Int J Clin Exp Med 2015;8(2):2804-2814
www.ijcem.com /ISSN:1940-5901/IJCEM0003971

Original Article

Comparison of the status of overweight/obesity among the youth of local Shanghai, young rural-to-urban migrants and immigrant origin areas

Jin-Kui Lu[1*], Xiao-Jian Yin[1*], Jian-Ping Xiong[2], Jian-Jun Liu[3], Takemasa Watanabe[4], Toyoho Tanaka[4]

[1]Key Laboratory of Adolescent Health Assessment and Exercise Intervention, Ministry of Education, School of Physical Education and Health, East China Normal University, Shanghai 200241, China; [2]Department of Physical Education, Jiangxi University of Finance and Economics, Nanchang 330013, China; [3]Department of Physical Education, University of International Business and Economics, Shanghai 201620, China; [4]School of Health and Sport Sciences, Chukyo University, 101 Tokodachi, Kaizu-Cho, Toyota, Aichi 470-0309, Japan. [*]Equal contributors.

Received November 19, 2014; Accepted January 9, 2015; Epub February 15, 2015; Published February 28, 2015

Abstract: Background: Obesity in adolescents and children has become a global public health problem and lots of factors influence the status of obesity and overweight. The present study aims to compare the health-related factors which could influence the obesity in Chinese children and adolescents in three different groups which including the local developed city group, rural-to-urban migrants group and immigrants origin areas group. Methods: We conducted a cross-sectional study consisted of 2457 children and adolescents aged 7-10 years old including 914 rural-to-urban migrants subjects, 795 local Shanghai subjects and 748 from immigrant origin areas. Physique measurements and self-reported information on health-related factors, such as physical activities, dietary habits, socioeconomic factors such as family income, sleep habits, etc. were collected by questionnaire. SPSS16.0 was used in the analysis. Results: Mean level of body height, body weight and sitting height were different among the three groups, local youth group was higher in all the indexes than the other two groups. Grip for both hands were higher in local group also, while the heart rate was lowest in rural-to-ruban migrants group. The mean BMI in three groups showed significant difference, highest for local group. Higher SBP level was found in city and rural-to-urban migrants group also. However, no difference of DBP between groups was detected. The distribution of pre-hypertension and hypertension in three groups were significantly different and the distribution of overweight and obesity between genders in all three groups were different. The prevalence of overweight was 19.04% in rural-to-urban migrants group (19.92% for male and 17.64% for female), 28.21% for city group (35.64% for male and 20.72% for female); while no overweight or obesity subjects were found in immigrant origin areas group in this study. When compared the overweight and obesity prevalence between city group and rural-to-urban migrants, we found the overweight was more common in the local youth group. Univariable Logistic regression analysis and multivariable analysis results suggested that the more rice intake, higher family income and SBP higher than 140 mmHg were risk factors to obesity for rural-to-ruban migrants, while good dietary habits (no TV watching during meals) was preventive factor to obesity and SBP higher than 120 mmHg and unsocial factor were associated with obesity for rural-to-urban migrants. Conclusions: Our study revealed the prevalence of overweight and obesity in developed city children and adolescents and rural-to-urban migrants were relatively high, especially more common in local population and male gender. Lifestyle, dietary and psychological factors offered important contribution in increasing or decreasing the risk of obesity.

Keywords: Obesity, children and adolescents, health-related factors, rural-to-urban migrants, diet

Introduction

Obesity has become one of the most important and the fastest growing health problem in both developed areas and developing ones. Excess adiposity among youth increases risk of adult obesity, cardio-metabolic diseases and psychosocial problems [1]. The worldwide prevalence of overweight and obesity for children and adolescents has increased dramatically these decades, which lead to associated health risks increased and considerable health care costs

increased [2-4]. The prevalence of childhood obesity has been rapidly rising in Mainland China also. It was reported that 43 million children were estimated to be overweight and obese in 2010, and 92 million were at risk of becoming overweight [5]. Similar high prevalence and increasing trend has been observed in many countries, no matter developed or developing ones [6-8]. In most of the developed metropolis and cities of China, the overweight and obesity status in children and adolescents increased 2-3 times between 1985 and 1995 [9]. Given the huge health burden resulting from overweight and obesity, efforts should be made to prevent the onset of them and associated diseases during early childhood. With the promotion of health awareness and concepts towards overweight and obesity, more and more Chinese people began to change their lifestyle and habits gradually, especially began from urban and developed areas recently. One the other hand, with the development of the society and economy, China has been undergoing rapid urbanization, over 100 million people in China were migrants by 2000 [10]. The population usually moved from rural to urban areas to seek employment opportunities while many children move with their parents from rural areas to the developed cities [11, 12]. Recent studies reported that the unhealthy behaviors during adolescence perpetuate into adulthood have lasting health impacts in this young population, which even might lead to poorer psychosocial health [13, 14]. Insufficient public awareness, lack of health education and promotion programmes, insufficient implementation of related regulations contribute to higher rates of unhealthy behaviors and are likely to be overrepresented among both overweight groups in the rural-to-urban young migrants.

Overweight and obesity in children and adolescents are likely to be the result of complex interactions among genes, lifestyle behaviors, dietary habits, and socioeconomic factors. As the targets of many public health strategies, lifestyle-related factors are modifiable [15, 16].

Therefore, we performed this study to compare the prevalence of overweight and obesity in a sample of children and adolescents of three groups of children which including the group of local developed city children and adolescents, group of rural-to-urban migrants and group of subjects of immigrant origin areas.

Methods

Study population

We conducted a cross-sectional study from July 2010 to January 2011 in Shanghai and immigrant origin places such as Anhui, Guizhou, Yunnan, etc areas, aiming to assess the differences in lifestyle behaviors, dietary habits, and familial factors among children and adolescents with different weight status. A total of 2457 students aged 7-10 years old were recruited. We adopted a multistage, stratified, cluster-sampling scheme and three public schools were selected randomly from each region. Samples from all of the classes in each school were included. Totally, 12 public schools and 162 classes were selected. Students who have chronic heart, renal, or hepatic disease were excluded. The final sample included 2457 students (1382 boys and 1075 girls). Informed consent was obtained from the parents of all subjects. The study was approved by the Ethics Committee of School of Physical Education and Health, East China Normal University. Data collection of personal information including age, gender, physical and sedentary behaviors, transportation mode to school, sleep duration and family income etc, which were corrected by trained personnel using a questionnaire. The dietary habits and key food items were evaluated. The content validity of the questionnaire was assessed by specialists. Body weight and height was measured with wearing light clothes without shoes. Body mass index (BMI) was calculated then using the formula weight (kg)/Height (m^2). Blood pressure (BP) was measured by trained personnel, using a mercury sphygmomanometer after subject rested for at least 5 min. The average of two measurements was used in the analysis. BP status was defined according to the Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents [17].

Pre-hypertension was defined as a systolic BP (SBP) and/or diastolic BP (DBP) $\geq$ 120/80 mmHg. Hypertension was defined as an SBP and/or DBP $\geq$ 140/90 mmHg.

Statistical analysis

Continuous variables were expressed as mean values and standard deviation (SD), whereas categorical variables were described as frequencies and percentages. Continuous variables were compared by using one-way analy-

Table 1. Physique and Biochemical Characteristics

Variables	Group 1 (n = 914)	Group 2 (n = 795)	Group 3 (n= 748)	< 0.0001
	Mean/number (SD or %)	Mean/number (SD or %)	Mean/number (SD or %)	*P* value
Age, year	9.40 (0.05)	9.46 (0.05)	9.87 (0.05)$^{\#,£}$	< 0.0001
Male gender	550 (60.18)	400 (50.31)	432 (57.75)$^{*,\#,£}$	< 0.0001
Body height, cm	133.53 (0.34)	137.89 (0.37)	129.11 (0.36)$^{*,\#,£}$	< 0.0001
Body weight, kg	30.26 (0.28)	33.31 (0.34)	25.06 (0.20)$^{*,\#,£}$	< 0.0001
Sitting height, cm	72.79 (0.16)	74.14 (0.18)	69.12 (0.20)*	< 0.0001
Grip (left)	12.14 (0.14)	12.63 (0.13)	12.38 (0.15)$^{*,£}$	0.015
Gro (right)	12.91 (0.15)	13.55 (0.14)	13.05 (0.17)$^{\#,£}$	0.005
Heart rate	87.68 (0.34)	89.42 (0.38)	91.07 (0.43)$^{*,\#,£}$	< 0.0001
BMI, kg/m^2	16.72 (0.10)	17.22 (0.11)	14.91 (0.07)$^{*,£}$	< 0.0001
BMI groups, kg/m^2				< 0.0001
Weight loss	3 (0.33)	3 (0.38)	45 (6.02)	
Normal	718 (78.56)	538 (67.76)	703 (93.98)	
Overweight	174 (19.04)	224 (28.21)	0 (0.00)	
Obesity	19 (2.07)	29 (3.65)	0 (0.00)	
SBP, mmHg	110.97 (0.35)	110.97 (0.42)	107.68 (0.43)$^{\#,£}$	< 0.0001
DBP, mmHg	68.09 (0.25)	67.16 (0.26)	65.33 (2.87)	0.201
SBP groups 1, mmHg				0.005
< 120	904 (98.91)	779 (97.99)	745 (99.73)	
≥ 120	10 (1.09)	16 (2.01)	2 (0.27)	
DBP groups 1, mmHg				< 0.0001
< 80	757 (82.82)	765 (97.95)	745 (99.73)	
≥ 80	157 (17.18)	16 (2.05)	2 (0.27)	
Prehypertension groups, mmHg				0.010
< 120/80	749 (82.67)	659 (83.52)	649 (87.82)	
≥ 120/80	157 (17.33)	130 (16.48)	90 (12.18)	
SBP groups 2, mmHg				0.005
< 140	904 (98.91)	779 (97.99)	745 (99.73)	
≥ 140	10 (1.09)	16 (2.01)	2 (0.27)	
DBP groups 2, mmHg				< 0.0001
< 90	896 (98.25)	775 (97.73)	695 (93.29)	
≥ 90	16 (1.75)	18 (2.27)	50 (6.71)	
Hypertension groups, mmHg				0.005
< 140/90	904 (98.91)	779 (97.99)	746 (99.73)	
≥ 140/90	10 (1.09)	16 (2.01)	2 (0.27)	

Group 1: rural-to urban migrants group; group 2: local city group; group 3: immigrant origin areas group; *significant difference between group 1 and group 2, $^{\#}$significant difference between group 1 and group 3, $^{£}$significant difference between group 2 and group 3.

ses of variance or t-test, while Chi-square analyses were used to examine associations between the categorical variables. The association between overweight or obesity and health-related factors was tested using univariable and multivariable logistic regression models, odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. All statistical analyses were performed using SPSS version 16.0 software, and $P < 0.05$ indicated statistical significance.

Results

The study sample consisted of 1382 boys and 1075 girls, aged 7-10 years old, mean age in three groups was 9.40 (0.05), 9.46 (0.05) and

Table 2. Prevalence of overweight and obesity in different groups

Prevalence	Weight loss	Normal	Overweight	Obesity	
	Number (%)	Number (%)	Number (%)	Number (%)	*P* Value
Group 1	3 (0.33)	718 (78.61)	174 (19.04)	19 (2.12)	0.139
Male	2 (0.44)	428 (76.81)	111 (19.92)	16 (2.93)	
Female	1 (0.31)	290 (81.23)	63 (17.64)	3 (0.82)	
Group 2	3 (0.44)	538 (67.82)	224 (28.21)	29 (3.73)	0.000
Male	2 (0.53)	235 (58.52)	143 (35.64)	22 (5.51)	
Female	1 (0.31)	303 (77.34)	81 (20.72)	7 (1.83)	
Group 3	703 (94.00)	45 (6.00)	0 (0.00)	0 (0.00)	0.038
Male	405 (92.50)	33 (7.50)	0 (0.00)	0 (0.00)	
Female	298 (96.10)	12 (3.90)	0 (0.00)	0 (0.00)	

Group 1: rural-to urban migrants group; group 2: local city group; group 3: immigrant origin areas group.

Table 3. Different blood pressure factors among the participants with different weight status

Variables	Group 1 (n = 914)		Group 2 (n = 795)		Group 3 (n = 748)	
	Not-obesity Number (%)	Obesity Number (%)	Not-obesity Number (%)	Obesity Number (%)	Not-obesity Number (%)	Obesity Number (%)
SBP						
< 140	902 (99.01)	2 (66.67)	775 (97.98)	3 (100.00)	745 (99.73)	0 (0.00)
≥ 140	9 (0.99)	1 (33.33)	16 (2.02)	0 (0.00)	2 (0.27)	0 (0.00)
total	911 (100.00)	3 (100.00)*	791 (100.00)	3 (100.00)	747 (100.00)	-
SBP						
< 120	748 (82.83)	1 (33.33)	657 (83.69)	1 (33.33)	747 (99.87)	0 (0.00)
≥ 120	155 (17.17)	2 (66.67)	128 (16.31)	2 (66.67)	1 (0.13)	0 (0.00)
	903 (100.00)	2 (100.00)	785 (100.00)	3 (100.00)	748 (100.00)	-
DBP						
< 90	893 (98.24)	3 (100.00)	771 (97.72)	3 (100.00)	695 (93.29)	0 (0.00)
≥ 90	16 (1.76)	0 (0.00)	18 (2.28)	0 (0.00)	50 (6.71)	0 (0.00)
	911 (100.00)	3 (100.00)	789 (100.00)	3 (100.00)	745 (100.00)	-
DBP						
< 80	911 (100.00)	3 (100.00)	791 (100.00)	3 (100.00)	747 (99.73)	0 (0.00)
≥ 80	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.27)	0 (0.00)
	911 (100.00)	3 (100.00)	791 (100.00)	3 (100.00)	748 (100.00)	-
hypertension						
< 140/90	902 (99.01)	2 (66.67)	775 (97.98)	3 (100.00)	746 (99.73)	0 (0.00)
≥ 140/90	9 (0.99)	1 (33.33)	16 (2.02)	0 (0.00)	2 (0.27)	0 (0.00)
	911 (100.00)	3 (100.00)*	791 (100.00)	3 (100.00)	748 (100.00)	-
Pre-hypertension						
< 120/80	756 (82.99)	1 (33.33)	663 (83.82)	1 (33.33)	958 (87.97)	0 (0.00)
≥ 120/80	155 (17.01)	2 (66.67)	128 (16.18)	2 (66.67)	90 (12.03)	0 (0.00)
	911 (100.00)	3 (100.00)	791 (100.00)	3 (100.00)	748 (100.00)	-

*$P < 0.05$ between not-obesity and obesity group.

9.87 (0.05) years old respectively. Body height, body weight and sitting height were different among the three groups; local city group was higher in all the indexes than the other two groups. Grip for both hands were higher in local city group also, while the heart rate was lowest in rural-to urban migrants. The mean BMI in three groups showed significant difference, highest for rural-to-urban migrants group, which was 17.22 (0.11) kg/m^2 and lowest in

Table 4. Different nutrition factors among the participants with different weight status

Variables	Group 1 (n = 914)		Group 2 (n = 795)		Group 3 (n = 748)	
	Not-obesity Number (%)	Obesity Number (%)	Not-obesity Number (%)	Obesity Number (%)	Not-obesity Number (%)	Obesity Number (%)
Rice intake						
2-3 times/day	426 (48.33)	0 (0.00)	384 (52.02)	0 (0.00)	618 (87.66)	0 (0.00)
1 times/day	369 (41.80)	2 (33.33)	74 (10.00)	0 (0.00)	48 (6.81)	0 (0.00)
1 times/2-4 day	66 (7.52)	2 (33.33)	35 (4.72)	0 (0.00)	23 (3.26)	0 (0.00)
1 times/5-6 day	10 (1.12)	1 (16.67)	19 (2.62)	0 (0.00)	11 (1.56)	0 (0.00)
1 times/week	10 (1.12)	1 (16.67)	222 (30.13)	2 (100.00)	3 (0.43)	0 (0.00)
No intake	1 (0.11)	0 (0.00)	4 (0.51)	0 (0.00)	2 (0.28)	0 (0.00)
total	882 (100.00)	6 (100.00)*	738 (100.00)	2 (100.00)	705 (100.00)	-
Bean intake						
2-3 times/day	48 (5.98)	0 (0.00)	33 (4.48)	0 (0.00)	81 (12.20)	0 (0.00)
1 times/day	213 (26.53)	0 (0.00)	120 (16.30)	0 (0.00)	118 (17.77)	0 (0.00)
1 times/2-4 day	183 (22.79)	0 (0.00)	308 (41.85)	1 (50.00)	154 (23.19)	0 (0.00)
1 times/5-6 day	89 (11.08)	2 (10.00)	104 (14.13)	1 (50.00)	57 (8.58)	0 (0.00)
1 times/week	159 (19.80)	0 (0.00)	102 (13.86)	0 (0.00)	97 (14.61)	0 (0.00)
No intake	111 (13.82)	0 (0.00)	69 (9.38)	0 (0.00)	157 (23.64)	0 (0.00)
total	803 (100.00)	2 (100.00)*	736 (100.00)	2 (100.00)	664 (100.00)	-
Egg intake						
2-3 times/day	135 (16.27)	1 (33.33)	120 (15.96)	0 (0.00)	108 (16.14)	0 (0.00)
1 times/day	425 (51.20)	2 (66.67)	333 (44.28)	2 (66.67)	151 (22.57)	0 (0.00)
1 times/2-4 day	119 (14.34)	0 (0.00)	242 (32.18)	1 (33.33)	180 (26.91)	0 (0.00)
1 times/5-6 day	48 (5.78)	0 (0.00)	29 (3.86)	0 (0.00)	70 (10.46)	0 (0.00)
1 times/week	62 (7.47)	0 (0.00)	22 (2.93)	0 (0.00)	90 (13.45)	0 (0.00)
No intake	41 (4.94)	0 (0.00)	6 (0.80)	0 (0.00)	70 (10.46)	0 (0.00)
total	830 (100.00)	3 (100.00)	752 (100.00)	3 (100.00)	669 (100.00)	-
Fish intake						
2-3 times/day	43 (5.34)	0 (0.00)	86 (11.56)	1 (33.330)	85 (11.30)	0 (0.00)
1 times/day	134 (16.65)	0 (0.00)	188 (25.27)	2 (66.67)	112 (16.870	0 (0.00)
1 times/2-4 day	203 (25.22)	0 (0.00)	348 (46.77)	0 (0.00)	144 (21.69)	0 (0.00)
1 times/5-6 day	124 (15.40)	2 (66.67)	49 (6.59)	0 (0.00)	80 (12.05)	0 (0.00)
1 times/week	252 (31.30)	1 (33.33)	50 (6.72)	0 (0.00)	144 (21.69)	0 (0.00)
No intake	49 (6.09)	0 (0.00)	23 (3.09)	0 (0.00)	109 (16.42)	0 (0.00)
total	805 (100.00)	3 (100.00)	744 (100.00)	3 (100.00)	664 (100.00)	-
Fruit intake						
2-3 times/day	244 (28.77)	0 (0.00)	159 (21.26)	0 (0.00)	140 (20.86)	0 (0.00)
1 times/day	399 (47.05)	3 (100.00)	428 (57.22)	0 (0.00)	164 (24.44)	0 (0.00)
1 times/2-4 day	100 (11.79)	0 (0.00)	99 (13.24)	0 (0.00)	137 (20.42)	0 (0.00)
1 times/5-6 day	43 (5.07)	0 (0.00)	26 (3.48)	1 (50.00)	72 (10.73)	0 (0.00)
1 times/week	36 (4.25)	0 (0.00)	26 (3.48)	1 (50.00)	74 (11.03)	0 (0.00)
No intake	26 (3.07)	0 (0.00)	10 (1.34)	0 (0.00)	84 (12.52)	0 (0.00)
total	848 (100.00)	3 (100.00)	748 (100.00)	2 (100.00)	671 (100.00)	-
Fungus intake						
2-3 times/day	23 (2.97)	1 (33.33)	15 (2.06)	0 (0.00)	40 (6.26)	0 (0.00)
1 times/day	77 (9.94)	0 (0.00)	47 (6.46)	0 (0.00)	42 (6.57)	0 (0.00)
1 times/2-4 day	81 (10.45)	0 (0.00)	203 (27.88)	1 (50.00)	38 (5.95)	0 (0.00)
1 times/5-6 day	90 (11.62)	0 (0.00)	136 (18.68)	0 (0.00)	41 (6.42)	0 (0.00)
1 times/week	189 (24.39)	0 (0.00)	195 (26.79)	1 (50.00)	94 (14.71)	0 (0.00)
No intake	315 (40.65)	0 (0.00)	132 (18.13)	0 (0.00)	384 (60.10)	0 (0.00)
total	775 (100.00)	2 (100.00)*	728 (100.00)	2 (100.00)	639 (100.00)	-
Meat intake						
2-3 times/day	221 (31.17)	1 (50.00)	311 (44.24)	2 (66.67)	203 (33.12)	0 (0.00)
1 times/day	270 (38.08)	1 (50.00)	258 (36.70)	1 (33.33)	135 (22.02)	0 (0.00)
1 times/2-4 day	89 (12.55)	0 (0.00)	102 (14.51)	0 (0.00)	89 (14.52)	0 (0.00)
1 times/5-6 day	30 (4.23)	0 (0.00)	13 (1.85)	0 (0.00)	36 (5.87)	0 (0.00)

1 times/week	61 (8.60)	0 (0.00)	13 (1.85)	0 (0.00)	58 (9.46)	0 (0.00)
No intake	38 (5.36)	0 (0.00)	6 (0.85)	0 (0.00)	92 (15.01)	0 (0.00)
total	709 (100.00)	2 (100.00)	703 (100.00)	3 (100.00)	613 (100.00)	-
Milk intake						
2-3 times/day	136 (16.96)	0 (0.00)	159 (21.29)	0 (0.00)	78 (11.96)	0 (0.00)
1 times/day	389 (48.50)	2 (100.00)	364 (48.73)	1 (50.00)	204 (31.29)	0 (0.00)
1 times/2-4 day	95 (11.85)	0 (0.00)	125 (16.73)	0 (0.00)	69 (0.58)	0 (0.00)
1 times/5-6 day	50 (6.23)	0 (0.00)	37 (4.95)	1 (50.00)	57 (8.74)	0 (0.00)
1 times/week	79 (9.85)	0 (0.00)	37 (4.95)	0 (0.00)	111 (17.02)	0 (0.00)
No intake	53 (6.61)	0 (0.00)	25 (3.35)	0 (0.00)	133 (20.40)	0 (0.00)
total	802 (100.00)	2 (100.00)	747 (100.00)	2 (100.00)	652 (100.00)	-
Vegetables intake						
2-3 times/day	473 (55.71)	2 (66.67)	453 (59.76)	0 (0.00)	344 (51.04)	0 (0.00)
1 times/day	266 (31.33)	1 (33.33)	191 (25.20)	2 (66.67)	132 (9.58)	0 (0.00)
1 times/2-4 day	50 (5.89)	0 (0.00)	74 (9.76)	1 (33.33)	53 (7.86)	0 (0.00)
1 times/5-6 day	12 (1.41)	0 (0.00)	20 (2.64)	0 (0.00)	32 (4.75)	0 (0.00)
1 times/week	26 (3.06)	0 (0.00)	12 (1.58)	0 (0.00)	53 (7.86)	0 (0.00)
No intake	22 (2.59)	0 (0.00)	8 (1.06)	0 (0.00)	60 (8.90)	0 (0.00)
total	849 (100.00)	3 (100.00)	758 (100.00)	3 (100.00)	674 (100.00)	-
Parents view towardsbreakfast						
Very important	801 (87.93)	3 (100.00)	741 (93.68)	3 (100.00)	524 (70.05)	0 (0.00)
important	95 (10.43)	0 (0.00)	42 (5.31)	0 (0.00)	130 (17.38)	0 (0.00)
Not important	15 (1.65)	0 (0.00)	8 (1.02)	0 (0.00)	94 (12.57)	0 (0.00)
total	911 (100.00)	3 (100.00)	791 (100.00)	3 (100.00)	748 (100.00)	0 (0.00)

*$P < 0.05$ between not-obesity and obesity group.

immigrant origin areas group, the city group and rural-to-urban migrants group was higher than immigrant origin areas group separately. SBP level was higher in city and local city group also. While no difference of DBP between the groups. The distribution of pre-hypertension and hypertension in three groups were significantly different. As shown in **Table 1**.

The distribution of overweight and obesity between genders in all three groups were different. The prevalence of overweight was 19.04% in rural-to urban migrants group (19.92% for male and 17.64% for female), 28.21% for local city (35.64% for male and 20.72% for female) while no overweight or obesity subjects were found in immigrant origin areas group in this study. When compared the overweight prevalence between city group and rural-to-urban migrants group, and we found the overweight was more common in the local city youth. Similar trend was found for obesity prevalence. As shown in **Table 2**.

After the comparison of the distribution, totally 24 possible health related factors were included in the regression analysis. There was different distribution for 8 variables including nutritious factors, lifestyle and dietary factors and psychological factors, which was summarized in **Tables 3**-**5**. **Table 6** showed us the univariable analysis and multivariable analysis results for the association between different possible healths related determinants and obesity for immigrant group and rural-to-urban migrants group. The results of univariable logistic regression in immigrant group youth suggested that more rice intake increased the risk of obesity in this population (OR = 2.692, 95% CI: 1.053-6.883, $P = 0.039$), so as the factor of higher family income (OR = 4.216, 95% CI: 0.999-17.796, $P = 0.050$) and higher SBP level (higher than 140 mmHg) (OR = 49.566, 95% CI: 4.114-596.890, $P = 0.002$). As for the multivariable logistic regression analysis, these factors were still showed significant association with obesity, which could increase the risk of obesity for 2.767 times (95% CI: 0.978-7.832, $P = 0.055$), 4.178 times (95% CI: 0.966-18.079, $P = 0.056$) and even 62.973 times (95% CI: 2.626-151.011, $P = 0.011$). However, the results for local city group were a little different, good dietary habits showed obvious affect in preventing the obesity in this population, while higher SBP level (higher than 120 mmHg) in this group and unsocial showed to increase the risk of obesity, OR in univariable analysis was 0.401 (95% CI: 0.128-1.251, $P = 0.116$), 10.234 (95% CI: 0.921-113.712, $P = 0.058$)

Table 5. Different other health-related factors among the participants with different weight status

Variables	Group 1 (n = 914)		Group 2 (n = 795)		Group 3 (n = 748)	
	Not-obesity Number (%)	Obesity Number (%)	Not-obesity Number (%)	Obesity Number (%)	Not-obesity Number (%)	Obesity Number (%)
Family income						
< 2000 RMB/month	268 (32.13)	0 (0.00)	84 (11.28)	0 (0.00)	367 (63.83)	0 (0.00)
2000-5000 RMB/month	349 (41.85)	1 (100.00)	255 (34.23)	1 (33.33)	167 (29.04)	0 (0.00)
> 5000 RMB/month	217 (26.02)	0 (0.00)	406 (54.50)	2 (66.67)	41 (7.13)	0 (0.00)
total	834 (100.00)	1 (100.00)*	745 (100.00)	3 (100.00)	575 (100.00)	-
unsocial						
yes	854 (93.74)	3 (75.00)	765 (96.71)	2 (66.67)	640 (85.56)	0 (0.00)
no	57 (6.26)	1 (25.00)	26 (3.39)	1 (33.33)	108 (14.44)	0 (0.00)
total	911 (100.00)	4 (100.00)	791 (100.00)	3 (100.00)*	748 (100.00)	-
Brush teeth time						
0/day	9 (0.99)	0 (0.00)	8 (1.01)	0 (0.00)	33 (4.41)	0 (0.00)
1/day	216 (23.71)	1 (33.33)	277 (35.02)	1 (33.33)	416 (55.61)	0 (0.00)
2/day	621 (68.17)	2 (66.67)	486 (61.44)	2 (66.67)	233 (31.15)	0 (0.00)
> 2/day	65 (7.14)	0 (0.00)	20 (2.53)	0 (0.00)	66 (8.82)	0 (0.00)
today	911 (100.00)	3 (100.00)	791 (100.00)	3 (100.00)	748 (100.00)	-
Sleep duration						
< 7 hours/day	4 (0.44)	0 (0.00)	1 (0.13)	0 (0.00)	5 (0.67)	0 (0.00)
7.1-8 hours/day	31 (3.40)	0 (0.00)	53 (6.70)	0 (0.00)	76 (10.16)	0 (0.00)
8.1-9 hours/day	261 (28.65)	0 (0.00)	275 (34.77)	2 (66.67)	217 (29.01)	0 (0.00)
9.1-10 hours/day	505 (55.43)	3 (100.00)	388 (49.05)	0 (0.00)	377 (50.40)	0 (0.00)
10.1-11 hours/day	97 (10.65)	0 (0.00)	73 (9.23)	1 (33.33)	72 (9.63)	0 (0.00)
> 11 hours/day	13 (1.43)	0 (0.00)	1 (0.13)	0 (0.00)	1 (0.13)	0 (0.00)
total	911 (100.00)	3 (100.00)	791 (100.00)	3 (100.00)	748 (100.00)	-
Computer using time						
0 hours/day	538 (59.06)	2 (66.67)	292 (36.92)	2 (66.67)	523 (69.92)	0 (0.00)
< 1 hours/day	251 (27.55)	1 (33.33)	384 (48.55)	1 (33.33)	144 (19.25)	0 (0.00)
1.1-2 hours/day	72 (7.90)	0 (0.00)	83 (10.49)	0 (0.00)	32 (4.28)	0 (0.00)
2.1-3 hours/day	16 (1.76)	0 (0.00)	13 (1.64)	0 (0.00)	19 (2.54)	0 (0.00)
3.1-4 hours/day	10 (1.10)	0 (0.00)	11 (1.39))	0 (0.00)	14 (1.87)	0 (0.00)
> 4 hours/day	24 (2.63)	0 (0.00)	8 (1.01)	0 (0.00)	16 (2.14)	0 (0.00)
total	911 (100.00)	3 (100.00)	791 (100.00)	3 (100.00)	748 (100.00)	-
Eating habit (watching TV during meals)						
everyday	58 (6.37)	0 (0.00)	112 (14.16)	0 (0.00)	58 (7.75)	0 (0.00)
> 4 times/week	369 (40.50)	0 (0.00)	570 (72.06)	3 (100.00)	342 (45.72)	0 (0.00)
2-3 times/week	202 (22.27)	2 (66.67)	74 (9.36)	0 (0.00)	159 (21.26)	0 (0.00)
< 1 time/week	123 (13.50)	1 (33.33)	23 (2.91)	0 (0.00)	79 (10.56)	0 (0.00)
never	159 (17.45)	0 (0.00)	0 (0.00)	0 (0.00)	110 (14.71)	0 (0.00)
total	911 (100.00)	3 (100.00)	791 (100.00)	3 (100.00)	748 (100.00)	-
Ways of go to school						
walk	101 (11.09)	1 (33.33)	342 (43.24)	1 (33.33)	671 (89.71)	0 (0.00)
By bus	66 (7.24)	0 (0.00)	86 (10.87)	0 (0.00)	34 (4.55)	0 (0.00)
By private car	84 (9.22)	0 (0.00)	93 (11.76)	0 (0.00)	11 (1.47)	0 (0.00)
By parents' bike(parents riding)	599 (65.75)	2 (66.67)	247 (31.23)	2 (66.67)	17 (2.27)	0 (0.00)
By bike	44 (4.83)	0 (0.00)	13 (1.64)	0 (0.00)	7 (0.94)	0 (0.00)
By subway	17 (1.87)	0 (0.00)	10 (1.26)	0 (0.00)	8 (1.07)	0 (0.00)
total	911 (100.00)	3 (100.00)	791 (100.00)	3 (100.00)*	748 (100.00)	-
Watching TV duration						
0 hour/day	81 (8.89)	0 (0.00)	76 (9.61)	0 (0.00)	86 (11.90)	0 (0.00)
< 1 hour/day	550 (60.37)	2 (66.67)	436 (55.12)	2 (66.67)	363 (48.53)	0 (0.00)
1-2 hours/day	177 (19.43)	0 (0.00)	194 (24.53)	0 (0.00)	159 (21.26)	0 (0.00)
2-3 hours/day	43 (4.72)	0 (0.00)	53 (6.70)	1 (33.33)	58 (7.75)	0 (0.00)
3-4 hours/day	23 (2.52)	1 (33.33)	15 (1.90)	0 (0.00)	38 (5.08)	0 (0.00)
> 4 hours/day	37 (4.06)	0 (0.00)	17 (2.15)	0 (0.00)	44 (5.88)	0 (0.00)
total	911 (100.00)	3 (100.00)*	791 (100.00)	3 (100.00)	748 (100.00)	-

*$P < 0.05$ between not-obesity and obesity group.

Table 6. The association between obesity and health-related factors in different groups

Variables	Group 1				Group 2		
	OR	OR (95% CI)	*P* Value		OR	OR (95% CI)	*P* Value
Univariable analysis model							
Rice	2.692	1.053-6.883	0.039	Eat behavior	0.401	0.128-1.251	0.116
Family income	4.216	0.999-17.796	0.050	SBP ≥ 120 mmHg	10.234	0.921-113.712	0.058
SBP ≥ 140 mmHg	49.566	4.114-596.890	0.002	Psy552	14.712	1.292-167.453	0.030
multivariable analysis model							
SBP ≥ 140 mmHg	62.973	2.626-151.011	0.011	Eat behavior	0.501	0.213-1.182	0.115
Rice 101	2.767	0.978-7.832	0.055	SBP ≥ 120 mmHg	11.831	0.963-145.305	0.054
Familyincome310	4.178	0.966-18.079	0.056	psycholo552	14.262	1.129-180.169	0.040

and 14.712 (95% CI: 1.292-167.453, *P* = 0.030), and the OR in multivariable analysis was 0.501 (95% CI: 0.213-1.162, *P* = 0.115), 11.831 (95% CI: 0.963-145.305, *P* = 0.054) and 14.262 (1.129-180.169, *P* = 0.040) respectively.

Discussion

A large sample of the Chinese children and adolescents was studied to explore current status of overweight and obesity among developed city children and adolescents, the rural-to-urban migrants and the immigrant origin areas subjects. Previous study from China indicated that the prevalence of overweight and obesity among 7-9 year-olds increased from approximately 1-2% in 1985 to 17% among girls and 25% among boys in 2000 in big cities [18]. While in this study emergent status in overweight and obesity was detected in the study population, not only for the city youth, but also rural-to-urban youth. Many studies suggest that among children of overweight and obesity are directly related to the number of hours that parents spent working outside the home, interfering with children's access to healthy foods and physical activity, which was line up with the features of our rural-to-urban migrants. Great attention should be paid to establishing appropriate prevention and treatment programs in this population. It was reported that the prevalence of adolescent obesity increased from 5 to 13% in boys and from 5 to 9% in girls between 1966-70 and 1988-91 in the U.S. [19]. In this study, when discussed the gender difference of overweight/obesity, higher prevalence in boys were more common in both developed city group and immigrant group, which might be associated with more concern towards body weight and control in girls [15-18].

It is well known that although genetic contributors to obesity in youth and their interactions with the environmental influences, many other factors have been linked to both current weight status and weight status later in life, such as dietary factors [20, 21]. The obese children were more likely to intake more high energy and carbohydrate food, to have a higher family income, or to have shorter sleep duration, et al [17-20]. While in this study, dietary determinants, lifestyle and psychological determinants were detected to influence the obesity status, however little different for city youth and rural-to-urban migrants.

Dietary determinants do influence the status of obesity in this study, while the rice intake showed association to obesity in immigrant youth and good diet habit seemed more contribution to the obesity prevention in local city youth. Many studies suggested that poor fiber carbohydrate food such as refined grains could lead to worse metabolic outcomes, and rice is an important grain and is considered as staple food for two thirds of the population worldwide [22, 23]. White rice is the main component and provides a major part of daily energy and carbohydrate requirements in China, especially southern China. Most of the investigations suggested the consumption of white rice contributes to the development of metabolic disorders, including obesity, particularly among Asian populations. However some others have reported different results [24-26]. Dietary habit factors such as frequent family dinners were associated with overweight and household food rules are associated with higher risk in young population [26-28]. And good dietary habit contributed greatly in overweight and obesity control in youth, for instance, health pattern family meals provide a dietary quality

advantage for children when compared to absence family meals [29-31]. The current study proved the previous opinions that good dietary habits such as no TV watching during meals absolutely could decrease the risk of obesity.

Apart from dietary factors, many socio-economic factors were associated with overweight and obesity, one of the important factors was family income. Studies in high income countries have identified that family and community factors as determinants of overweight and obesity among children and adolescents [32, 33], including the elements of family structure, being only child, certain diet and physical activity behaviors and other socioeconomic factors [34]. Most developing countries and areas experienced large increases in the prevalence of overweight and obesity during the past 20 years, including China [35, 36]. Regarding family income, previous study found that among children and adolescents, those in higher income groups were more likely to be obese in China and Russia, whereas those in lower income groups were at a higher risk of being obese in the U.S. [37]. Our study indicated that obese participants were more likely to have a higher family income, similar to the result found in a Jordanian population [38] and contrary to the result in Canadian population [39]. And psychological factors such as unsocial factor were seldom reported in previous studies [40, 41]. But the unsocial feature of the youth usually lead to their sedentary behaviors, unhealthy snack food intake, might be associated with overweight and obesity indirectly.

Furthermore, many studies reported that blood pressure had close relation to overweight and obesity [42-44]. In the 1990s, the prevalence of hypertension among children and adolescents was approximately 2% to 38%. Currently, the prevalence varies from 1% to 13% depending on the methodology used. Because obesity has become epidemic in developing countries, the incidence of hypertension also may be increasing. In the current cross-sectional study, positive association was found between higher SBP and obesity, which confirmed the previous results.

Although many studies have reported that some health-related factors, such as skipping breakfast, physical inactivity, and long hours of TV watching and video game playing, were associated with childhood and adolescent obesity [45], we failed to find statistically significant results, possibly due to the different definitions of the variables and an insufficient sample size.

There are limitations in the present study. First, our data were obtained from a cross-sectional study and are not representative of children and adolescents throughout the whole country. Thus conclusions to the general population should be done cautiously. Second, these analyses rely on self-reports from children and their parents, which might compromise the accuracy. In addition, our results are based on a cross-sectional design, so we could not define a causal association between health-related factors and obesity status.

In summary, the prevalence of overweight and obesity in developed city children and adolescents and rural-to-urban migrants were relatively high in this study, even more common in local city youth population and male gender. Lifestyle, dietary and psychological factors offered important contribution in increase or decrease the risk of obesity.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Jin-Kui Lu, Key Laboratory of Adolescent Health Assessment and Exercise Intervention, Ministry of Education, School of Physical Education and Health, East China Normal University, Shanghai 200241, China. Tel: +86-21-54345481; Fax: +86-21-54345481; E-mail: jinkuil@163.com

References

[1] Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. Pediatrics 1998; 101: 518-25.

[2] Zheng L, Sun Z, Zhang X, Xu C, Li J, Hu D and Sun Y. Predictors of progression from prehypertension to hypertension among rural Chinese adults: results from Liaoning Province. Eur J Cardiovasc Prev Rehabil 2010; 17: 217-222.

[3] Weiss R, Dziura J, Burgert TS, Tamborlane WV, Taksali SE, Yeckel CW, Allen K, Lopes M, Savoye M, Morrison J, Sherwin RS and Caprio S. Obesity and the metabolic syndrome in children and adolescents. N Engl J Med 2004; 350: 2362-2374.

[4] Biro FM, Huang B, Morrison JA, Horn PS and Daniels SR. Body mass index and waist-to-height changes during teen years in girls are influenced by childhood body mass index. J Adolesc Health 2010; 46: 245-250.
[5] De Onis M, Blössner M and Borghi E. Global prevalence and trends of overweight and obesity among preschool children. Am J Clin Nutr 2010; 92: 1257-1264.
[6] Kautiainen S, Rimpelä A, Vikat A and Virtanen SM. Secular trends in overweight and obesity among Finnish adolescents in 1977-1999. Int J Obes Relat Metab 2002 Disord 26: 544-552.
[7] Sanigorski AM, Bell AC, Kremer PJ and Swinburn BA. High childhood obesity in an Australian population. Obesity (Silver Spring) 2007; 15: 1908-1912.
[8] Stamatakis E, Wardle J and Cole TJ. Childhood obesity and overweight prevalence trends in England: evidence for growing socioeconomic disparities. Int J Obes (Lond) 2010; 34: 41-47.
[9] Ji CY, Sun JL and Chen TJ. Dynamic analysis on the prevalence of obesity and overweight school-age children and adolescents in recent 15 years in China. Zhonghua Liu Xing Bing Xue Za Zhi 2004; 25: 103-108.
[10] Duan CR and Zhou FL. Studies on left behind children in China [in Chinese]. Population Research 2005; 29: 29-36.
[11] Hu X, Cook S and Salazar MA. Internal migration and health in China. The Lancet 2008; 372:1717-1719.
[12] Keung Wong DF, Li CY and Song HX. Rural migrant workers in urban China: living a marginalized life. International Journal of Social Welfare 2007; 16: 32-40.
[13] McKay L, Macintyre S and Ellaway A. Migration and health: a review of the international literature MRC Social and Public Health Sciences Unit, Occasional Paper no. 12. Glasgow: MRC Social and Public Health Unit; 2003.
[14] D'Emilio AL, Cordero B and Bainvel B. The Impact of International Migration: Children left behind in selected countries of Latin America and the Caribbean United Nations Children's Fund (UNICEF). New York; 2007.
[15] Franco M, Sanz B, Otero L, Domínguez-Vila A and Caballero B. Prevention of childhood obesity in Spain: a focus on policies outside the health sector. SESPAS report 2010. Gac Sanit 2010; 24: 49-55.
[16] Janssen I, Katzmarzyk PT, Boyce WF, King MA and Pickett W. Overweight and obesity in Canadian adolescents and their associations with dietary habits and physical activity patterns. J Adolesc Health 2004; 35: 360-367.
[17] National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. Pediatrics 2004; 114: 555-576.
[18] Wang L, Kong L, Wu F, Bai Y and Burton R. Preventing chronic diseases in China. Lancet 2005; 366: 1821-1824.
[19] Kosti RI and Panagiotakos DB. The epidemic of obesity in children and adolescents in the world. Cent Eur J Public Health 2006; 14: 151-159.
[20] Whitaker R, Wright J, Pepe M, Seidel K and Dietz W. Predicting obesity in young adulthood from childhood and parental obesity. New Engl J Med 1997; 337: 869-873.
[21] Skinner JD, Bounds W, Carruth BR, Morris M and Ziegler P. Predictors of children's body mass index: a longitudinal study of diet and growth in children aged 2-8y. Int J Obes Relat Metab Disord 2004; 28: 476-482.
[22] McKeown NM, Meigs JB, Liu S, Saltzman E, Wilson PW and Jacques PF. Carbohydrate nutrition, insulin resistance, and the prevalence of the metabolic syndrome in the Framingham Offspring Cohort. Diabetes Care 2004; 27: 538-546.
[23] Liese AD, Schulz M, Fang F, Wolever TM, D'Agostino RB Jr, Sparks KC and Mayer-Davis EJ. Dietary glycemic index and glycemic load, carbohydrate and fiber intake, and measures of insulin sensitivity, secretion, and adiposity in the Insulin Resistance Atherosclerosis Study. Diabetes Care 2005; 28: 2832-2838.
[24] Zhang G, Pan A, Zong G, Yu Z, Wu H, Chen X, Tang L, Feng Y, Zhou H, Chen X, Li H, Hong B, Malik VS, Willett WC, Spiegelman D, Hu FB and Lin X. Substituting white rice with brown rice for 16 weeks does not substantially affect metabolic risk factors in middle-aged Chinese men and women with diabetes or a high risk for diabetes. J Nutr 2011; 141: 1685-1690.
[25] Nanri A, Mizoue T, Noda M, Takahashi Y, Kato M, Inoue M and Tsugane S. Rice intake and type 2 diabetes in Japanese men and women: the Japan Public Health Center-based Prospective Study. Am J Clin Nutr 2010; 92: 1468-1477.
[26] Villegas R, Liu S, Gao YT, Yang G, Li H, Zheng W and Shu XO. Prospective study of dietary, a carbohydrates, glycemic index, glycemic load, and incidence of type 2 diabetes mellitus in middle aged Chinese women. Arch Intern Med 2007; 167: 2310-2316.
[27] Wannamethee SG, Shaper AG and Whincup PH. Modifiable lifestyle factors and the metabolic syndrome in older men: Effects of lifestyle changes. J Am Geriatr Soc 2006; 54: 1909-1914.
[28] Zhu S, St-Onge MP, Heshka S and Heymsfield SB. Lifestyle behaviors associated with lower

risk of having the metabolic syndrome. Metabolism 2004; 53: 1503-1511.
[29] Feldman S, Eisenberg ME, Neumark-Sztainer D and Story M. Associations between watching TV during family meals and dietary intake among adolescents. J Nutr Educ Behav 2007; 39: 257-263.
[30] Powell LM, Han E and Chaloupka FJ. Economic contextual factors, food consumption, and obesity among U.S. adolescents. J Nutr 2010; 140: 1175-1180.
[31] Esmaillzadeh A, Kimiagar M, Mehrabi Y, Azadbakht L, Hu FB and Willett WC. Dietary patterns, insulin resistance, and prevalence of the metabolic syndrome in women. Am J Clin Nutr 2007; 85: 910-918.
[32] Davison KK and Birch LL. Childhood overweight: a contextual model and recommendations for future research. Obes Rev 2001; 2: 159-171.
[33] McLeroy KR, Bibeau D, Steckler A and Glanz K. An ecological perspective on health promotion programs. Health Educ 1988; 15: 351-377.
[34] Chen AY and Escarce JJ. Family structure and childhood obesity, Early Childhood Longitudinal Study-Kindergarten Cohort. Prev Chronic Dis 2010; 7: A50.
[35] Popkin BM and Slining MM. New dynamics in global obesity facing low- and middle-income countries. Obes Rev 2013; 14: 11-20.
[36] Wang Y and Lobstein T. Worldwide trends in childhood overweight and obesity. Int J Pediatr Obes 2006; 1: 11-25.
[37] Wang Y. Cross-national comparison of childhood obesity: the epidemic and the relationship between obesity and socioeconomic status. Int J Epidemiol 2001; 30: 1129-1136.
[38] Khader Y, Irshaidat O, Khasawneh M, Amarin Z, Alomari M and Batieha A. Overweight and obesity among school children in Jordan: prevalence and associated factors. Matern Child Health J 2009; 13: 424-431.
[39] Phipps SA, Burton PS, Osberg LS and Lethbridge LN. Poverty and the extent of child obesity in Canada, Norway and the United States. Obes Rev 2006; 7: 5-12.
[40] Stein D, Weinberger-Litman SL and Latzer Y. Psychosocial perspectives and the issue of prevention in childhood obesity. Front Public Health 2014; 2: 104.
[41] Richmond RC, Skugarevsky O, Yang S, Kramer MS, Wade KH, Patel R, Bogdanovich N, Vilchuck K, Sergeichick N, Smith GD, Oken E and Martin RM. The association of early childhood cognitive development and behavioural difficulties with pre-adolescent problematic eating attitudes. PLoS One 2014; 9: e104132.
[42] Constantine E and Merritt C. Hypertensive emergencies in children: Identification and management of dangerously high blood pressure. Minerva Pediatr 2009; 61: 175-184.
[43] Monego ET and Jardim PC. Determinants of risk of cardiovascular diseases in schoolchildren. Arq Bras Cardiol 2006; 87: 37-45.
[44] Burke V, Beilin LJ, Dunbar D and Kevan M. Associations between blood pressure and overweight defined by new standards for body mass index in childhood. Prev Med 2004; 38: 558-564.
[45] Sun Y, Sekine M and Kagamimori S. Lifestyle and overweight among Japanese adolescents: the Toyama Birth Cohort Study. J Epidemiol 2009; 19: 303-310.