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ORIGINAL RESEARCH REPORT



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Does self-perceived income priority matter? The association between income inequality and allostatic load in China

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ABSTRACT

There is a scarcity of evidence about the association between income inequality and allostatic load (AL) across diverse population, which is critical to identify the downstream biological pathway of the inequality-health linkage. This study aimed to determine the association of income inequality with AL, and assess whether there are differences in such association between people with different perception of income priority. We utilized data from the 2006 and 2009 wave of China Health and Nutrition Survey (CHNS). Multilevel linear regression analyses were conducted to examine the association between AL score and community Gini coefficient. Additionally, to investigate whether the association of income inequality and AL score would vary among individuals with different perception of income priority, a cross-level interaction term for Gini coefficient and self-perceived income priority was applied. Both the cross-sectional analysis in 2009 (coefficient = 0.081, p = .016) and the time-lagged analysis (0.106, 0.008) suggested that community-level Gini coefficient was positively associated with AL. Similar result was only found among individuals from low median income communities in subsample analysis. Additionally, the cross-level interaction between Gini coefficient and self-perceived income priority was significantly associated with AL among respondents from low-median income communities. There is a positive association between income inequality and AL among Chinese adults, with individual who perceived income as a higher priority in their life suffering more from income inequality. This study contributes to the increasing efforts and new perspective to understand the inner mechanism of both the detrimental effect of income inequality and the accumulation of AL.

Introduction

Since the detrimental effect of widening income gap between the rich and the poor was proposed by Wilkinson at the end of the last century (Wilkinson, 1992), a robust body of research linking income inequality and population health sprang up in the following decades. Higher level of inequality has been demonstrated to be associated with an elevated risk of multiple health outcomes, ranging from lower life expectancy, obesity, and schizophrenia (Wilkinson & Pickett, 2006), to even COVID-19 guite recently (Oronce et al., 2020). Although potential mechanisms linking income inequality with population health have been proposed - material deprivation and the eroding social capital resulted from the highly unequal environment tend to exert detrimental effect on individual's health (Pickett & Wilkinson, 2015), related empirical evidence with nuanced analyses, especially for those to ravel the downstream pathway remain scarce. To be specific, how was ecological-level income inequality associated with individual's health in terms of such a variety of outcomes?

At the same time, increasing criticism on self-reported health outcome promoted the burgeoning attention and

efforts in collecting biomarker data in demographic surveys (Seeman, 2001), which allow researchers to measure individual's health status more accurately. As a novel biomarker measure of "the wear and tear on the body", allostatic load (AL) represents the cumulative physiological dysregulation in patterns of response to environmental stress and challenges (McEwen & Stellar, 1993). From the perspective of biological risk, increased AL that resulted from stress, may disturb regular tissue and organ functioning, and further affect a wide range of health conditions in cardiovascular system, metabolic system, immune system, urinary system, and the brain (McEwen, 1998). Such theoretical inference has been confirmed by a bundle of empirical evidence, which indicated AL as a valid and powerful predictor of cardiovascular disease (Juster & Lupien, 2012), diabetes (Mattei et al., 2010), obesity (Carlsson et al., 2011), preeclampsia (Hux & Roberts, 2015), rheumatoid arthritis (Straub & Cutolo, 2001), cognitive decline (Lucassen, 2016), depression (Carbone, 2021), and the overall mortality (Mattei et al., 2010; Seeman et al., 2004). Therefore, since income inequality has been recognized as a rising environmental stressor in most of the societies nowadays (Alesina et al., 2004), it is quite rational and essential to speculate on

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the potential association between income inequality and AL. Is AL a key mediator to link the stress from ecological income inequality with disease outcomes in a variety of physiological and mental health system? The answer to this question will provide critical evidence to identify the downstream biological pathway of the inequality-health linkage.

As a cumulative phenomenon, AL is hypothesized to develop across the life span, and such initiation and progression of physiological dysregulation generally depend on the frequency of individual's exposure and response to stress and challenges (Seeman et al., 2010). However, more importantly, the accumulation of AL may also relate to individual's self-perceived challenge or stress. Some studies argued that the subjective interpretation of external stimulus may be even more critical than the objective measurement to health conditions (Ambrey et al., 2014). From this perspective, in the extreme case, one could suffer from exaggerated or prolonged physiological responses to the stress that solely due to his/her own perception, regardless of the actual presence of these stressors like high inequality (Seeman et al., 2010). Thus, the difference in the self-interpretation of the circumstances and stimuli between individuals could result in significant disparity of AL accumulation. From this point of view, it is plausible that selfperceived indicators are related to income inequality, which will further operate the inequality-AL linkage.

Nevertheless, there is a scarcity of empirical evidence about the association between income inequality and AL across diverse population, let alone any investigation on the potential moderating effect of self-perception that related to income or income inequality.

In light of the plenty of evidence on inequality-health association and the precursory characteristics of AL for poor health outcome, this study aimed to determine the association of income inequality with AL among Chinese adults, and assess whether there is difference in such association between people with different perception of income priority. We hypothesized that the level of income inequality is positively associated with AL score, and such association is more pronounced among those who perceived income as a higher priority. Considering the complexity of the ongoing socioeconomic and health transitions in current China (Popkin, 2014), and learning from the significant difference of inequality-health linkage across economic levels of regions showed in previous studies (Wilkinson & Pickett, 2006), we also postulated that the association between income inequality and AL, as well as the moderating effect of self-perceived indicators, will vary between regions with different level of economic development. This study will provide valuable insights for underlying mechanisms about how income inequality get "under the skin" to affect population health with evidence from a non-Western, developing nation.

Methods

Data source

We utilized data from China Health and Nutrition Survey (CHNS). CHNS is a panel survey designed to examine the effects of health, nutrition, and family planning and policies to see how the socio-economic transformation of Chinese society is affecting the population's health and nutritional status. This survey initiated in 1989, and nine additional panels were collected in 1991–2015. It employed a multistage, random cluster method to collect more than 4000 households across nine provinces in the northeast, central and south China, which include more than 40% of the population in mainland China. The average individual response rate across different waves was 88%. Details about the survey design and sampling are described elsewhere (Popkin et al., 2010).

Since the CHNS collected biomarker data from fasting blood samples for the first time in 2009, which is also currently the only available biomarker data permitting the construction of AL in CHNS, we used data from the 2006 and 2009 wave of the CHNS survey to examine the time-lagged and instant association between income inequality and AL. Subjects for this study are adult participants aged 18 years or older in the 2009 wave of the CHNS. Among 7673 adults whose blood sample with no missing data to calculate AL score, 129 respondents were excluded due to missing value on covariates (sex, marital status, residence, education, and household income per capita), resulting in a sample size of 7544 respondents for the final analysis on the instant association between income inequality and AL. To test if there's any time-lagged effect of income inequality on AL, the crosssectional analysis was also conducted by regressing the AL score in 2009 on the same set of independent variables in the 2006 wave. A total number of 5 264 respondents with no missing value on covariates were successfully merged with their AL scores in 2009 wave.

Measures

Allostatic load (AL)

AL is often employed as aggregated score of high-risk indicators on four major systems including cardiovascular, metabolic, inflammation, and urinary system. According to the measure in previous research (Seeman et al., 2010; Xu, 2018) and the available biomarkers in the CHNS, we include systolic and diastolic blood pressure for cardiovascular system; body mass index (BMI), waist-to-hip ratio, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, total cholesterol, triglycerides, HbA1c, and fasting glucose for metabolic system; high-sensitivity C-reactive protein (CRP) and albumin for inflammation; and creatinine clearance and uric acid for urinary system. Each biomarker was employed as a dichotomous variable indicating whether its reading falls into the range of high risk (1 = yes, 0 = no). The cut-points for high-risk categories of these biomarkers were chosen based on the recommendation of international health organizations, the CHNS biomarker manual (China Health and Nutrition Survey, 2011) and previous studies on Chinese population (Xu, 2018; Xu et al., 2016; Yan et al., 2012). Consistent with the method in previous literature, the AL score was calculated by summing up the dichotomous indicators of high risk in all four systems. The detailed

Table 1. Prevalence of high-risk individual biomarkers for allostatic load in 2009 China Health and Nutrition Survey (N = 7673)

Biomarkers	% High risk	High-risk range			
Cardiovascular System					
Systolic blood pressure	13.5	>=140 mmHg			
Diastolic blood pressure	21.78	> = 90 mmHg			
Metabolic system		-			
BMI	29.15	>= 25			
Waist-to-hip ratio	47.95	Male $>$ 0.9; female $>$ 0.85;			
High-density lipoprotein (HDL)	25.24	Male $<$ 40 mg/dl; female $<$ 50 mg/dl			
Low-density lipoprotein (LDL)	29.66	> 130 mg/dl			
Total cholesterol	33.78	> = 200 mg/dl			
Triglycerides	28.42	> = 160 mg/dl			
HbĂĺc	3.65	>= 7%			
Fasting glucose	6.14	$> = 126 \mathrm{mg/dl}$			
Inflammation System		5			
High-sensitivity C-reactive protein (CRP)	23.19	>= 0.3 mg/dl			
Albumin	0.34	<3.8 g/dl			
Urinary system		5			
Creatinine clearance	12.49	ages $18-19 < 0.5$ or > 1.0 mg/dl; ages $20 + male < 0.66$ or > 1.25 ; ages $20 + female < 0.52$ or > 1.04 mg/dl			
Uric acid	9.12	ages 18+ male $<$ 3.5 or $>$ 8.5 mg/dl; ages 18-34 female $<$ 2.5 or $>$ 6.2 mg/dl; ages 35-44 female $<$ 2.5 or $>$ 7.0 mg/dl; ages 45 + female $<$ 2.5 or $>$ 7.5 mg/dl;			
Mean allostatic score (SD)	2.84 (2.20)				

description of the high-risk categories for each biomarker is presented in Table 1.

Community-level income inequality (Gini coefficient) and median income

In this study, community-level income inequality was estimated using the Gini coefficient, which is the most commonly used measurement of income inequality. Gini coefficient ranges from 0 to 1, with 0 indicating absolute equal distribution of income and 1 indicating maximal unequal situation. We calculated community-level Gini coefficient based on the following mathematical form (Chen & Crawford, 2012):

$$\operatorname{Gini} = \frac{2}{n^2 \overline{x}} \sum_{i=1}^n i x_i - \frac{n+1}{n}$$

where x is household income per capita, \overline{x} is the mean income of the sample in the community, n is the total number of respondents in the community and l is the rank of x_i in the household income per capita distribution.

As a community-level control variable, median income was also calculated based on respondent's household income per capita. The community-level median income was employed as continuous variable in the analysis. We also conduct sub-sample analysis by community median income level, in which each community was assigned to one of three ordinal categories based on tertiles of community-level median income, respectively.

Self-perceived income priority

The self-perceived income priority was measured based on the question in the CHNS survey: How important is income in your life? The answer ranges from 1 (not important at all) to 5 (the most important). We categorized the respondents' answer into not very important (including 1: not important at all, 2: not very important, and 3: important) and very important (including 4: very important and 5: the most important). Individual-level covariates

Socio-demographic control variables include age (as continuous variable), sex (male or female), marital status (married, divorced/widowed/separated, and single), residence (urban or rural), education attainment (no schooling, elementary school, middle school, high school or equivalent, college, or above) and household income per capita in quartiles (quartile 1 (low) to quartile 4 (high)).

Statistical analysis

Descriptive analyses were used to provide frequency tables, percentages of population by each biomarker of AL, and socio-demographic variables.

We conducted multilevel linear regression analyses with 7544 (5264 for time-lagged analysis) individuals at level 1, nested within 218 communities at level 2. We used the Gini coefficient multiplied by 10 in all the multivariate analyses so that the results could be illustrated easily. Similarly, the multi-level linear regression for cross-sectional and time-lagged analyses was also conducted in subsample analysis by community-level median income tertiles.

To examine whether the association of income inequality and AL would vary among individuals with different perception of income priority, multilevel regression with a crosslevel interaction term for Gini coefficient and self-perceived income priority was applied for cross-sectional and timelagged analyses in total sample, and sub-samples by community median income tertiles. The software Stata version 15 for Mac (StataCorp, College Station, TX) was used for statistical analysis.

Results

Descriptive analyses

Table 1 presents the frequency and prevalence of high risks for AL biomarkers among Chinese adults in 2009. Diastolic blood pressure in cardiovascular system, BMI, waist-to-hip ratio, HDL, LDL, total cholesterol, triglycerides in metabolic system, and CRP in inflammation system were the common risky biomarkers, with the prevalence of high-risk respondents were higher than 20%. The prevalence of HbA1c and fasting glucose in metabolic system, and albumin in urinary system were relatively low among our subjects. The mean AL score was 2.84 with a standard deviation of 2.2.

Table 2 shows the results of descriptive analyses of independent variables among Chinese adults in 2006 and 2009 waves of CHNS. The mean age was 49.6 in both 2006 and 2009 waves, 45.7% of the respondents were male in 2006 and the percentage increased to 46.7% in 2009. Married rate in 2006 was 89% and it dropped to 85.5% in 2009. Less than one-third of the respondents were from urban area and

Table 2. Descriptive analyses of sample characteristics (age >= 18 years, 2009 and 2006).

	200	9	200	6
	Mean or %	SD	Mean or %	SD
Age	49.64	14.67	49.56	13.72
Gender				
Male	46.77	-	45.73	-
Female	53.23	-	54.27	-
Marital status				
Married	85.53	-	89.02	-
Divorced/separated/widowed	8.26	-	7.16	-
Single	6.21	-	3.82	-
Residence				
Urban	32.27	-	31.41	-
Rural	67.73	-	68.59	-
Education				
No schooling	21.87	-	25.5	-
Elementary	19.79	-	19.83	-
Middle school	34.1	-	31.25	-
High school or equivalent	19.1	-	19.63	-
College or above	5.14	-	3.79	-
Household income per capita				
Quartile 1 (lowest)	21.18	-	20.06	-
Quartile 2	23.71	-	24.64	-
Quartile 3	26.23	-	26.28	-
Quartile 4 (highest)	28.88	-	29.03	-
Self-perceived income priority				
Not very important)	58.18	-	50.66	-
Very important)	41.82	-	49.34	-
Community median income (RMB)	9041.1	4997	5917.13	3738.45
Community Gini coefficient	0.41	0.12	0.4	0.11

Table 3. Multilevel linear regression model of allostatic load.

more than 20% of the subjects received no formal education. The average community median income in 2006 was 5917.1 RMB, and it sharply increased to 9041.1 RMB in 2009, reflecting the rapid economic growth in China. The average community Gini coefficient in 2006 was 0.40, which equals to the international warning line, and it increased a little to 0.41 in 2009. Almost half of the respondents in 2006 perceived income as very important in their life, and the percentage dropped to 41.8% in 2009. Appendix Tables 1 and 2 present the distribution of respondents' self-perceived income priority by quartiles of household income per capita and community-level income inequality. It suggests that there was no significant difference or regular variation in the distribution among individual from different quartiles of income or income inequality.

Association between income inequality and allostatic load

Table 3 reports the coefficient estimates from the multilevel linear regression on AL scores. After adjusting for community-level median income and individual-level socio-demographic variables, the cross-sectional analysis in 2009 suggests that community-level Gini coefficient was significantly associated with AL score (coefficient = 0.081, p = .016). And for each 0.1 increase in community-level Gini coefficient, there was a 0.081 increase in AL score among those who lives in this community. The time-lagged analysis of AL score in 2009 regressed on independent variables measured in 2006 showed similar result (0.106, 0.008). The community-level Gini coefficient was also positively associated with AL score in 2009.

Subsample analysis by community median income tertiles

Table 4 reports the subsample multilevel linear regression by community median income tertiles. The cross-sectional analysis result of respondents from communities with low

	2009			2006 (lagged effect)		
	Coefficient	SE	р	Coefficient	SE	р
Community level						
Gini X 10	0.081	0.034	.016	0.106	0.04	.008
Median income per capita (K)	0.026	0.009	.006	0.012	0.014	.398
Individual level						
Age	0.045	0.002	<.001	0.045	0.003	<.001
Male (ref = female)	-0.082	0.049	.097	-0.212	0.058	<.001
Marital status (ref = single)						
Married	0.11	0.11	.317	-0.045	0.157	.773
Divorced/separated/widowed	0.087	0.146	.55	-0.121	0.198	.543
Urban (ref = rural)	-0.015	0.087	.865	0.1	0.101	.321
Education (ref = no schooling)						
Elementary	0.038	0.078	.63	-0.088	0.088	.318
Middle school	-0.02	0.078	.794	-0.06	0.089	.5
High school or equivalent	-0.056	0.091	.541	0.061	0.103	.552
College or above	-0.173	0.138	.211	-0.189	0.175	.279
Household income per capita (ref = quartile 1)						
Quartile 2	-0.088	0.732	.226	-0.043	0.085	.615
Quartile 3	-0.018	0.074	.805	0.027	0.087	.757
Quartile 4 (highest)	0.139	0.08	.083	0.376	0.096	<.001

Table 4. Multilevel linear regression model of allostatic load (subsample analysis).

		2009			2006 (lagged effect)	
	Community median income (low) Coefficient (SE)	Community median income (medium) Coefficient (SE)	Community median income (high) Coefficient (SE)	Community median income (low) Coefficient (SE)	Community median income (medium) Coefficient (SE)	Community median income (high) Coefficient (SE)
Community level						
Gini X 10	0.174 (0.060)**	0.064 (0.056)	0.006 (0.054)	0.127 (0.064)*	0.064 (0.066)	0.118 (0.072)
Median income per	-0.041 (0.074)	0.094 (0.061)	-0.018 (0.014)	0.125 (0.113)	0.339 (0.104)**	0-0.032 (0.205)
capita (K)						
Individual level						
Age	0.041 (0.004)***	0.046 (0.004)***	0.049 (0.004)***	0.045 (0.005)***	0.044 (0.005)***	0.049 (0.005)***
Male (ref = female)	-0.288 (0.916)**	-0.277 (0.084)**	0.215 (0.081)**	-0.399 (0.109)***	-0.411 (0.097)***	0.123 (0.098)
Marital status (ref = single)						
Married	0.024 (0.194)	0.215 (0.192)	0.097 (0.185)	-0.041 (0.294)	-0.040 (0.259)	-0.140 (0.267)
Divorced/separated/widowed	0.089 (0.732)	0.028 (0.253)	0.194 (0.243)	-0.089 (0.360)	-0.098 (0.335)	-0.222 (0.335)
Urban (ref = rural)	-0.015 (0.207)	-0.147 (0.141)	0.028 (0.117)	-0.024 (0.231)	0.081 (0.157)	0.188 (0.147)
Education (ref $=$ no schooling)						
Elementary	0.200 (0.131)	0.035 (0.128)	-0.107 (0.147)	0.098 (0.147)	-0.183 (0.142)	-0.180 (0.172)
Middle school	0.032 (0.133)	0.079 (0.129)	-0.172 (0.141)	0.060 (0.152)	-0.113 (0.145)	-0.138 (0.169)
High school or equivalent	-0.009 (0.178)	0.097 (0.157)	-0.192 (0.151)	0.305 (0.207)	-0.003 (0.169)	0-0.031 (0.178)
College or above	-0.168 (0.411)	0.322 (0.335)	-0.349 (0.190)	0.219 (0.661)	-0.125 (0.350)	-0.345 (0.243)
Household income per capita						
(ref = quartile 1)						
Quartile 2	-0.007 (0.105)	-0.143 (0.123)	-0.239 (0.181)	-0.192 (0.121)	0.162 (0.136)	-0.060 (0.228)
Quartile 3	0.196 (0.124)	0.024 (0.120)	-0.415 (0.165)*	-0.076 (0.143)	0.027 (0.137)	0.219 (0.211)
Quartile 4 (highest)	-0.111 (0.166)	0.123 (0.139)	-0.075 (0.161)	-0.013 (0.227)	0.403 (0.152)**	0.554 (0.207)**

****p* < .001; ***p* < .01; **p* < .05.

Table 5. Multilevel linea	r regression model (of allostatic load	(cross-level interaction	with self-perceived i	income priority).
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		Community median	Community median	Community median
	Total sample	income (low)	income (medium)	income (high)
	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
	2009			
Cross-level interaction				
Gini X income priority (ref = Gini X not very important)				
Gini X very important	0.049 (0.040)	0.138 (0.065)*	-0.033 (0.076)	0.088 (0.073)
Gini X 10	0.058 (0.128)	0.101 (0.070)	0.054 (0.064)	-0.012 (0.057)
Income priority (ref = not very important)				
Very important	-0.126 (0.171)	-0.716 (0.355)*	0.277 (0.330)	-0.143 (0.273)
	2006 (lagged eff	ect)		
Cross-level interaction				
Gini X income priority (ref $=$ Gini X not very important)				
Gini X very important	0.028 (0.051)	0.073 (0.089)	-0.055 (0.087)	0.092 (0.100)
Gini X 10	0.094 (0.047)*	0.093 (0.078)	0.104 (0.078)	0.073 (0.082)
Income priority (ref = not very important)				
Very important	-0.083 (0.213)	-0.314 (0.395)	0.230 (0.383)	-0.220 (0.370)
, ,	, ,	. ,	, ,	. ,

All models were adjusted for age, sex, marital status, residence, education, and household income quartiles. *p < .05.

median income in 2009 showed similar patterns with that of total sample. Gini coefficient was positively associated with AL score. However, no significant association between income inequality and AL score was found among respondents from communities with medium or high median income. Similarly, the significant association between Gini coefficient and AL score was only found among respondents from communities with low median income in the time-lagged analysis of AL score in 2009 regressed on independent variables measured in 2006.

Association between income inequality and allostatic load (cross-level interaction with self-perceived income priority)

Table 5 presents the result of multilevel linear regression on AL score with cross-level interaction terms with self-perceived income priority in both total sample and sub-sample. The cross-sectional analysis shows that the cross-level interaction

between Gini coefficient and self-perceived income priority was significantly associated with AL score among respondents from communities with low median income. This suggests that the association between income inequality and AL was more pronounced among individuals who perceived income as a higher priority (very important) than that among those who perceived income as lower priority (not very important) in poor communities. Nevertheless, no significant association between the cross-level interaction terms and AL score was found in total sample, samples of community with medium median income and high median income. And the cross-level interaction was not significantly associated with AL score in total sample or any subsample timelagged analysis.

Discussion

This study, to our knowledge, is among the first to investigate the association between income inequality and AL, with further novel assessment on potential moderating effect of self-perceived priority of income. Overall, the findings are consistent with our theoretical expectation about the psychosocial mechanisms linking income inequality to chronic health risks. There was positive association between income inequality and AL, and such association was only found to be significant in low-income communities. Additionally, the inequality-AL linkage was more pronounced among individuals who perceived income as a higher priority in their life than those with relatively lower priority perception. These findings are strengthened by time-lagged multilevel regression analyses, which to some extent, address the challenge of reverse causality between income inequality and AL, underline the downstream biological pathway and psychosocial mechanisms of income inequality-health linkage, and provide empirical evidence to support the importance of perception/belief in physiological response to environmental stressor.

First of all, our results suggested that community-level income inequality was positively associated with AL among Chinese adults. And the similar result from the time-lagged analysis showed that the potential impact of inequality on AL could last as long as three years. This was in line with most of previous studies focusing on income inequality and health outcomes (Pickett & Wilkinson, 2015). As Wilkinson argued, the inequality-health relation is the result of the relative deprivation - individual's perception of their economic position in relation to others may generate excessive chronic stress (Kawachi & Kennedy, 1999). And it has also been suggested that social cohesion and trust were significantly lower in regions with higher income inequality, which further leads to increased chronic stress (Wilkinson, 2002). Such chronic stress often impairs memory, weaken the immune responses, affects hormonal system, elevates the risk of cardiovascular diseases (Sapolsky, 2005), and also indirectly incurs risky health behaviors, all of which were relevant to the indicators of AL. Besides the psychosocial pathway, income inequality could also affect physiological system through material mechanism. Relatively less investment in human, health and social infrastructure has been found in more unequal societies compared to that in more egalitarian regions (Kaplan et al., 1996). Poor accessibility to health care service may fail to prevent individual from accumulation of biological dysregulation.

The sub-sample analysis suggested that the positive inequality-AL relationship was found to be only significant in low-income communities. Similar pattern has been observed in previous studies on chronic diseases (Boydell et al., 2004; Diez-Roux et al., 2000). For example, ecological research from south London showed that higher inequality was associated with elevated incidence of schizophrenia, but only in the most deprived wards (Boydell et al., 2004). Possible mechanism involves that factors like neighborhood deprivation or human development index might mediate material pathway in the association between income inequality and health outcomes (Ribeiro et al., 2017). In particular, individuals from more deprived districts may be more socially or economically marginalized. Thus, their health status is more dependent on local public resources (Ahern & Galea, 2006). Increased level

of AL has been suggested to be correlated with worse selfrated health, more difficulties, as well as other conditions such as ischemic heart disease among low-SES individuals (Sabbah et al., 2008). Research based on a longitudinal study of elderly in United States found that higher AL explained more than one-third of the difference in mortality risk between those of higher SES and those of lower SES (Seeman et al., 2004). Integrating with our finding, more attention on the detrimental effect of income inequality should be paid to individuals from deprived communities or in poverty than to society as a whole.

We also found that individuals who perceived income as a higher priority suffered from more adverse effect of income inequality on AL than those with relatively lower income-priority perception. Our supplementary analysis showed that the distribution of people with different self-perception of income priority was roughly homogeneous between different income groups or different level of income inequality groups, which excludes the possibility that the higher or lower income-priority perception group was actually a group of individuals with similar characteristics of income or income inequality. This finding is in line with one study on neighborhood perceptions and AL in the United States (Carbone, 2020), which indicated that individual's perceived neighborhood trust, safety and conditions were inversely associated with AL. As mentioned before, the physiological dysregulation is postulated to be driven not only by the actual encountered stress, but also by the perceived challenges. To be specific, the association between individual and environmental stress could be mediated by a cognitive process, known as cognitive appraisal, which will further determine physiological response and coping strategies. From this perspective, when individuals perceive income as a higher priority in their life, they are more likely to be aware of the income level of people around, and thereby be more sensitive to income inequality as an environmental stressor. Coupled with the perception of relative position in the social hierarchy, the negative emotions like shame or distrust will be produced and translated "inside" the body into poorer health status via psycho-neuro-endocrine mechanism (Lynch et al., 2000). Meanwhile, in low-income communities, individual who perceived income as a higher priority could be those who are sensitive to the negative influence of income inequality, such as the deterioration of public resources and social cohesion, and could also be those who have higher aspiration to improve their income. Such aspiration under the circumstance of the invidious competition in high inequality regions could lead to the faster accumulation of AL by chronic stress and hard work.

Limitation

This study is subject to several limitations. First and foremost, because the biomarker data is only available for one wave, it is impossible to draw conclusion with causal inference. Any causal interpretation of the presented results was based on theoretical reasoning. Second, the missing data may result in potential bias in our analysis. However, such bias was relatively minor since only about 7% of the subjects were with missing values. Third, this study used one-item question to measure the perceived income priority, which is prone to measurement bias (Cundiff et al., 2013). Further research on related topic is advised to employ multiple items to ensure the validity of the perception measurement so that the bias could be minimized. Fourth, several characteristics (e.g. the distribution of perceived income priority) changed between 2006 and 2009 wave, which may reduce the robustness of our result. It also worth to mention that CHNS sample only cover nine provinces of China mainland, any extrapolation from these findings to the entire country should be cautious.

Conclusion

We found a positive association between income inequality and AL among Chinese adults, with individual who perceived income as a higher priority in their life suffering more from income inequality. This study contributes to the increasing efforts and new perspective to understand the inner mechanism of both the detrimental effect of income inequality and the accumulation of AL. The finding has potential policy implications. The issue of income inequality in impoverished regions should be paid with extra attention to reduce widening gap between the rich and poor, and reinforce the investment on public resources and infrastructure. Additionally, advocacy for a healthy, less-competitive environment both in daily life and at workplace to reduce unnecessary stress among working population is needed for the government, community, and employer.

Disclosure statement

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Appendix Table 1. Self-perceived income priority among respondents by quartiles of household income per capita (N (%))

		Self-perceived income priority							
		2009		2006					
Household income per capita	Not very important	Very important	Chi-square (p)	Not very important	Very important	Chi-square (p)			
Quartile 1 (lowest)	903 (56.97)	682 (43.03)	1.931 (.587)	464 (44.96)	568 (55.04)	29.154 (.000)			
Quartile 2	1021 (57.62)	751 (42.38)	_	641 (49.81)	646 (50.19)				
Quartile 3	1162 (58.98)	808 (41.02)	-	679 (49.45)	694 (50.55)	-			
Quartile 4 (highest)	1270 (58.69)	894 (41.31)	-	841 (55.58)	672 (44.42)	-			

Appendix Table 2. Self-perceived income priority among respondents by quartiles of community-level income inequality (*N* (%))

		Self-perceived income priority							
		2009		2006					
Income inequality quartiles	Not very important	Very important	Chi-square (p)	not very important	very important	Chi-square (p)			
Quartile 1 (lowest)	1157 (57.79)	845 (41.21)	3.331 (.343)	745 (53.83)	639 (46.17)	9.586 (.022)			
Quartile 2	1058 (57.34)	787 (42.66)	-	655 (48.38)	699 (51.62)	-			
Quartile 3	1153 (59.90)	772 (40.10)	-	640 (50.20)	635 (49.80)	-			
Quartile 4 (highest)	988 (57.48)	731 (42.52)	-	585 (49.08)	607 (50.92)	-			