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The obesity pay gap: gender, body size, and wage inequalities—a longitudinal study of Chinese adults, 1991–2011

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Abstract Sociocultural values promoting Western body-type ideals have proliferated over the past 20 years. An important question is whether the same obesity wage penalties seen in the United States, such as wage reductions for obese individuals, are emerging in China as ideals of beauty change to reflect Western ones. We hypothesize that Westernisation will exacerbate the impact of body size on wages for years to come, particularly for urban non-manual workers whose workplaces call for extensive interpersonal relations with employers, colleagues, and customers. This study examines the economic outcomes for individuals aged 18–55, focusing on 6600 female and 8488 male participants in the longitudinal 1991–2011 China Health and Nutrition Survey. Linear fixed-effects regression models estimate the net effect of body mass index (BMI) on wages, as well as the marginal effect of BMI on wages, by survey year. All analyses control for demographic backgrounds and household fixed effects, and are stratified by gender. The results show that normal-weight women with non-manual jobs in 2011 made 2.79–2.95 times more than they had in 1991, while overweight women made 2.66–2.76 times more, and obese women made only 2.57–2.63 times more. The results also indicate that women with non-manual jobs have been subject to wage disparities since 2000. Specifically, the wage disparity for heavier women living in urban areas with non-manual jobs increased significantly after 2000, while current male obesity rates may have been propelled by social acceptance of larger body sizes among men, particularly for manual workers living in rural areas.

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Introduction

Chinese society has extensively emphasized facial characteristics over body shape as a public locus of beauty (Jung and Forbes 2007; Lee 1999). For example, Lee and Lee (2000) described Chinese culture as defining female attractiveness based on the rhythms of physical traits in "five organs," including eyebrows, eyes, ears, nose, and mouth. Yet traditional Chinese body size preference and body weight perceptions remain under debate. Leung et al. (2001) argue that traditional Chinese culture considers body shape defined by thinness and fragility as a symbol of feminine beauty. Lee (1999) and Han (2003) find that plump body figures for women are the traditional Chinese preference. Lately, accelerated urbanisation, along with explosive economic development and West-dominated fashion ideas (Wu and Delong 2006), have led Chinese young women to identify beauty with slenderness (Chen et al. 2007; Leung et al. 2001; Luo et al. 2005; Xu et al. 2010). Gottschang (2001) observed that Chinese modernisation has reshaped norms for the female body, even among pregnant and postpartum women. With changes in diet and daily routines, such as the rise of energy-dense, sugar-rich, high-fat diets and sedentary lifestyles (Astrup et al. 2008; Bell et al. 2002; Huang et al. 2015; Ng et al. 2009), women experience even greater difficulty in maintaining ideal body size today compared with the past. The ever-increasing pressure felt by women to attain the ideal body type has led to an upsurge in eating disorders in Chinese society (Chen and Jackson 2008; Huon et al. 2002; Lee and Lee 2000; Tong et al. 2014).

Past studies argued that for men, Western culture associates larger body size with dominance and virility (Cassidy 1991). Weight gain, with attention on increasing muscle while keeping body fat low, has positive connotations for men (Pope et al. 2000). On the other hand, little research has been conducted on Chinese men's body identities. Chinese men are still far less preoccupied with body image than are Western men (Yang et al. 2005), and body dissatisfaction has not been linked to Chinese men's self-esteem or depression (Davis and Katzman 1997).

Past studies on the obesity wage penalty in labour markets were focused primarily on how body type discrepancy by gender generates discriminatory economic outcomes. For example, studies suggested a negative association between body size and economic wellbeing in women (Baum and Ford 2004; Cawley 2004; Conley and Glauber 2007; Glass et al. 2010). Although some studies showed an obesity wage penalty for men (Baum and Ford 2004; Johar and Katayama 2012; Kline and Tobias 2008), others stated that the association does not exist (Averett and Korenman 1996). Three main mechanisms through which body weight adversely affects wages are proposed. First, unobserved variables could cause both obesity and low wages (Cutler et al. 2003). For example, an individual's underlying personality traits, such as higher levels of somatic anxiety, may be responsible for both obesity and lower wages. Second, lower wages may cause obesity; lower wages may be associated with poor diet and physical inactivity, which increase the risk for heavier body weight. Third, the body type–wage differential may result from bias, prejudice, and distaste toward less attractive individuals in the workplace, particularly for white-collar workers (Carr and Friedman 2005), whose jobs involve more social interactions than those of blue-collar workers do (Han et al. 2009; Johar and Katayama 2012). Size discrimination in the workplace may lower wages as employers withhold promotions or unjustly terminate obese employees; scholars have also suggested that employees who perceive weight discrimination are at higher risk for poor health outcomes, which decrease productivity in the workplace and thus may reduce future earnings (Schafer and Ferraro 2011).

Past research into the economic consequences of body weight has focused predominantly on Western populations. China has shifted from a centrally planned to a market-based economy since initiating reforms in the 1980s. In addition, large populations of people born after the economic reforms migrated into urban areas to pursue opportunities for non-agricultural jobs and more glamorous lives in cities (Luo and Wang 2003; Wang 2008). The number of tenured employees working in labour-intensive and permanent occupations provided by state-run and collectively owned enterprises has declined noticeably. This decline has been accompanied by an increase in non-manual employee work in privately owned industries. The economic expansion in China has not only brought about major changes in occupational structure, but it has also increased affluence in urban areas; as a result, interpersonal relationships with customers and colleagues have increased in the workplace. Wage penalties may emerge because of the increased frequency of interpersonal relationships in workplaces where body size discrimination or preference is present.

Our innovation in this paper is to test relationships between obesity and wages in China. Following previous discussions, we propose that an obesity wage penalty may continue to emerge in modern China due to increasingly frequent social interactions in urban areas and workplaces where there exists discrimination on the part of customers or colleagues against overweight or obese workers. We hypothesize that (a) a wage penalty, a negative association between body size and wages, exists for women, and this penalty will increase over time, particularly for occupations requiring extensive interpersonal relationships in urban areas, because of increased exposure to Western values that reshape norms for the female body; and (b) a positive association, or no association, between body size and wages exists for men regardless of occupation, residential area or survey year, because Chinese society is less likely to prefer thinner males.

Method

Study population

The China Health and Nutrition Survey (CHNS) is an ongoing longitudinal project that gathers data on health, nutrition, and socioeconomic indicators at the individual, household, and community levels. The survey began in China in 1989 with follow-ups in 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011. A multistage, random-cluster procedure was used to draw an initial sample from eight provinces. A new province (Heilongjiang) and its sampling units were added in 1997. Counties in each province were stratified by income levels, and multistage random sampling was used to select four counties in each province based on per-capita income reported by the National Bureau of Statistics. Within each county or urban area, neighbourhoods were randomly selected from urban and suburban, townships, and villages. Twenty randomly selected households were chosen within each neighbourhood. There were 190 primary sampling units, including 4020 households first surveyed in 1989, and all individuals within a household (a total of 15,927 individuals) were interviewed. Follow-up levels were high, but families that migrated from one community to another did not receive follow-up. Response rates were approximately 88 % at the individual level and 90 % at the household level for the previous year's participants (Popkin et al. 2010). CHNS data are not nationally representative; however, previous research findings on key physical composition and dietary data trends based on CHNS are similar to those revealed by nationally representative data (Ge et al. 1994; Wang et al. 2006).

Our analysis has omitted the 1989 survey because the 1989 wave collected information only from preschoolers and young adults ages 20–45, and lacked information on health limitations. The flow chart and the basis for sampling are presented in Fig. 1. Height and weight measurements were obtained by health care experts from 1991 to 2011, and only the subsample of 51,787 person-years (61.72 % of the total sample) with complete weight and height information was included. In addition, there were 16,422 person-years (31.71 %) for which wage information was available. We found that 75.96 % of the person-years with missing wage values were peasant farmers and concluded that those data are missing because wages are not relevant for individuals who were peasant farmers and did not consider themselves salaried employees. Among those 16,422 cases, 178 women who were pregnant or breastfeeding during any given survey were omitted, and information regarding years of education was available for only 15,400 person-years. Among those 15,400 cases, 312 person-years who did not provide the requested information concerning hours worked per day, health restraints, or marital status were omitted from the sample. Finally, 15,088 person-years who provided information regarding age, years of education, health constraints, marital status, occupation, and average daily working hours were left in the study sample group. The subsample included 8488 male person-years and 6600 female person-years observed in CNHS survey waves 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011. The mean length of follow-up periods of survey waves were 2.86 years and the standard deviation was 77 years.

Measurements

Dependent variable

Wage refers to non-retirement salaries earned by the person and is used in this study as the economic outcome variable. Wages come from CHNS longitudinal files, which have all of the data for each individual in each wave. For interpretability,

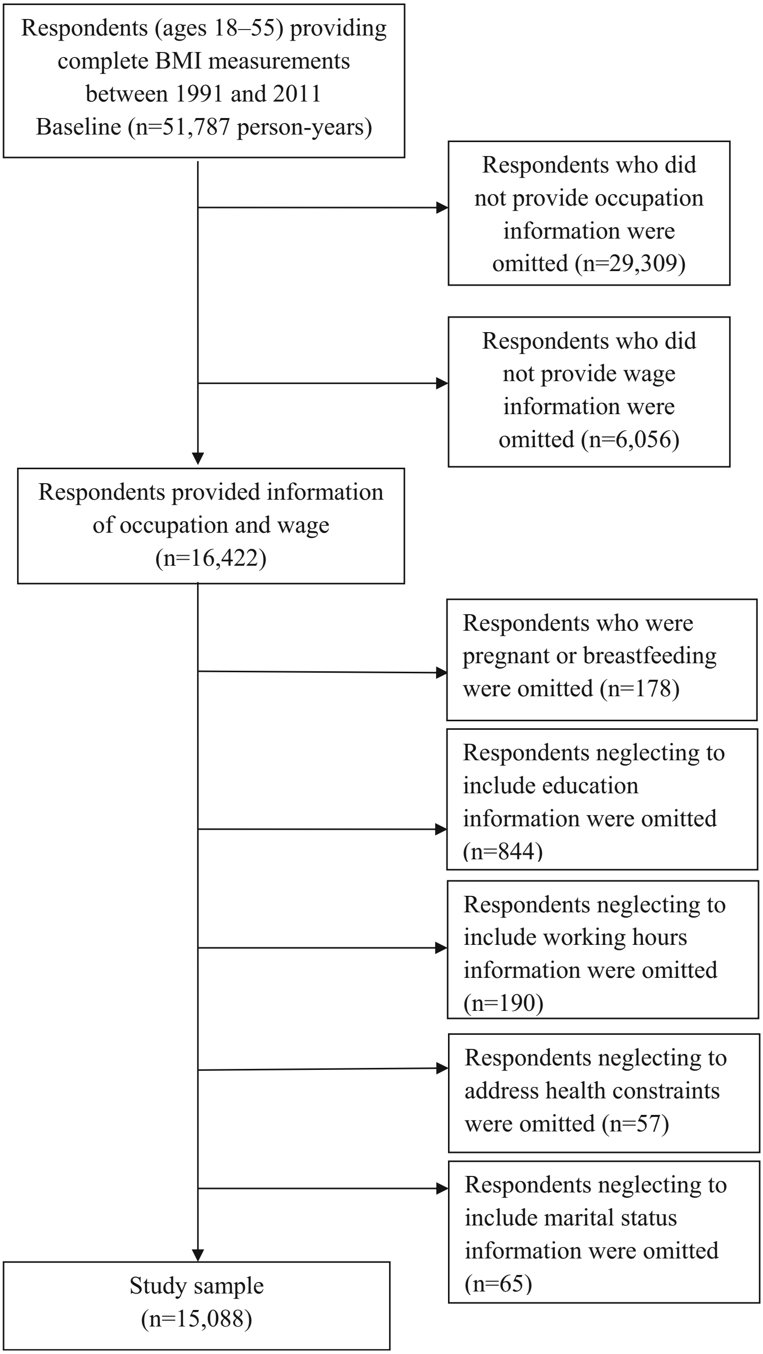

Fig. 1 Flow chart depicting the derivation of the study's sample

wages have been logged. In such models, the logged case refers to the proportional change in the wage for a one coefficient increase.

Independent variable

In our study, *Body mass index* (BMI) is defined as $\left(\frac{Weight(kg)}{Height(m^2)}\right)$ in its continuous form. The current overweight and obesity guidelines, based on findings within Western populations, are not appropriate for Chinese populations, because the absolute levels of diabetes and hypertension on age- and sex-specific bases are higher in people of Chinese origin (James et al. 2001). Therefore, our study applies the Chinese definitions of *overweight* (defined as $24\left(\frac{\mathrm{kg}}{\mathrm{m}^2}\right) \leq \mathrm{BMI} < 28\left(\frac{\mathrm{kg}}{\mathrm{m}^2}\right)$) and *obesity* (defined as $\mathrm{BMI} \geq 28\left(\frac{\mathrm{kg}}{\mathrm{m}^2}\right)$) (Zhou 2002).

In this study, we categorised salaried *Occupations* into two groups by type of interactions in the workplace. (a) Non-manual workers require a high level of interactions with employers, colleagues, or customers in the workplace. Included in this category are senior professional workers (doctor, professor, lawyer, architect, and engineer), junior professional workers (midwife, nurse, teacher, editor, and photographer), administrators, executives, managers (working proprietor, government official, section chief, department or bureau director, administrative cadre, village leader), athletes, actors, and musicians. Service workers include office staff (secretary, office helper), helpers (housekeeper, cook, waiter, doorkeeper, hairdresser, counter salesperson, launderer, and child-care worker), skilled workers (foreman, group leader, craftsman) army officers, police officers, ordinary soldiers, and police officers. (b) Manual labourers: These salaried occupations require minimal interactions with colleagues or customers in the workplace; non-skilled workers (ordinary labourer, logger) and drivers are grouped into this category. Finally, CHNS recognised two kinds of *Residential areas*, urban and rural, based on information from the administrative systems of the central government of China.

We argue that manual labourers, particularly those in rural areas, experience less interpersonal contact with colleagues and customers than do non-manual workers; therefore, physical appearance is less likely to have an impact on their wages. In addition, we predict that non-manual labourers who work in urban areas are most likely to be affected by their body sizes in years to come because Chinese society increasingly emphasizes lean body shapes, especially in urban areas.

Covariates

Previous Western studies have suggested that weight gain is associated with negative health consequences (Must et al. 1999; Renehan et al. 2008; Shai et al. 2006), such as less productivity because of absenteeism, sick leave, and injuries that limit performance in the workplace (Schmier et al. 2006; Schultz and Edington 2007). Our models include health constraints to understand whether health limitations have confounded associations between weight status and wage outcomes. The variable health constraints is entered as a dichotomous variable based on whether the participant self-reported having been sick or injured or suffering from a chronic or acute disease in the last 4 weeks.

Studies indicate that marital status is an important predictor for wages. For example, married men earn higher wages than their never-married counterparts (Antonovics and Town 2004). It is reasonable to believe that full-time employees earn higher wages than those who work part-time or irregular hours; in addition, higher education usually leads to higher wages. In short, several important confounders are controlled for in this study, including (a) marital status, recoded as a binary variable (currently married and currently not married [includes single, divorced, widowed and separated]), with married coded as 1; (b) working hours, measured as the average working hours per day in the past year and entered as a continuous variable from 0 to 24; and (c) education, measured as the total number of years of formal schooling completed and entered as a continuous variable from 0 to 18. Finally, all models have controlled for survey years 1991–2011, entered as a categorical variable.

Statistical analyses

Fixed-effect (FE) methods are designed to study the causes of changes within a unit (individual, household, country, etc.) by controlling for potential unobserved heterogeneity bias to generalise the results to all units in the analysis. In this study, we used fixed-effects linear regression models to strengthen conclusions about a causal effect of BMI on wage outcomes.

The CHNS is panel data containing observations over multiple time periods, and FE regression models are able to incorporate all available measurements from each individual, which maximizes our analytic sample. In those models, the "cluster" refers to each individual when repeated measurements in each year are nested (level 2); in addition, all the individuals were followed within households in any given survey year; our regressions controlled for household fixed effects. Specifically, the linear regression model with time-invariant covariates in our study is written as:

$$\ln(Wage)_{it} = \alpha_t + \sum_{k=2}^{K} \beta_k x_{kit} + \sum_{m=1}^{M} \gamma_m z_m + u_i + v_j + \varepsilon_{it} \tag{1}$$

where α_t is an intercept; β and γ are vectors of coefficients. The symbol x represents time-varying covariates, including the independent variables: body mass index, and confounders marital status, educational years, health limitations, and working hours. The symbol z represents time-invariant covariates, including year-specific and person-specific effects that play a role in changing individual wage outcomes. Covariates with "person-specific effects" are those that affect individual wages in different ways but are constant across time, such as childhood socioeconomic status (SES), intelligence, or ethnicity. Covariates with "year-specific effects" are those that affect all individuals' wages in the same way but change over time, such as income tax rates, national policy, the rate of inflation, economic growth, etc. This model contains three error terms: ε_{it} represents the random variation of each individual at each wave, u_i represents the effect of all unobserved variables on wage outcomes that vary across individuals but are constant over time, and v_j represents unobserved variations at the household level.

When estimating first-difference equations, the factors that are constant over time such as, $\sum_{m=1}^{M} r_m z_m$ and u_i are removed from the equation, and the final equation is written as:

$$\ln(Wage_{it}) - \ln(Wage_{it-1}) = \Delta\alpha + \sum_{k=1}^{K}(\beta_k - \beta_{k-1})(x_{2it} - x_{kit-1}) + \Delta\varepsilon_{it} \quad (2)$$

Finally, we believe that body size may have different impacts on men's and women's wages; based on the previous discussion, the models were run separately by gender. In addition, we argue that the wage penalty for non-manual workers living in urban areas will be more pronounced; we ran the models separately for manual/non-manual workers and by residential areas. To test if the effects of focal variables of interest varied significantly with regard to manual/non-manual workers or urban/rural areas, we formally tested differences between manual/non-manual workers and urban/rural areas with fully interactive models that reproduced our manual/non-manual worker- and urban/rural area- specific models. In addition, we used marginal effects measurements to evaluate the instantaneous change in the wage as a function of a change in BMI divided by survey years while keeping all the other covariates constant. We present the figures based on the marginal effect measurement to interpret the effect on wages of all the regressors by gender and occupations. All FE models were run on Stata, Version 13 (Stata Corporation, College Station, TX, USA).

Results

Tables 1 and 2 present descriptive statistics by person-year divided by survey year and gender. These are means-averaged across all person-years from 1991 to 2011. Both men and women are more likely to be non-manual workers during 1991–2011. Women report health constraints slightly more frequently, while men are older, work longer hours per day, and are more likely to be married and live in rural areas. The average wage for men is also higher than that for women during 1991–2007.

In general, BMI is slightly higher for men than women; the rate of being overweight or obese (BMI $\geq$ 24) also increased more drastically for men than women between 1991 and 2011. For example, the incidence of being overweight or obese for women is 24.07 % in 1991 and 32.30 % in 2011, while for men those figures respectively, are 22.36 and 51.41 %.

Tables 3 and 4 present the estimated effects of BMI on log wages during 1991–2011 separated by gender based on FE linear regression. Years of education, marital status, health constraints, working hours, and household fixed-effects are controlled in all models; survey year is also controlled, but coefficients for survey year main effects are not shown in the tables. In these models, all coefficients refer to the per cent change in wages. The quadratic model of the relationship between BMI and wages provides outcomes similar to the linear relationship between BMI and

Table 1 Descriptive statistics by survey stage, CHNS 1991–2011 (women)

	1991		1993		1997		2000		2004		2006		2009		2011	
	Mean or %	SD	Mean or %	SD	Mean or %	SD	Mean or %	SD	Mean or %	SD	Mean or %	SD	Mean or %	SD	Mean or %	SD
Body mass index (kg/m^2)	22.10	2.86	22.16	2.92	22.68	3.05	22.98	3.21	22.41	3.01	22.28	2.95	22.43	3.07	23.10	4.06
Overweight or obeseobesity (BMI $\geq$ 24, %)	24.07		25.78		32.27		34.51		37.24		25.19		27.32		32.30	
Health constraints (%)	8.93		6.00		6.54		4.55		11.02		7.24		10.17		13.19	
Age (years)	33.40	8.92	34.13	8.74	35.66	8.73	37.40	8.52	37.51	8.78	38.06	8.83	38.62	8.96	38.41	8.60
Married (%)	78.00		78.41		81.22		79.97		82.99		84.16		82.72		85.04	
Education (years)	9.02	3.51	9.16	3.56	9.76	3.48	10.64	3.37	11.56	3.28	11.83	3.42	11.52	3.60	12.03	3.50
Working hours (day)	7.94	1.09	7.92	1.29	7.82	1.30	7.83	1.48	7.99	1.44	8.10	1.42	8.21	1.51	8.06	1.43
Wage (per 100 yuan/month)	.98	.46	1.53	1.32	3.75	2.51	5.56	5.34	8.32	7.40	9.65	8.85	14.07	14.37	22.03	23.82
Log wage	4.50	.50	4.85	.62	5.80	.50	6.16	.51	6.54	.57	6.69	.57	7.05	.59	7.64	.62
Non-manual labourers (%)	71.12		65.59		71.07		79.46		81.89		82.50		82.34		88.15	
Urban residents (%)	61.98		58.03		60.64		55.89		58.58		54.15		51.84		62.07	
Observations[a]	1018		834		719		594		635		663		787		1350	

[a] The observations in table refer to individuals having two or more observations during any given year between 1991 and 2011 and were included in our final fixed-effects linear regression. This accounts for the sample size variation over time

Table 2 Descriptive statistics by survey stage, CHNS 1991–2011 (men)

	1991		1993		1997		2000		2004		2006		2009		2011	
	Mean or %	SD	Mean or %	SD	Mean or %	SD	Mean or %	SD	Mean or %	SD	Mean or %	SD	Mean or %	SD	Mean or %	SD
Body mass index (kg/m^2)	22.04	2.78	22.12	2.67	22.94	2.99	23.37	3.20	23.99	3.30	23.90	3.17	23.84	3.39	24.21	4.17
Overweight or obeseobesity (BMI $\geq$ 24, %)	22.36		22.62		32.61		40.14		47.08		47.34		47.62		51.41	
Health constraints (%)	8.72		4.80		6.19		5.50		10.49		8.85		6.89		10.14	
Age (years)	35.31	9.43	36.35	9.47	37.64	9.63	38.54	9.45	39.73	9.26	40.26	9.22	40.67	9.21	40.48	9.13
Married (%)	82.32		81.53		81.22		81.96		85.70		86.15		85.84		86.70	
Education (years)	9.42	3.37	9.53	3.23	9.94	3.20	10.57	3.20	11.43	3.10	11.59	3.26	11.09	3.27	11.92	3.34
Working hours (day)	7.98	1.02	7.88	1.24	7.88	1.36	7.97	1.47	8.22	1.77	8.12	1.50	8.25	1.59	8.27	1.54
Wage (per 100 yuan/month)	1.22	.73	1.90	1.96	4.71	3.45	7.20	8.29	9.84	9.77	13.11	17.77	20.24	28.04	28.24	30.22
Log wage	4.69	.53	5.04	.63	5.99	.56	6.34	.62	6.72	.53	6.94	.58	7.35	.60	7.72	.59
Non-manual labourers (%)	72.64		65.74		71.52		74.91		74.73		73.44		74.20		74.98	
Urban residents (%)	56.30		50.13		52.12		48.63		53.04		48.13		47.53		56.90	
Observations[a]	1261		1083		969		837		839		881		1031		1587	

[a] The observations in table refer to individuals having two or more observations during any given year between 1991 and 2011 and were included in our final fixed-effects linear regression. This accounts for the sample size variation over time

Table 3 BMI on wage outcomes based on linear RE and FE regression models, CHNS 1991–2011 (women)

	Random effect	Fixed effect					
	All	All		Urban		Rural	
				Non-manual	Manual	Non-manual	Manual
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
BMI	−.000 (.002)	.000 (.003)	.022*** (.006)	.024** (.008)	.023 (.021)	.021* (.009)	.007 (.014)
Education (years)	.041*** (.002)	.023*** (.003)	.023*** (.003)	.030*** (.004)	.008 (.009)	.021*** (.005)	−.002 (.009)
Working hours (day)	.032*** (.005)	.031*** (.006)	.031*** (.006)	.030** (.010)	.021 (.027)	.033** (.011)	.058*** (.017)
Married (ref. = non-married)	.118*** (.020)	.087*** (.021)	.081*** (.021)	.060* (.030)	.206* (.086)	.101** (.034)	.138† (.075)
Health constraints	−.015 (.023)	−.016 (.025)	−.020 (.025)	−.011 (.033)	.000 (.090)	−.015 (.051)	−.192* (.085)
1991 × BMI (reference)			–	–	–	–	–
1993 × BMI			−.011 (0.008)	−.020 (.014)	−.041† (.022)	.016 (.014)	−.011 (.019)
1997 × BMI			−.014† (.008)	−.004 (.013)	−.029 (.024)	−.009 (.015)	−.014 (.019)
2000 × BMI			−.023** (.008)	−.030* (.012)	−.021 (.027)	−.020 (.016)	.005 (.019)
2004 × BMI			−.026** (.008)	−.017 (.013)	−.043 (.035)	−.032* (.014)	−.002 (.021)
2006 × BMI			−.020* (.009)	−.031* (.012)	−.006 (.024)	−.014 (.015)	.008 (.032)
2009 × BMI			−.036*** (.009)	−.053*** (.013)	.021 (.046)	−.006 (.014)	−.028 (.028)
2011 × BMI			−.032*** (.007)	−.039*** (.010)	−.005 (.031)	−.021* (.011)	−.036 (.023)
Constant	3.768*** (.074)	3.992*** (.084)	3.511*** (.141)	3.479*** (.224)	3.461*** (.451)	3.484*** (.225)	3.806*** (.385)
R squared	–	.85	.85	.86	.83	.86	.88
Adj. R squared	–	.83	.83	.84	.77	.83	.83
Observations	6600	6600	6600	2956	692	2203	749

All models are controlled for survey year and individual/household fixed effects. Robust standard errors are reported in parentheses

*** $p < .001$; ** $p < .01$; * $p < .05$; † $p < .10$

Table 4 BMI on wage outcomes based on linear RE and FE regression models, CHNS 1991–2011 (men)

	Random effect	Fixed Effect					
	All	All		Urban		Rural	
				Non-manual	Manual	Non-manual	Manual
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
BMI	.007** (.002)	.006** (.002)	.016** (.005)	.018* (.007)	.001 (.019)	.018* (.008)	−.003 (.020)
Education (years)	.021*** (.002)	.017*** (.003)	.016*** (.003)	.023*** (.004)	.010 (.010)	.009* (.004)	.017† (.009)
Working hours (day)	.037*** (.004)	.037*** (.007)	.038*** (.007)	.023† (.012)	.046* (.019)	.048*** (.013)	.053*** (.013)
Married (ref. = non-married)	.207*** (.018)	.228*** (.019)	.226*** (.019)	.229*** (.030)	.205** (.070)	.175*** (.034)	.326*** (.048)
Health constraints	.007 (.022)	−.011 (.026)	−.010 (.026)	.047 (.035)	−.139 (.118)	−.021 (.044)	−.026 (.092)
1991 × BMI (reference)			–	–	–	–	–
1993 × BMI			−.011 (.008)	−.028* (.012)	.034 (.032)	.005 (.015)	−.009 (.023)
1997 × BMI			−.016* (.008)	−.019 (.012)	−.008 (.028)	−.038** (.013)	.075* (.030)
2000 × BMI			−.007 (.008)	.000 (.012)	−.021 (.027)	−.005 (.016)	−.014 (.028)
2004 × BMI			−.006 (.007)	−.006 (.012)	−.005 (.027)	−.013 (.012)	−.010 (.026)
2006 × BMI			.005 (.007)	−.003 (.012)	.015 (.025)	.004 (.012)	.039 (.029)
2009 × BMI			−.009 (.007)	−.019 (.011)	.012 (.026)	−.007 (.013)	.007 (.024)
2011 × BMI			−.018** (.006)	−.017 (.009)	−.007 (.023)	−.025* (.010)	.012 (.022)
Constant	3.873*** (.063)	3.927*** (.082)	3.709*** (.127)	3.743*** (.187)	4.063*** (.464)	3.683*** (.216)	3.897*** (.421)
R squared	–	0.83	0.85	0.83	0.85	0.86	.85
Adj. R squared	–	0.81	0.83	0.76	0.82	0.81	.81
Observations	8488	8488	8488	3147	1024	3030	1287

All models are controlled for survey year and individual/*household* fixed effects. Robust standard errors are reported in parentheses

*** $p < .001$; ** $p < .01$; * $p < .05$; † $p < .10$

wages, and thus only the linear specification is shown. In addition, we investigated non-linear relationships between wage and being underweight, normal weight, overweight, and obese, but no evidence of non-linear relationships was found.

The results in Tables 3 and 4 indicate that in the random effect models, BMI is a significant, positive determinant of wage rates for men (Model 1, Table 4) but not for women (Model 1, Table 3). Similarly, FE regressions show that, for women, BMI and wages are not associated when this relationship is constrained to be constant across all years (Model 2, Table 3). Relaxing this constraint, however, shows evidence that the effect of BMI on wages for women varies by survey year (Model 3, Table 3), showing that wage disparities increase with weight gain by survey year: the year by BMI interactions are significantly negative in the year 1997 and later (Model 3, Table 3). For men, BMI is positively associated with wages (Model 2, Table 4); however, the effect of BMI on wages only differs from that witnessed in 1991 in the years 1997 and 2011 (Model 3, Table 4).

Furthermore, we examined whether the effects of BMI on wages vary by survey year divided by occupational groups and residential areas. Our results show that wage disparity increased over time for female non-manual labourers, particularly for those living in urban areas (Model 4, Table 3), but not for manual workers, regardless of residential area (Models 5 and 7, Table 3). No evidence exists showing that the wage gap increased over time for males, except for non-manual labourers living in rural areas in 2011 (Model 6, Table 4) and manual workers living in rural areas in 1997 (Model 7, Table 4).

To provide a good understanding of wage change by BMI in survey years relative to the reference year 1991, we further estimated the marginal effect of BMI on wages by survey year. The results are presented in Figs. 2 (women) and 3 (men). In addition, the appendix presents the instantaneous change in wages as a function of changes in BMI in 2000 and 2011 compared with 1991, while all the other covariates are kept constant. Note that the data gathered from individuals in the sample with BMIs less than 18 or greater than 30 are not included in the figures or appendix; the results show that trends continue for these extreme cases.

Figures 2 and 3 illustrate that, compared with 1991, wages increased significantly for years afterward regardless of gender or occupation. Table 3 shows that wage disparity increases by BMI for women after 1997. Specially, the appendix indicates that female non-manual workers with BMIs less than 24 enjoyed wages 1.56–1.69 times higher in 2000 than in 1991, while their overweight or obese counterparts made only 1.38–1.54 times more money (Appendix, Women, Model 1). In addition, the appendix shows that, except for male manual workers, the gaps of wage-increase rates between individuals with normal weight and their overweight or obese counterparts rose between 2000 and 2011, regardless of gender or occupation. For example, female manual workers with a BMI of 18 made 1.59 times more in 2000 than in 1991, while those with BMIs of 30 made only 1.49 times more, a factor lower only by .10 (Appendix, Women, Model 3). However, this gap increased to .42 in 2011. Although our FE models show no evidence of wage disparity increasing by BMI among female manual and male non-manual workers between 1991 and 2011 (Tables 3 and 4), if these gaps in wage-increase rates continue into the future, weight penalties may also emerge among female manual workers and male non-manual workers.

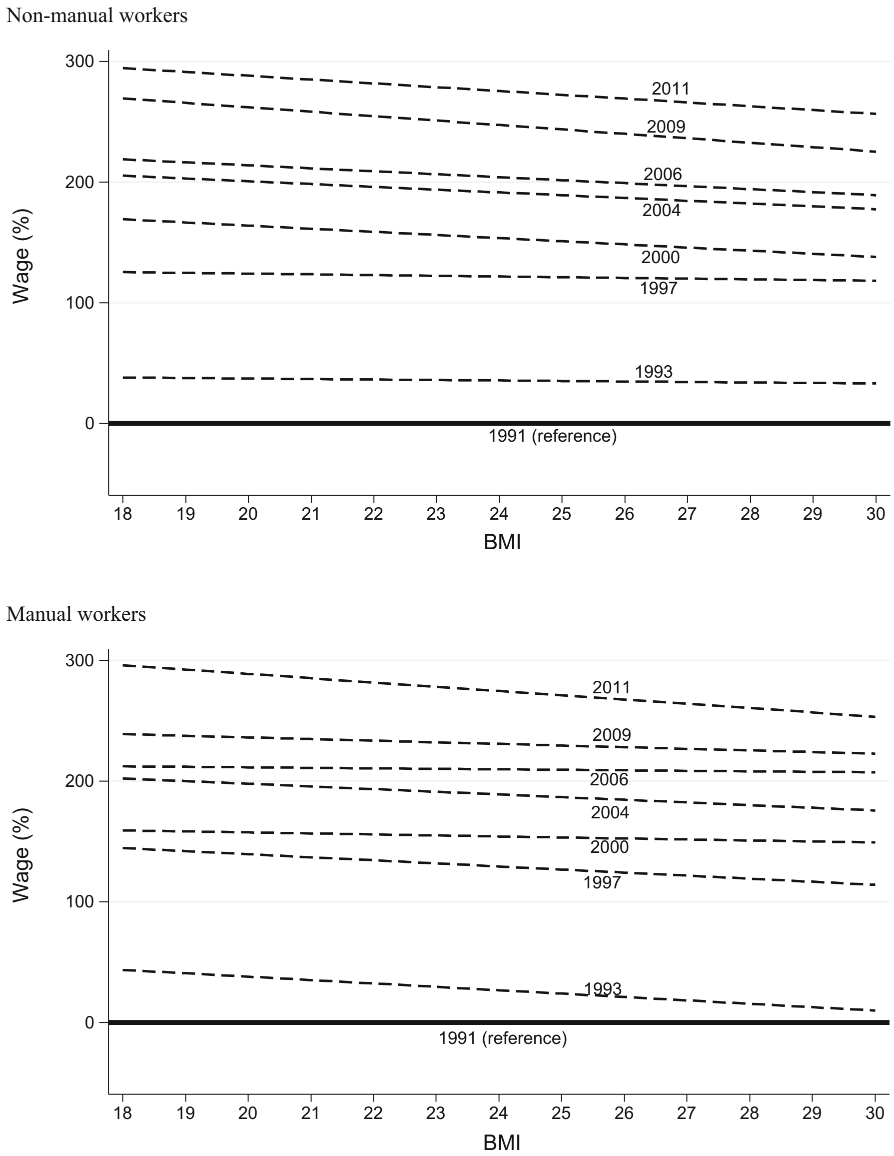

Fig. 2 Survey year wage differentials by BMI (women)

Discussion and conclusions

Past Western studies have established the negative association between obesity and wages, especially for women (Averett and Korenman 1996; Cawley 2004). However, whether the same weight-wage associations exist in modern China is still uncertain. China has been undergoing rapidly rising obesity rates starting in the late 1980s (Du et al. 2002; Ma et al. 2005; Wang et al. 2006). Our contribution in this

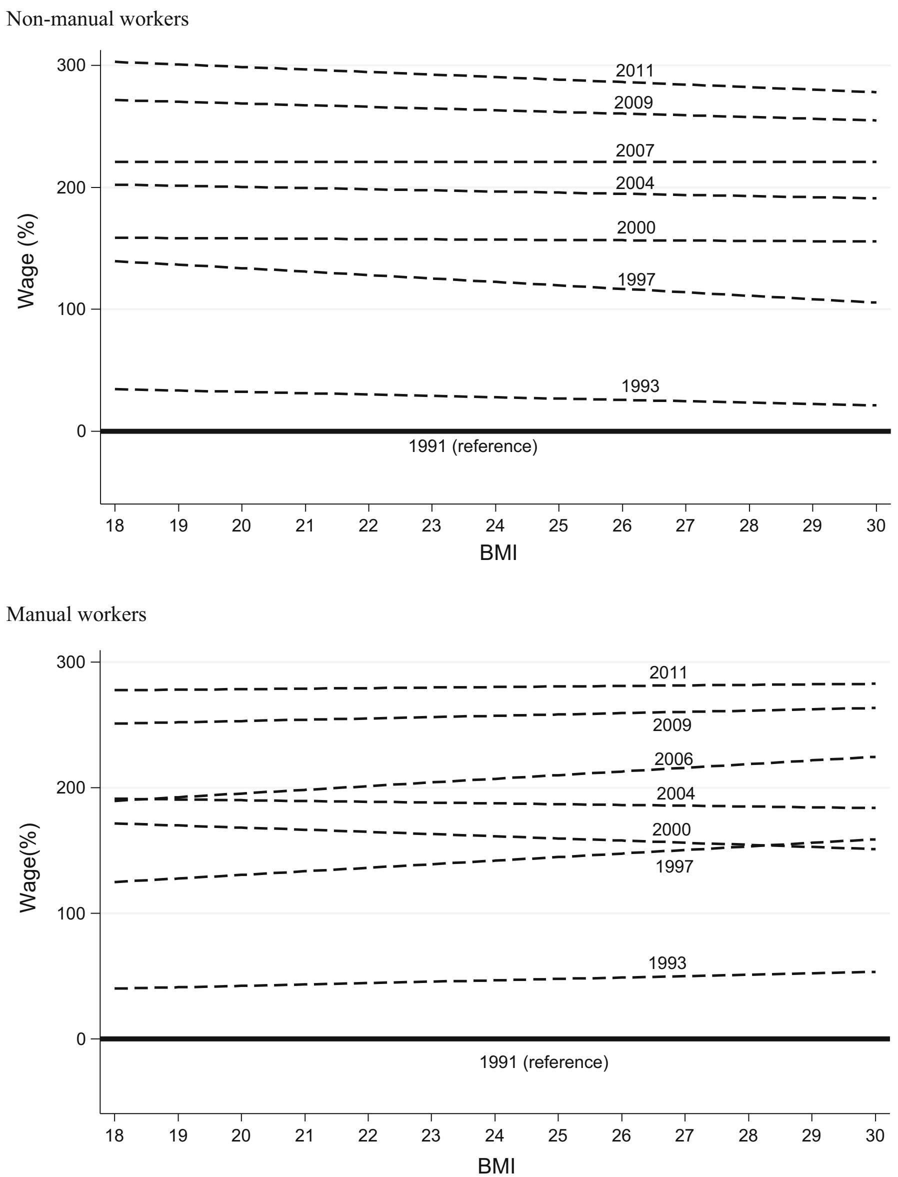

Fig. 3 Survey year wage differentials by BMI (men). The *dashed lines* represent the marginal effects of unit increase in the BMI. The *solid horizontal line* represents 1991, the reference year

paper is to examine China's experience of how increasing body weight affects individual economic wellbeing in the rapidly developing world and to compare these patterns to established research literature primarily from the West.

Our sample showed the incidence of being overweight or obese to be 32.30 % among female adults and 51.41 % among male adults in 2011, figures similar to estimates made by the World Health Organisation's Global Info Database in 2010, which indicated 32 % of female adults and 45 % of male adults in China were categorised as overweight or obese (Patterson 2011). This study proposes three main mechanisms by which body weight adversely affects wages. First, unobserved variables may cause both obesity and low wages, and second, lower wages may cause obesity. Third, the body type–wage differential may result from bias, prejudice, and distaste toward less attractive individuals in the workplace. We selected FE regression models because they are designed to study the causes of changes within an individual by controlling for potential unobserved heterogeneity bias and are efficient in estimating the effect of variables that vary considerably within an individual. In other words, standard regression models are more likely to suffer from omitted variable bias and spuriousness because unmeasured factors are likely to be correlated with both the dependent variable and key independent predictors. Our FE models offer stronger causal evidence because unmeasured factors that do not change within individuals over time cannot bias the relationship between the outcome and predictor variables (Allison 2009; Baltagi 2008; Wooldridge 2010). Therefore, we can minimize the first two mechanisms in explaining the relationship between body weight and wages. Further, we examined whether the association between BMI and wages varied by occupation type; employers for manual and non-manual occupations may discriminate differently with regards to body type. We supposed that gaining weight may have different impacts on wages for men and women because of diverse and gendered perceptions of physical attractiveness in terms of body size affected by Chinese sociocultural perspectives. In addition, past Western studies have shown that the obesity wage penalty is mostly found in occupations requiring a greater degree of social interaction (Han et al. 2009). We believed that the density in urban areas made interpersonal interactions relatively more frequent than in rural areas. Further, we assumed that occupations requiring frequent interpersonal interactions would display the most significant effects of BMI on wages in Chinese culture. Finally, China's government has shifted its policies away from aiding state-run and collectively owned enterprises primarily engaged in agricultural production, and toward promoting the growing service sector and privately owned industries. We believe that weight penalties have emerged in recent years because of rapid sociocultural changes in body perception and a simultaneous increase in the frequency of interpersonal interactions in workplaces, especially in urban areas within metropolitan districts. Our results show that the wages of female non-manual workers living in urban areas have been most significantly affected by weight penalties since 2000, when those wages are compared with wages earned in the reference year 1991. On the other hand, we found that heavier male manual workers enjoy a higher wage-increase rate than their thinner counterparts, but this association is not significant except in 1997. In general, we did not find wage disparity increasing by BMI among female manual and male non-manual workers, regardless of their residential areas, between 1991 and 2011; however, weight penalties may emerge among female manual workers and male non-manual workers if the gaps in wage-increase rates between individuals with normal weight and their overweight or obese counterparts continue to grow in the future.

Obesity is shown to be related to health, quality of life, sick leave, and workplace productivity (Gates et al. 2008; Hassan et al. 2003; Jia and Lubetkin 2005; Neovius et al. 2009; Van Duijvenbode et al. 2009). It is also well known that Asian populations are more vulnerable to obesity-attributable deaths and health concerns caused by obesity (Wen et al. 2009). China's experience suggests an urgent need to understand the underlying mechanism by which social determinants may contribute to the rapidly growing obesity gradient. Once we understand the causes, we can develop effective intervention strategies and lessen the high economic burden of obesity in the developing world. The study calls attention to the fact that Chinese society does not favour heavier women, at least as measured by their economic wellbeing in the workplace, contrary to the traditional view that plumpness was desirable and attractive in Chinese society. On the other hand, we found increasing economic rewards to obese manual workers, although the increase is not significant. It is unlikely that the wage gaps for manual workers are due to a sociocultural preference for obese employees, whose rate of interpersonal interactions in the workplace is lower; however, given the lack of public awareness of the risks of obesity, Chinese public health strategies for preventing and controlling obesity should target male manual labourers, the most vulnerable population in the future.

This study has some limitations. First, we are aware that the FE model improves on the random effects model, but it is not ideal if unobserved factors exist that vary over time in a way that can influence both BMI and wages. Further, unemployed individuals have been eliminated from the sample, and past studies have demonstrated that obese individuals are less likely to be employed than their non-obese counterparts (Averett and Korenman 1996; Gortmaker et al. 1993). Future studies should examine whether obesity is associated with the risk of unemployment. Third, BMI is a number calculated from weight and height; as a result, muscularity and body fat can both contribute to increasing body mass index. Furthermore, the simplistic classification of occupations and residential areas prevents us from refining the mechanisms underlining the association between body size and wage outcomes. Whether discrimination by employers, customers, or colleagues is responsible for wage disparities by occupation needs further investigation. While our results cannot isolate discrimination as a cause, the pattern of our results is consistent with body-type discrimination. Finally, the CHNS survey only followed up individuals who continued to reside in selected households in any given year; individuals who moved out of their households were not followed. For that reason, we are unable to estimate the association between body weight and economic well-being among individuals who no longer lived in their original households. Despite these limitations, our work has made important first steps to test how obesity and wages are associated in the rapidly developing world, a relationship that is likely to gain increasing importance as the incidence of being overweight or obese spreads across the globe.

Appendix

See Table 5.

Table 5 Marginal effect of BMI on log wage by occupation in 2000 and 2011 (reference = 1991)

WHO weight status definition (universal criteria)	Chinese weight status definition	BMI	Non-manual		Manual	
			2000 Model 1	2011 Model 2	2000 Model 3	2011 Model 4
Women						
		18	1.69*** (.06)	2.95*** (.05)	1.59*** (.11)	2.96*** (.13)
		19	1.67*** (.05)	2.91*** (.05)	1.58*** (.10)	2.92*** (.12)
		20	1.64*** (.04)	2.88*** (.04)	1.58*** (.08)	2.89*** (.10)
		21	1.61*** (.04)	2.85*** (.04)	1.57*** (.07)	2.85*** (.09)
		22	1.59*** (.04)	2.82*** (.04)	1.56*** (.06)	2.82*** (.08)
		23	1.56*** (.04)	2.79*** (.04)	1.55*** (.06)	2.78*** (.08)
	Overweight	24	1.54*** (.04)	2.76*** (.04)	1.54*** (.06)	2.75*** (.08)
Overweight		25	1.51*** (.04)	2.73*** (.04)	1.55*** (.07)	2.71*** (.09)
		26	1.48*** (.05)	2.69*** (.05)	1.53*** (.07)	2.68*** (.10)
		27	1.46*** (.05)	2.66*** (.05)	1.52*** (.09)	2.64*** (.11)
	Obese	28	1.43*** (.06)	2.63*** (.06)	1.51*** (.10)	2.61*** (.13)
		29	1.41*** (.07)	2.60*** (.06)	1.50*** (.12)	2.57*** (.14)
Obese		30	1.38*** (.08)	2.57*** (.07)	1.49*** (.13)	2.54*** (.16)
Difference between wage-increase rates for workers with BMIs 18 and 30			.31	.38	.10	.42

Table 5 continued

WHO weight status definition (universal criteria)	Chinese weight status definition	BMI	Non-manual		Manual	
			2000 Model 1	2011 Model 2	2000 Model 3	2011 Model 4
Men						
		18	1.59*** (.06)	3.03**** (.05)	1.72*** (.11)	2.78*** (.10)
		19	1.58*** (.05)	3.01*** (.05)	1.70*** (.09)	2.78*** (.09)
		20	1.58*** (.05)	2.99*** (.04)	1.68*** (.08)	2.79*** (.08)
		21	1.58*** (.04)	2.97*** (.04)	1.67*** (.07)	2.79*** (.07)
		22	1.58*** (.04)	2.95*** (.04)	1.65*** (.06)	2.79*** (.07)
		23	1.57*** (.04)	2.93*** (.04)	1.63*** (.06)	2.80*** (.07)
	Overweight	24	1.57*** (.04)	2.90*** (.04)	1.61*** (.07)	2.80*** (.07)
Overweight		25	1.57*** (.05)	2.88*** (.04)	1.60*** (.08)	2.81*** (.08)
		26	1.57*** (.05)	2.86*** (.04)	1.58*** (.09)	2.81*** (.09)
		27	1.56*** (.05)	2.84*** (.05)	1.56*** (.11)	2.82*** (.10)
	Obese	28	1.56*** (.06)	2.82*** (.05)	1.55*** (.13)	2.82*** (.11)
		29	1.56*** (.07)	2.80*** (.06)	1.53*** (.14)	2.82*** (.13)
Obese		30	1.56*** (.08)	2.78*** (.06)	1.51*** (.16)	2.83*** (.14)
Difference between wage-increase rates for workers with BMIs 18 and 30			.03	.25	.21	−.05

We employed models separated into gender subgroups, controlling for education, working hours, marital status, health constraints, and household fixed effects. The unit of analysis is person-years. Estimates displayed in the table are calculated marginal effects from the interaction terms of BMI in survey years 2000 and 2011, using survey year 1991 as the reference group. Standard errors are reported in parentheses *** $p < .001$, ** $p < .01$, * $p < .05$, † $p < .10$

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