RURAL-URBAN DISPARITIES IN DIETARY HABITS AND ANTHROPOMETRIC INDICATORS AMONG CHINESE STUDENTS

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Abstract. A "poverty belt" surrounding Beijing has formed, consisting of 2.7 million rural residents who live below the poverty line residing in nearly 4,000 villages of 32 Hebei counties adjacent to Beijing. This study examined disparities in dietary habits and anthropometric indicators between Chinese students living in Beijing metropolitan area and those in the rural "poverty belt" surrounding Beijing. Multivariate linear, negative binomial, and logistic regressions were conducted to estimate differences in dietary habits and anthropometric indicators between urban and rural students. Students ($N = 646$) from four primary and middle schools were surveyed, two located in Beijing metropolitan area and the other two within the rural "poverty belt" surrounding Beijing. Rural students on average consumed fruit and vegetables 1.93 times less than their urban counterparts in the past week; whereas they consumed sugar-sweetened beverages 1.30 times and junk foods 4.98 times more than their urban counterparts in the past week. The waist-to-hip ratio of rural students was on average 0.04 higher than that of their urban counterparts. In subgroup analysis by sex, no urban-rural differences in body mass index, overweight/obesity rate, waist circumference, waist-to-hip ratio, or body fat percentage were identified among boys; whereas the waist circumference and waist-to-hip ratio of rural girls were on average 5 cm and 0.06 higher than urban girls, respectively. In conclusion, rural students had noticeably poorer dietary habits and worse weight-related health indicators than their urban counterparts. Improving diet quality among Chinese rural students is essential in reducing rural-urban health disparities.

Keywords: rural health, diet, body weight, China

INTRODUCTION

Childhood obesity is linked to various immediate and long-term adverse health outcomes such as sleep apnea, hypertension, heart disease, stroke, type 2 diabetes, osteoarthritis, and certain types of cancer, and leads to psychosocial problems such as stigmatization and poor self-esteem (Dietz, 2004; Daniels *et al*, 2005; Freedman *et al*, 2007; Li *et al*, 2009; CDC, 2011; Kushi *et al*, 2012). China's economy and society have undergone significant transitions over the past few decades, which

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profoundly influence the health status of children and adolescents (Zong and Li, 2014). On the one hand, physical growth of children in China is found to have improved during the past three decades, and this improvement tends to concentrate among school-age children and adolescents (Zong and Li, 2014; Zhi *et al*, 2015). On the other hand, the prevalence of childhood obesity in China has increased substantially over the same period, partially attributable to transition towards a high-energy Western diet and a sedentary lifestyle (Shang *et al*, 2012). A recent study documented trends in overweight and obesity among rural children and adolescents in a Chinese province (Zhang *et al*, 2016). The prevalence of obesity increased from 0.03% in 1985 to 17.2% in 2014 among boys, and from 0.12% in 1985 to 9.1% in 2014 among girls (Zhang *et al*, 2016). In contrast to their urban counterparts, Chinese rural residents are disadvantaged in multiple domains such as lower employment rate and wage (Chen *et al*, 2012; National Bureau of Statistics of China, 2016), poorer education attainment (Fu, 2005; Wu, 2013), immature health care system (Liu *et al*, 2007; Jian *et al*, 2010), and underdeveloped public infrastructure (Fan and Zhang, 2004; Henderson, 2009). Inequalities in these socioeconomic factors are thought to contribute to the substantial gap in weight-related behaviors and outcomes between rural and urban populations including youth (Zimmer *et al*, 2007; Zimmer *et al*, 2010a,b).

Hebei Provincial Development Strategy identifies a "poverty belt" surrounding Beijing, which consists of 2.7 million rural residents below poverty line living in 3,798 villages of 32 Hebei counties adjacent to Beijing (Asian Development Bank and Hebei Provincial Finance Bureau, 2005). This high concentration of population in poverty surrounding China's capital—one of the most developed local economies in China and worldwide—represents unprecedented rural-urban social inequality (Asian Development Bank and Hebei Provincial Finance Bureau, 2005). The annual per-capita income in 2005 averaged less than USD100 among the "poverty belt" residents. The formation of this "poverty belt" could be partially attributed to the long-term military restriction, and resource allocation that favored major nearby cities including Beijing and Tianjin. Little research has been conducted to document the manifestation and health consequences of such extreme inequality.

This study aimed to examine rural-urban disparities in dietary habits and anthropometric indicators among Chinese students. Survey samples consisted of primary- and middle-school students residing either in Beijing or within the rural "poverty belt" surrounding Beijing. It was hypothesized that compared to their urban counterparts, students living in the rural area would have significantly poorer diet quality and worse weight-related indicators, after adjusting for individual and family characteristics.

MATERIALS AND METHODS

Study setting

The study sample came from a cross-sectional survey conducted by the Beijing Normal University during April-June 2015. Paper-based questionnaires were administered in four schools—two (one primary and one middle school) in Beijing metropolitan area, and the other two (one primary and one middle school) in the rural area of Hebei Province which is adjacent to the suburb of Beijing. Both rural schools are located in villages that are considered as part of the "poverty belt" surrounding Beijing (Asian Development Bank and Hebei Provincial Finance Bureau, 2005). Within each school, two classes were randomly selected and all students in these classes were recruited for survey participation.

Survey questionnaire

A total of 647 paper-based questionnaires (220 in urban and 427 in rural schools) were distributed to students at grades 4 to 8, with a completion rate of 89.7% (91.3% in urban and 88.8% in rural schools). Rural schools had a much larger class size than urban schools, resulting in a larger study sample from rural schools. The survey includes questions regarding individual and family sociodemographics as well as students' dietary habits. The three diet-related questions are: "How many times in the past week did you consume fruit and vegetables?", "How many times in the past week did you consume sugar-sweetened beverages?", and "How many times in the past week did you consume junk foods?"

Based on the above questions, three diet-related dependent variables were constructed regarding the number of times in the past week consuming fruit and vegetables, sugar-sweetened beverages and junk foods.

Anthropometric indicators

Besides administering questionnaires, trained researchers also measured students' weight and stature height using digital scale and stadiometer, waist and hip circumferences using a tape measure, and body fat percentage using Tanita® Body Composition Analyzer BC-750. All anthropometric measurement devices comply with the National Student Physical Health Standard (Ministry of Education of the People's Republic of China, 2014).

Based on the above measures, six weight-related dependent variables were constructed: a continuous variable for body mass index (BMI, kg/m^2), a dichotomous variable for childhood overweight (non-overweight children in the reference group), a dichotomous variable for childhood obesity (non-obese children in the reference group), a continuous variable for waist circumference, a continuous variable for waist-to-hip ratio, and a continuous variable for body fat percentage. Childhood overweight and obesity were defined based on the Chinese age- and sex-specific growth chart of height and weight (Ji, 2005).

Other individual characteristics

The following individual characteristics were adjusted for in the regression analyses: a dichotomous variable for a child's sex (girl, with boy in the reference group), a continuous variable for a child's age in years, four categorical variables for a child's grade (grades 5, 6, 7, and 8, with grade 4 in the reference group), a count variable for household size, a dichotomous variable for single child status (the only child in the household, with twin and/or sibling in the reference group), a dichotomous variable for parents' marital status (married, with divorced or separated in the reference group), a dichotomous variable for primary guardian's sex (male, with female in the reference group), a continuous variable for primary guardian's age in years, and three categorical variables for primary guardian's education (primary school education, middle or high school education, and college and above education, with no formal education in the reference group).

Statistical analysis

Dietary habits, anthropometric indicators, and other individual characteristics stratified by rural/urban school attendance were summarized in descriptive statistics. Two-sample *t*-test was used to assess the difference in means of a continuous or count variable between rural and urban students. Pearson's chi-square test was used to test the difference in proportions of a dichotomous or categorical variable between rural and urban students.

Four linear regressions were performed on the continuous dependent variables (*ie*, BMI, waist circumference, waist-to-hip ratio, and body fat percentage). Three negative binomial regressions were performed on the count dependent variables for the number of times in the past week consuming fruit and vegetables, sugar-sweetened beverages, and junk foods. Negative binomial regression is a generalization of the Poisson model that relaxes the Poisson restriction on the mean-variance equality (Hilbe, 2011). Two logistic regressions were performed on the dichotomous dependent variables for childhood overweight and obesity. All regressions adjusted for individual characteristics. Average marginal effects were calculated based on the estimated coefficients from negative binomial regressions and logistic regressions using the Stata function "margins". The key independent variable in all regressions was a dichotomous variable for rural schools (urban schools in the reference group). In the subgroup analyses, separate regressions were performed on the boy and girl samples.

All statistical analyses were conducted using Stata 14.2 SE version (StataCorp, College Station, TX).

Human subjects protection

This study was approved by the Beijing Normal University Institutional Review Board. Student and parent informed consents were obtained upon administration of the survey.

RESULTS

Table 1 reports individual characteristics of the survey sample by rural/urban school attendance. Boys and girls were largely equally distributed in both rural and urban schools, with an average age of eleven and half years old. Over three quarters of the rural sample consisted of primary school students, whereas less than 60% of the urban sample consisted of primary school students. Rural school students had a larger average household size than their urban counterparts (4.9 *vs* 3.5 people). Most (94%) urban students were the only child in the household, compared to merely 12% in their rural counterparts. Over a tenth of students in rural or urban schools had divorced parents. Over 40% and 30% of rural and urban students' primary guardians were male, mostly fathers and sometimes grandfathers. The age of their primary guardians averaged about 45 years old for both rural and urban students. Urban students' primary guardians' tended to have a much higher education level. Over 40% of urban students' primary guardians had a college and above education, in comparison to less than 3% in their rural counterparts.

Table 2 reports dietary habits and anthropometric indicators by rural/urban school attendance. Rural students performed significantly worse than their urban counterparts in all three diet-related measures. Rural students on average consumed fruit and vegetables 1.93 [95% confidence interval (CI): 1.55, 2.31] times less than their urban counterparts in the past week; whereas they consumed sugar-sweetened beverages 1.30 (95% CI: 1.04, 1.55) times and junk foods 4.98 (95% CI: 4.30, 5.66) times more than their

Table 1
Individual characteristics of the survey sample by rural and urban residence.

Individual characteristics	Attribute	Rural (95% CI)	Urban (95% CI)	p-value
Sample size		427	219	
Child's sex				
Male	Dichotomous	49.9% (45.1, 54.6)	48.9% (42.2, 55.5)	0.81
Child's age				
Age in years	Continuous	11.57 (11.44, 11.69)	11.59 (11.35, 11.83)	0.89
Child's grade				
Grade 4 (primary school)	Categorical	25.5% (21.4, 29.7)	21.9% (16.4, 27.4)	0.30
Grade 5 (primary school)	Categorical	27.9% (23.6, 32.1)	18.3% (13.1, 23.4)	0.005
Grade 6 (primary school)	Categorical	22.3% (18.3, 26.2)	17.8% (12.7, 22.9)	0.18
Grade 7 (middle school)	Categorical	12.9% (9.7, 16.1)	21.0% (15.6, 26.4)	0.01
Grade 8 (middle school)	Categorical	11.5% (8.4, 14.5)	21.0% (15.6, 26.4)	0.003
Household size				
Number of people in household	Count	4.91 (4.77, 5.06)	3.47 (3.34, 3.59)	0.000
Single child status				
Single child in the family	Dichotomous	11.7% (8.7, 14.8)	94.1% (90.9, 97.2)	0.000
Parents' marital status				
Divorced	Dichotomous	11.0% (8.0, 14.0)	10.5% (6.4, 14.6)	0.84
Primary guardian's sex				
Male	Dichotomous	40.9% (36.2, 45.6)	30.6% (24.5, 36.7)	0.009
Primary guardian's age				
Age in years	Continuous	45.48 (44.39, 46.57)	44.82 (43.71, 45.93)	0.40
Primary guardian's education				
No formal education	Categorical	14.3% (11.0, 17.6)	6.5% (3.2, 9.7)	0.001
Primary school education	Categorical	41.7% (37.0, 46.4)	1.4% (0.0, 2.9)	0.000
Middle or high school education	Categorical	41.2% (36.5, 45.9)	7.8% (4.2, 11.4)	0.000
College and above education	Categorical	2.8% (1.2, 4.4)	47.00% (40.3, 53.7)	0.000

Pearson's chi-square test is used to test the difference in proportions of a dichotomous or categorical variable between urban and rural residents.
Two-sample t-test is used to test the difference in means of a continuous or count variable between urban and rural residents.

Table 2
Dietary habits and anthropometric indicators by rural and urban residence.

Variable	Attribute	Rural (95% CI)	Urban (95% CI)	Difference (rural-urban)	*p*-value
Dietary habit					
Number of times consuming fruit/vegetables in past week.	Count	4.55 (4.29, 4.80)	6.48 (6.28, 6.68)	-1.93 (-2.31, -1.55)	0.000
Number of times consuming sugar-sweetened beverages in past week.	Count	1.74 (1.57, 1.92)	0.45 (0.34, 0.55)	1.30 (1.04, 1.55)	0.000
Number of times consuming junk foods in past week.	Count	6.22 (5.75, 6.69)	1.24 (1.02, 1.46)	4.98 (4.30, 5.66)	0.000
Anthropometric indicator					
Body mass index (kg/m^2)	Continuous	19.03 (18.69, 19.37)	18.97 (18.50, 19.43)	0.06 (-0.51, 0.64)	0.83
Childhood overweight	Dichotomous	0.20 (0.16, 0.24)	0.24 (0.18, 0.29)	-0.03 (-0.10, 0.03)	0.32
Childhood obesity	Dichotomous	0.08 (0.05, 0.11)	0.09 (0.05, 0.12)	-0.01 (-0.05, 0.04)	0.78
Waist circumference (cm)	Continuous	67.25 (66.33, 68.16)	67.54 (66.22, 68.87)	-0.30 (-1.89, 1.29)	0.71
Waist-to-hip ratio	Continuous	0.83 (0.82, 0.84)	0.79 (0.78, 0.80)	0.04 (0.03, 0.05)	0.000
Body fat percentage	Continuous	19.39 (18.51, 20.26)	20.35 (19.19, 21.51)	-0.96 (-2.45, 0.53)	0.21

Pearson's chi-square test is used to test the difference in proportions of a dichotomous variable between urban and rural residents. Two-sample *t*-test is used to test the difference in means of a continuous or count variable between urban and rural residents.

urban counterparts in the past week. The prevalence of overweight among rural and urban students was 20% and 24%, respectively, and prevalence of obesity among rural and urban students was 8% and 9%, respectively. The rural-urban differences in anthropometric indicators were statistically non-significant ($p \geq 0.05$) except for waist-to-hip ratio. The waist-to-hip ratio of rural students was on average 0.04 (95% CI: 0.03, 0.05) higher than that of their urban counterparts.

Table 3 reports regression-adjusted rural-urban differences in dietary habits and anthropometric indicators. Compared to the raw differences without adjusting for individual characteristics, regression-adjusted rural-urban differences remain fairly similar. Adjusting for individual characteristics, rural students consumed fruit and vegetables 2.11 (95% CI: 1.16, 3.06) times less than their urban counterparts in the past week; whereas they consumed sugar-sweetened beverages 1.87 (95% CI: 1.13, 2.61) times and junk foods 5.77 (95% CI: 3.98, 7.57) times more than their urban counterparts in the past week. The adjusted rural-urban differences in anthropometric indicators were statistically non-significant ($p \geq 0.05$) except for waist-to-hip ratio. The waist-to-hip ratio of rural students was on average 0.03 (95% CI: 0.01, 0.05) higher than that of their urban counterparts.

Table 4 reports regression-adjusted rural-urban differences in dietary habits and anthropometric indicators by sex. There tended to be some sex differences in the estimated rural-urban disparities but none of these differences were statistically significant. Rural boys consumed fruit and vegetables 2.03 (95% CI: 0.67, 3.39) times less than their urban counterparts in the past week, which was fairly comparable to rural girls, who consumed fruit and vegetables 2.16 (95% CI: 1.10, 3.81) times less than their urban counterparts in the past week. Rural boys consumed sugar-sweetened beverages 2.30 (95% CI: 1.25, 3.35) times and junk foods 5.20 (95% CI: 2.81, 7.58) times more than their urban counterparts in the past week; whereas rural girls consumed sugar-sweetened beverages 1.81 (95% CI: 0.70, 2.92) times and junk foods 6.38 (95% CI: 3.59, 9.16) times more than their urban counterparts in the past week. None of the anthropometric indicators significantly differed between rural and urban boys; whereas the waist circumference and waist-to-hip ratio of rural girls were on average 5.00 (95% CI: 0.10, 9.91) and 0.06 (95% CI: 0.03, 0.10) higher than those of their urban counterparts, respectively.

DISCUSSION

This study assessed rural-urban disparities in dietary habits and anthropometric indicators among Chinese students. Survey samples came from primary- and middle-school students residing either in Beijing or within the rural "poverty belt" surrounding Beijing. Rural students consumed fruit and vegetables less frequently but sugar-sweetened beverages and junk foods more frequently than their urban counterparts. Rural students also had higher waist-to-hip ratio than their urban counterparts. While no significant urban-rural differences in BMI, overweight/obesity rate, waist circumference, waist-to-hip ratio, or body fat percentage were identified among boys, rural girls had significantly higher waist circumference and waist-to-hip ratio than urban girls.

Over the last two decades, Chinese rural residents underwent a profound transition from under-nutrition to over-

Table 3
Regression-adjusted rural-urban differences in dietary habits and anthropometric indicators.

Variable	Attribute	Model	Raw difference (rural - urban)	Adjusted difference (rural - urban)
Dietary habit				
Number of times consuming fruit/vegetables in past week.	Count	Negative binomial	-1.93*** (-2.31, -1.55)	-2.11*** (-3.06, -1.16)
Number of times consuming sugar-sweetened beverages in past week.	Count	Negative binomial	1.30*** (1.04, 1.55)	1.87*** (1.13, 2.61)
Number of times consuming junk foods in past week.	Count	Negative binomial	4.98*** (4.30, 5.66)	5.77*** (3.98, 7.57)
Anthropometric indicator				
Body mass index (kg/m^2)	Continuous	Linear	0.06 (-0.51, 0.64)	0.35 (-1.05, 1.76)
Childhood overweight	Dichotomous	Logistic	-0.03 (-0.10, 0.03)	0.01 (-0.17, 0.18)
Childhood obesity	Dichotomous	Logistic	-0.01 (-0.05, 0.04)	0.02 (-0.11, 0.15)
Waist circumference (cm)	Continuous	Linear	-0.30 (-1.89, 1.29)	0.39 (-3.41, 4.20)
Waist-to-hip ratio	Continuous	Linear	0.04*** (0.03, 0.05)	0.03** (0.01, 0.05)
Body fat percentage	Continuous	Linear	-0.96 (-2.45, 0.53)	0.26 (-3.37, 3.89)

Regression models adjusted for individual characteristics reported in Table 1. Average treatment effects were calculated based on regression estimates, with 95% confidence intervals in parenthesis. *, $0.01 \le p < 0.05$; **, $0.001 \le p < 0.01$; and ***, $p < 0.001$.

Table 4
Regression-adjusted rural-urban differences in dietary habits and anthropometric indicators by sex.

Variable	Attribute	Model	Adjusted difference in boys (rural - urban)	Adjusted difference in girls (rural - urban)
Dietary habit				
Number of times consuming fruit/vegetables in past week.	Count	Negative binomial	-2.03** (-3.39, -0.67)	-2.16*** (-3.81, -1.10)
Number of times consuming sugar-sweetened beverages in past week.	Count	Negative binomial	2.30*** (1.25, 3.35)	1.81** (0.70, 2.92)
Number of times consuming junk foods in past week.	Count	Negative binomial	5.20*** (2.81, 7.58)	6.38*** (3.59, 9.16)
Anthropometric indicator				
Body mass index (kg/m^2)	Continuous	Linear	-0.55 (-2.69, 1.59)	1.39 (-0.45, 3.24)
Childhood overweight	Dichotomous	Logistic	-0.003 (-0.26, 0.26)	0.02 (-0.21, 0.25)
Childhood obesity	Dichotomous	Logistic	-0.006 (-0.21, 0.19)	0.06 (-0.11, 0.22)
Waist circumference (cm)	Continuous	Linear	-3.92 (-9.80, 1.96)	5.00* (0.10, 9.91)
Waist-to-hip ratio	Continuous	Linear	-0.002 (-0.03, 0.03)	0.06*** (0.03, 0.10)
Body fat percentage	Continuous	Linear	-1.85 (-7.72, 4.02)	2.71 (-1.34, 6.77)

Regression models adjusted for individual characteristics reported in Table 1. Average treatment effects were calculated based on regression estimates, with 95% confidence intervals in parenthesis. *, $0.01 \le p < 0.05$; **, $0.001 \le p < 0.01$; and ***, $p < 0.001$.

nutrition (Dearth-Wesley *et al*, 2008). On the one hand, underweight prevalence was gradually reduced in rural children, especially among children from low-income households (Dearth-Wesley *et al*, 2008). On the other hand, overweight rate increased rapidly among low-income rural populations (Dearth-Wesley *et al*, 2008). This major shift in the distribution of body weight status among rural children results in "catching up" with their urban counterparts in terms of overweight/obesity prevalence. Based on data from the China Health and Nutrition Survey, urbanicity was strongly and positively associated with BMI during 1991–2000, whereas the trends became similar between rural and urban areas during 2000–2011 (Gordon-Larsen *et al*, 2014). This coincides with the findings from this study that rural students resembled their urban counterparts in the majority of weight-related indicators, and had even higher levels in one to a few of them.

Previous studies warned against food insecurity and micronutrient deficiency among Chinese rural children and infants (Hannum *et al*, 2014; Luo *et al*, 2015). While that issue is likely to continue into the future, our study adds to the overall picture a new challenge—poor diet quality characterized by low fruit and vegetable intake and high sugar-sweetened beverage and discretionary food intake. Fast-food intake has been on the rise among Chinese urban children over the past few decades, which is thought to have contributed to the childhood obesity epidemic (Braithwaite *et al*, 2014; Gao *et al*, 2014). It is likely that fast food consumption becomes increasingly popular and prevalent among rural children as well, with further reduced food quality and nutritional value to accommodate the lower purchasing power among rural residents (Xue *et al*, 2016). However, few studies have investigated fast-food consumption patterns among Chinese rural children.

The rural-urban disparities in dietary habits and anthropometric indicators identified in this study might be part of the profound consequences of the industrial development strategy long indorsed by the Chinese central government (Yang and Fang, 2000). Factor market has long been distorted to favor development in urban areas in order to advance the goal of industrialization at the expense of equality and wellbeing of rural residents (Yang and Fang, 2000). Following the inception of economic reforms in 1978, the central government has constantly been under pressure to raise income level of the urban population using various transfer programs so as to preserve political legitimacy and regime stability (Yang and Fang, 2000). The growing rural-urban divide has affected many social aspects, including health outcomes. Compared to the urban population, the overall health status and quality of life are found to be considerably lower among people living in rural China (Fang *et al*, 2009; Dong and Simon, 2010). Rural residents also have a significantly higher proportion of depression and lower levels of social support (Dong and Simon, 2010). Low income and health/nutrition literacy, poor sanitation condition, and lack of medical care resources might contribute to the health disparity between rural and urban populations (Fu, 2005; Liu *et al*, 2007; Jian *et al*, 2010; Chen *et al*, 2012; Wu, 2013).

Promoting nutritious diet and physical activity are essential in improving weight-related health outcomes among Chinese rural students and reducing rural-urban disparities. The Chinese central government launched the "Sunshine School Meal" program in 2011. Currently the program serves approximately 32.1 million students residing in over a third of all rural villages in China (China Development Research Foundation, 2015). A further expansion of this program with enhanced meal quality is likely to improve rural students' nutritional status. In addition, nutrition education can be essential for school children to adopt a healthy eating habit, and should be incorporated into the core curriculum. Although physical education (PE) is mandatory in Chinese schools, its curriculum and implementation differ substantially across regions (Jin, 2013). It is possible that due to a lack of facilities, staff and regular supervision, rural schools compromise PE delivery with reduced effectiveness. Improving the availability of exercise facilities in communities has become a national policy, as highlighted in China's Twelfth Five-Year Plan (2011-2015) for the Sport Industry (General Administration of Sport of China, 2012). It includes building new exercise facilities (*eg*, community fitness centers, parks, roadside open spaces with exercise equipment) and enhances the accessibility of existing facilities (*eg*, extending the operating hours of school gyms/playgrounds) (General Administration of Sport of China, 2012). Creating a neighborhood environment conducive to physical activity might reduce sedentary behaviors and help Chinese rural students adopt a more active lifestyle (An and Zheng, 2014; Zheng and An, 2015).

This paper is the first study that documents dietary habits and anthropometric indicators among rural students living in the "poverty belt" surrounding Beijing in comparison to their Beijing counterparts. The strengths of this study include a relatively large sample comprising primary and middle school students residing in rural as well as urban areas, and weight-related clinical measures. However, a few limitations of the study should be noted. Children's height and body composition are constantly changing during the aging process. Pediatric growth charts have been widely used by pediatricians, nurses and parents to track the growth of children. Percentiles or z-scores of BMI, waist circumference, and waist-to-hip ratio based on the sex- and age-specific growth charts prove to be a more appropriate measure than their respective raw value because they take children's body development into consideration. We thus used the Chinese age- and sex-specific growth chart of height and weight (Ji, 2005) to define childhood overweight and obesity. However, the growth chart only publishes a few major cutoff values but does not include all data that enable the conversion of any specific BMI value to a BMI percentile or z-score. Similar situations hold for waist circumference and waist-to-hip ratio. We thus presented BMI, waist circumference and waist-to-hip ratio as raw values in the study. Nevertheless, this treatment might not have a large impact on the modeling results as we controlled age in all regression analyses. This cross sectional study is an observational investigation. Although we controlled for a series of individual and family characteristics, due to the lack of a randomized experimental design, we could not completely rule out the possibility of confounding. Therefore, no casual inference should be drawn from the study findings. Measurement limitations pertain to the outcome measures in the diet analysis. The paper-based survey does not comprehensively capture diet, but only contains a few questions on eating habits. Items are not specific to the type of food consumed, and respondents are provided with limited instructions on how to frame their responses. Answers to the diet-related questions were self-reported and subject to recall error and social desirability bias (Hebert *et al*, 2008). Schools were not randomly selected from each region (*ie*, Beijing and the rural "poverty belt" surrounding Beijing), so that the study findings may not be generalized to the regional student population.

In conclusion, this study examined disparities in dietary habits and anthropometric indicators between Chinese students living in Beijing metropolitan area and those in the rural "poverty belt" surrounding Beijing. Adjusting for individual and family characteristics, rural students had poorer dietary habits and worse weight-related health indicators than their urban counterparts. Improving diet quality among Chinese rural students is essential in reducing rural-urban health disparities. Policy interventions are warranted to create a rural neighborhood environment conducive to physical activity and adoption of an active lifestyle.

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