in our models, our study sample size is too small to allow for further exploration on how the SES-CVRF relationship differs between rural and urban areas.

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 to explore potential interventions aimed at reducing CVD risks in China and India as these two countries continue their trajectory of rapid economic growth.

Acknowledgments

Funding for the LASI pilot study was provided by the National Institute on Aging (NIA), grant 1R21 AG034443. This research project was also funded by a pilot study grant from the USC/UCLA Center on Biodemography and Population Health (CBPH) was provided by the NIA, grant P30 AG017265.

Funding: this study was funded by the National Institute on Aging (NIA), grant 1R21 AG034443. This research project was also funded by a pilot study grant from the USC/UCLA Center on Biodemography and Population Health (CBPH) was provided by the NIA, grant P30 AG017265.

References

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

Banks J, Marmot M, Oldfield Z, Smith JP. Disease and disadvantage in the United States and in England. JAMA. 2006 May 3; 295(17):2037–45. [PubMed: 16670412]

Bansal SK, Saxena V, Kandpal SD, Gray WK, Walker RW, Goel D. The prevalence of hypertension and hypertension risk factors in a rural Indian community: A prospective door-to-door study. J Cardiovasc Dis Res. 2012 Apr; 3(2):117–23. DOI: 10.4103/0975-3583.95365 [PubMed: 22629029]

Barik A, Rai RK, Gorain A, Majumdar S, Chowdhury A. Socio-economic disparities in tobacco consumption in rural India: evidence from a health and demographic surveillance system. Perspect Public Health. 2016; 136(5):278–87. DOI: 10.1177/1757913915609947 [PubMed: 26475772]

Breslow L, Buell P. Mortality from coronary heart disease and physical activity of work in California. J Chronic Dis. 1960 Apr.11:421–44. [PubMed: 13804227]

Busingye D, Arabshahi S, Subasinghe AK, Evans RG, Riddell MA, Thrift AG. 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. 2014 Oct; 43(5): 1563–77. DOI: 10.1093/ije/dyu112 [PubMed: 24867304]

Chichlowska KL, Rose KM, Diez-Roux AV, Golden SH, McNeill AM, Heiss G. Individual and neighborhood socioeconomic status characteristics and prevalence of metabolic syndrome: the Atherosclerosis Risk in Communities (ARIC) Study. Psychosom Med. 2008; 70(9):986–92. [PubMed: 18799428]

Chiaying Sandy, Chien, Feeney, Kevin, Liu, Jenny, Meijer, Erik, Lee, Jinkook. Harmonized LASI pilot data documentation: Version A. 2013

Cox AM, McKevitt C, Rudd AG, Wolfe CD. Socioeconomic status and stroke. Lancet Neurol. 2006 Feb; 5(2):181–8. [PubMed: 16426994]

Deedwania PC, Gupta R, Sharma KK, Achari V, Gupta B, Maheshwari A, Gupta A. High prevalence of metabolic syndrome among urban subjects in India: a multisite study. Diabetes Metab Syndr. 2014 Jul-Sep;8(3):156–61. DOI: 10.1016/j.dsx.2014.04.033 [PubMed: 25220918]

Dow WH, Rehkopf DH. Socioeconomic gradients in health in international and historical context. Ann N Y Acad Sci. 2010 Feb.1186:24–36. DOI: 10.1111/j.1749-6632.2009 [PubMed: 20201866]

Dummer TJ, Cook IG. Health in China and India: a cross-country comparison in a context of rapid globalisation. Soc Sci Med. 2008; 67(4):590–605. DOI: 10.1016/j.socscimed.2008.04.019 [PubMed: 18554766]

González MA, Rodríguez Artalejo F, Calero JR. Relationship between socioeconomic status and ischaemic heart disease in cohort and case-control studies: 1960-1993. Int J Epidemiol. 1998 Jun; 27(3):350–8. [PubMed: 9698119]

Gupta R, Joshi P, Mohan V, Reddy KS, Yusuf S. Epidemiology and causation of coronary heart disease and stroke in India. Heart. 2008 Jan; 94(1):16–26. [PubMed: 18083949]

Joshi R, Cardona M, Iyengar S, Sukumar A, Raju CR, Raju KR, Raju K, Reddy KS, Lopez A, Neal B. Chronic diseases now a leading cause of death in rural India--mortality data from the Andhra Pradesh Rural Health Initiative. Int J Epidemiol. 2006 Dec; 35(6):1522–9. [PubMed: 16997852]

Lee J. Pathways from education to depression. J Cross Cult Gerontol. 2011; 26(2):121–35. [PubMed: 21416333]

Lee J, Smith JP. The effect of health promotion on diagnosis and management of diabetes. J Epidemiol Community Health. 2012 Apr; 66(4):366–71. DOI: 10.1136/jech.2009.087304 [PubMed: 21282142]

Lee J, McGovern ME, Bloom DE, Arokiasamy P, Risbud A, O'Brien J, Kale V, Hu P. Education, gender, and state-level disparities in the health of older Indians: Evidence from biomarker data. Econ Hum Biol. 2015 Dec.19:145–56. DOI: 10.1016/j.ehb.2015.09.003 [PubMed: 26398850]

Ge H, Li J. Cardiovascular diseases in China: Current status and future perspectives. IJC Heart & Vasculature. 2015 Oct.6:25–31. DOI: 10.1016/j.ijcha.2014.10.002 [PubMed: 28785622]

Sood, S., Ma, N. A Comparison of the Health Systems in China and India. RAND Corporation; 2008. http://www.rand.org/content/dam/rand/pubs/occasional_papers/2008/RAND_OP212.pdf

Marmot MG. Socio-economic factors in cardiovascular disease. J Hypertens Suppl. 1996 Dec; 14(5):S201–5. [PubMed: 9120680]

Rahman M, Fukui T. Bidi smoking and health. Public Health. 2000; 114(2):123–127. [PubMed: 10800151]

Reddy KS. Cardiovascular disease in non-Western countries. N Engl J Med. 2004; 350:2438–2440. [PubMed: 15190135]

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

Smith JP. Nature and causes of trends in male diabetes prevalence, undiagnosed diabetes, and the socioeconomic status health gradient. Proc Natl Acad Sci U S A. 2007; 104(33):13225–31. DOI: 10.1073/pnas.0611234104 [PubMed: 17698965]

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. J Population Ageing. Santa Monica, CA: RAND Corporation; 2010. Health Outcomes and Socio-Economic Status Among the El Status Among the Elderly in China: Evidence from the CHARLS Pilot.

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

Tanamas SK, Lean ME, Combet E, Vlassopoulos A, Zimmet PZ, Peeters A. Changing guards: time to move beyond body mass index for population monitoring of excess adiposity. QJM. 2015 Jul; 109(7):443–6. DOI: 10.1093/qjmed/hcv201 [PubMed: 26527773]

United Nations. World Population Perspects. 2015. https://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf

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

World Bank. Hospital bed data per country. 2016a. http://data.worldbank.org/indicator/SH.MED.BEDS.ZS

World Bank. GDP growth per country. 2016b. http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG

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

World Health Organization. World Health Statistics. 2010. http://www.who.int/gho/publications/world_health_statistics/EN_WHS10_Full.pdf

World Health Organization. Global Health Observatory Data Repository. 2016. http://apps.who.int/gho/data/node.main.A1444

Xavier D, Pais P, Devereaux PJ, Xie C, Prabhakaran D, Reddy KS, Gupta R, et al. Treatment and outcomes of acute coronary syndromes in India (CREATE): a prospective analysis of registry data. Lancet. 2008; 371:1435–42. [PubMed: 18440425]

Yusuf S, Hawken S, Ounpuu S, Dans T, Avezum A, et al. Effects of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): Case-control study. Lancet. 2004; 364:937–952. DOI: 10.1016/s0140-6736(04)17018-9 [PubMed: 15364185]

Zhao Y, Hu Y, Smith JP, Strauss J, Yang G. Cohort profile: the China Health and Retirement Longitudinal Study (CHARLS). Int J Epidemiol. 2014 Feb; 43(1):61–8. DOI: 10.1093/ije/dys203 [PubMed: 23243115]

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 (standard deviation), years	57.2 (10.3)	57.8 (10.1)	56.8 (10.4)*	60.0 (9.9)	60.5 (9.6)ǂ	59.6 (10.1)*ǂ
Age categories, %						
45 years – 59 years	61.2	60.0	62.5	53.0	53.0	55.3*ǂ
60 years – 74 years	30.8	31.9	29.7	37.5	37.5ǂ	35.1*ǂ
75 years or over	8.0	8.1	7.8	9.5	9.5ǂ	9.6ǂ
% women	51.6			53.8		
% living in rural area	74.7	76.2	73.2	65.2	66.3ǂ	64.2*ǂ
Education categories, %						
Illiterate	47.4	40.7	53.6*	29.9	13.6ǂ	43.7*ǂ
Literate	11.4	11.7	11.1	19.0	21.1ǂ	17.2*ǂ
Primary school	13.2	14.3	12.3	22.2	27.5ǂ	17.7*ǂ
Junior high school or above	28.0	33.3	23.0*	28.9	37.8ǂ	21.3*
Per capita expenditures in local Rupees or Yuans (median)	20752	20816	20751	6380	6408	6356
Per capita expenditures in US dollars (median)	457	458	456	861	865	858
Per capita expenditures in US dollars and adjusted for purchase power parities (median)	1386	1390	1385	1297	1316	1281
Waist circumference >102 cm for male or >88 cm for female	22.2	8.0	35.5*	22.9	4.7ǂ	38.6*ǂ
Body mass index >= 30 kg/m^2	5.1	2.2	7.8*	4.7	2.9ǂ	6.1*ǂ
Hypertension						
(a) Self-reports of doctor-diagnosis	17.3	15.2	19.2*	24.9	23.6ǂ	26.0*ǂ
(b) Taking medication	14.0	11.9	15.9*	19.4	18.2ǂ	20.5*ǂ
(c) Systolic >= 140 mmHg or diastolic >= 90 mmHg	42.8	42.0	43.6	31.7	30.5ǂ	32.7ǂ
(d) Total: (a) or (b) or (c)	50.1	47.5	52.5	41.8	40.4ǂ	43.0*ǂ
Among the total hypertensive (d) ǂǂ						

	LASI **			CHARLS		
	Total	Men	Women	Total	Men	Women
% 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=Longitudinal Aging Study in India; CHARLS=China Health and Retirement Longitudinal Study

++ 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)	**1.67(1.07-2.62)**	**1.70(1.17-2.47)**	**1.87(1.17-3.00)**	**1.73(1.20-2.49)**	**1.32(1.02-1.60)**	1.09(1.00-1.19)	**1.28(1.02-1.61)**	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

+LASI=Longitudinal Aging Study in India; CHARLS=China Health and Retirement Longitudinal Study

**Model 1 included age, rural residency, respondent education attainment, and per capita expenditure. Model 2 included spousal education level, in addition to the variables in Model 1

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)	**2.41(1.22-4.75)**	**1.83(1.13-2.98)**	**3.06(1.48-6.31)**	**1.84(1.10-2.73)**	1.17(0.86-1.59)	1.00(0.84-1.19)	1.18(0.85-1.87)	0.99(0.83-1.18)

[*] 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

[+] LASI=Longitudinal Aging Study in India; CHARLS=China Health and Retirement Longitudinal Study

[**] Model 1 included age, rural residency, respondent education attainment, and per capita expenditure. Model 2 included spousal education level, in addition to the variables in Model 1

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)	1.03(0.57-1.55)	1.28(0.94-1.74)	1.05(0.81-1.36)	1.22(0.91-1.65)	1.04(0.95-1.13)	0.99(0.91-1.07)	1.03(0.94-1.13)	0.99(0.91-1.07)

[*] 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

[+] LASI=Longitudinal Aging Study in India; CHARLS=China Health and Retirement Longitudinal Study

[**] Model 1 included age, rural residency, respondent education attainment, and per capita expenditure. Model 2 included spousal education level, in addition to the variables in Model 1