Biological Risks among the Middle-Aged and Elderly in China: Gender, Education, and Urban-Rural Differences

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Abstract: China is facing particular challenges because of its rapid aging and dramatic transformations in economic, social and cultural conditions over a short time. The prevalence of chronic health conditions has increased. However, there is little research on the demographic and social patterning of health in China using biological measures. This paper examines biological risk profiles for a representative sample of middle-aged and older Chinese with an emphasis on gender, education and urban-rural differences. We found little significant difference by gender and educational differences in biological risk, except that having higher education is associated with lower cardiovascular risk. Urban-rural differences are present for total number biological risks, metabolic and inflammatory risk. Compared to the rural population, the urban population and floating population are more likely to have greater total biological risk and higher metabolic risk. The floating population has the highest total risk overall and higher inflammatory risk than rural population.

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INTRODUCTION

Although population aging is occurring in nearly all societies (United Nations, 2013; (Banister, Bloom, & Rosenberg, 2010), China is facing particular challenges because of its rapid aging and the dramatic transformations in economic, social and cultural conditions over a relatively short time. These macro-level changes have been accompanied by individual-level changes in patterns of food consumption, physical activity and migration (Du, Wang, Zhang, Zhai, & Popkin, 2014; Monda, Gordon-Larsen, Stevens, & Popkin, 2007; Yang et al., 2008). Undernutrition also has been reduced (Du et al., 2014) and the demand for manual labor has decreased (Gong et al., 2012). Additionally, the Chinese diet is shifting toward higher fat and lower carbohydrate content (Popkin, Horton, Kim, Mahal, & Shuigao, 2001). Infectious diseases have been reduced so that now chronic diseases account for about 80% of deaths and 70% of disability-adjusted life-years lost in China (Wang, Kong, Wu, Bai, & Burton, 2005) and the prevalence of chronic health conditions, such as obesity, hypertension and diabetes has increased (Kun, Liu, Pei, & Luo, 2013; Liang, Liu, Du, & Qiu, 2014; Xi, He, Hu, & Zhou, 2013).

Population aging in China is further complicated by large urban-rural differences in public health conditions. Generally, the urban population has better education, higher income and better access to health services than the rural population (Gong et al., 2012). The urban population has also seen greater changes in diet, lifestyle, and environment which may place them at higher risk for chronic diseases. For instance, western-style diets and sedentary lifestyles have become prevalent in cities (Bell, Ge, & Popkin, 2001; Gong et al., 2012) and urban areas are facing severe challenges from ambient air pollution, which has become an important health concern (Kan, Chen, & Tong, 2012). Rural-to-urban migrants may be particularly vulnerable to poor health because they experience urban health risks without the support of urban programs. The reason for the lack of support programs is that a large number of rural-to-urban migrants are living and working in cities without transferring their *hukou* (the Chinese official household registration system) to their new place of residence. A *hukou* officially ties a person to a place of residence and determines the welfare support a person is entitled. This so called "floating population" is largely excluded from urban services, including access to health services (Hu, Cook, & Salazar, 2008). Because the urban population, the rural population and the floating population are exposed to different lifestyles, natural environment and social conditions, the relationship between urban-rural residence and population aging should be considered when we discuss health disparities in the Chinese older population.

In addition to the dynamics of rural-urban residence, demographic characteristics and socioeconomic status pattern chronic health outcomes and the biological pathways preceding them (Crimmins & Seeman, 2004). The relationships between demographic factors, socio-economic factors and health have been studied mainly in developed countries. For example, studies in the U.S. suggest gender differences in multiple indicators of biological risk that vary both by age and over time (Jenkins & Ofstedal, 2014). Moreover, higher socioeconomic status is consistently related to better health and lower biological risk in Western countries (Crimmins, Kim, & Seeman, 2009; Seeman et al., 2004). Less is known about the demographic and social patterning of health in China. The objective of our study is to address this gap in the literature by using data from a nationally representative survey of the Chinese population aged 45 and older.

This paper examines biological risk profiles for middle-aged and older Chinese with an emphasis on gender, education, and urban-rural differences. We focus on biological risk profiles instead of diagnosed health outcomes or self-rated health because biomarkers provide an objective measure of health, which is particularly useful when studying a population in which exposure to the medical system and knowledge of physiological measures of health may be limited. Previous studies have focused on traditional cardiovascular risk indicators, such as smoking, or individual biological indicators. A variety of biomarkers are used in this study, since most health outcomes have multi-factorial etiologies and are the results of multiple sources of biological dysregulation (Seeman et al., 2004). Also, this study particularly focuses on the floating population, which refers to those who are currently living in urban areas without transferring their *hukou* status from agricultural to non-agricultural. The findings from this study will improve our understanding of status-based differences in aging and health in a rapidly urbanizing country.

METHODS

Dataset

Data for this study come from the baseline survey of the China Health and Retirement Longitudinal Study (CHARLS), which was conducted by Peking University in 2011-12 in 28 provinces, 150 counties/districts, and 450 villages/urban communities across China. CHARLS is a nationally representative longitudinal study of persons aged 45 years or older and their spouses living in households. Sampling was conducted at four levels: county, neighborhood, household, and respondent (described in greater detail in Zhao, et al., 2013).

Non-blood-based biomarkers, including blood pressure, pulse rate, standing height, and weight, were collected as part of the main survey. Blood-based biomarkers were collected separately in a subsequent visit to a local health facility (Zhao, et al., 2014). Respondents were asked to fast overnight before the blood draw but a blood sample was collected even if a respondent did not fast. Three tubes of venous blood were collected by medically-trained staff from the China Centers for Disease Control based on a standard protocol. Blood was prepared at the local health facilities and shipped cold to Beijing where blood-based biomarkers were assayed from plasma (Zhao, et al., 2014).

Analytic Sample

The national baseline survey collected information from 17,708 respondents in total of whom 11,847 (66.9%) provided a blood sample. We excluded non-fasting samples, individuals who had extreme values for body mass index (i.e. BMI< 10 or BMI>100) and individuals who did not have values for any of the biomarkers examined in this study (N=5,278; 29.8%). The final analytic sample includes 8,696 CHARLS respondents (49.1%).

Measures and Analysis

Dependent Variables

Eleven biomarkers are used in this study. For each biomarker, a dichotomous indicator was created indicating “high risk” and “low risk”. Risk was determined using clinical cutoff values for high-risk (Table 1). We divide the risk factors into three subgroups based on physiological system. Measures of cardiovascular risk include high systolic blood pressure, high diastolic

blood pressure, low diastolic blood pressure, and rapid pulse. Measures of metabolic risk include high total cholesterol, low high-density lipoprotein (HDL) cholesterol, high low-density lipoprotein (LDL) cholesterol, high triglycerides, high body mass index (BMI) and high plasma glucose. The measure of inflammatory risk is C-reactive protein (CRP). The total number of biological risks is calculated by summing the numbers of biomarkers in the high-risk range.

[Insert Table 1 here]

Independent Variables

Four education categories are denoted using three dummy variables: illiterate (omitted reference group), literate, primary school and junior/secondary school or higher. Urban-rural populations are categorized based on their usual places of residence and their *hukou* status. The urban population is defined as those who hold non-agricultural *hukou,* regardless of their usual place of residence (6.8% of this group resides in urban areas). The rural population is defined as those whose usual places of residence are rural areas and hold agricultural *hukou*. The "floating population" is defined as those whose usual places of residence are in urban areas but who still hold agricultural *hukou.*

Analytic strategy

We use Stata 13.0 for all analyses. For linear regression models, covariates include age, smoking status, alcohol consumption (i.e., drinking), use of medication for control of current chronic health conditions**,** and coverage by public medical insurance. All analyses are weighted using the CHARLS biological examination weight to adjust for the complex sampling design of CHARLS and improve generalizability.

RESULTS

Descriptive Analysis

Table 2 shows the summary statistics for all variables included in the regression models. The mean of age is 59.2. The sample has more females (53.5%) than males (46.5%) and a larger rural (53.5%) than urban population (24.2%). Educational attainment varied from illiterate (25.8%), literate (17.9%), primary school educated (22.0%) to some junior school and above (34.3%), showing a reasonable socioeconomic diversity. As for the covariates, 28.7% of the sample currently smoke and 29.3% are moderate drinkers. About a quarter of the middle-aged and older adults in China are currently taking medication to control chronic health conditions and a third are overweight or obese. Public medical insurance covered more than 90% of our target population.

[Insert Table 2 here]

Table 3 presents the mean value and prevalence of high risk for each biomarker. Some biological risks are more prevalent than others. More than a quarter of the sample has high systolic blood

pressure (29.0%) and low HDL cholesterol (25.8%). More than 14% of the sample has high triglycerides and nearly 13% has high diastolic blood pressure. There are relatively few obese persons (5.9%) or individuals with a rapid pulse (5.6%).

[Insert Table 3 here]

Table 4 shows that the range of the total number of biological risks is 0-8. More than half of the sample has no or only one factor in the high risk range and a small percentage (3.3%) of the target population has more than 5 biological risks in total. The distribution for each subgroup of biological risks is also shown. Approximately 57% of the target population has zero cardiovascular risk factors, while 31.4% has one factor at risk level. More than half (53.6%) of the sample do not have any metabolic risk, which indicates that almost half of the target population have some metabolic risks. The prevalence of inflammatory risk is relative low at 18.2.

[Insert Table 4 here]

Regression Analysis

Coefficients from linear regression models are shown in Table 5. Significant gender differences are found for cardiovascular risk, metabolic risk, and inflammatory risk, but not for total number of biological risks. Females have lower levels of cardiovascular risk and inflammatory risk, but higher metabolic risk. However, after we control for our stated covariates, the significance of these differences disappears.

Significant educational differences are found only for cardiovascular risk. Compared to the illiterate, the literate (beta coefficient = -0.02, $p < 0.01$) and those who have junior/secondary school education or higher (beta coefficient = -0.02, $p < 0.01$) have fewer cardiovascular risks. However the associations of education with total number of biological risks, metabolic risk, and inflammatory risk are not significant. Urban-rural differences are present for all the biological risk factors we examine, except cardiovascular risk. Compared to the rural population, the urban population and floating population are more likely to have greater total biological risk and higher metabolic risk. The floating population has the highest total risk overall. Although there are no significant differences in the level of inflammatory risk between the rural population and the urban population, the floating population has higher inflammatory risk than rural population.

Some significant associations between covariates and biological risks are also found. Advanced age is a risk factor for higher levels of biological risks. Overweight and obesity are positively associated with higher levels of cardiovascular risk (beta coefficient = 0.02 for overweight and beta coefficient = 0.05 for obesity) and inflammatory risk (beta coefficient = 0.08 for overweight, beta coefficient = 0.13 for obesity). Heavy drinkers have higher cardiovascular risk than non-drinkers and medication use is associated with greater cardiovascular and metabolic risks, but not inflammatory risk.

CONCLUSION AND DISCUSSION

Analyses of CHARLS 2011-2012, a nationally representative sample of China, provides an objective biological risk profile for the Chinese middle-aged and older population. In general, we find little significant difference by gender and education in biological risk, except that having higher education is associated with lower cardiovascular risk. In terms of urban-rural differences, living in rural area is related to lower risk. It is important to note that the floating population is at a particularly disadvantaged position. Possible explanations for the urban-rural differences could be that the rural population is more likely to do physical activity and eat healthy food and less likely to live in polluted areas, thus they perform better in many health measures. Those who are living in urban areas are more likely to eat fast food and have an unbalanced diet, live in crowded and polluted areas, and have fewer chances to do manual labor. The floating population, which has fewer resources but is faced with the same health risk factors as the urban population, has the worst level of biological risk.

In closing, the limitations of the present analysis and requisite steps for further research must be acknowledged. First, the mechanisms behind the differences of the biological risks should be further explored. Measures of diet and living environment should be investigated in future analyses, as potential mediators of these differences. Second, since the results are preliminary, we do not conduct missing data analysis and just use education as the only socioeconomic indicator in this paper. In moving forward, we will incorporate advanced missing data techniques and explore whether household consumption is also an important factor.

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Table 1. Clinical High-Risk Criteria for Risk Factors in CHARLS 2011-12

Biological Risk Indicators	
Cardiovascular risk factors	
High systolic blood pressure	⩾ 140 mm Hg
High diastolic blood pressure	⩾ 90 mm Hg
Low diastolic blood pressure	< 60 mm Hg
Pulse rate at 60s	⩾ 90 mm Hg
Metabolic risk factors	
Total cholesterol	⩾ 240 mg/dL
HDL cholesterol	< 40 mg/dL
Fasting LDL cholesterol	>160 mg/dL
Fasting triglycerides	⩾ 200 mg/dL
Body mass index	⩾ 30 kg/m
Glucose	⩾ 126mg/dL
Inflammatory risk factor	
C-reactive protein	> 3.0 mg/L

Table 2. Sample Description for the Baseline Survey of CHARLS

Variable	N	%
Age	59.20 (mean)	
Less than 50	1,701	21.39
50-59	3,026	34.92
60-69	2,559	26.21
70-79	1,181	14.45
80+	229	3.03
Gender		
Male	3,963	46.50
Female	4,727	53.50
Education		
Illiterate	2,553	25.82
Literate	1,652	17.86
Primary	1,916	22.05
Junior and Above	2,573	34.27
Urban/Rural		
Rural Population	5,418	53.46
Floating Population	1,803	22.30
Urban Population	1,469	24.24
Smoking		
Non-smokers	5,348	61.75
Current smokers	2,557	28.72
Former smokers	757	9.52
Drinking		
Not drinking in the last 12 months	5,864	66.00
Drinking less than twice a day	2,404	29.30
Drinking more than twice a day	428	4.69
Use of Medication		
None	6,678	75.43
One	1,607	19.40
More than one	411	5.27
BMI		
Normal Weight	5,937	66.36
Overweight	2,339	27.76
Obesity	420	5.87
Coverage of Public Medical Insurance		
No Public Medical Insurance	551	7.46
Public Medical Insurance	8,111	92.54

Table 3. Descriptive Statistics for Biological Measures in CHARLS 2011-12

	Mean	SD	Min	Max	High Risk %	High Risk N
Cardiovascular risk factors						
Systolic blood pressure	130.38	21.50	60.50	213	29.04	2,454
Diastolic blood pressure	75.68	12.11	35.33	142.67	12.77	1,054 (High BP)
					8.57	752 (Low BP)
Pulse rate at 60s	72.46	10.44	38	147	5.56	509
Metabolic risk factors						
Total cholesterol	193.96	38.30	23.97	480.93	10.53	997
HDL cholesterol	51.37	15.22	5.03	158.89	25.79	2,048
LDL cholesterol	117.37	35.00	0.39	385.83	10.00	942
Triglycerides	128.86	92.60	2.66	1235.46	14.36	1,148
Body mass index	23.54	3.96	11.65	71.29	5.87	420
Plasma Glucose	109.59	34.57	20.52	722.70	12.02	1,091
Inflammatory risk factor						
C-reactive protein	2.79	7.76	0.01	178.10	17.62	1,546

Table 4. Number of Biological Risks among Chinese Elderly

	Number of biological risks	%
Total Biological Risks	0	28.21
	1	27.88
	2	21.71
	3	12.04
	4	6.84
	5+	3.32
Cardiovascular Risk Factor	0	56.75
	1	31.38
	2+	11.87
Metabolic Risk Factor	0	53.57
	1	24.18
	2	14.54
	3+	7.73
Inflammatory Risk Factor	0	81.84
	1	18.16

Table 5. Coefficients from Linear Regression Models Estimating Biological Risks

	Model 1				Model 2			
	Total Number of Biological Risks	% of Cardiovascular Risk	% of Metabolic Risk	% of Inflammatory Risk	Total Number of Biological Risks	% of Cardiovascular Risk	% of Metabolic Risk	% of Inflammatory Risk
Female	-0.01	-0.02 ***	0.02 **	-0.05 ***	0.00	-0.01	0.01	-0.03
Urban/Rural (ref=Rural population)								
Floating population	0.22 **	0.00	0.03 ***	0.04 **	0.23 ***	0.00	0.03 ***	0.04 **
Urban population	0.44 ***	0.02 **	0.05 ***	0.04	0.19 *	-0.00	0.03 **	-0.00
Education (ref = illiteracy)								
Literate	-0.04	-0.02 **	0.02	-0.06 ***	-0.05	-0.02 **	-0.01	-0.03
Primary	-0.04	-0.02 *	0.01	-0.05 *	0.01	-0.01	0.01	-0.02
Junior and above	-2.23 ***	-0.04 ***	0.00	-0.09 ***	-0.07	-0.02 **	0.01	-0.03
Age (ref = less than 50)								
50-59					0.19 *	0.01	0.02 *	0.05 **
60-69					0.15 *	0.01	0.01	0.07 ***
70-79					0.24 **	0.04 ***	-0.01	0.14 ***
80+					0.45 ***	0.07 ***	-0.00	0.21 ***
BMI (ref = normal weight)								
Overweight					--	0.02 ***	--	0.08 ***
Obesity					--	0.05 **	--	0.13 **
Smoking (ref = nonsmokers)								
Current smokers					0.03	0.01	0.00	0.02
Former smokers					0.07	-0.01	0.01	0.05
Drinking (ref = not drinking)								
Drinking a little					-0.07	-0.00	-0.01	-0.02
Drinking twice a day or more					0.03	0.04 **	-0.02	-0.01
Medication (ref = 0)								
Only one					0.77 ***	0.07 ***	0.07 ***	0.04
More than one					1.33 ***	0.09 ***	0.15 ***	0.01
Medical Insurance (ref= no public insurance)								
Public medical insurance					-0.19	-0.02 *	-0.01	-0.02
N	*8,682*	*8,682*	*8,682*	*8,682*	*8,621*	*8,621*	*8,621*	*8,621*

Note: ****P<0.001, ** p<0.01, * p<0.05*