Original Article

Understanding the differences in obesity among working adults between Taiwan and China

Satoru Shimokawa PhD[1], Hung-Hao Chang PhD[2] and Per Pinstrup-Andersen PhD[3]

[1]*Division of Social Science, Hong Kong University of Science and Technology, Kowloon, Hong Kong*
[2]*Department of Agricultural Economics, National Taiwan University, Taipei, Taiwan*
[3]*Division of Nutritional Science, Cornell University, Ithaca, New York, USA*

Objective: To investigate the difference in the prevalence of obesity and the associations between the risk of obesity and socioeconomic factors with regard to working adults in China and Taiwan. Data: the 2000 China Health and Nutrition Survey and the 2001 National Health Interview Survey in Taiwan, which contains information from 20-60-year-old working adults in China (3,067 men and 2,998 women) and Taiwan (6,475 men and 6,341 women). Method: Variables were converted to cross-economy comparable forms, and the estimated prevalence of obesity across socioeconomic groups was compared between China and Taiwan. Probit models were used to examine the associations between socioeconomic factors and the probability of being obese. Results: In China, the prevalence of obesity was higher in the higher income, more educated, and more sedentary occupation groups, while it was higher in the lower income and less educated groups in Taiwan. Also, our results indicate that occupational types rather than income and education levels are more significantly associated with the probability of being obese in China, whereas income and education levels rather than occupational types are more significantly associated with the probability of being obese in Taiwan. These findings may indicate that, when an economy becomes more developed, the association between obesity risk and income and education levels becomes more significant and negative especially among women, while the association between obesity risk and occupational types decreases especially among men.

Key Words: obesity, socioeconomic factors, adults, Taiwan, China

INTRODUCTION

An estimated one to two billion people in the world are obese. A rapidly increasing prevalence of obesity and its social and economic costs have been recognized as important public health and economic development problems not only in high-income countries but also in middle- and low-income countries.[1-5] However, the prevalence of obesity across socioeconomic and demographic groups differs across countries. In general, high prevalence of obesity tends to be evident among the poor population in high-income countries, and among the rich population in low-income countries. In some middle- and low-income countries, however, the burden of obesity has been shifting from the rich towards the poor population.[3,4] In addition, evidence has shown that women are more likely to be obese than men in some countries (e.g., Cuba, Brazil, and South Africa), while the opposite is found in other countries (e.g., Austria, Belgium, and Spain).[3,6] These findings may imply that the effect of socioeconomic and demographic factors on the risk of obesity is influenced by the level of economic development and country specific variables. In particular, understanding how the associations between socioeconomic factors and obesity risk may change, following economic transition is of particular policy interests for the authorities in transition economies to effectively prevent obesity through public interventions.

Comparisons of the prevalence of adult obesity across countries have been studied in prior literature. Since the prevalence of obesity is at least partly determined by socioeconomic factors such as diets,[7] physical activity,[8,9] residential place,[10] employment status,[11] and leisure,[12] some studies have compared the relationship between socioeconomic factors and the risk of obesity across countries.[1,3,4,13] However, most studies made comparisons between countries with different background such as the comparisons between China, Brazil, and the United States.[13] Such comparisons may provide limited knowledge for understanding the extent to which socioeconomic factors affect the risk of being obese because they fail to control for the effects of genetic and cultural difference, or other unobserved factors between countries on the disparity in the prevalence of obesity.

This study compares the role of socioeconomic factors in predicting the risk of obesity in Taiwan and China. To

Corresponding Author: Hung-Hao Chang, Department of Agricultural Economics, National Taiwan University, Taipei 10617, Taiwan.
Tel: (886)2-33662656; Fax: (886)2-23628496
Email: hunghaochang@ntu.edu.tw
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the best of our knowledge, this comparison had not been studied in the existing literature. In addition, in contrast to previous studies of cross-county comparison, Taiwan and China share similar genetic and cultural characteristics. At the same time, the levels of economic development in Taiwan and China are significantly different. Thus, conducting the comparison between Taiwan and China provides useful information to examine the role of socioeconomic factors in predicting the risk of obesity at the different levels of economic development. This paper pays special attention to income levels, education levels, and occupational types as key socioeconomic factors that may be associated with obesity risk and change through the transition of economy. From a public policy standpoint, Taiwan's experience provides useful information for policy makers of China to predict how the prevalence of obesity would change in China if China's current economic development continues, in order to develop a better strategy to prevent increasing obesity through socioeconomic policies.

DATA AND METHODS

Our sample consists of 20-60 year-old workers and is drawn from the 2000 China Health and Nutrition Survey (CHNS) in China and the 2001 National Health Interview Survey (NHIS) in Taiwan. The CHNS covered 9 provinces that vary substantial in geography, economic development, and health indicators. [13] On the other hand, NHIS consists of data collected from residents in major areas in Taiwan, with rich information on controllable health conditions. In addition to the socioeconomic factors, questions related to cigarette smoking, alcohol use, and body weight were also included in the survey. The details of the sampling design and methods for these surveys are described on the CHNS website (http://www.cpc.unc.edu/china) and the NHIS website (http://nhis.nhri.org.tw), respectively. We excluded pregnant women from both samples, and further restricted our analysis to respondents who reported complete information of key variables such as income and education histories. We also dropped potential outliers by restricting the samples to include only individuals with BMI above 14 and below 50. This sample selection criterion yielded 3,067 male workers and 2,998 female workers in China and 6,475 male workers and 6,341 female workers in Taiwan.

Anthropometric measures

Height and weight were measured in physical examination in the CHNS while self-reported in the NHIS. To examine the potential influence of this difference on our results, we compared our results of Taiwan to the findings in Chu (2005).[14] Chu (2005) estimated obesity rates in Taiwan using the Nutrition and Health Survey in Taiwan (NAHSIT) in which weight and height were directly measured. We use body mass index (BMI [kg/m^2]) and three distinct cut-off points of 25, 27, and 28 to define obesity. The cut-off points of obesity for Asians are still inconsistent. And, a cut-off of 25 is recommended for defining obesity among Asian adults,[16] whereas cut-offs of 27 and 28 are recommended for Taiwanese adults[14] and Chinese adults,[17] respectively.

Socioeconomic Factors

To make the appropriate comparison between Taiwan and China, we transformed the original data in several ways. First, four per capita income levels (Lowest 25%, Lower Middle 25%, Upper Middle 25%, and Highest 25%) were defined by the 25^{th}, 50^{th}, and 75^{th} quantiles (For more careful examination of the relationship between income and BMI, see Jolliffe 2007).[18] Because the NHIS in Taiwan provides only categorical household income, we calculated per capita household income by assigning a mean of each category to the belonging households and dividing the mean by the household size. On the other hand, the CHNS collected a continuous per capita income. Thus, we check the robustness of our results by comparing the results between the categorical income and the continuous income cases for China.

To capture the level of human capital, we included indicators for worker's highest education level attained, Very Low, Low, Middle, and High. *Very Low* is defined as 'quit primary school or lower'; *Low* as 'attain primary school'; *Middle* as 'attain lower or upper middle school'; and *High* as 'attain above upper middle school'.

To capture individual's daily energy expenditure, we classified primary occupations into four categories using the criteria for 'physical demands - strength rating' in the Dictionary of Occupational Titles (DOI).[15] The categories are sedentary, light, medium, and heavy (Heavy and Very Heavy in the DOI are combined). In general, sedentary and light work involves lifting only negligible amount of weight (e.g., office work), while sedentary work involves sitting most of the time, light work requires a significant degree of walking and standing or constant lifting of materials with negligible weight. In contrast, medium and heavy work involves lifting a significant amount of weight (e.g., farming). Medium work requires exerting 20-50 pounds of force occasionally, and heavy work requires exerting larger than 50 pounds of forth occasionally.

The patterns of energy intake (i.e., food consumption) and energy expenditure may also differ by the location where people live even if they are classified into the same income, education, and occupational categories. To control such heterogeneity, we include an urban dummy and several region dummies. We used the urban dummy defined by the population density at the county level (see the CHNS and the NHIS websites for more detailed definition). For the regional dummies, we divided Taiwan into northern, central, eastern, and southern regions, and divided China into east coastal, central, north eastern, and western regions.

In addition, a quadratic term for age in years was specified to allow for non-linearity effect of age on the probability of being obese. We use age in years as a continuous variable rather than several categorical variables because it is necessary to include at least one continuous variable in the probit model. We also included indicators for the current status of smoking, drinking, and health insurance. These factors may directly influence the risk of being obese or may be indirectly correlated with the risk of being obese through the respondent's attitude of health risks.

Statistical Analysis

Empirical analyses were conducted using Stata 10 (StataCorp, Taxas, USA, 2007). We first estimated the prevalence of obesity for each socioeconomic and demographic group to clarify the difference in the prevalence of obesity across socioeconomic and demographic groups in China and Taiwan. We took the sampling survey design into account, and constructed 95% confidence intervals for the estimates. To further investigate the associations between the risk of being obese and socioeconomic status, we estimated the probit models by gender. The *p*-values were obtained using Wald tests adjusted for the clustered survey designs. The estimated coefficients of the probit model were interpreted by calculating the marginal effects, which capture the effects of an additional unit change in the exogenous determinants (i.e., socioeconomic factors) on the risk of being obese. The marginal effect of each variable was evaluated at the mean level of the sample.

RESULTS

Table 1 shows that the socioeconomic and demographic compositions are significantly different between Taiwan and China. Because our estimation uses four quantile categories of per capita income, the proportions of such categories will be about the same in Taiwan and China. Thus, Table 1 presents the proportion under the national poverty line to compare economic status in Taiwan and China. In our sample, the proportions of high education and sedentary and light work are higher in Taiwan, whereas the proportions of lower education, medium and heavy work, and people under the national poverty line are higher in China. We examine how these differences can explain the differences in obesity prevalence between Taiwan and China.

We start our analysis by discussing the extent to which obesity rates may differ across per capita income levels, education levels, and occupational types by country and gender (Table 2). Obesity rates are estimated for the cut-off of 25 and the national cut-off of each economy. Because the patterns of obesity prevalence between genders and across socioeconomic factors are robust against the

Table 1. Socio-demographic composition of our sample between genders and between Taiwan and China

		Taiwan (% share)			China (% share)			Taiwan-China Differences (% share)		
		Men	Women	Diff	Men	Women	Diff	Men	Women	Total
Age	20y-35y	41.4	39.3	2.1***	31.6	33.9	-2.3*	9.8***	5.4***	7.6***
	35y-50y	41.9	42.4	-0.5	47.2	49.0	-1.8	-5.3***	-6.6***	-5.9***
	50y-60y	16.7	18.3	-1.6**	21.2	17.1	4.1***	-4.5***	1.2	-1.7***
Education Level	Very Low	2.0	8.4	-6.3***	13.8	28.1	-14.4***	-11.7***	-19.8***	-15.7***
	Low	14.5	18.8	-4.4***	20.5	21.2	-0.7	-6.0***	-2.3***	-4.2***
	Middle	20.6	16.8	3.8***	53.1	40.7	12.3***	-32.5***	-23.9***	-28.3***
	High	63.3	56.9	6.4***	12.7	10.0	2.7***	50.6***	47.0***	48.8***
Occupational Type	Sedentary	38.3	33.9	4.4***	10.8	7.2	3.6***	27.5***	26.7***	27.1***
	Light	27.4	47.5	-20.1***	18.1	18.0	0.1	9.3***	29.5***	19.3***
	Medium	8.8	6.2	2.6***	13.8	8.4	5.4***	-5.0***	-2.2***	-3.6***
	Heavy	23.4	12.7	10.8***	57.3	66.4	-9.1***	-33.9***	-53.7***	-43.7***
Per capita income (1=poverty; 0=non-poor)	Poverty	14.5	14.9	-0.4	24.8	25.2	-0.4	-10.3***	-10.3***	-10.3***
Smoke (1=Yes; 0=No)		50.1	4.3	45.8***	60.4	2.9	57.4***	-10.3***	1.3***	-4.6***
Drink (1=Yes; 0=No)		46.6	11.0	35.6***	64.0	9.8	54.2***	-17.4***	1.2	-8.2***
Medical insurance (1=Have; 0=Otherwise)		97.4	98.6	-1.1***	23.4	19.5	3.9***	74.0***	79.1***	76.5***
Urban (1=urban; 0=Rural)		55.5	57.6	-2.1**	65.6	64.9	0.8	-10.2***	-7.3***	-8.7***
Regions (Taiwan)	North	27.8	28.2	-0.3	-	-	-	-	-	-
	Central	32.6	32.3	0.4	-	-	-	-	-	-
	South	32.9	33.2	-0.3	-	-	-	-	-	-
	East	4.7	4.6	0.1	-	-	-	-	-	-
Regions (China)	East Coast	-	-	-	21.6	21.4	0.2	-	-	-
	Central	-	-	-	30.3	30.9	-0.6	-	-	-
	Northeast	-	-	-	25.2	23.7	1.4	-	-	-
	West	-	-	-	22.9	23.9	-1.0	-	-	-
Total Observation Number		6,475	6,341		3,067	2,998				

Note: (1) Differences in the % shares are tested using a t test where variances are assumed different between compared groups. *, **, and *** represent the significance at the 10, 5, and 1 percent level.

(2) Income poverty is defined by the national poverty line for each of Taiwan (7,598 new Taiwan dollars) and China (625 Chinese yuan).

Data Source: We use data from the 2000 China Health and Nutrition Survey and the 2001 National Health Interview Survey in Taiwan.

Table 2. Prevalence of obesity by gender, education level, occupational type, and per capita income level in Taiwan and China (%)

	Taiwan				China			
	25≤BMI		27≤BMI		25≤BMI		28≤BMI	
	Men	Women	Men	Women	Men	Women	Men	Women
Overall	36.9 (35.7, 38.1)	25.1 (24.0, 26.2)	20.4 (19.4, 21.3)	16.0 (15.1, 16.9)	22.2 (20.7, 23.6)	22.7 (21.2, 24.2)	6.1 (5.3, 7.0)	6.6 (5.7, 7.4)
Education								
Very Low	57.6 (49.0, 66.1)	63.2 (59.1, 67.3)	44.7 (36.1, 53.3)	51.3 (47.1, 55.6)	15.8 (12.4, 19.3)	23.6 (20.7, 26.4)	3.5 (1.7, 5.2)	6.4 (4.8, 8.0)
Low	45.8 (42.6, 49.0)	43.9 (41.1, 46.8)	27.9 (25.0, 30.7)	28.1 (25.6, 30.7)	18.6 (15.6, 21.6)	23.9 (20.6, 27.2)	4.4 (2.8, 6.0)	7.6 (5.5, 9.6)
Middle	37.0 (34.4, 39.6)	24.9 (22.3, 27.5)	20.7 (18.5, 22.8)	15.4 (13.2, 17.6)	20.9 (19.0, 22.9)	23.3 (20.9, 25.6)	6.4 (5.3, 7.6)	7.0 (5.6, 8.4)
High	34.3 (32.9, 35.8)	13.8 (12.7, 14.9)	17.8 (16.7, 19.0)	7.4 (6.6, 8.3)	40.2 (35.3, 45.0)	15.1 (11.0, 19.1)	10.6 (7.6, 13.7)	3.3 (1.3, 5.3)
Occupation Type								
Sedentary	38.0 (36.1, 39.9)	16.6 (15.0, 18.2)	19.9 (18.3, 21.4)	9.0 (7.8, 10.2)	36.1 (30.9, 41.2)	21.8 (16.3, 27.3)	10.4 (7.1, 13.6)	6.8 (3.5, 10.2)
Light	33.1 (30.9, 35.2)	28.9 (27.3, 30.5)	19.3 (17.5, 21.1)	20.0 (18.6, 21.5)	32.9 (29.0, 36.8)	25.2 (21.6, 28.9)	9.7 (7.3, 12.2)	7.8 (5.6, 10.1)
Medium	39.9 (35.8, 43.9)	29.4 (24.9, 33.9)	23.3 (19.8, 26.7)	16.7 (13.0, 20.4)	23.4 (19.4, 27.4)	24.4 (19.1, 29.7)	7.9 (5.3, 10.4)	7.4 (4.2, 10.6)
Heavy	37.4 (34.9, 39.8)	34.0 (30.7, 37.3)	21.4 (19.4, 23.5)	21.0 (18.2, 23.9)	15.9 (14.2, 17.6)	21.9 (20.1, 23.6)	3.8 (2.9, 4.7)	6.1 (5.1, 7.1)
Per Capita Income Level								
Lowest 25 %	40.7 (38.4, 43.0)	34.3 (32.1, 36.5)	25.5 (23.5, 27.6)	24.5 (22.5, 26.5)	16.6 (14.0, 19.3)	20.7 (17.9, 23.6)	4.1 (2.7, 5.5)	6.2 (4.5, 7.9)
Lower Middle 25%	35.8 (33.3, 38.3)	24.6 (22.3, 26.8)	18.8 (16.7, 20.8)	15.9 (14.0, 17.9)	19.2 (16.4, 22.0)	23.2 (20.2, 26.1)	5.2 (3.6, 6.7)	5.8 (4.2, 7.5)
Upper Middle 5%	35.6 (33.3, 37.9)	23.7 (21.7, 25.8)	19.1 (17.2, 21.0)	14.5 (12.7, 16.2)	22.5 (19.6, 25.5)	23.2 (20.2, 26.2)	6.5 (4.8, 8.3)	7.4 (5.6, 9.3)
Highest 25%	35.2 (32.9, 37.5)	16.5 (14.6, 18.3)	17.5 (15.7, 19.3)	8.1 (6.8, 9.5)	30.3 (27.0, 33.5)	23.6 (20.6, 26.6)	8.7 (6.7, 10.7)	6.8 (5.0, 8.6)

Note: the numbers in the parentheses following an estimate are the 95% binomial confidence intervals for the estimate.
Data Source: We use data from the 2000 China Health and Nutrition Survey and the 2001 National Health Interview Survey in Taiwan.

choice of the cut-offs, we focus on the results for the cut-off of 25. Overall, the obesity rate was about 22.5% in both gender groups in China, whereas men were more likely to be obese (36.9%) than women (25.1%) in Taiwan. Chu (2005) used the cut-off of 27 and observed a similar pattern in the prevalence of obesity in Taiwan using data from the 2000 NHIS in which height and weight were directly measured (15.9 and 10.7 % among men and women aged 20 or above, respectively).[15] Thus, the observed gender disparity in our results was not solely explained by the difference in survey methods between the CHNS and the NHIS.

Obesity rates were positively correlated with per capita income and education levels in China, while the opposite was found in Taiwan (Table 2). Moreover, obesity rates were significantly higher among workers engaged in sedentary work than those engaged in heavy work in China, while such a pattern was not evident in Taiwan. The relationships also differ by gender. Among Taiwanese women, obesity rates decreased significantly when per capita income level increased (from 34.3 to 16.5%); education level increased (from 63.2 to 13.8%); and occupations become more sedentary (from 34.0 to 16.6%). Among Taiwanese men, in contrast, obesity rates decreased much less when per capita income level increased (from 40.7 to 35.2%); education level increased (from 57.6 to 34.3%); and occupations become more sedentary (from 37.4 to 33.1%). Among Chinese men, obesity rates increased significantly when per capita income level increased (from 16.6 to 30.3%); education level increased (from 15.8 to 40.2%); and occupations become more sedentary (from 15.9 to 36.1%). However, among Chinese women, obesity rates are not significantly different across income levels and occupation types and increased significantly only when education level decreased (from 15.1 to 23.6%).

To have a better understanding on the association between the prevalence of obesity and socioeconomic factors in Taiwan and China, we conducted probit regression analysis. Because we observed significant differences in

Table 3. Marginal effects (at means) for probit regressions of an obesity indicator on socio-demographic variables

Dependent Variable: (1 if obese; 0 otherwise)		Taiwan				China			
		Men		Women		Men		Women	
Variables		25≤BMI	27≤BMI	25≤BMI	27≤BMI	25≤BMI	28≤BMI	25≤BMI	28≤BMI
Age	Linear	0.031***	0.013***	0.006	-0.003	0.030***	0.006*	0.033***	0.016***
	Squared	0.000***	0.000***	0.000	0.000**	0.000***	0.000*	0.000***	0.000***
Education	Low	-0.113**	-0.121***	-0.089***	-0.081***	0.021	0.007	0.015	0.009
	Middle	-0.151***	-0.159***	-0.156***	-0.116***	0.022	0.014	0.005	0.000
	High	-0.156***	-0.211***	-0.256***	-0.226***	0.091**	0.011	-0.123***	-0.038**
Per capita Income	Lower Middle 25%	-0.041**	-0.053***	-0.045***	-0.032***	-0.010	-0.002	0.004	-0.007
	Upper Middle 25%	-0.035**	-0.043***	-0.052***	-0.042***	-0.004	0.005	0.000	0.009
	Highest 25%	-0.039**	-0.052***	-0.095***	-0.080***	0.012	0.004	-0.017	0.003
Occupa-tional Type	Sedentary	0.002	0.008	-0.030*	-0.016	0.118***	0.047***	0.019	0.026
	Light	-0.012	0.004	-0.011	0.013	0.114***	0.047***	0.088***	0.036**
	Medium	0.027	0.030	0.001	-0.003	0.042*	0.034**	0.045	0.019
Smoke		-0.029**	-0.004	0.002	0.006	-0.031**	0.000	-0.095**	0.004
Drink		0.037***	0.004	-0.006	0.000	0.009	0.005	0.008	-0.023*
Insurance		-0.013	-0.019*	-0.025**	-0.015	0.030*	0.008	0.019	0.006
Urban		0.049	0.031	-0.091**	-0.083**	0.030	0.012	0.035	-0.014
Region (Taiwan)	North	-0.010	0.003	-0.038	-0.033*	-	-	-	-
	Central	-0.018	0.012	-0.042*	-0.038**	-	-	-	-
	South	0.018	0.028	0.007	0.006	-	-	-	-
Region (China)	East Coast	-	-	-	-	0.239***	0.080***	0.194***	0.053***
	Central	-	-	-	-	0.131***	0.053***	0.091***	0.033***
	North East	-	-	-	-	0.258***	0.091***	0.205***	0.068***
Observed probability		0.369	0.204	0.251	0.160	0.222	0.061	0.227	0.066
% Correctly Predicted		98.9%	97.6%	88.2%	79.9%	88.8%	81.3%	92.1%	84.5%
Wald Chi Squared		221.6	148.5	936.3	763.0	289.3	81.0	185.7	67.3
Pseudo R-squared		0.027	0.023	0.143	0.151	0.095	0.063	0.063	0.051
Observation Number		6,474		6,341		3,067		2,998	
Mean Variance Inflation Factor		10.68		9.11		8.50		8.39	

the relationship between obesity rates and socioeconomic factors by country and gender, the probit models were estimated by country and gender. Table 3 presents the marginal effects for the probit regressions. The marginal effects represent the change in the obesity risk of the average individual (i.e., the change in the conditional probability of being obese) for an infinitesimal change in each continuous independent variable or a discrete change in each dummy variable. In general, our models performed fairly well, and the Chi-squared statistics were ranged from 67 to 936. We also predicted whether or not each individual would be obese applying the prediction equations to our sample. When an individual's predicted probability of being obese was greater than 50%, the individual was predicted to be obese. Overall, 79.9 to 98.9% of observed BMI statuses were correctly predicted.

In Table 3, three findings are of notice. First, the marginal effects of all income dummies were negative and statistically significant in both gender groups in Taiwan, whereas the effects of all income dummies were insignificant in both gender groups in China. In Taiwan, the negative effects become more substantial for higher income levels among women, while the effects are approximately the same across income levels among men. For example, the conditional probability of being obese among Taiwanese women was 4.5 and 9.5 percent lower in the lower middle 25% and the highest 25% than the lowest 25%, respectively. In the CHNS data set, we also examined the effect of the continuous per capita income instead of the categorical dummies for the robust check of our finding. The marginal effect of the continuous per capita income was positive but insignificant. Moreover, we examined the effect of per capita income by excluding either education dummies or occupational dummies from our model. The marginal effect of per capita income was positive and significant at the 10 percent level only when we exclude occupation dummies among men (although the correlations between per capita income and occupation dummies are low [-0.17 to 0.29]); and the effects are insignificant for all other cases.

Second, the marginal effects of all education dummies were negative and statistically significant in both gender groups in Taiwan, whereas only the marginal effect of the high-education dummy was significant in both gender groups in China. In Taiwan, the negative effects become more substantial for higher education levels in both gender groups. In China, the marginal effect of the high-education dummy was positive for men and negative for women. For example, the conditional probability of being obese among Taiwanese women was 8.9 and 25.6 percent

lower in the low and high levels than in very low level, respectively.

Third, the marginal effects of occupational types tended to be more significant in China than in Taiwan. In China, the marginal effects of all occupational dummies are more significant and positive for more sedentary occupational type among men, while the effects are significant and positive only for light work among women. In Taiwan, only the marginal effects of sedentary work is significant and negative among women. For example, in China, the conditional probability of being obese was 4.2 and 11.8 percent point higher among men engaged in medium and sedentary work than those engaged in heavy work, respectively.

Besides these findings above, our results also show that regional effects on obesity prevalence are more significant in China than in Taiwan, which may indicate that living environments vary more significantly across regions in China than in Taiwan. Also, the marginal effect of the urban dummy is significant only among Taiwanese women and is negative, which indicates that women are less likely to be obese in urban areas than rural areas in Taiwan. The marginal effects of other variables were sensitive to the choice of cut-off points and did not systematically explain the difference in the prevalence of obesity either between Taiwan and China or between gender groups.

Lastly, we check the robustness of our results against potential collinearity and interaction effects of occupational types and region dummies. We computed the variance inflation factors for each model to test collinearity (see Table 3) and no significant evidence of collinearity is revealed. We also included cross-product terms between occupation dummies and region dummies into our models and tested the partial significance of the cross-product terms. Although the results are suppressed for parsimony, we found no significant evidence of such interaction effects i.e., cross-product terms are jointly insignificant in all models.

DISCUSSION

Overall, our findings imply that the relationship between obesity risk and socioeconomic factors and even important predictors of obesity risk may change through economic development. Our results indicate that occupational types rather than income and education levels are more significantly associated with the probability of being obese in China; and obesity risk is 4.2-11.8% and 1.9-8.8% lower among men and women engaged with heavy work than those engaged in more sedentary work, respectively. In contrast, income and education levels rather than occupational types are more significantly correlated with the probability of being obese in Taiwan; obesity risk is 11.3-15.6% and 8.9-25.6% higher among men and women with very low education than those with higher education, respectively; and obesity risk is 3.9-4.1% and 4.5-9.5% higher among men and women in the poorest group than those in higher income groups, respectively. These findings may indicate that, when an economy becomes more developed, the association between obesity prevalence and income as well as education levels increase, especially among women, while the association with occupational types decrease, especially among men.

It should be noted that our analysis is not to conclude that income has no effect on obesity risk in China or lower-income economies. Rather, our findings are consistent with the conventional hypothesis that obesity risk increases with incomes in low-income economies such as China and then starts falling as incomes continue to increase and reach a certain level in higher-income economies such as Taiwan. Such relationship between obesity risk and income was clearly shown in table 2. Our probit regression results provide further implications about this relationship. That is, the strenuousness of job-related activity may be a key factor explaining a positive correlation between obesity risk and income in low-income economies. In contrast, a negative correlation between obesity risk and income in higher-income economies may be attributable to some unobserved factors that change with income levels (e.g., knowledge of health risk) rather than the strenuousness of job-related activity.

Lastly, our results may shed some light on the implications of the following question: why do such changes in the relationship between obesity risk and socioeconomic factors occur when an economy becomes more developed? Some explanations are possible. For instance, a decreasing association between obesity risk and occupational types may be due to the improvement of production technology. That is, technological improvement may increase farm productivity and reduce the energy requirement of farming, while such improvement may increase the efficiency of office work but affect its energy requirement to a lesser extent. Thus, due to the fact that production technology is generally more sophisticated in Taiwan than in China, the difference in energy requirement between farmers and office workers can be less in Taiwan than in China. In addition, increasing negative associations between obesity risk and income as well as education levels can be possibly due to the change in food preference, knowledge about health risk, and attitude toward obesity. While such negative associations are widely evident in the developed world,4 underlying causes of such associations are complex and still controversial. Moreover, the change in attitude toward obesity may also influence labor demand and complex the association between obesity risk and occupational types. Thus, to clarify what contributes to the observed changes in the relationship between obesity risk and socioeconomic factors, further research efforts are necessary on more detailed pathways connecting obesity risk and each of the income levels, education levels, and occupational types.

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AUTHOR DISCLOSURES

No conflict of interests of authors.

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Original Article

Understanding the differences in obesity among working adults between Taiwan and China

Satoru Shimokawa PhD[1], Hung-Hao Chang PhD[2] and Per Pinstrup-Andersen PhD[3]

[1]*Division of Social Science, Hong Kong University of Science and Technology, Kowloon, Hong Kong*
[2]*Department of Agricultural Economics, National Taiwan University, Taipei, Taiwan*
[3]*Division of Nutritional Science, Cornell University, Ithaca, New York, USA*

探討中國與台灣有工作之成年人肥胖的差異

目的：探討中國與台灣有工作之成年人肥胖盛行率以及其社經影響因子的差異。資料：擷自 2000 年中國健康與營養調查與 2001 年台灣國民健康調查。分析對象集中於 20 歲到 60 歲有工作的成年人。中國樣本共包含 3,067 位男性與 2,998 位女性，台灣樣本共包含 6,474 位男性以及 6,341 位女性。方法：用於分析中的變數與肥胖盛行率已轉換成同一比較基礎。應用二元 Probit 模型來解釋社經變數與肥胖率的關係。結果：在中國，高所得、高教育、以及從事久坐工作的成年人有較高肥胖率。在台灣，低所得與低教育程度工作者有較高肥胖率。另外，中國分析反映出，相較於所得與教育程度，職業別和肥胖率有較高關聯性。但是在台灣，所得與教育程度相較於職業別，對肥胖而言關聯較顯著。本文研究發現指出，當經濟發展趨向成熟時，教育程度與所得對肥胖率有負向顯著影響，尤其對女性而言；反之，肥胖風險與職業別的關聯性卻降低，此現象對男性工作者尤其明顯。

關鍵字：肥胖、社經因子、成年人、台灣、中國