I Z A Institute of Labor Economics

Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 13421

Inequality of Opportunity in Bodyweight among Middle-Aged and Older Chinese: A Distributional Approach

Peng Nie
Lanlin Ding
Andrew M. Jones

JUNE 2020

DISCUSSION PAPER SERIES

IZA DP No. 13421

Inequality of Opportunity in Bodyweight among Middle-Aged and Older Chinese: A Distributional Approach

Peng Nie
Xi'an Jiaotong University, University of Hohenheim and IZA

Lanlin Ding
Xi'an Jiaotong University

Andrew M. Jones
University of York and Monash University

JUNE 2020

ISSN: 2365-9793

IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Inequality of Opportunity in Bodyweight among Middle-Aged and Older Chinese: A Distributional Approach

Using the 2011 and 2015 waves of the China Health and Retirement Longitudinal Study (CHARLS) linked with the 2014 CHARLS Life History Survey, we provide a comprehensive analysis on inequality of opportunity (IOp) in both body mass index (BMI) and waist circumference (WC) among middle-aged and older Chinese. We find that IOp ranges from 65.5% to 74.6% for BMI (from 82.1% to 95.5% for WC). Decomposition results show that spatial circumstances such as urban/rural residence and province of residence are dominant. Health status and nutrition conditions in childhood are the second largest contributor. Distributional decompositions further reveal that inequality in bodyweight is not simply a matter of demographic (age and gender) inequalities; our set of spatial and health and nutrition conditions in childhood become much more relevant towards the right tails of the bodyweight distribution, where the clinical risk is focused.

JEL Classification: D63, I12, I14

Keywords: inequality of opportunity, body mass index, waist circumference, CHARLS, Shapley-Shorrocks decomposition, unconditional quantile regressions

Corresponding author:
Peng Nie
School of Economics and Finance
Xi’an Jiaotong University
710061 Xi’an
China

E-mail: niepeng2017@mail.xjtu.edu.cn

1. Introduction

The high prevalence and rising levels of excess weight and obesity around the world have become a global public health crisis (Ng *et al.*, 2014a; Wang *et al.*, 2019b), with worldwide obesity nearly tripling since 1975. More than 1.9 billion adults aged 18+ were overweight, and over 650 million were obese in 2016 (WHO, 2020). Obesity is not only a medical condition in itself but also increases the prevalence of chronic diseases, such as cardiovascular disease (CVD), stroke, type 2 diabetes and a subset of cancers (Haslam & James, 2005; Hill & Peters, 1998), as well as particular social and mental health risks (OECD, 2019). Importantly, obesity follows a socioeconomic gradient (Peeters & Backholer, 2015), and bodyweight inequality is an important driver for the future development of inequalities in health and longevity (Hoffmann *et al.*, 2015; Kulhánová *et al.*, 2016).

The processes that lead to adiposity involve numerous factors, including genetic predisposition, behavioral, environmental, social and cultural dynamics, family behaviors and circumstances (Bilger *et al.*, 2017; Matheson, 2016). In essence, disparities in such determinants are precursors for inequality in obesity, and identifying the underlying sources of these inequalities over the life course is important to reduce the high levels of obesity and associated health inequalities (Department of Health Public Health Research Consortium *et al.*, 2007). As suggested by previous studies (e.g., Alesina & Angeletos, 2005; Carrieri *et al.*, 2020; Carrieri & Jones, 2018; Davillas & Jones, 2020a; Rosa Dias, 2009; Trannoy *et al.*, 2010; Wendelspiess Chávez Juárez & Soloaga, 2014), not all of these sources of bodyweight inequalities are equally objectionable. Specifically, bodyweight inequalities due to factors that reflect individual choices (referred to as efforts), such as lifestyles, might be ethically acceptable and, to some extent, regarded as fair. In contrast, sources such as family socioeconomic characteristics which are beyond individuals' control (referred as circumstances) are typically regarded as illegitimate and objectionable. This perspective on social attitudes toward health inequalities and inequity chimes with the literature on inequality of opportunity (IOp), which has emerged in social choice theory and normative economics (Roemer, 1998, 2002; Roemer & Trannoy, 2016).

The life course approach proposes that inequalities observed in later life are a result of disadvantages experienced across an individual's life, in other words, they accumulate over the life course (WHO, 2018). The WHO Commission on the Social Determinants of Health (CSDH) also underscores the role of childhood circumstances as a key source of unfair health inequality (Marmot *et al.*, 2008). For example, both early-life circumstances and efforts can lead to adverse socioeconomic conditions and poor health in adulthood and continue to later life. In particular, to some extent, bodyweight inequalities in middle-aged or older adults reflect accumulated effects of health determinants, such as childhood circumstances, backgrounds and lifestyles, across a lifespan. As highlighted by the WHO report of the Commission on Social Determinants of Health, an understanding of health inequalities and their determinants is important to establish informed policies to reduce them (WHO, 2008).

Based on Roemer's conceptual framework for IOp (Roemer, 1998, 2002; Roemer & Trannoy, 2016), our study is the first comprehensive analysis of IOp in bodyweight (including BMI and WC) among middle-aged and elderly Chinese to explore to what extent the objectionable circumstances and legitimate efforts explain bodyweight inequalities. China offers an interesting and unique setting for studying IOp in bodyweight among the middle-aged and older adults: First, over the past four decades of unprecedented economic growth, China has witnessed a major shift in diet – most notably, an increased intake of edible oils, fried foods, animal-sourced foods and snacks – accompanied by a sharp decline in occupational and domestic physical activity (Ng *et al.*, 2014b; Nie *et al.*, 2019a; Xi *et al.*, 2012). The prevalence of adult general obesity has tripled (increased from 3.6% in 1992 to 11.9% in 2012) (Wang *et al.*, 2019a) and the rate of abdominal obesity has also increased by more than 50% (Zhang *et al.*, 2019). Meanwhile, several studies confirm that, due to reduced total energy expenditure and muscle loss with ageing, high prevalence of overweight and obesity among middle-aged and older adults has become a major concern (Liu *et al.*, 2018; Smith *et al.*, 2014; Zhang *et al.*, 2020). With the highest number of obese adults worldwide (The GBD 2015 Obesity Collaborators, 2017), China's rates of obesity-related non-communicable diseases (NCDs) have also increased dramatically and have become a major risk factors for morbidity, disability and mortality (Popkin, 2008). Consequently, China spends 24 billion yuan annually, 2.46% of its annual national health care expenditure, on overweight, obesity and their complications (Qin & Pan, 2016). This expenditure clearly indicates the magnitude of the challenge posed by this rapidly increasing obesity to China's health care system (Zhao *et al.*, 2008). Second, although the overall health status of the Chinese population has improved greatly, with life expectancy growing from 68 in 1981 to 77 in 2019 (World Population Review, 2019), the rapid economic growth has not been accompanied by equally substantial improvements in health and this has become a source of concern (Baeten *et al.*, 2013; Tang *et al.*, 2008). Rising health disparities are widespread in China and this is particularly evident among older people (WHO, 2015). In addition, over the period of 1991-2011, inequality in obesity increased significantly, especially among individuals with low socioeconomic status (SES) and those living in rural areas (Nie *et al.*, 2019b). The rise in aggregate obesity inequality is not being driven by changes in the demographic structure but rather by a population-wide increase across all subpopulations, suggesting that general increases in obesity might alter norms and perceptions of ideal bodyweight in the whole population, thereby cementing higher obesity rates (Nie *et al.*, 2019b).

Following Roemer's framework, which partitions sources of inequality into legitimate efforts and illegitimate circumstances, a large body of empirical applications have examined IOp in different outcomes, such as income (e.g., Aaberge *et al.*, 2011; Almås *et al.*, 2011; Checchi & Peragine, 2010; Corak, 2013; Marrero & Rodríguez, 2013), education (e.g., Asadullah & Yalonetzky, 2012; Gamboa & Waltenberg, 2012; Waltenberg & Vandenberghe, 2007) and health (e.g., Carrieri *et al.*, 2020; Carrieri & Jones, 2018; Davillas & Jones, 2020a; Rosa Dias, 2009). Regarding IOp in bodyweight, Salas-Ortiz (2020) uses data from the 2012 and 2016 National Survey of Health and Nutrition to examine *ex ante* IOp in body mass index (BMI) and waist circumferences (WC) for Mexican adults. She shows that circumstances such as age and parental diabetes are the key contributors to IOp in bodyweight. Yet, despite the importance of knowing what contributes to a country's bodyweight inequality, there is no research on the IOp in bodyweight[1] in China.

We extend the existing literature in four ways:

First, our study is the first attempt to examine IOp in bodyweight (both BMI and WC) and to explore to what extent the circumstances and efforts explain bodyweight inequality in China, in a setting that has the largest number of people affected by obesity worldwide and where obesity inequality has increases sharply over time (Nie *et al.*, 2019b; The GBD 2015 Obesity Collaborators, 2017).

Second, unlike the commonly-used mean-based decomposition, our distributional analysis based on RIF quantile regressions reveals how the contributions of circumstances and efforts vary over the whole distribution of bodyweight, with a particular focus on the upper tails of the distribution, where individuals are at high risk of obesity and other health problems.

Third, the 2014 CHARLS Life History Survey allows us to introduce a rich set of childhood circumstances that may contribute to IOp, which addresses a concern that poor information on circumstances may lead to an underestimate of IOp and therefore mislead policymakers into a false sense of complacency that health inequality is largely fair (Kanbur & Wagstaff, 2016).

[1] Regarding bodyweight inequality, existing studies focus on the following three aspects. First, tracking changes of the mean or distributions of bodyweight across time (see, for instance, Contoyannis & Wildman, 2007; Madden, 2012; Nie *et al.*, 2019b). Second, identifying demographic and socioeconomic disparities (e.g., gender, age, education, income, region and childhood SES) in bodyweight (see, for instance, Aizawa & Helble, 2017; Ball *et al.*, 2002; Baum & Ruhm, 2009; Davillas & Jones, 2020b; Deuchert *et al.*, 2014; Dykes *et al.*, 2004; Giskes *et al.*, 2008; Monda *et al.*, 2008; Popkin *et al.*, 1995). Third, using concentration indices (CI) to quantify socioeconomic-related bodyweight inequality (e.g., Aizawa & Helble, 2017).

Fourth, our study uses objective measures of bodyweight, which few studies have at their disposal. The inclusion of both BMI and WC is particularly important for China because approximately two thirds obese adults would be missed if solely BMI was adopted to define obesity (Du *et al.*, 2013). Relative to BMI, WC is a stronger predictor of cardio-metabolic risk, particularly among Chinese adults (Du *et al.*, 2013). Having such rich objective data is important in order to credibly assess IOp in bodyweight.

The remainder of the paper is organized as follows: Section 2 documents the empirical strategy. Section 3 describes the datasets used, and then Section 4 presents the results. Section 5 discusses the major findings and concludes.

2. Methods

2.1 Estimation strategy

Following Roemer's (1998) framework, the determinants of individual bodyweight can be separated into following components: circumstances (C_i), for which individuals are not held responsible, efforts (E_i), which are under the partial control of individuals, and demographics (D_i) (including gender and age). Inequalities due to circumstances (i.e. IOp) should be compensated (*compensation principle*) whereas inequalities arising from different efforts are normatively acceptable (*reward principle*). Following the existing literature on IOp in health (Bricard *et al.*, 2013; Deuchert *et al.*, 2014; Ferreira & Gignoux, 2011; Jusot *et al.*, 2013; Roemer & Trannoy, 2015), individual bodyweight y_i is assumed to be a function of circumstances, efforts and demographics.[2] We also assume that circumstances are unaffected by efforts, but efforts may be influenced by circumstances and demographics. Thus, a generalized production function for bodyweight y_i of individual i can be defined as:

$$y_i = h(C_i, E(C_i, D_i, v_i), D_i, u_i) \tag{1}$$

[2] Whether the bodyweight differences due to biological factors (e.g. gender and age) are legitimate is a philosophical issue. Following Jusot *et al.* (2013), we separate gender and age from other circumstances.

where v_i and u_i are unobserved error terms. Specifically, v_i represents random variation in effort that is independent of C_i, and D_i, and u_i denotes random variation in bodyweight that is independent of C_i, E_i and D_i.

In accordance with Bricard *et al.* (2013) and Jusot *et al.* (2013), we adopt a linear parametric approach, which does not suffer from the curse of dimensionality especially for a rich set of circumstances. The latter arises in the nonparametric approach due to insufficient sample sizes for specific social *types* (groups of individuals who share identical circumstances) and *tranches* (groups of individuals who share same efforts). Assuming additive separability and linearity of $h(\cdot)$ and $E(\cdot)$ (Davillas & Jones, 2020a), we have a linear structural form for individual bodyweight:

$$y_i = \alpha C_i + \beta E_i + \gamma D_i + \varepsilon_i \quad (2)$$

According to Roemer's definition of equality of opportunity, IOp requires that efforts to be purged of any contamination from circumstances and demographics, meaning that they are the pure or direct contribution of efforts. Thus, we estimate auxiliary regressions, which regress each effort on demographics and circumstances:

$$E_i = \delta C_i + \lambda D_i + e_i \quad (3)$$

where e_i is the effort purged from circumstances and demographics. We then substitute the vector of efforts E_i in equation (2) with the estimated residuals $\hat{e}_i$ of equation (3). Therefore, the equation (2) can be reformulated as:

$$y_i = \alpha C_i + \beta \hat{e}_i + \gamma D_i + \varepsilon_i \quad (4)$$

In this form the first term on the right-hand side captures the total (direct and indirect) contribution of circumstances, while the second term captures the direct contribution of efforts (e.g. Carrieri *et al.*, 2020). We use ordinary least squares (OLS) to estimate the bodyweight production function. Regarding the binary variables of efforts used in our analysis, following Bricard *et al.* (2013), we employ a linear probability model for the auxiliary equations (3). The main interest of our paper is on the explained variance of bodyweight in equation (4). Finally, we quantify the magnitude of explained bodyweight inequalities (i.e. explained variances) and the individual contributions of circumstances, efforts and demographics.

2.2 Mean-based regressions

Since we aim to quantify the magnitude of bodyweight inequality and decompose it into different sources, the variance share is a suitable index of IOp for two key reasons. First, its decomposition has desirable properties such as independence of the level of disaggregation, consistent decomposition and population symmetry (Shorrocks, 1982). Second, as Ferreira and Gignoux (2014) highlight, the variance share is simple to calculate: it is the R^2 of an OLS regression. Despite its simplicity, it provides a parametric approximation to the lower bound on the share of total inequality in bodyweight that is explained by circumstances, efforts and demographics. Therefore, the estimate of equation (4) can also be expressed as:

$$\hat{y}_i = \hat{\alpha} C_i + \hat{\beta} \hat{e}_i + \hat{\gamma} D_i \tag{5}$$

Specifically, the variance of explained bodyweight is given by:

$$\sigma^2(\hat{y}_i) = cov(\hat{y}_C, \hat{y}_i) + cov(\hat{y}_{\hat{e}}, \hat{y}_i) + cov(\hat{y}_D, \hat{y}_i) \tag{6}$$

where $\hat{y}_C$, $\hat{y}_{\hat{e}}$, and $\hat{y}_D$ are the first, second and third terms of the right hand of equation (5), respectively. Based on the OLS estimates, the contribution of the group of observed circumstances to the explained bodyweight inequality (IOp) is given by:

$$IOp = cov(\hat{y}_C, \hat{y}_i)/\sigma^2(\hat{y}_i) \tag{7}$$

Similarly, the combined contributions of efforts (IEF) and of demographics (DEM) to total explained bodyweight inequality can be written as:

$$IEF = cov(\hat{y}_{\hat{e}}, \hat{y}_i)/\sigma^2(\hat{y}_i) \tag{8}$$

$$DEM = cov(\hat{y}_D, \hat{y}_i)/\sigma^2(\hat{y}_i) \tag{9}$$

2.3 RIF quantile regressions

In the context of IOp using a mean-based approach, based on fitted values from OLS regressions, implies utilitarian reward and inequality neutrality towards individuals that share the same values of the independent variables. However, this assumption may be regarded as too restrictive and we may wish to give greater weight to the upper tail of the distribution of bodyweight, where individuals are at great risk of health problems (Davillas & Jones, 2020a). To allow for this we use the RIF unconditional quantile regression approach (Firpo *et al.*, 2009) to estimate marginal effects of circumstances, efforts and demographics at different points of the bodyweight distribution. Then we quantify the contribution of each set of factors to the explained bodyweight inequality at different quantiles of bodyweight distribution.

We first regress the RIF vector on the factor variables:

$$RIF\big(y_i;\ q_Y(\tau)\big) = \alpha^\tau C_i + \beta^\tau \hat{e}_i + \gamma^\tau D_i + \varepsilon_i^\tau \quad (10)$$

The estimate of equation (10) is:

$$\hat{y}_i^\tau = \hat{\alpha}^\tau C_i + \hat{\beta}^\tau \hat{e}_i + \hat{\gamma}^\tau D_i \quad (11)$$

where $\hat{y}_i^\tau$ is the estimated RIF value for individual *i* at quantile τ, $\hat{\alpha}^\tau$, $\hat{\beta}^\tau$ and $\hat{\gamma}^\tau$ represent the estimated coefficients of circumstances, efforts and demographics, respectively, at different quantiles (τ). Then we can express the variance of explained bodyweight at quantile τ as:

$$\sigma^2(\hat{y}_i{}^\tau) = cov(\hat{y}_C^\tau, \hat{y}_i^\tau\ ) + cov(\hat{y}_{\hat{e}}^\tau, \hat{y}_i^\tau) + cov(\hat{y}_D^\tau, \hat{y}_i^\tau) \quad (12)$$

Where $\hat{y}_C^\tau$, $\hat{y}_{\hat{e}}^\tau$ and $\hat{y}_D^\tau$ is the first, second and third terms of the right hand of equation (11), respectively. Similarly to equations (7) to (9), we compute the contributions of circumstances, efforts and demographics at different quantiles of bodyweight.

Since the RIF equations are additive and linear, we also use a Shapley-Shorrocks decomposition to identify the relative contribution of each factor for circumstances, efforts and demographics at the different quantiles.

2.4 Shapley-Shorrocks decomposition

We decompose the total explained bodyweight inequality into its underlying sources.

Specifically, the regression-based Shapley decomposition method can identify the contributions of each factor to the total explained variance (Ferreira & Gignoux, 2014; Shorrocks, 2013). The main advantage of this decomposition technique is that it is path independent, i.e., the order of changing variables for the decomposition does not affect the results. Additionally, it is also exactly additive, meaning that the different components sum up to the total explained variance (Wendelspiess Chávez Juárez & Soloaga, 2014). To do so, we first estimate variance for all possible permutations of each independent variable, and then average the marginal effect of each independent variable in every case on total explained variance to obtain the contribution of each independent variable to explained bodyweight inequality (Ferreira & Gignoux, 2014; Ferreira *et al.*, 2011; Wendelspiess Chávez Juárez & Soloaga, 2014).

3. Data

3.1 Data and study population

The data are drawn from the China Health and Retirement Longitudinal Study (CHARLS), administered by the National School of Development together with the Institute for Social Science Surveys at Peking University, a nationally representative longitudinal survey of the middle-aged and elderly in China, including assessments of social, economic, and health circumstances of community-residents (Zhao *et al.*, 2014). The CHARLS sample is obtained via multistage stratified probability proportional to size (PPS) sampling design (Zhao *et al.*, 2014). The national baseline survey was conducted in 2011-2012 on 17,708 respondents residing in 10,257 households in 450 villages/urban communities. Two follow-up interviews were conducted in 2013 and 2015. In 2014, there was a retrospective Life History Survey, including demographics, household SES, health, work, wealth history of respondents and rich information of individual circumstances, which facilitates estimation of IOp. The CHARLS is part of a group of ageing surveys worldwide that are harmonized to the Health and Retirement Study (HRS) in the US, the English

Longitudinal Survey on Ageing (ELSA) in England, and the Survey on Health, Ageing and Retirement in Europe (SHARE) in Europe.

Our analytical sample is middle-aged and elderly adults aged 45+ in 2011 and 2015. We first match the 2011 and 2015 CHARLS to the 2014 Life History Survey to enable linkage of respondents' anthropometric measures with their childhood circumstances. Given that some individuals interviewed in 2011 or 2015 are not included in 2014, we use *t-tests* to check whether there are statistically significant differences in demographic, socioeconomic and lifestyle variables between the matched sample and the original samples in 2011 or 2015. As shown in Table A.1 of the Appendix, we do not find any evidence of significant differences, other than for urban/rural residence and employment status in 2011. Second, we retain the individuals without missing values for any of the explanatory variables for demographics, efforts and circumstances from the matched sample. Table A.2 in the Appendix reveals no evidence of statistical differences between the matched sample and the matched sample without the missing values for explanatory variables (with the exception of age in 2011 and 2015 and marital status in 2011). Since we attempt to retain the largest sample possible for analysis of each bodyweight measure, the number of observations for BMI and WC differs slightly because of missing data for the individual bodyweight indicators. Our final analysis samples are 7,231 for BMI and 7,181 for WC in 2011 and 9,729 for BMI and 9,620 for WC in 2015. As Table A.3 in the Appendix shows, there are no statistically significant differences between our analytical samples and the matching sample with no missing values for explanatory variables, indicating that there is not an issue with sample selection on observables in our study.

3.2 Bodyweight variables

The CHARLS includes professionally measured weight, height and waist circumference, which eliminates the reporting bias inherent in self-reported anthropometric information (Shields *et al.*, 2011). This bias tends to result in underestimation of BMI (Burkhauser & Cawley, 2008). We adopt BMI defined as weight (in kg) divided by the square of height (in metres) and WC (in cm) as bodyweight indicators.

3.3 Circumstances

Following the existing literature (Davillas & Jones, 2020a; Trannoy *et al.*, 2010; Yan *et al.*, 2020), we classify the circumstances into five domains (see Table 1):

(1) Region/province: including urban or rural residence (1 = rural, 0 = urban) and province of residence;

(2) War. China experienced the War with Japan and the Civil War in the 1930s and 1940s. We use two dummies measuring whether an individual was born during the War with Japan or the Civil War periods, respectively;

(3) Parental health status and health behaviors in childhood: including parental health status (1 = long time in bed, 0 = none), mother's smoking (1 = yes, 0 = no), and father's smoking (1 = yes, 0 = no) and drinking (1 = yes, 0 = no);

(4) Health nutrition and conditions in childhood. It is widely acknowledged that poor social conditions early in life such as hunger and other adversities can exert long-term impacts on individuals' health capital (e.g., Alvarado *et al.*, 2008; Barker, 1994; Cui *et al.*, 2020). As such, we include self-reported health (SRH) before age 15 (1 = much less healthy, 2 = somewhat less healthy, 3 = about average, 4 = somewhat healthier, 5 = much healthier) and whether they experienced hunger before age 17 (1 = yes; 0 = no);

(5) Household SES in childhood, including parental political status (1 = Communist Party member, 0 = no), mother's education (1 = illiterate, 0 = literate), father's education (1 = illiterate, 0 = literate) and self-reported household SES compared with the average family in the same community/village at that time (1 = a lot worse off than them, 2 = somewhat worse off than them, 3 = same as them, 4 = somewhat better off than them, 5 = a lot better off than them).

3.4 Efforts

We introduce a set of efforts including lifestyles and SES, which have been showed to affect bodyweight (Sturm, 2002; Wang *et al.*, 2012; Zhang *et al.*, 2020). Specifically, the lifestyles include alcohol drinking (1 = yes, 0 = no) and smoking (1 = yes, 0 = no). The respondent SES variables encompass their education (1 = high, 0 = low), current marital status (1 = married/partnered, 0 = separated/divorced/widowed/never married) and current employment status (1 = yes, 0 = no).

4. Results

4.1 Descriptive statistics

Table 1 shows the descriptive statistics for our analysis sample. The mean values of BMI and WC are 23.62 and 85.76 in 2011, respectively, and increase to 23.98 and 86.86 in 2015. The prevalence of general obesity increases from 11.8% to 13.1%, and central obesity from 61.7% to 66.2%. These results are in line with Xi *et al.*'s (2012) report of a moderate increase in general obesity but a sharper rise in abdominal obesity. Nevertheless, the increase in both general obesity and central obesity within the 5-year timeframe of our analysis is striking.

Regarding circumstances, approximately 61.8% of respondents resided in rural areas in 2011 and this proportion decreased to 57.0% in 2015. During the period 2011-2015, the trajectories of parental health status and smoking, as well as father's alcohol drinking are relatively stable. It is noteworthy that, parental illiteracy declines over the study period, from 89.5% to 86.4% for mothers, and from 63.3% to 58.2% for fathers, respectively, which reflects improvements in education over time.

As for the efforts, the prevalence of drinking alcohol increases from 38.2% in 2011 to 47% in 2015. During the same period, there is an upward trend in smoking, increasing from 38.4% to 43%. There is also a slight rise in the proportion with higher education, increasing from 10.6% in 2011 to 11.6% in 2015. The prevalence of being married or partnered is stable over the study period, with 87.8% in 2011 and 87.2% in 2015.

Table 1 Descriptive statistics

Variables	2011			2015			
	Mean/	SD	Obs.	Mean/	SD	Obs.	Mean diff.

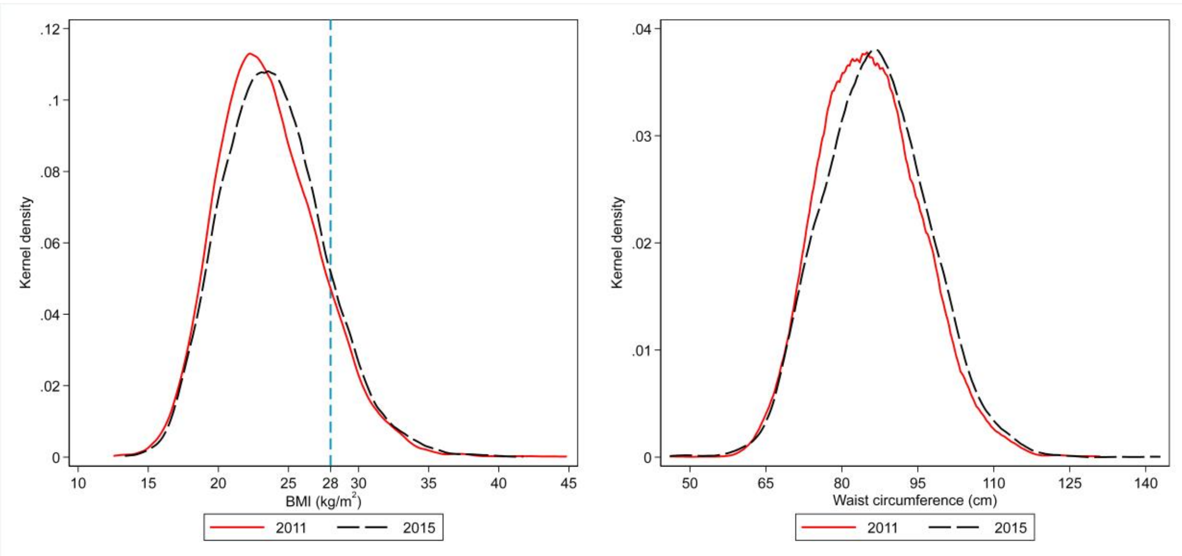
	proportions			proportions			
Bodyweight							
Body mass index (BMI, kg/m^2)	23.623	3.564	7231	23.980	3.677	9729	0.357***
Waist circumference (WC, cm)	85.760	9.810	7181	86.864	10.538	9620	1.104***
General obesity [a]	0.118	0.317	7231	0.131	0.342	9729	0.012*
Central obesity [a]	0.617	0.477	7181	0.662	0.480	9620	0.045***
Demographics							
Gender (1=male, 0=female)	0.458	0.488	7231	0.472	0.507	9729	0.014
Age	58.540	8.944	7231	60.198	9.667	9729	1.658***
Circumstances							
Urban/rural residence (1=rural, 0=urban)	0.618	0.476	7231	0.570	0.503	9729	-0.049***
War							
Born in the Japanese War era	0.164	0.363	7231	0.141	0.353	9729	-0.023***
Born in the Civil War era	0.128	0.327	7231	0.114	0.322	9729	-0.014**
Parental health status and health behaviors			7231			9729	
Parental health status	0.176	0.374		0.176	0.387		-0.0002
Mother’s smoking	0.102	0.296		0.104	0.311		0.003
Father’s smoking	0.506	0.490		0.526	0.507		0.020**
Father’s alcohol drinking	0.071	0.252		0.073	0.265		0.002
Health and nutrition conditions in childhood							
Self-reported health before age 15			7231			9729	
Much less healthy	0.050	0.213		0.045	0.211		-0.004
Somewhat less healthy	0.087	0.276		0.088	0.287		0.001
About average	0.506	0.490		0.505	0.508		-0.001
Somewhat healthier	0.186	0.381		0.189	0.398		0.003
Much healthier	0.172	0.370		0.173	0.384		0.001
Experienced hunger before age 17	0.712	0.444	7231	0.686	0.471	9729	-0.026***
Household SES in childhood							
Parental political status	0.140	0.340	7231	0.159	0.371	9729	0.019**
Mother’s education	0.895	0.300	7231	0.864	0.349	9729	-0.032***
Father’s education	0.633	0.472	7231	0.582	0.501	9729	-0.051***
Household economic status			7231			9729	
A lot worse off than them	0.230	0.413		0.217	0.419		-0.013
Somewhat worse off than them	0.153	0.353		0.154	0.367		0.001
Same as them	0.524	0.489		0.527	0.507		0.002
Somewhat better off than them	0.079	0.264		0.090	0.290		0.011*
A lot better off than them	0.013	0.113		0.012	0.111		-0.001
Efforts							
Lifestyles							
Alcohol drinking	0.382	0.476	7231	0.470	0.507	9729	0.087***
Smoking	0.384	0.477	7231	0.430	0.503	9729	0.047***
Socioeconomic status (SES)							
High education	0.106	0.301	7231	0.116	0.325	9729	0.010
Married/partnered	0.878	0.320	7231	0.872	0.340	9729	-0.007
Employed	0.705	0.447	7231	0.673	0.477	9729	-0.032***

Notes: Sampling weights are applied. The significance level is based on independent *t-tests*. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[a] We define general obesity (BMI of 24 kg/m^2 or over) and central obesity (WC ≥ 85 cm for men and WC ≥ 80 cm for women) according to the criteria of the Working Group on Obesity in China (Zhou & the Cooperative Meta-analysis Group of Working Group on Obesity in China, 2002).

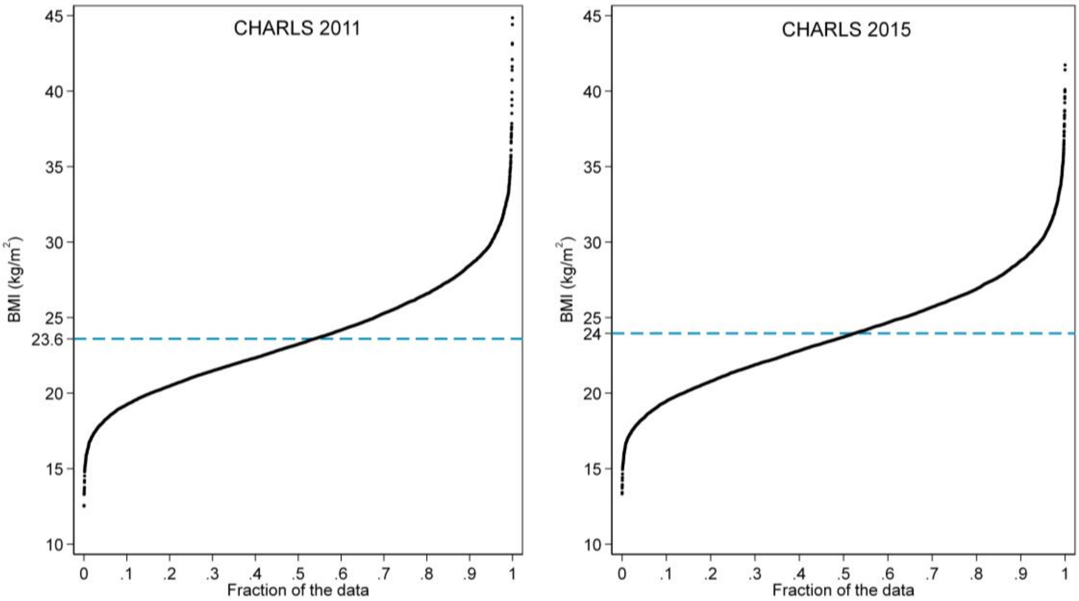
We also graph the kernel density curves for BMI and WC by survey years (see Figure 1). During the period 2011-2015, we find a clear rightward shift in BMI and WC distributions, reflecting the significant increases in both general obesity and central obesity. Figures 2 and 3 depict different quantiles of BMI and WC distributions for both survey years. The BMI value increases monotonically, from 21.0 at the 25th quantile, to 23.2 at the median and 28.5 at the 90th quantile in 2011 (from 21.4 at the 25th quantile to 23.7 at the median and 28.8 at the 90th quantile in 2015). Similarly, WC rises from 78.2 at the 25th quantile to 85 at the median and 99 at the 90th quantile in 2011 (from 79.4 at the 25th quantile to 86.5 at the median and 100.2 at the 90th quantile in 2015). Clearly, a shift of bodyweight from normal weight to obesity is discernable from the lower part to the upper tail of the distribution of bodyweight, for both BMI or WC.

Figure 1 Kernel density estimates for BMI and WC by survey year



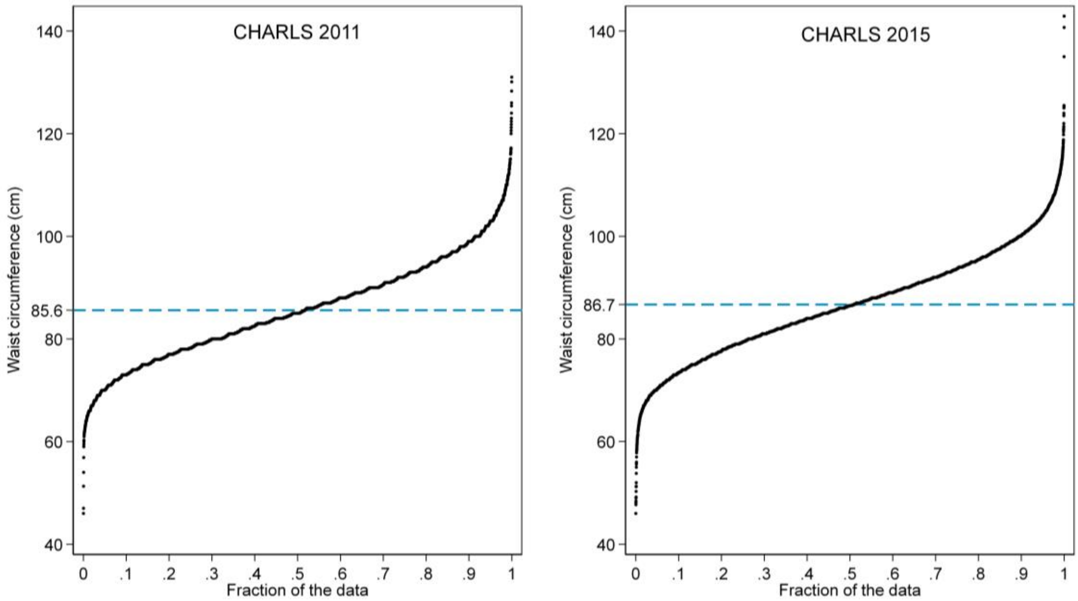
Notes: The blue dashed line is the cutoff for general obesity for Chinese adults. Two-sample *Kolmogorov-Smirnov* tests reject the null hypothesis of equality in distributions between two waves (*p-value* = 0.000 for both BMI and WC).

Figure 2 Quantiles of BMI by survey year



Notes: The blue dashed line is the mean of BMI.

Figure 3 Quantiles of WC by survey year



Notes: The blue dashed line is the mean of waist circumference.

4.2 Mean-based measures of IOp

To quantify the contributions to overall bodyweight inequality, we first perform the Shapley-Shorrocks decomposition based on the OLS regressions for BMI and WC (see

Appendix Table A.4). Table 2 and Figure 4 show the decomposition results. Circumstances are the dominant contributor to total explained inequality in BMI in both survey years, with 69.0% in 2011 and 69.4% in 2015, respectively. This also holds for WC, with 88.6% in 2011 and 92.4% in 2015. The second contributor to total explained inequality in BMI is demographics, ranging between 22.0% in 2011 and 23.9% in 2015. Nonetheless, the contribution of demographics to explained inequality in WC is negligible. The contribution of efforts to explained inequality in BMI (6.7%-9.0%) is comparable to that of explained inequality in WC (7.2%-10.8%).

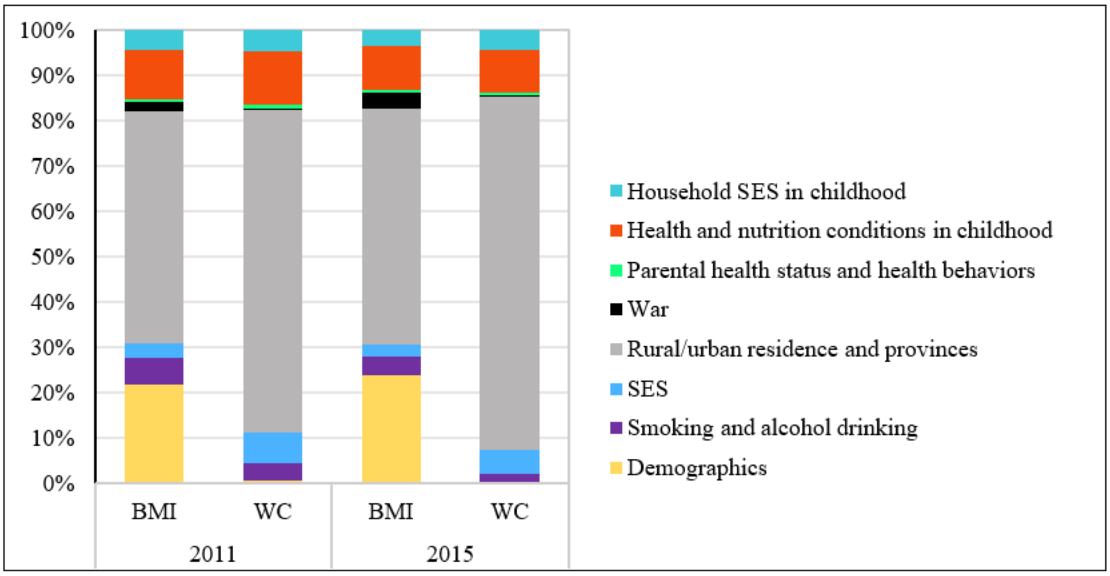
With respect to contributions of specific circumstances: rural/urban residence and province of residence are the largest contributors to IOp in bodyweight, accounting for 51.2%-52.2% for BMI, and 71.1%-78.0% for WC. In addition, the contribution of health nutrition conditions in childhood to IOp in bodyweight is non-trivial. However, the contributions of household SES, war and parental health status and health behaviors to IOp in bodyweight are relatively small. Interestingly, the contribution of circumstances to explained inequality in bodyweight rise over time, especially for WC, which might be driven by the increasing contribution of spatial factors.

Table 2 Mean-based Shapley decomposition results—BMI and WC (variance share)

	2011		2015	
	BMI	WC	BMI	WC
Explained variance	16.25%***	12.67%***	13.50%***	10.57%***
Demographics (gender and age)	21.96%***	0.62%	23.93%***	0.37%
Efforts				
Lifestyles (smoking and alcohol drinking)	5.71%***	3.73%***	4.04%***	1.85%***
SES	3.29%***	7.03%***	2.63%***	5.33%***
Total	9.00%	10.76%	6.67%	7.18%
Circumstances				
Rural/urban residence and provinces	51.18%***	71.09%***	52.20%***	77.96%***
War	2.22%	0.14%	3.57%	0.09%
Parental health status and health behaviors	0.44%	1.05%	0.55%	0.56%
Health and nutrition conditions in childhood	10.77%***	11.80%***	9.68%***	9.49%***
Household SES in childhood	4.43%**	4.53%**	3.39%*	4.34%***
Total	69.04%	88.61%	69.39%	92.44%

Notes: Sampling weights are applied. Bootstrapped standard errors in parenthesis (500 replications). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure 4 Mean-based Shapley decomposition results—BMI and WC



4.3 RIF-based measures of IOp

Table 3 and Figure 5 display the Shapley-Shorrocks decomposition based on RIF regressions. Several findings are worth mentioning: first, similar to the mean-based decomposition results, circumstances remain the largest contributor to explained inequality in bodyweight at all quantiles ranging between 66.5% at the 25th quantile and 72.8% at the 90th quantile for BMI in 2011 and from 65.5% at the 25th quantile to 71.7% at the 90th quantile in 2015. This also holds for WC. In line with mean-based decomposition results, the second contributor to explained inequality in BMI is demographics. In contrast, for both BMI and WC, the contribution of efforts is marginal over all quantiles (except for WC at the median in 2011 and the 25th quantile in 2015).

Second, regarding observed circumstances, rural/urban residence and province of residence are the dominant factors. Health and nutrition conditions in childhood come out as the second largest contributor in IOp in bodyweight. Nevertheless, the contribution of household SES in childhood to the explained inequality in weight outcomes is only marginal. This also applies to the contributions of war, parental health status and health behaviors.

Third, it is worthwhile to emphasize that, the contribution of circumstances increases towards the upper tail of the distribution of bodyweight, where individuals are most at risk of general obesity or central obesity. For instance, it increases from 87.0% at the 25th quantile to 93.1% at the median and 95.5% at the 90th quantile for WC in 2015. Particularly, among the circumstance factors, the relative contribution of health and nutrition conditions in childhood to IOp in bodyweight increases from 10.4% at the 25th quantile to 12.4% at the 90th quantile for BMI in 2011 (from 10.2% to 14.8% for WC). We still observe a similar pattern in 2015.

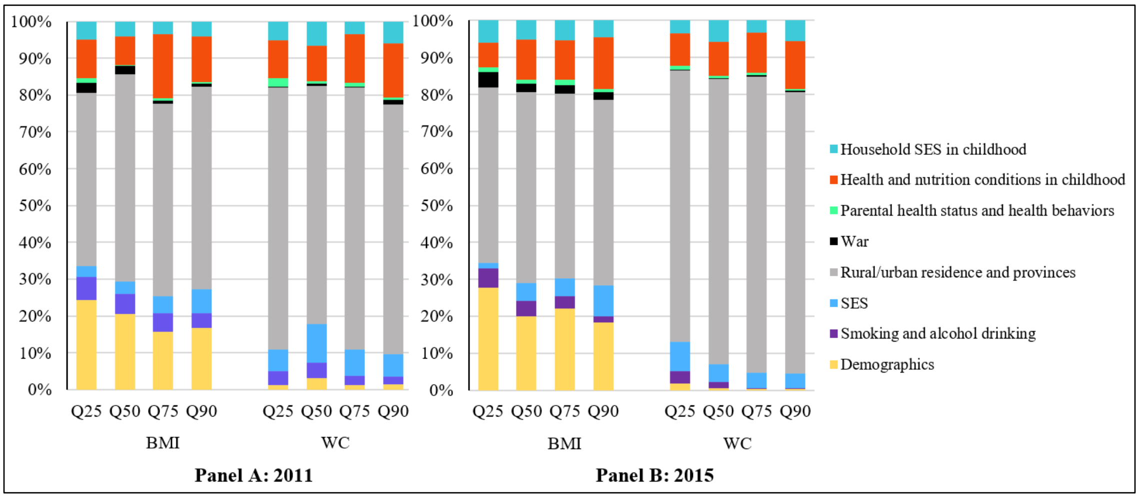
Finally, it is also interesting that the contribution of demographics to BMI declines towards the upper tail of the BMI distribution, from 24.2% at the 25th quantile to 16.7% at the 90th in 2011 (from 27.8% at the 25th quantile to 18.4% at the 90th in 2015). As for efforts, we also observe that the relative contribution of lifestyles declines towards the upper tails of both BMI and WC distributions in both waves (e.g., from 6.3% at the 25th quantile to 4.4% at the 90th for BMI, and from 3.8% at the 25th quantile to 2.0% at the 90th for WC in 2011). For SES, its contribution increases from 2.9% to 6.4% for BMI in 2011 (from 1.5% to 8.2% for BMI in 2015). In 2015, the contribution of SES for WC decreases from 7.8% to 4.0%. Such results may suggest that SES disparities in WC are less visible especially towards the upper tail of WC. One possible explanation is that with the sharp rise in the rate of central obesity, it has become more and more common for Chinese adults to be centrally obese, regardless of low or high SES groups (Lao *et al.*, 2015), i.e., the prevalence of central obesity has increased across all SES groups.

Table 3 RIF-based Shapley decomposition results—BMI and WC (variance share)

	BMI				WC			
Panel A: 2011								
Quantiles	Q25	Q50	Q75	Q90	Q25	Q50	Q75	Q90
	21.06	23.30	25.94	28.43	78.40	85.33	92.21	99.19
Explained variance	11.20%	12.05%	9.92%	5.29%	7.31%	10.20%	8.58%	5.01%
Demographics (gender and age)	24.24%***	20.44%***	15.70%***	16.71%***	1.23%	3.14%***	1.16%	1.40%
Efforts								
Lifestyles (smoking and alcohol drinking)	6.32%***	5.61%***	5.00%***	4.14%***	3.81%***	4.14%***	2.49%***	2.04%*
SES	2.92%***	3.21%***	4.70%***	6.39%***	5.77%***	10.63%***	7.16%***	6.16%***
Total	9.24%	8.82%	9.70%	10.53%	9.58%	14.77%	9.65%	8.20%
Circumstances								
Rural/urban residence and provinces	47.15%***	56.43%***	52.31%***	55.06%***	71.23%***	64.64%***	71.24%***	67.76%***
War	2.59%	2.20%	0.78%	0.77%	0.33%	0.57%	0.31%	1.23%
Parental health status and health behaviors	1.42%**	0.36%	0.54%	0.49%	2.26%	0.57%	0.96%	0.68%
Health and nutrition conditions in childhood	10.44%***	7.58%***	17.54%***	12.42%***	10.18%***	9.68%***	13.14%***	14.79%***
Household SES in childhood	4.91%**	4.18%	3.42%	4.02%	5.19%*	6.64%**	3.55%	5.93%
Total	66.51%	70.75%	74.59%	72.76%	89.19%	82.10%	89.20%	90.39%
Panel B: 2015								
Quantiles	Q25	Q50	Q75	Q90	Q25	Q50	Q75	Q90
	21.45	23.75	26.28	28.71	79.62	86.66	93.75	100.30
Explained variance	8.89%	10.12%	7.40%	4.53%	6.45%	8.12%	6.42%	4.78%
Demographics (gender and age)	27.79%***	20.02%***	22.03%***	18.40%***	1.81%**	0.48%	0.31%	0.24%
Efforts								
Lifestyles (smoking and alcohol drinking)	5.14%***	4.05%***	3.43%***	1.68%*	3.41%***	1.63%**	0.17%	0.33%
SES	1.53%**	4.91%***	4.88%***	8.20%***	7.81%***	4.88%***	4.21%***	3.96%***
Total	6.67%	8.96%	8.31%	9.88%	11.22%	6.51%	4.38%	4.29%
Circumstances								
Rural/urban residence and provinces	47.53%***	51.58%***	49.81%***	50.36%***	73.44%***	77.30%***	80.14%***	76.21%***
War	4.09%	2.48%	2.42%	1.90%	0.23%	0.13%	0.31%	0.23%
Parental health status and health behaviors	1.16%	0.99%	1.36%*	0.98%	0.96%	0.68%	0.78%	0.54%
Health and nutrition conditions in childhood	6.84%***	10.81%***	10.73%***	13.96%***	8.94%***	9.06%***	10.73%***	12.92%***
Household SES in childhood	5.91%***	5.16%***	5.35%	4.51%	3.40%	5.84%***	3.34%	5.58%
Total	65.53%	71.02%	69.67%	71.71%	86.97%	93.01%	95.30%	95.48%

Notes: Sampling weights are applied. Bootstrapped standard errors in parenthesis (500 replications). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure 5 RIF-based Shapley decomposition results—BMI and WC



Overall, we consistently find that rural/urban residence and province of residence are the leading contributors to IOp in bodyweight. Figures 6 and 7 show the mean values of BMI and WC by provinces in both waves. Generally, substantial geographical heterogeneities exist in bodyweight: in 2011, the mean BMI value ranges from 22.0 in Guangxi to 25.8 in Beijing (between 22.6 in Yunnan and 25.6 in Beijing in 2015). However, the average value of WC ranges from 81.3 in Guangxi to 93.2 in Xinjiang in 2011 (from 81.0 in Guizhou to 95.9 in Xinjiang in 2015). Such results are also in accordance with previous studies (Zhang *et al.*, 2020; Zhang *et al.*, 2019) that reveal a North-South gradient in bodyweight.

Figure 8 displays urban-rural disparities in bodyweight. In both waves, the mean BMI and WC values in the urban area are higher than these in the rural area (BMI: 24.4 versus 23.1 in 2011, 24.5 versus 23.6 in 2015; WC: 87.9 versus 84.4 in 2011, 88.5 versus 85.6 in 2015). Interestingly, during the period of 2011-2015, the urban-rural difference in both BMI and WC become smaller. Such results are consistent with previous studies, showing that although urban residents are more likely to be overweight or obese (Fang & Liang, 2017; Hou, 2008; Shen *et al.*, 2019; Wang *et al.*, 2007; Zhang, 2019) whereas the prevalence of general obesity and abdominal obesity is increasing faster in rural than in urban areas in China (Bixby *et al.*, 2019; Gong *et al.*, 2012; Nie *et al.*, 2019b; Popkin, 2019; Van de Poel *et al.*, 2009; Xi *et al.*, 2012).

Figure 6 Geographical variations of the mean BMI and WC in 2011

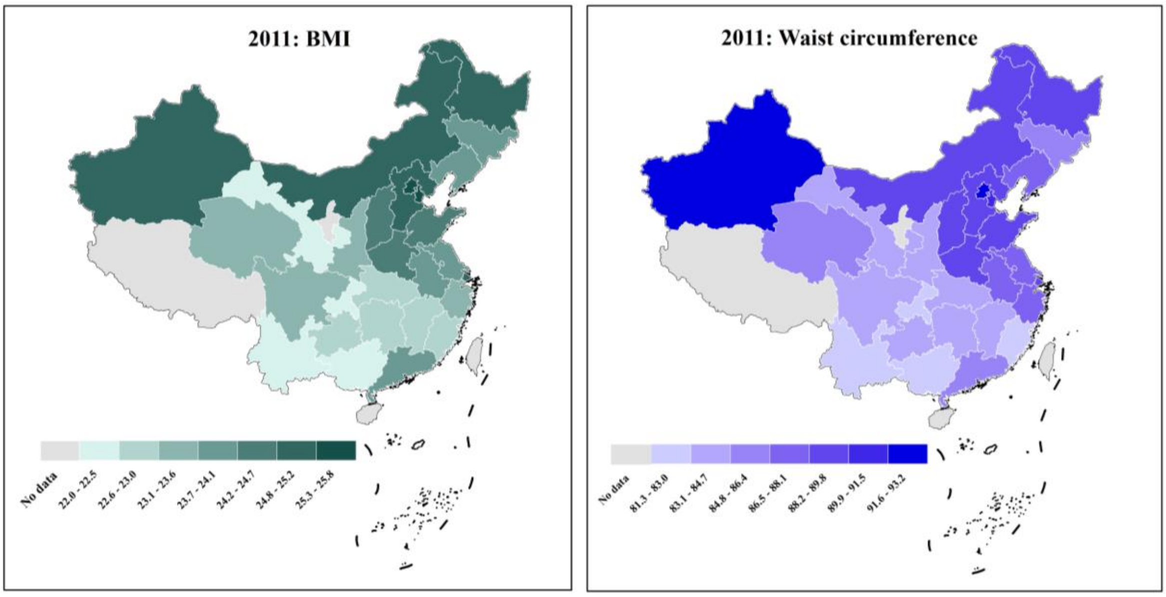


Figure 7 Geographical variations of the mean BMI and WC in 2015

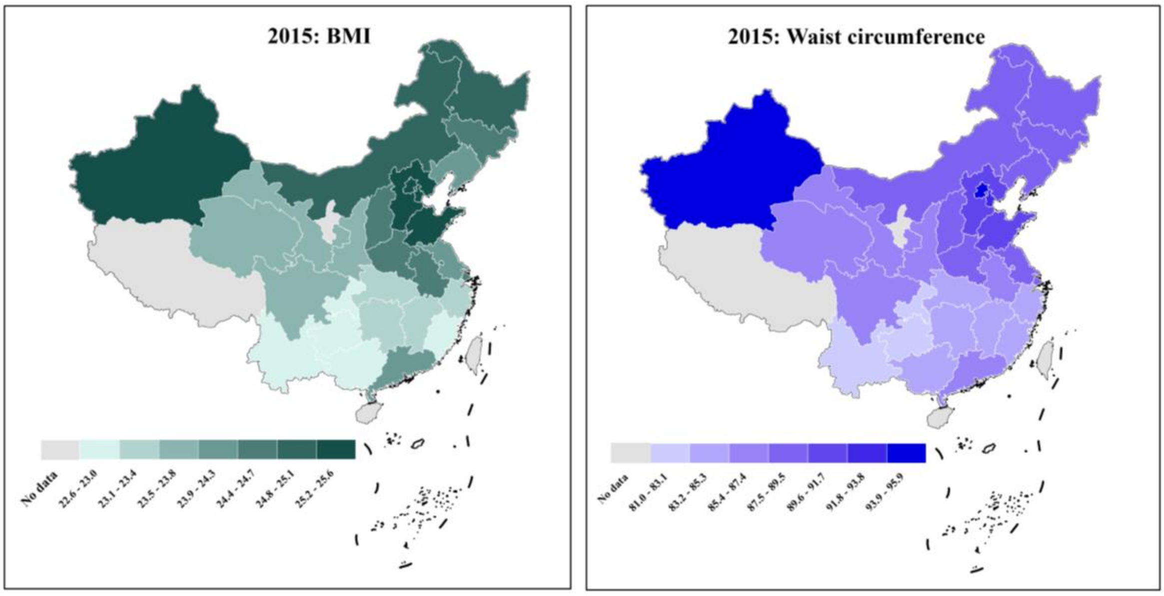
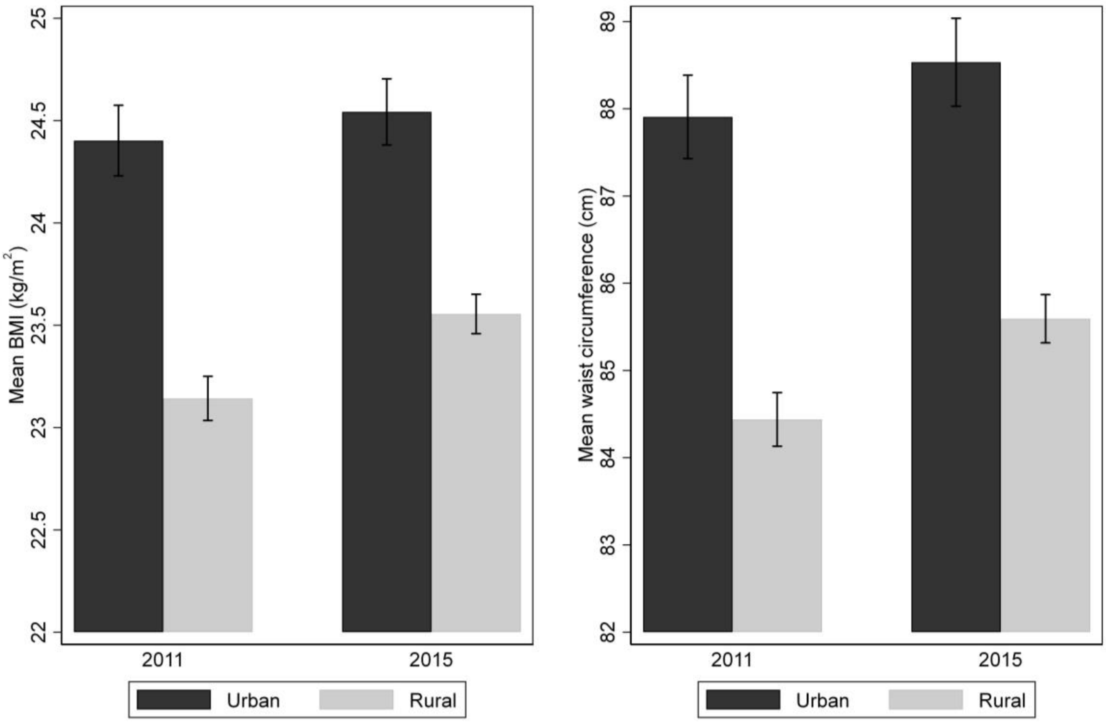


Figure 8 Mean BMI and WC by urban and rural residence in 2011 and 2015



5. Discussion

As a developing country, China is currently undergoing rapid economic, social and cultural transformations, including an accelerated pace of nutritional transition that may lead to a greatly increased burden of chronic diseases such as obesity (Xi *et al.*, 2012; Zhai *et al.*, 2009). Although many studies have investigated the associations of adulthood obesity with demographic, socioeconomic, dietary and physical activity factors in China, virtually no research examines IOp in bodyweight to disentangle legitimate and inequitable sources of bodyweight inequality, especially the contribution of inequitable circumstances. Understanding the sources of bodyweight inequality in Roemer's framework of equality of opportunity is crucial to effectively reduce bodyweight inequality. This is because if bodyweight inequality is mainly due to efforts that are under individual control, such inequality may be regarded as reasonable and acceptable. However, if inequality mainly comes from circumstances for which individuals are not held responsible, such inequality is ethically objectionable. In this regard, it is essential that differentiated health policies should be designed to mitigate unequal circumstances and compensate people for an unequal playing field.

Using nationally representative survey data from CHARLS, our study is the first attempt to provide a comprehensive analysis of IOp in bodyweight among middle-aged and elderly Chinese. We identify the relative contributions of circumstances, demographics and efforts when explaining inequality in bodyweight. Further, employing the RIF-based Shapley-Shorrocks decomposition, we quantify heterogeneous contributions of circumstances, demographics and efforts to IOp over the whole distribution of bodyweight, with a particular focus on the upper tails of the distribution of bodyweight, where individuals are at high risk of obesity.

The study yields several findings. First, we find that the obesity problem is growing in middle-aged and elderly adults in China. During such a short timeframe (from 2011 to 2015), both BMI and WC values have increased and the prevalence of general obesity and central obesity also rapidly grows. These results are in line with previous studies on the dynamics of Chinese adulthood bodyweight (Nie *et al.*, 2019a; Sun *et al.*, 2018; Zhang *et al.*, 2019). Moreover, the rate of central obesity is substantially higher than that of general obesity and the increase in central obesity is faster than that of general obesity, which is also mirrored by previous studies (e.g., Zhang *et al.*, 2019).

Second, our decomposition results reveal that the relative contribution of circumstances (i.e. IOp) to total explained inequality in bodyweight is dominant and. Among observed circumstances, the largest contribution is attributable to urban/rural residence and province of residence. Our finding of considerable geographical heterogeneities in the mean BMI and WC values echoes previous research, indicating that a striking North-South gradient exists in the prevalence of obesity (Zhang *et al.*, 2020; Zhang *et al.*, 2019). Additionally, health and nutrition conditions in childhood comes out as the second largest contributor to IOp in bodyweight. This may imply that health status and nutrition conditions in childhood play a vital role in adult bodyweight, and disparities of these early-life circumstances may greatly contribute to adult bodyweight inequality. To some extent, our results accord with "*life course epidemiology*" studies (Kuh & Ben-Shlomo, 2016), showing that early social and biological factors affect adults health, ageing and disease risk. A growing number of studies confirm the early life origins of adulthood chronic diseases and function (e.g., Adhvaryu *et al.*, 2019; Briana & Malamitsi-Puchner, 2018; Hoffman *et al.*, 2019). Particularly, metabolic programming by early nutrition conditions could partially explain the developments of later obesity and adult diseases (Liu *et al.*, 2019; Rolland-Cachera *et al.*, 2016).

Third and more importantly, results from the RIF-based Shapley decomposition reveal heterogeneities in the contributions of observed circumstances, efforts and demographics to IOp in individual bodyweight. It is noteworthy that the relative contribution of observed circumstances to total explained inequality in bodyweight increases towards the upper tails of both BMI and WC distributions. In particular, regarding circumstances, the contribution of health and nutrition conditions in childhood to IOp in bodyweight increases towards the upper tail of BMI and WC, where individuals are most at risk of obesity. However, the contribution of biological factors (gender and age) declines at the high quantiles, especially for BMI. As for the efforts, the contribution of lifestyles declines towards the upper tails of both BMI and WC distributions in 2011 and 2015. This may imply that the conventional mean-based Shapley-Shorrocks decomposition would mask the heterogeneous contributions of measured circumstances such as regions/provinces, health and nutrition conditions in childhood to IOp in bodyweight outcomes. More importantly, our unconditional quantile-based decomposition supports the conclusion that obesity is not simply a matter of demographic (age and gender) inequalities, as our set of spatial and health and nutrition conditions in childhood circumstances become much more relevant towards the right tails of bodyweight distribution, where clinical concerns are focused.

Our findings have potential policy implications. In addition to preventing obesity among young people, our study may suggest that effective public health strategies mitigating adiposity in the middle-aged and the elderly should be developed. Thus, there is an urgent need for public health interventions to respond to obesity at all ages (Schooling *et al.*, 2006). Also, given that observed circumstances play a dominant role in explained inequality in bodyweight, public health policies should pay special attention to unreasonable circumstances disparities, especially urban and rural residence and province of residence to effectively mitigate obesity inequality. Marked provincial diversity in obesity prevalence indicates health equality remains a challenge in China. Improving health equity has long been a government priority, and *Healthy China 2030* (Zhou *et al.*, 2019) includes justice and equity as one of its four core principles. Thus tailored, province-specific policy development and interventions are urgently needed to lessen major risk factors (e.g. obesity) of chronic diseases in each province. Finally, various health programs and interventions aiming at improving childhood health and nutrition conditions are also desirable to achieve health equity in the long term.

Acknowledgements

Andrew Jones acknowledges funding from the Leverhulme Trust Major Research Fellowship (grant number MRF-2016-004). Peng Nie acknowledges funding from National Natural Science Foundation of China (grant number 71804142) and the Start-up Fund for Young Talent Support Plan (grant number 113055107001). The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors, and all errors are our own.

References

Aaberge, R., Mogstad, M., & Peragine, V. (2011). Measuring long-term inequality of opportunity. *Journal of Public Economics, 95*(3-4), 193-204.

Adhvaryu, A., Fenske, J., & Nyshadham, A. (2019). Early life circumstance and adult mental health. *Journal of Political Economy, 127*(4), 1516-1549.

Aizawa, T., & Helble, M. (2017). Socioeconomic inequality in excessive body weight in Indonesia. *Economics & Human Biology, 27*, 315-327.

Alesina, A., & Angeletos, G. M. (2005). Fairness and redistribution. *American Economic Review, 95*(4), 960-980.

Almås, I., Cappelen, A. W., Lind, J. T., Sørensen, E. Ø., & Tungodden, B. (2011). Measuring unfair (in)equality. *Journal of Public Economics, 95*(7-8), 488-499.

Alvarado, B. E., Zunzunegui, M. V., Béland, F., Bamvita, J. M., & Sciences, M. (2008). Life course social and health conditions linked to frailty in Latin American older men and women. *The Journals of Gerontology Series A: Biological Sciences, 63*(12), 1399-1406.

Asadullah, M. N., & Yalonetzky, G. (2012). Inequality of educational opportunity in India: Changes over time and across states. *World Development, 40*(6), 1151-1163.

Baeten, S., Van Ourti, T., & van Doorslaer, E. (2013). Rising inequalities in income and health in China: Who is left behind? *Journal of Health Economics, 32*(6), 1214-1229.

Ball, K., Mishra, G., & Crawford, D. (2002). Which aspects of socioeconomic status are related to obesity among men and women? *International Journal of Obesity, 26*(4), 559-565.

Barker, D. J. P. (1994). *Mothers, babies and disease in later life*. London: British Medical Journal Publishing Group.

Baum, C. L., & Ruhm, C. J. (2009). Age, socioeconomic status and obesity growth. *Journal of Health Economics, 28*(3), 635-648.

Bilger, M., Kruger, E. J., & Finkelstein, E. A. (2017). Measuring socioeconomic inequality in obesity: Looking beyond the obesity threshold. *Health Economics, 26*(8), 1052-1066.

Bixby, H., Bentham, J., Zhou, B., Di Cesare, M., Paciorek, C. J., Bennett, J. E., *et al.* (2019). Rising rural body-mass index is the main driver of the global obesity epidemic in adults. *Nature, 569*(7755), 260-264.

Briana, D. D., & Malamitsi-Puchner, A. (2018). Developmental origins of adult health and disease: The metabolic role of BDNF from early life to adulthood. *Metabolism, 81*, 45-51.

Bricard, D., Jusot, F., Trannoy, A., & Tubeuf, S. (2013). Inequality of opportunities in health and the principle of natural reward: Evidence from European countries. In P. R. Dias & O. O'Donnell (Eds.), *Health and Inequality* (Vol. 21, pp. 335-370): Emerald Group Publishing Limited.

Burkhauser, R. V., & Cawley, J. (2008). Beyond BMI: The value of more accurate measures of fatness and obesity in social science research. *Journal of Health Economics, 27*(2), 519-529.

Carrieri, V., Davillas, A., & Jones, A. M. (2020). A latent class approach to inequity in health using biomarker data. *Health Economics, 29*(7), 808-826.

Carrieri, V., & Jones, A. M. (2018). Inequality of opportunity in health: A decomposition-based approach. *Health Economics, 27*(12), 1981-1995.

Checchi, D., & Peragine, V. (2010). Inequality of opportunity in Italy. *The Journal of Economic Inequality, 8*(4), 429-450.

Contoyannis, P., & Wildman, J. (2007). Using relative distributions to investigate the body mass index in England and Canada. *Health Economics, 16*(9), 929-944.

Corak, M. (2013). Income inequality, equality of opportunity, and intergenerational mobility. *Journal of Economic Perspectives, 27*(3), 79-102.

Cui, H., Smith, J. P., & Zhao, Y. (2020). Early-life deprivation and health outcomes in adulthood: Evidence from childhood hunger episodes of middle-aged and elderly Chinese. *Journal of Development Economics, 143*, 102417.

Davillas, A., & Jones, A. M. (2020a). Ex ante inequality of opportunity in health, decomposition and distributional analysis of biomarkers. *Journal of Health Economics, 69*, 102251.

Davillas, A., & Jones, A. M. (2020b). Regional inequalities in adiposity in England: Distributional analysis of the contribution of individual-level characteristics and the small area obesogenic

environment. *Economics & Human Biology, 38*, 100887.
Department of Health Public Health Research Consortium, Law, C., Power, C., Graham, H., & Merrick, D. (2007). Obesity and health inequalities. *Obesity Reviews, 8*(s1), 19-22.
Deuchert, E., Cabus, S., & Tafreschi, D. (2014). A short note on economic development and socioeconomic inequality in female body weight. *Health Economics, 23*(7), 861-869.
Du, T., Sun, X., Yin, P., Huo, R., Ni, C., & Yu, X. (2013). Increasing trends in central obesity among Chinese adults with normal body mass index, 1993–2009. *BMC Public Health, 13*, 327.
Dykes, J., Brunner, E. J., Martikainen, P. T., & Wardle, J. (2004). Socioeconomic gradient in body size and obesity among women: The role of dietary restraint, disinhibition and hunger in the Whitehall II study. *International Journal of Obesity, 28*(2), 262-268.
Fang, C., & Liang, Y. (2017). Social disparities in body mass index (BMI) trajectories among Chinese adults in 1991–2011. *International Journal for Equity in Health, 16*, 146.
Ferreira, F. H. G., & Gignoux, J. (2011). The measurement of inequality of opportunity : Theory and an application to Latin America. *Review of Income and Wealth, 57*(4), 622-657.
Ferreira, F. H. G., & Gignoux, J. (2014). The measurement of educational inequality: Achievement and opportunity. *The World Bank Economic Review, 28*(2), 210-246.
Ferreira, F. H. G., Gignoux, J., & Aran, M. (2011). Measuring inequality of opportunity with imperfect data: The case of Turkey. *The Journal of Economic Inequality, 9*(4), 651-680.
Firpo, S., Fortin, N. M., & Lemieux, T. (2009). Unconditional quantile regressions. *Econometrica, 77*(3), 953-973.
Gamboa, L. F., & Waltenberg, F. D. (2012). Inequality of opportunity for educational achievement in Latin America: Evidence from PISA 2006–2009. *Economics of Education Review, 31*(5), 694-708.
Giskes, K., van Lenthe, F. J., Turrell, G., Kamphuis, C. B. M., Brug, J., & Mackenbach, J. P. (2008). Socioeconomic position at different stages of the life course and its influence on body weight and weight gain in adulthood: A longitudinal study with 13-year follow-up. *Obesity, 16*(6), 1377-1381.
Gong, P., Liang, S., Carlton, E. J., Jiang, Q., Wu, J., Wang, L.*, et al.* (2012). Urbanisation and health in China. *The Lancet, 379*(9818), 843-852.
Haslam, D. W., & James, W. P. T. (2005). Obesity. *The Lancet, 366*(9492), 1197-1209.
Hill, J. O., & Peters, J. C. (1998). Environmental contributions to the obesity epidemic. *Science, 280*(5368), 1371.
Hoffman, D. J., Bigoni, A., & Carrieri, A. (2019). Epidemiology of early nutrition and adult health: Metabolic adaptations and body composition. In A. Vaiserman (Ed.), *Early Life Origins of Ageing and Longevity* (pp. 3-22). Cham: Springer International Publishing.
Hoffmann, R., Eikemo, T. A., Kulhánová, I., Kulik, M. C., Looman, C., Menvielle, G.*, et al.* (2015). Obesity and the potential reduction of social inequalities in mortality: Evidence from 21 European populations. *European Journal of Public Health, 25*(5), 849-856.
Hou, X. (2008). Urban-rural disparity of overweight, hypertension, undiagnosed hypertension, and untreated hypertension in China. *Asia Pacific Journal of Public Health, 20*(2), 159-169.
Jusot, F., Tubeuf, S., & Trannoy, A. (2013). Circumstances and efforts: How important is their

correlation for the measurement of inequality of opportunity in health? *Health Economics, 22*(12), 1470-1495.

Kanbur, R., & Wagstaff, A. (2016). How useful is inequality of opportunity as a policy construct. In K. Basu & J. Stiglitz (Eds.), *Inequality and Growth: Patterns and Policy* (Vol. 1, pp. 131-148). London: Palgrave Macmillan.

Kuh, D., & Ben-Shlomo, Y. (2016). Early life origins of adult health and aging. In L. K. George & K. F. Ferraro (Eds.), *Handbook of Aging and the Social Sciences (Eighth Edition)* (pp. 101-122). San Diego: Academic Press.

Kulhánová, I., Menvielle, G., Hoffmann, R., Eikemo, T. A., Kulik, M. C., Toch-Marquardt, M., *et al.* (2016). The role of three lifestyle risk factors in reducing educational differences in ischaemic heart disease mortality in Europe. *European Journal of Public Health, 27*(2), 203-210.

Lao, X. Q., Ma, W., Chung, R. Y. N., Zhang, Y., Xu, Y., Xu, X., *et al.* (2015). The diminishing socioeconomic disparity in obesity in a Chinese population with rapid economic development: Analysis of serial cross-sectional health survey data 2002–2010. *BMC Public Health, 15*, 1282.

Liu, D., Yu, D., Zhao, L., Fang, H., Zhang, J., Wang, J., *et al.* (2019). Exposure to famine during early life and abdominal obesity in adulthood: Findings from the great Chinese famine during 1959–1961. *Nutrients, 11*(4), 903.

Liu, X., Wu, W., Mao, Z., Huo, W., Tu, R., Qian, X., *et al.* (2018). Prevalence and influencing factors of overweight and obesity in a Chinese rural population: The Henan rural cohort study. *Scientific Reports, 8*, 13101.

Madden, D. (2012). A profile of obesity in Ireland, 2002–2007. *Journal of the Royal Statistical Society: Series A (Statistics in Society), 175*(4), 893-914.

Marmot, M., Friel, S., Bell, R., Houweling, T. A. J., & Taylor, S. (2008). Closing the gap in a generation: Health equity through action on the social determinants of health. *The Lancet, 372*(9650), 1661-1669.

Marrero, G. A., & Rodríguez, J. G. (2013). Inequality of opportunity and growth. *Journal of Development Economics, 104*, 107-122.

Matheson, A. (2016). Reducing social inequalities in obesity: Complexity and power relationships. *Journal of Public Health, 38*(4), 826-829.

Monda, K. L., Adair, L. S., Zhai, F., & Popkin, B. M. (2008). Longitudinal relationships between occupational and domestic physical activity patterns and body weight in China. *European Journal of Clinical Nutrition, 62*(11), 1318-1325.

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., *et al.* (2014a). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet, 384*(9945), 766-781.

Ng, S. W., Howard, A. G., Wang, H. J., Su, C., & Zhang, B. (2014b). The physical activity transition among adults in China: 1991–2011. *Obesity Reviews, 15*(S1), 27-36.

Nie, P., Ding, L., & Sousa-Poza, A. (2019a). Decomposing adult obesity trends in China (1991–2011). *Economics & Human Biology, 34*, 5-15.

Nie, P., Ding, L., & Sousa-Poza, A. (2019b). Obesity inequality and the changing shape of the

bodyweight distribution in China. *China Economic Review, 58*, 101348.
OECD. (2019). *The heavy burden of obesity: The economics of prevention*. Paris: OECD.
Peeters, A., & Backholer, K. (2015). Reducing socioeconomic inequalities in obesity: The role of population prevention. *The Lancet Diabetes & Endocrinology, 3*(11), 838-840.
Popkin, B. M. (2008). Will China's nutrition transition overwhelm its health care system and slow economic growth? *Health Affairs, 27*(4), 1064-1076.
Popkin, B. M. (2019). Rural areas drive the global weight gain. *Nature, 569*(7755), 200-201.
Popkin, B. M., Paeratakul, S., Ge, K., & Zhai, F. (1995). Body weight patterns among the Chinese: Results from the 1989 and 1991 China Health and Nutrition Surveys. *American Journal of Public Health, 85*(5), 690-694.
Qin, X., & Pan, J. (2016). The medical cost attributable to obesity and overweight in China: Estimation based on longitudinal surveys. *Health Economics, 25*(10), 1291-1311.
Roemer, J. E. (1998). *Equality of opportunity*. Boston: Havard University Press.
Roemer, J. E. (2002). Equality of opportunity: A progress report. *Social Choice and Welfare, 19*(2), 455-471.
Roemer, J. E., & Trannoy, A. (2015). Equality of opportunity. In A. B. Atkinson & F. Bourguignon (Eds.), *Handbook of Income Distribution* (Vol. 2, pp. 217-300): Elsevier.
Roemer, J. E., & Trannoy, A. (2016). Equality of Opportunity: Theory and Measurement. *Journal of Economic Literature, 54*(4), 1288-1332.
Rolland-Cachera, M. F., Akrout, M., & Péneau, S. (2016). Nutrient intakes in early life and risk of obesity. *International Journal of Environmental Research and Public Health, 13*(6), 564.
Rosa Dias, P. (2009). Inequality of opportunity in health: Evidence from a UK cohort study. *Health Economics, 18*(9), 1057-1074.
Salas-Ortiz, A. (2020). Understanding the role of inequality of opportunity in body mass index and waist circumference among Mexican. Health, Econometrics and Data Group (HEDG) Working Papers 20/04, HEDG. Department of Economics, University of York.
Schooling, C. M., Lam, T. H., Li, Z. B., Ho, S. Y., Chan, W. M., Ho, K. S., *et al.* (2006). Obesity, physical activity, and mortality in a prospective Chinese elderly cohort. *Archives of Internal Medicine, 166*(14), 1498-1504.
Shen, C., Zhou, Z., Lai, S., Tao, X., Zhao, D., Dong, W., *et al.* (2019). Urban-rural-specific trend in prevalence of general and central obesity, and association with hypertension in Chinese adults, aged 18-65 years. *BMC Public Health, 19*, 661.
Shields, M., Gorber, S. C., Janssen, I., & Tremblay, M. S. (2011). Obesity estimates for children based on parent-reported versus direct measures. *Health Reports, 22*(3), 47-58.
Shorrocks, A. F. (1982). Inequality decomposition by factor components. *Econometrica, 50*(1), 193-211.
Shorrocks, A. F. (2013). Decomposition procedures for distributional analysis: A unified framework based on the Shapley value. *Journal of Economic Inequality, 11*(1), 99-126.
Smith, J. P., Strauss, J., & Zhao, Y. (2014). Healthy aging in China. *The Journal of the Economics of Ageing, 4*, 37-43.
Sturm, R. (2002). The effects of obesity, smoking, and drinking on medical problems and costs. *Health Affairs, 21*(2), 245-253.
Sun, J., Zhou, W., Gu, T., Zhu, D., & Bi, Y. (2018). A retrospective study on association between

obesity and cardiovascular risk diseases with aging in Chinese adults. *Scientific Reports, 8*, 5806.

Tang, S., Meng, Q., Chen, L., Bekedam, H., Evans, T., & Whitehead, M. (2008). Tackling the challenges to health equity in China. *The Lancet, 372*(9648), 1493-1501.

The GBD 2015 Obesity Collaborators. (2017). Health effects of overweight and obesity in 195 countries over 25 years. *New England Journal of Medicine, 377*(1), 13-27.

Trannoy, A., Tubeuf, S., Jusot, F., & Devaux, M. (2010). Inequality of opportunities in health in France: A first pass. *Health Economics, 19*(8), 921-938.

Van de Poel, E., O'Donnell, O., & Van Doorslaer, E. (2009). Urbanization and the spread of diseases of affluence in China. *Economics & Human Biology, 7*(2), 200-216.

Waltenberg, F. D., & Vandenberghe, V. (2007). What does it take to achieve equality of opportunity in education? *Economics of Education Review, 26*(6), 709-723.

Wang, H., Wang, J., Liu, M. M., Wang, D., Liu, Y. Q., Zhao, Y.*, et al.* (2012). Epidemiology of general obesity, abdominal obesity and related risk factors in urban adults from 33 communities of northeast China: The CHPSNE study. *BMC Public Health, 12*, 967.

Wang, Y., Mi, J., Shan, X. Y., Wang, Q. J., & Ge, K. Y. (2007). Is China facing an obesity epidemic and the consequences? The trends in obesity and chronic disease in China. *International Journal of Obesity, 31*(1), 177-188.

Wang, Y., Sun, M., & Yang, Y. (2019a). *China blue paper on obesity prevention and control*. Beijing: Peking University Medical Publisher.

Wang, Y., Xue, H., Sun, M., Zhu, X., Zhao, L., & Yang, Y. (2019b). Prevention and control of obesity in China. *The Lancet Global Health, 7*(9), e1166-e1167.

Wendelspiess Chávez Juárez, F., & Soloaga, I. (2014). Iop: Estimating ex-ante inequality of opportunity. *The Stata Journal, 14*(4), 830-846.

WHO. (2008). Closing the gap in a generation: Health equity through action on the social determinants of health: Final report of the Commission on Social Determinants of Health. Geneva: World Health Organization.

WHO. (2015). China country assessment report on ageing and health. Geneva: World Health Organization.

WHO. (2018). The life-course approach: From theory to practice case stories from two small countries in Europe. Copenhagen: WHO Regional Office for Europe.

WHO. (2020). Obesity and overweight. Geneva: World Health Organization.

World Population Review. (2019). *Life expectancy by country 2019*. Retrieved from https://worldpopulationreview.com/countries/life-expectancy-by-country/

Xi, B., Liang, Y., He, T., Reilly, K. H., Hu, Y., Wang, Q.*, et al.* (2012). Secular trends in the prevalence of general and abdominal obesity among Chinese adults, 1993–2009. *Obesity Reviews, 13*(3), 287-296.

Yan, B., Chen, X., & Gill, T. M. (2020). Health inequality among Chinese older adults: The role of childhood circumstances. *The Journal of the Economics of Ageing, 17*, 100237.

Zhai, F., Wang, H., Du, S., He, Y., Wang, Z., Ge, K.*, et al.* (2009). Prospective study on nutrition transition in China. *Nutrition Reviews, 67*(s1), S56-S61.

Zhang, L., Wang, Z., Wang, X., Chen, Z., Shao, L., Tian, Y.*, et al.* (2020). Prevalence of overweight and obesity in China: Results from a cross-sectional study of 441 thousand adults, 2012–2015. *Obesity Research & Clinical Practice, 14*(2), 119-126.

Zhang, N. (2019). Urban–rural disparities in cardiovascular disease risks among middle-aged and older Chinese: Two decades of urbanisation. *Ageing and Society*, 1-23.

Zhang, X., Zhang, M., Zhao, Z., Huang, Z., Deng, Q., Li, Y., *et al.* (2019). Geographic variation in prevalence of adult obesity in China: Results from the 2013–2014 national chronic disease and risk factor surveillance. *Annals of Internal Medicine, 172*(4), 291-293.

Zhao, W., Zhai, Y., Hu, J., Wang, J., Yang, Z., Kong, L., *et al.* (2008). Economic burden of obesity-related chronic diseases in Mainland China. *Obesity Reviews, 9*(s1), 62-67.

Zhao, Y., Hu, Y., Smith, J. P., Strauss, J., & Yang, G. (2014). Cohort profile: The China Health and Retirement Longitudinal Study (CHARLS). *International Journal of Epidemiology, 43*(1), 61-68.

Zhou, B. F., & the Cooperative Meta-analysis Group of Working Group on Obesity in China. (2002). Predictive values of body mass index and waist circumference for risk factors of certain related diseases in Chinese adults: Study on optimal cut-off points of body mass index and waist circumference in Chinese adults. *Asia Pacific Journal of Clinical Nutrition, 11*(s8), S685-S693.

Zhou, M., Wang, H., Zeng, X., Yin, P., Zhu, J., Chen, W., *et al.* (2019). Mortality, morbidity, and risk factors in China and its provinces, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. *The Lancet, 394*(10204), 1145-1158.

Appendix:

Table A.1 Statistical tests to compare the full sample and matched sample

Variables	2011			2015		
	Matched	Full sample	Mean diff.	Matched	Full sample	Mean diff.
Gender	0.466	0.472	0.006	0.470	0.471	0.001
Age	58.98	59.15	0.171	60.63	60.51	-0.117
Rural/urban residence	0.656	0.636	-0.021***	0.633	0.621	-0.012
Born in the Japanese War era	0.170	0.169	-0.001	0.149	0.147	-0.002
Born in the Civil War era	0.131	0.127	-0.003	0.118	0.117	-0.002
Alcohol drinking	0.389	0.391	0.001	0.461	0.462	0.001
Smoking	0.393	0.396	0.004	0.435	0.435	-0.001
Education	0.100	0.107	0.007	0.093	0.097	0.004
Marital status	0.881	0.876	-0.005	0.865	0.866	0.001
Employment status	0.712	0.691	-0.021***	0.688	0.685	-0.003

Notes: The matched sample is observations from the full sample that can be linked with the 2014 CHARLS Life History Survey. The significance is based on independent *t-tests*. *** $p < 0.01$.

Table A.2 Statistical tests of demographics, efforts and circumstances variables

Variables	2011			2015		
	Matched sample with no missing demographics, efforts and circumstances	Matched sample	Mean diff.	Matched sample with no missing demographics, efforts and circumstances	Matched sample	Mean diff.
Gender	0.467	0.466	-0.001	0.472	0.470	-0.002
Age	58.36	58.98	0.625***	60.18	60.63	0.448***
Alcohol dinking	0.393	0.389	-0.004	0.466	0.461	-0.004
Smoking	0.391	0.393	0.002	0.435	0.435	0.0001
High education	0.105	0.100	-0.006	0.101	0.093	-0.007
Married/partnered	0.894	0.881	-0.013***	0.875	0.865	-0.010
Employed	0.725	0.712	-0.013	0.697	0.688	-0.010
Urban/rural residence	0.654	0.656	0.003	0.634	0.633	-0.001
Born in the Japanese War era	0.161	0.170	0.009	0.141	0.149	0.008
Born in the Civil War era	0.130	0.131	0.001	0.117	0.118	0.001
Parental health status	0.186	0.195	0.010	0.189	0.198	0.009
Mother's smoking	0.105	0.106	0.001	0.110	0.110	-0.0004
Father's smoking	0.503	0.500	-0.003	0.522	0.520	-0.002
Father's alcohol drinking	0.070	0.072	0.002	0.072	0.073	0.001
Self-reported health before age 15						
Much less healthy	0.047	0.052	0.005	0.047	0.052	0.005
Somewhat less healthy	0.078	0.079	0.001	0.079	0.081	0.001
About average	0.518	0.520	0.002	0.510	0.512	0.002
Somewhat healthier	0.186	0.183	-0.003	0.190	0.186	-0.003
Much healthier	0.170	0.165	-0.006	0.174	0.169	-0.004
Experienced hunger before age 17	0.719	0.720	0.001	0.695	0.697	0.001
Parental political status	0.137	0.129	-0.008	0.146	0.139	-0.008
Mother's education	0.900	0.906	0.006	0.875	0.881	0.006
Father's education	0.632	0.644	0.012	0.597	0.609	0.012
Household SES in childhood						
A lot worse off than them	0.227	0.246	0.019***	0.227	0.245	0.017***
Somewhat worse off than them	0.158	0.159	0.001	0.161	0.161	0.00001
Same as them	0.526	0.509	-0.017	0.521	0.506	-0.015
Somewhat better off than them	0.079	0.076	-0.003	0.083	0.080	-0.003
A lot better off than them	0.010	0.009	-0.001	0.009	0.009	0.0004

Notes: The matched sample is observations from the full sample that can be linked with the 2014 CHARLS Life History Survey. The significance is based on independent *t-tests*. *** $p < 0.01$.

Table A.3 Statistical tests (*p-values*) between the matched sample with no missing demographics, efforts and circumstances and analytical sample

Variables	2011		2015	
	BMI	WC	BMI	WC
Gender	0.487	0.545	0.988	0.948
Age	0.306	0.224	0.653	0.583
Alcohol dinking	0.829	0.782	0.969	0.924
Smoking	0.802	0.822	0.934	0.985
High education	0.140	0.093	0.911	0.861
Married/partnered	0.465	0.424	0.803	0.829
Employed	0.263	0.321	0.523	0.940
Urban/rural residence	0.175	0.099	0.771	0.992
Born in the Japanese War era	0.486	0.469	0.933	0.955
Born in the Civil War era	0.474	0.449	0.878	0.969
Parental health status	0.892	0.904	0.913	0.719
Mother's smoking	0.815	0.919	0.994	0.969
Father's smoking	0.920	0.990	0.981	0.845
Father's alcohol drinking	0.908	0.763	0.883	0.961
Self-reported health before age 15				
Much less healthy	0.749	0.537	0.972	0.866
Somewhat less healthy	0.821	0.670	0.932	0.736
About average	0.932	0.957	0.838	0.998
Somewhat healthier	0.992	0.950	0.959	0.870
Much healthier	0.902	0.965	0.892	0.867
Experienced hunger before age 17	0.501	0.562	0.982	0.804
Parental political status	0.571	0.674	0.983	0.886
Mother's education	0.367	0.349	0.993	0.983
Father's education	0.919	0.854	0.972	0.821
Household SES in childhood				
A lot worse off than them	0.411	0.382	0.988	0.834
Somewhat worse off than them	0.954	0.969	0.922	0.946
Same as them	0.842	0.914	0.948	0.849
Somewhat better off than them	0.534	0.430	0.969	0.906
A lot better off than them	0.285	0.351	0.933	0.870

Notes: *p* values are reported.

Table A.4 OLS regressions for BMI and WC among Chinese adults aged 45+

	2011		2015	
	BMI	WC	BMI	WC
Male	-0.862***	-0.521**	-0.773***	-0.234
	(0.090)	(0.256)	(0.085)	(0.261)
Age	-0.060***	0.019	-0.060***	-0.012
	(0.007)	(0.022)	(0.007)	(0.021)
Residuals				
Alcohol drinking	0.038	0.217	0.064	0.663**
	(0.107)	(0.316)	(0.099)	(0.292)
Smoking	-0.952***	-1.912***	-0.774***	-1.080***
	(0.127)	(0.371)	(0.133)	(0.404)
High education	-0.006	-0.599	0.170	0.687
	(0.155)	(0.439)	(0.148)	(0.430)
Married/partnered	0.344**	1.146**	0.273**	0.980***
	(0.148)	(0.468)	(0.118)	(0.365)
Employed	-0.657***	-2.279***	-0.510***	-1.730***
	(0.119)	(0.330)	(0.110)	(0.324)
Rural	-1.170***	-3.303***	-0.975***	-2.621***
	(0.104)	(0.292)	(0.092)	(0.266)
Born in the Japanese War era	0.154	0.059	0.050	-0.083
	(0.164)	(0.470)	(0.154)	(0.474)
Born in the Civil War era	0.238*	0.426	0.098	0.093
	(0.137)	(0.396)	(0.133)	(0.419)
Parental health status	0.078	-0.294	0.011	0.022
	(0.117)	(0.320)	(0.105)	(0.317)
Mother's smoking	-0.331**	-0.102	-0.274**	-0.716*
	(0.149)	(0.447)	(0.133)	(0.408)
Father's smoking	0.094	0.278	0.134	0.342
	(0.094)	(0.266)	(0.093)	(0.284)
Father's alcohol drinking	0.218	0.813	-0.034	-0.225
	(0.176)	(0.526)	(0.185)	(0.579)
Self-reported health before age 15				
Somewhat less healthy	-0.173	-0.080	-0.211	1.167
	(0.307)	(0.730)	(0.290)	(0.820)
About average	0.282	1.034*	0.245	1.498***
	(0.270)	(0.576)	(0.229)	(0.515)
Somewhat healthier	0.927***	2.707***	0.717***	2.691***
	(0.281)	(0.650)	(0.239)	(0.559)
Much healthier	1.227***	3.168***	1.012***	3.418***
	(0.284)	(0.634)	(0.247)	(0.596)
Experienced hunger before 17	0.021	-0.041	0.079	0.327
	(0.106)	(0.299)	(0.098)	(0.291)
Parental political status	0.083	0.059	0.013	0.203
	(0.132)	(0.382)	(0.128)	(0.376)
Mother’s education	0.107	0.075	0.307**	0.784*
	(0.156)	(0.442)	(0.147)	(0.423)
Father’s education	-0.155	-0.250	-0.168*	-0.665**
	(0.096)	(0.269)	(0.094)	(0.297)
Household SES in childhood				

Somewhat worse off than them	0.111	0.531	0.199	0.893**
	(0.149)	(0.440)	(0.132)	(0.371)
Same as them	-0.073	-0.066	0.065	0.526*
	(0.118)	(0.338)	(0.109)	(0.311)
Somewhat better off than them	0.447**	1.609***	0.299	1.240**
	(0.196)	(0.602)	(0.192)	(0.613)
A lot better off than them	0.606	2.675*	0.668	2.038
	(0.581)	(1.486)	(0.565)	(1.480)
Constant	28.555***	86.338***	27.641***	86.739***
	(1.172)	(2.324)	(0.788)	(2.175)
N	7231	7181	9729	9620
R^2	0.157	0.127	0.132	0.107

Notes: Sample weights are applied. Province dummies are controlled. Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.