JOURNAL OF ECONOMIC DEVELOPMENT
Volume 44, Number 1, March 2019

AN ECONOMIC ANALYSIS OF HOUSEHOLD INCOME INEQUALITY AND BMI IN CHINA

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This paper explores the relationship between household income inequality at county level and Body Mass Index (BMI). The hypotheses associating BMI with income inequality are tested. Unlike most literature that found positive linear relationship between prevalence of overweight or obesity and household income inequality, by using a longitudinal data from China Health and Nutrition Survey (CHNS) between 1991 and 2011, we find that BMI will first decrease with household income inequality and then increase at an increasing rate, which suggests that high inequality may speed up the possibility of being overweight and obese. Policy measures on controlling obesity should be directed towards reducing inequality.

Keywords: Inequality, BMI, China, Household Income, Health
JEL Classification: I12, I14, O53

1. INTRODUCTION

Globally inequality is increasing and this has been very significant in the Organization for Economic Co-operation and Development (OECD) countries over the past three decades (OECD, 2011). Inequality has been linked with various societal problems such as higher rates of depression, violence, stress, crime rates and poor population health (Chetty et al., 2016; Enamorado, López-Calva, Rodríguez-Castelán, and Winkler, 2016; Wilkinson and Pickett, 2006).

Though several studies have looked into the relationship between income inequality and health, there still remain mixed conclusions on this relationship (Daly, Duncan, Kaplan, and Lynch, 1998; McLeod, Lavis, Mustard, and Stoddart, 2003; Mellor and Milyo, 2002). For example Pickett, Kelly, Brunner, Lobstein, and Wilkinson (2005) in a review of 168 literature found that 87 were totally supportive of the relationship between income inequality and health, 44 being partially supportive and 37 provided no support for the relationship. The main reason for the unsupportive relationship was that these studies focused on small geographical areas. Small geographic areas limit the extent of income inequality and hence the positive relationship. In another review of 98 studies, Lynch et al. (2004) did not find any relationship between income inequality and overall population health, however they report that income inequality could have an effect on specific health outcomes. Majority of these studies are however based on developed countries, though inequality in emerging economies like China is increasing.

The economic transformation in China has led to various improvements in wealth. For example Gini coefficient increased from 0.2 and 0.3 in 1970 to about 0.47 in 2008 (Bakkeli, 2016). Luo and Zhu (2008) attributes increase in inequality to difference in education and the employment sector. In addition to increasing income inequality, the Chinese population is experiencing a decrease in health outcomes in its population and this is reflected in the increased reported incidence of HIV, hypertension and smoking (Bakkeli, 2016). Evidence shows that from 1992 to 2002, the obesity rate in China experienced remarkable increase among various age groups, regions and sex groups (Wang et al., 2007). With the economy growing rapidly in China and increasing income inequality the question therefore arising is whether there is any relationship between income inequality and BMI in China and what could this relationship be?

Our objective in this paper is to add to the literature on inequality and health, with a focus on China, an emerging economy as well as BMI. We seek to understand the extent to which inequality affects BMI among Chinese population. We go further to find the effect of the relationship with respect to gender while controlling for other factors such as location, age, education level and marital status.

Our study differs from previous studies in many ways. Firstly, we explain the relationship between income inequality and BMI. Secondly instead of considering health in general we identify BMI as a specific health variable. We used BMI in our study for various reasons, it is easy to measure, it provides information on calorie consumed relative to calorie needs and it serves as a great measure for overweight and obesity. To control for some of the limitations associated with using BMI we excluded pregnant women and people who were deformed or had lost body parts. Thirdly we use a unique data set for an emerging economy China and include the most recent wave 2011. This is an individual level data which is based on different geographic regions and counties in China. This is important considering the fact that most studies on within country analyses have focused on the US and other developed countries. We controlled for fixed effects and also consider the effect of inequality and income across time. Finally, China being an emerging economy provides lot of opportunity and outcomes that could have implications in other economies.

The major findings from this study show that there is a “U” shaped relationship between income inequality and BMI in China. This is different from previous studies that report a positive relationship between income inequality and health. We find that other factors such as education, age and marital status has significant effect on this relationship.

This paper presents a review of related literature on income inequality and health. Next we present our empirical model and all assumptions to support the model. We then present a description of the data before discussing the empirical results based on the theoretical model.

2. LITERATURE REVIEW

Research on income inequality and health found varying conclusions. The general accepted relationship was that income inequality is positively related with ill health. The wide acceptance of this theory based on previous studies was confirmed by Wilkinson (1997). However recent studies have indicated that this relationship is based on the method of analysis used and is only significant in low and middle income countries. For example Pickett and Wilkinson (2015) in a systematic review of 165 studies on the association between income inequality and health, find that more than 70 percent reported a positive relationship between income inequality and worse health outcomes. Studies supporting this outcome however were mostly based on large areas where income serves as a measure of scale of social stratification. Similarly, Diez-Roux, Link, and Northridge (2000) using a two stage multi-level regression model and the Behavioral Risk Factor Surveillance System 1990 data showed that there was a positive relationship between income and BMI amongst individuals in the lowest income level. The authors however find no relationship or negative relation with individuals in the higher income levels. In another study Pop et al. (2013) find that there is a positive relationship between health and inequality only in middle and low income countries and this relationship was not significant in high income economies.

The relationship between income inequality and specific health conditions also vary. Chetty et al. (2016) in a study of the US older population finds higher income to be associated with longevity. The study reports that men in the top 1 percent live 14.6 years longer than those in the lower 1 percent. This was a little lower for women which was 10 years. Pickett et al. (2005) analyzed the association between obesity, deaths from diabetes and daily caloric intake and income inequality among the top 50 countries with the highest Gross National Income (GNI). They find that income inequality is positively related with obesity for both men and women. In another study, Komro, Livingston, Markowitz, and Wagenaar (2016) find that a dollar increase in income reduced the low birth weight among children by about 1 to 2 percent.

Research on the relationship between income inequality and overweight or obesity, especially in developing countries are limited. Few studies have focused on income inequality and health in China and these are similar to our study. Though these studies used the China Health and Nutrition Survey (CHNS) they find conflicting results on the relationship between income inequality and health. A reason could be the way inequality was measured. For example, Pei and Rodriguez (2006) studied income inequality and health in China between 1991 and 1997 using Gini coefficient from other studies. The authors find that the risk of reporting poor health increased with income inequality. In another study, Li and Zhu (2006) using similar data set reported an inverted "U"- shape relationship between income inequality and health. Additionally, they find that high income inequality also increases the probability of engaging in other behaviors such as smoking and alcohol consumption. They measured income inequality at the community level which allows for greater variation in income inequality as well as comparison among people who are closely related. In a more recent study, Bakkeli (2016) finds that income inequality has no effect on health among Chinese. The health indicator that was used is the individual self-reported physical function.

Our study differs from these studies in various ways. Firstly, we look specifically at BMI as a health variable instead of looking at the general health of the population. Secondly, we calculated the county level Gini coefficient for each household based on the self-reported income. Thirdly, we use a dynamic framework to analyze the relationship between obesity and inequality in China. This gives us more information on how income inequality and BMI has changed overtime in China.

3. THEORETICAL FRAMEWORK

3.1. The Dynamics of Weight Management

Our theoretical framework is based on Lakdawalla and Philipson (2009), and we extended their work by introducing an income inequality element in the model. Our objective is to examine how the steady state weight varies with the income inequality after an individual solves for the utility maximizing problem. Assume that the utility for an individual during the current period of time depends on food consumption, F, other health-improving consumption, X, and her current weight level, W. This can be written as $U(F, X, W)$, where U is a continuous, strictly concave, differentiable and bounded function. U increases as food consumption increases, but it is not monotonic in weight. With a given level of basic food and other health-improving consumption, the individual tries to maximize her utility over time. Additionally, assume that food intake and other health-improving consumption are not substitutes, in the sense that $UFX \geq 0$, which rules out perverse incentives for the rich at higher material consumption level to eat less than the poor. In addition, we assume extra consumption of F can be caused by Q, an income inequality factor. As we mentioned earlier, factors like social stress from income-disparate environments (Kahn et al., 1998) may cause an individual to increase consumption, a pattern known as stress-eating or eating for comfort.

An individual manages their weight by solving a dynamic problem where her weight, W, is the state variable. Weight is a capital stock that depreciates over time, and can be accumulated by food intake or reduced by physical activity. Denoting S as the physical activity, the transition equation relating the current weight to the next period's weight, W', can be written as:

$$W' = (1 - \delta)W + g(F, S), \tag{1}$$

where the depreciation rate is δ and is less than one, and g is a continuous, concave function that increases with food consumption and decreases with the strenuousness of the home or market production. Food consumption, F, is bounded below by zero and above by a finite physical limit; because these bounds will never bind, we do not need to track them analytically. The individual's value function is given by:

$$v(W) = Max_{F,X,W'}\{U(F(Q),X,W) + \beta v(W')\}, \tag{2}$$
$$\text{s.t. } pF(Q) + X \leq Y,\ W' = (1-\delta)W + g(F(Q),S),$$

where Y is the individual's income, p is the price of low quality food consumption. A reduction in p and S can be interpreted as an agricultural innovation on the supply side and a sedentary technological improvement on the demand side.

Because of continuity and strict concavity, the value function can be differentiated, resulting in the following first order (F.O.C.) and envelope conditions:

$$U_F(F(Q),Y-pF(Q),W) + \beta v'(W')g_F(F(Q),S) = pU_X(F(Q),Y-pF(Q),W), \tag{3}$$
$$v'(W) = U_W(F(Q),Y-pF(Q),W) + \beta v'(W')(1-\delta).$$

The F.O.C. implies that the marginal utility of other consumption is equal to the overall marginal utility of food consumption, which equals the marginal utility of eating, plus the marginal value of the weight change caused by eating. The envelope condition says that, in the long run, the marginal value of additional weight equals the marginal utility of weight in the current period plus the discounted future marginal utility of weight.

As long as the marginal utility of food $U_F - pU_X$ is falling in weight, there is a unique and stable steady state in food consumption and weight:

$$v'\big(W + g(F(Q),S)\big) = \frac{pU_X - U_F}{g_F(F(Q),S)}. \tag{4}$$

The above equation (4) denotes food as a function of W, Y, Q, S and p, illustrating that the marginal benefit of weight tomorrow should be equal to the marginal cost of spending resources on weight gain today. The optimal food policy, Φ, decreases in current weight W. When W increases, v' falls as a result of concavity, and $pU_X - U_F$ rises, because $U_F - pU_X$ is falling in weight. Therefore, the marginal utility of weight in the next period declines below its cost, or $v' < pU_X - U_F/g_F$. To restore equilibrium, the individual will consume less food. This will give rise to the fact that $\Phi_W(W;S,p,Y,Q) < 0$.

A unique and stable steady-state is given by the fact that the optimal food consumption falls as weight increases (Figure 1). The steady state food consumption level, $F(W,S,Q)$, is defined implicitly through $g(F(W,S,Q),S) = \delta W$. Here, F rises in W, S and Q. When the steady state curve intersects the optimal food policy, Φ, we will have an associated steady state equilibrium (W^*,F^*). This steady state equilibrium is unique because $F_W > 0$ and $\Phi_W < 0$. It is also stable because when weight lies below this steady-state level, food consumption exceeds the steady-state food intake. Conversely, when weight lies above it, food intake is less than the steady-state food intake.

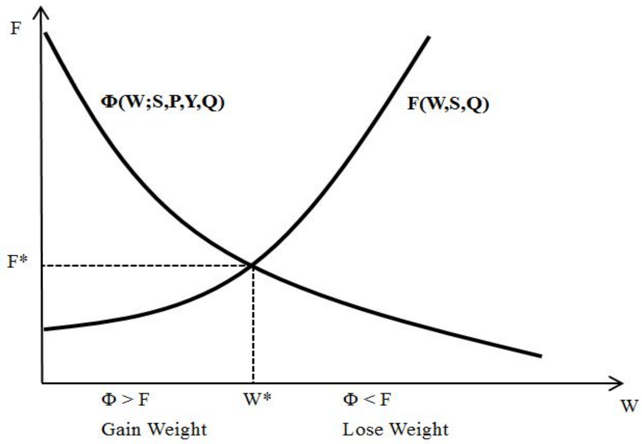

Figure 1. Steady State Food Consumption and Optimal Food Policy

3.2. The Steady-state Determinants of Weight

The steady state equilibrium for food and weight choice can be written as $W_p{}^*(S, p, Y, Q)$ and $F_p{}^*(S, p, Y, Q)$, respectively. From Equation (4), an increase in the food price increases the marginal cost of weight gain, while leaving the marginal benefit intact. This yields: $\Phi_p{}^*(W, S, p, Y, Q) < 0$. An increase in the food price shifts the optimal food policy curve inward and lowers steady state weight and food consumption, so that $W_p{}^*(S, p, Y, Q) < 0$ and $F_p{}^*(S, p, Y, Q)$. It could also lead to a U-shaped or a quadratic relationship between income inequality and weight.

3.3. Income and Income Inequality Effects

Here, we introduce an inequality tolerance level, Q_0, and assume $U_{WX} < 0$ when $Q < Q_0$; $U_{WX} \geq 0$ when $Q \geq Q_0$. That means when an individual is below the threshold, without much social stress, she cares about controlling weight and paying attentions on healthy consumptions that helps her control weight instead of the consumptions of low quality food. When an individual is below the threshold ($Q < Q_0$), an increase in Q could increase the X instead of low quality food consumption, which in turn reduces U_W. So by analyzing the marginal benefit of weight and marginal cost of weight from optimal food policy equation (4), we find $\Phi_Q(W; S, p, Y, Q) < 0$ therefore, a growth in income inequality shifts the Φ inward, which induces a decrease in steady-state weight ($W_Q^* < 0$). Conversely, for overweight individuals, Q will raise U_W and a growth in income inequality will shift Φ outward and increase the steady state weight ($W_Q^* > 0$). The effects on equilibrium food intake are similar. When the inequality is low, income inequality shifts the optimal food policy in, and $F_Q^* < 0$. For the high inequality, it shifts the optimal food policy out, and $F_Q^* > 0$.

3.4. The Time Series Behavior of Weight and Its Determinants

Changes in weight over time arise from simultaneous changes in all the factors discussed above: We denote the time path of steady state of food consumption as $F(t) = F^*(S(Y(t)), p(t), Y(t), Q(t))$ and denote $W(t) = W^*(S(Y(t)), p(t), Y(t), Q(t))$ as the time path of steady state weight. The partial derivatives of F^* and W^* have been analyzed: an individual is below the inequality tolerance threshold, when $W_Q^* < 0$, while it is $W_Q^* > 0$ when she is above the threshold. While these are the partial effects, the total change over time in food intake and weight is influenced by simultaneous changes in income, income inequality, physical activity, and prices. Technological improvement may raise income and reduce physical activity; it can also lower the supply price of food. All these forces tend to raise weight and lower the equilibrium price of food.

4. EMPIRICAL ANALYSES

In our empirical study, we examine whether adult BMI is correlated with income inequality and other factors. We begin with a discussion of several analyses that link income and income inequality to BMI and obesity. We then specify the empirical test for each analysis.

4.1. Panel Data Analyses

Using longitudinal data, we estimate the following specification

$$BMI_{it} = \beta_0 + \beta_1 Q_{it} + \beta_2 Q_{it}^2 + \beta_3 Y_{it} + \beta_4 D_{it} + \beta_5 age_{it} + \beta_6 age_{it}^2 + \beta_7 year_t + \varepsilon_{it}. \quad (5)$$

The subscript i represents individual i, and t stands for time t. The dependent variable BMI_{it} is the BMI adjusted for reporting error. Q_{it} is the county level household income inequality associated with i, Y_{it} represents the household income associated with i's family, we include a vector of demographic variables, D_{it}, that contains the highest education level completed, as well as an indicator for being married with a spouse present and an urban indicator. Next, we allow for weight to have an inverted U-shape in age: people gain weight as they approach middle age, but they begin to lose weight as they grow. This means that β_5 should be positive, while β_6 should be negative. We then use $year_t$ to represent a vector of year dummies. Finally, this regression illustrates the conditional variation in weight across groups with different income statuses at a point in time. By estimating the empirical relationship between weight and various demographic characteristics, we can identify the growth in weight that results from demographic changes.

4.2. Fixed-effect Model

Instead of examining variation in income and in BMI across household income at a point in time, we may estimate how changes in a household's income over time influence changes in its member's BMI over time. Here, if we assume fixed effects, we impose time-invariant individual effects that may be correlated with the regressors. The fixed-effect model assists in controlling for unobserved heterogeneity when this heterogeneity is constant over time and is correlated with independent variables. This constant can be removed from the data through differencing. The model set-up is:

$$BMI_{it} = \beta_0 + \beta_1 Q_{it} + \beta_2 Q_{it}^2 + \beta_3 Y_{it} + \beta_4 D_{it} + \beta_5 age_{it} + \beta_6 age_{it}^2 + u_i + \varepsilon_{it}, \quad (6)$$

where u_i is the unobserved individual time-invariant fixed effect, and ε_{it} is the time-variant error term. u_i could represent ability, genetics or historical factors that do not change over time; in this context, it is correlated with regressors (i.e., unobserved genetics factors that are associated with income or demographic variables such as education). This unobserved heterogeneity may be purged by using the fixed-effect regression model. Formally, we will get $BMI_{it} - \overline{BMI}_i = (X_{it} - \bar{X}_i)\beta + (\varepsilon_{it} - \bar{\varepsilon}_i)$, where X_{it} is a vector of predictor variables, and $\bar{X}_1$ is the time-average estimator.

5. DATA

Our empirical work for this paper is based on the micro-level data retrieved from the China Health and Nutrition Survey (CHNS), which was collected by the Carolina Population Center (CPC) at the University of North Carolina at Chapel Hill, the Institute of Nutrition and Food Hygiene, and the Chinese Academy of Preventive Medicine. Our panel analysis is made up of the following years, 1991, 1993, 1997, 2000, 2004, 2006, 2009 and 2011. The sample households were randomly drawn from eight provinces: Liaoning, Shandong, Jiangsu, Henan, Hubei, Hunan, Guangxi, and Guizhou. Two cities and four counties were sampled in each province, and then four neighborhoods in each city and one county-town neighborhood and three villages in each county were then randomly selected. The CHNS data contain detailed information on household and individual characteristics, as well as health-related information such as physical condition, health behaviors and self-reported health status.

We restrict our sample to men and women over the age of 18 for whom there is a complete set of data on health and demographic variables (age, sex, marital status, education, and family income). Since we need to construct household income, income inequality and relative deprivation indices, we also exclude those with non-positive household income.

Table 1. Descriptive Statistics of BMI, Income Inequality, and Other Variables in China, 1991 – 2011 (n= 80,028 observations)

Variables	Mean	Standard Deviation	Min	Max
Body Mass Index (BMI)				
Whole Sample	22.725	3.292	12.124	39.792
All Men	22.622	3.175	12.684	39.792
All Women	22.818	3.392	12.124	39.751
Cofactors				
County Gini	0.348	0.100	0.037	0.762
HH Income Centile Rank	0.556	0.289	0.011	1
HH Income (1000 CNY)	8.657	16.649	0	600
Years of Education	7.002	4.310	0	18
Age	45.828	15.896	18	100.8
Marital Status (0=not married, 1=married)	0.887	0.316	0	1
Gender (0=male, 1=female)	0.527	0.499	0	1
Family size	3.942	1.575	1	14
Rural (0=urban, 1=rural)	0.653	0.476	0	1

To measure BMI we employed reported data on height and weight. The investigators measured the height and weight for each respondent which eliminates problems associated with self reporting. BMI defined as weight in kilograms divided by the square of height in meters enables us to obtain an estimate of the prevalence of obesity. In our study we considered actual BMI and we deleted observations for those who had lost body parts and who were pregnant, since their BMIs are not representative.

The household income is based on data from the Constructed Income Files, which more properly fits our model assumption. The household income is set up as household total income inflated to 2011 levels. There are questions about nine potential sources of income in the questionnaires: business, farming, fishing, gardening, livestock, non-retirement wages, retirement income, subsidies, and other income. After calculating household income from each source, total household income was constructed as the sum from all nine sources. The value at each wave was then inflated to 2011 Yuan currency values. Gini Coefficient is used to measure the household income inequality at the county level. For each county, we calculate the Gini based on household income. Following Eibner and Evans (2001), we also construct the relative deprivation index—an individual's centile rank within the reference group, where income is sorted in ascending order as the proxy for relative income. Higher centile rank means a lower level of relative deprivation. Since the Gini coefficient depicts the overall income distribution of a society, relative deprivation reflects a person's position or rank relative to the incomes of others within a reference group. In order to be consistent with the Gini coefficient, we use households in the same county as the reference group to generate these relative deprivation measures. We also control for socio-demographic categories, including age and age squared; highest education level attained; indicators for gender and marital status, family size, and year; and rural and provincial indicators. Table 1 presents the descriptive statistics for the period between 1991 to 2011. The Gini coefficient for the period was 0.348. Fifty two percent of the respondents were female and about 65 percent lived in the rural areas. The average family size is 3.9 and the average age for respondent is 45 years.

6. ESTIMATION RESULTS

In this section, we employ several regression models to systematically test the theoretical predictions we have discussed. The main purpose of our study is to examine the correlation between adult BMI and household income inequality.

Table 2 shows the OLS estimation of inequality on BMI. The first column represents results for the full sample; the second column represents male and the third female population. The results echoes the findings of previous research, that is, people are more likely to develop obesity in middle age. A novel feature of the results is the analysis of BMI variation across the income distribution. For both males and females, we see the "U"-shaped relationship as a result of the dynamic interaction between the demand for basic consumption and the demand for quality of life consumption. We find that initially there is a negative relationship between BMI and Gini-coefficient. This implies that BMI will initially decrease with inequality but increase as inequality continues to increase. In Table 3, we estimated the relationship between BMI and inequality only based on data from 1992 to 2012. We find that there was a "U" shaped relationship between inequality and BMI in the pooled sample and men. In Table 4 we construct a fixed effect model to cater for difference across years. Results from Table 4 suggest that nearly all weight gain occurs over time, rather than as a result of shifts in the composition of the population. Using the fixed year effects, we find that the parameter estimates differ but the general conclusions remains the same, that is, there is a "U" shaped relationship between BMI and income inequality in all groups. Furthermore the individual control variables show some interesting patterns. We find that age, marital status, household income rank and education are all positively associated with BMI. These results were also found across gender. Interacting education and income rank, we find that educated male with high incomes are positively associated with BMI while an educated female is negatively associated with BMI.

Table 2. Linear Regressions Measuring the Effects of Household Income Inequality on Adult BMI, 1991-2011

Dependent Variable: BMI			
	Whole Sample	All Men	All Women
County Gini	-7.025***	-6.661***	-7.075***
	(0.649)	(0.889)	(0.935)
County Gini Squared	8.922***	8.141***	9.253***
	(0.835)	(1.145)	(1.201)
Control variables			
Household Income	0.528***	0.344***	0.365***
	(0.028)	(0.034)	(0.035)
Household Income Rank	0.580***	0.796***	0.193
	(0.094)	(0.126)	(0.140)
Age	0.132***	0.136***	0.124***
	(0.005)	(0.008)	(0.007)
Age Squared	-0.044***	-0.049***	-0.037***
	(0.005)	(0.007)	(0.007)
Household Income * Income Rank	-0.147***	0.072***	-0.111***
	(0.013)	(0.009)	(0.019)
Year Dummy			
1993	0.082*	0.080	0.080
	(0.050)	(0.068)	(0.071)
1997	0.313***	0.334***	0.305***
	(0.051)	(0.069)	(0.073)
2000	0.665***	0.643***	0.694***
	(0.052)	(0.070)	(0.075)
2004	0.814***	0.831***	0.811***
	(0.052)	(0.071)	(0.074)
2006	0.841***	0.879***	0.820***
	(0.053)	(0.073)	(0.076)
2009	0.676***	0.733***	0.660***
	(0.057)	(0.078)	(0.081)
2011	1.075***	1.101***	1.096***
	(0.057)	(0.079)	(0.082)
Constant	17.235***	17.018***	19.841***
	(0.240)	(0.337)	(0.323)
Observation	74416	35500	38916
R-squared	0.185	0.181	0.179

Note: Numbers in parentheses are t-statistics under robust standard errors. *, ** and *** represent significant level of 10, 5, and 1 percent.

Table 3. Initial Panel Data Analysis for Household Income Inequality on Adult BMI 1991-2011

Dependent Variable: BMI			
Total	Whole Sample	All Men	All Women
County Gini	-6.035***	-6.798***	-5.349***
	(0.398)	(0.569)	(0. 556)
County Gini Squared	4.743***	5.725	3.863***
	(0.506)	(0.726)	(0. 707)
Constant	24.380***	23.934***	24.778***
	(0.215)	(0.308)	(0. 299)
Observation	80228	37971	42257

Note: Numbers in parentheses are t-statistics under robust standard errors. *, ** and *** represent significant level of 10, 5, and 1 percent.

Table 4. Fixed Effect Regressions for Household Income Inequality on Adult BMI 1991-2011

Dependent Variable: BMI			
Total	Whole Sample	Male	Female
County Gini	-4.119***	-4.640***	-3.656***
	(0.431)	(0.612)	(0.607)
County Gini Squared	3.345***	4.070***	2.706***
	(0.543)	(0.771)	(0.764)
Control variables			
Household Income	0.066***	0.026*	0.053***
	(0.014)	(0.014)	(0.013)
Household Income Rank	1.286***	1.367***	1.175***
	(0.092)	(0.128)	(0.132)
Age	0.047***	0.047***	0.048***
	(0.003)	(0.005)	(0.005)
Age Squared	-0.016***	-0.015***	-0.018***
	(0.003)	(0.005)	(0.004)
Education	0.044***	0.045***	0.041***
	(0.006)	(0.008)	(0.008)
Marital Status	0.195***	0.354***	0.074***
	(0.019)	(0.029)	(0.026)
Education * Income Rank	-0.001	0.002**	-0.004***
	(0.001)	(0.001)	(0.001)
Household Income * Income Rank	-0.016***	-0.022***	-0.003
	(0.004)	(0.005)	(0.006)
Constant	19.692***	18.768***	20.538***
	(0.259)	(0.373)	(0.361)
Observation	74416	35500	38916

Note: Numbers in parentheses are t-statistics under robust standard errors. *, ** and *** represent significant level of 10, 5, and 1 percent.

Table 5. Fixed Effect Regressions for Household Income Inequality on Adult BMI for Different Income Quartiles, 1991-2011

Dependent Variable: BMI			
Total	.25 percentile	.50 percentile	.75 percentile
County Gini	-3.803***	-2.776***	-3.463***
	(1.115)	(0.666)	(0.509)
County Gini Squared	2.290*	0.844	2.219***
	(1.393)	(0.840)	(0.641)
Control variables			
Household Income	1.877	0.705	1.261***
	(1.062)	(1.193)	(0.216)
Household Income Rank	0.651	0.305	1.926***
	(5.307)	(1.396)	(0.497)
Age	0.030***	0.032***	0.039***
	(0.007)	(0.005)	(0.004)
Age Squared	-0.007	-0.006	-0.012***
	(0.007)	(0.004)	(0.004)
Education	0.042**	0.031***	0.024***
	(0.020)	(0.011)	(0.008)
Marital Status	0.093**	0.117***	0.137***
	(0.040)	(0.027)	(0.021)
Education * Income Rank	0.046	0.046***	0.025***
	(0.042)	(0.011)	(0.004)
Household Income * Income Rank	-3.053	-0.656	-1.090***
	(1.061)	(1.191)	(0.207)
Constant	21.622***	22.549***	19.788***
	(5.363)	(1.458)	(0.575)
Observation	15424	32145	50175

Note: Numbers in parentheses are t-statistics under robust standard errors. *, ** and *** represent significant level of 10, 5, and 1 percent.

Table 5 presents the results for the association between BMI and inequality with reference to different income levels. The first column refers to the 25th percentile, second column is the 50th percentile and the third column is the 75th percentile. We find that while a strong "U" shaped relationship exists between those who are in the 75th percentile, and there was no significant quadratic association between BMI and income inequality for those who are in the 50th percentile. This finding is very interesting. Unlike previous studies that find the inequality affects health of only those in the higher income levels, in our study we find that the effect of inequality on BMI is "U" shaped across all income levels. The quadratic pattern between BMI and inequality is more prevalent as average income increase.

7. DISCUSSION AND CONCLUSION

In this paper, we employ a micro data from China to provide a theoretical examination and empirical test of the predictions that link household income inequality to adult BMI, using a panel data analysis. We find evidence in support of our predictions. First, our results show a "U"-shaped relationship between BMI and household income inequality. Additional inequality brings about lower BMI when inequality and social stress is low. However, rising inequality tends to increase BMI when the Gini coefficient and social stress is above a certain level. Our results also show that the "U" shaped relationship is evidenced across all income levels. This is very interesting especially given that previous studies find that inequality affects the health of only the poor. One reason may be due to how we calculated our inequality which was based on the county. That is maybe in a poor county one's inequality with be based on those in the same county and not those in the general population as a whole.

Our results also show that education has a positive relationship with BMI for both men and women in the fixed effect model though. This is important because we would expect that people who are educated should have lower BMI. An explanation could possibly be based on the type of education. For example if the education does not focus on health in general then though people may be educated they may not necessarily have healthy life styles. It is interesting because being educated and living in a rural area is also associated with a higher BMI. An intriguing part of our study was the fixed effect model which measured the effect of inequality on BMI across time. We find that over time BMI decreases with inequality then increases rapidly. We also find that there are variations of this effect across gender. This has several implications on the health of the household and the economy as a whole. Policy measures on inequality should focus on both males and females. Additionally, as household income increases it is important for measures to be taken in promoting health, nutritional and life style choices across gender and in both rural and urban areas.

While this study has its limitations, it is among one of the first to provide the evidence from a developing country on the nonlinear relationship between household income inequality and BMI. Although the sample size is relatively small compared with the data from many U.S. studies, the set of CHNS data we have used is one of the best data sets available in the context of developing economies, and is probably the best Chinese data set available. Another limitation is that we focus on only one dimension of inequality, that is, household income inequality at county level. We do not claim that county-level inequality is necessarily more important than inequality at the provincial or country level however by using the county level data helps us to better see the people and households interacting with each other more closely. Finally, our empirical tests are tests of correlations between household income inequality and individual BMI. The causal link may not be established until more evidence becomes available regarding the intermediate mechanisms through which inequality affects BMI.

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Received August 24, 2017, Revised December 21, 2018, Accepted December 24, 2018.