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Title: Ethnicity, socio-economic status and the nutritional status of Chinese children and adolescents: findings from three consecutive national surveys between 2005 and 2014

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Abstract

Background: Economic development has brought rapid shifts in the food environment of Chinese children and adolescents.

Objectives: To assess the changes in childhood nutritional status across ethnic groups and economic status from 2005 to 2014.

Methods: 664 094 Chinese Han and 224 151 ethnic minority children and adolescents aged 7-18 years were assessed in three national cross-sectional surveys (2005, 2010 and 2014). Gross domestic product (GDP) per capita of each ethnic group was categorized into four strata of socioeconomic status. To assess ethnic disparities at each time point, we used logistic regression to estimate the prevalence odds ratios (OR) for thinness, overweight and obesity in the 24 ethnic minority groups versus Han Chinese.

Results: Children in the two upper economic strata (over about US$4000 GDP per capita) had a high prevalence of overweight and obesity, while those in the two lower economic strata (below US$4000 GDP per capita) had a high prevalence of thinness. From 2005 to 2014, the prevalence of thinness decreased from 18.6% to 13.1% in Han children, and from 20.4% to 17.1% in ethnic minority students. At the same time, the prevalence of overweight and obesity increased from 10.4% to 17.7% in Han children, and from 4.3% to 9.2% in ethnic minority students, respectively.

Conclusions: A rapid nutritional transition has occurred from 2005 to 2014 with shifts from thinness to overweight and obesity in both Han and ethnic minority children and adolescents,

reflecting local GDP per capita.

INTRODUCTION

Globally, the nutritional transition of children and adolescents is deeply affected by economic change [1-3]. For example, the global economic and food crisis that emerged in 2008 greatly influenced local economies and food supplies and directly affected population nutrition; the Food and Agriculture Organization of the United Nations (FAO) estimated that 1.02 billion people suffered from starvation at this time [4,5]. Declining trends in the prevalence of malnutrition in the 1990s were seen to reverse in 2008, with 642 million people in Asia, for example, having poor nutrition [6]. Children's nutritional requirements for growth make them especially vulnerable to undernutrition at times of economic crises which are commonly accompanied by surging food prices, food shortages and declines in household income [7,8].

Notwithstanding the background of the global economic crisis, overweight and obesity is becoming increasingly prevalent in Chinese children and adolescents.[9] Socioeconomic development is accompanied by greater food security, reduction in the burden of infectious diseases and changing patterns of health risk behaviors, such as physical inactivity [10-13]. In China, for example, the FAO suggests that food shortages have not occurred during the past 10 years, a decreasing proportion of family income is spent on food (a sign of increasing wealth) [5,14], and the burden of childhood infectious diseases has steadily decreased[15]. However, over the same time cooking styles have shifted from predominantly steaming and boiling to frying, and dietary intake has shifted from cereals and tubers to energy-dense foods

[10,16,17]. Rates of physical inactivity and drinking sugar sweetened beverages have also increased among Chinese children and adolescents during the past decades [11,18]. While socioeconomic development has brought many benefits to China, it has also changed patterns of health risk behaviors related to the nutritional transition from thinness to overweight and obesity.

In children and adolescents, severe thinness as well as overweight and obesity are associated with adverse health consequences throughout the life-course [19]. Thinness in children is a major concern, especially in developing countries. According to the WHO, approximately 16% of children in lower middle income countries (LMICs) are classified as severely thin [20]. In contrast, childhood and adolescence are common periods for the emergence of overweight and obesity, which once established typically persists into adulthood [19]. In the past three decades, the prevalence of childhood overweight and obesity has increased rapidly among high-, middle- and low-income countries [21-23], including China [24]. There is increasing evidence to show that tracking of childhood overweight and obesity into adulthood accounts for a substantially elevated future burden of cardiovascular disease, diabetes, musculoskeletal problems and cancer [25,26].

In China, there have been clear secular trends in the nutritional transition of children and adolescents [3,27]. Yet beyond socioeconomic status, ethnicity may also influence nutritional transitions in relation, for example, to cultural differences in food preferences and cooking styles [28]. A multi-ethnic country like China provides a good opportunity to assess the

association between nutritional status and ethnicity, as well as socioeconomic status. For example, within China, there has been a large ethnic difference in cardiovascular disease (CVD) risks, and correspondingly awareness, control, and rates of several major CVD including hypertension [29-32]. Yet to date, there has been little research about the nutritional transition of Chinese children and adolescents of differing ethnicities

In this study, we used data from the Chinese National Survey on Students' Constitution and Health (CNSSCH, 2014, 2010 and 2005), a successive series of national cross-sectional surveys which are representative of Han and ethnic minority students in China. The objectives of the present study were to: (1) describe the nutritional transition among a representative sample of students from Chinese Han and 24 ethnic minority groups over a 10-year period, and (2) explore the association between the nutritional transition and GDP per capita changes.

Subjects and methods

Study population

Data were obtained from the 2005, 2010 and 2014 cycles of the CNSSCH, a large nationally representative survey of Chinese school-aged children and adolescents that was designed to investigate their health status, and approved by six relevant ministries, including the Ministry of Education, General Administration of Sport, Ministry of Health, State Ethnic Affairs Commission, Ministry of Science and Technology, and Ministry of Finance [33]. The sampling procedures and investigation procedures have been previously described in detail

[34,35], and were the same for each time point of the CNSSCH surveys, and for the Han and ethnic minority students. In summary, participants in each survey year were primary or secondary school students aged 7-18 years, who were selected by stratified cluster sampling such that sampling took place in classes that were selected randomly from each grade in the selected schools. The schools containing ethnic minority students were randomly selected in minority regions or prefectures from 12 provinces (Ethnic Minority Autonomous Regions or Ethnic Minority Autonomous Prefectures). Han students were not studied in Tibet, Taiwan, Hong Kong or Macao. The present study included boys and girls of Han ethnicity, together with the following 24 ethnic minority groups: Mongol, Hui, Tibetan, Uyghur, Miao, Zhuang, Bouyei, Korean, Dong, Yao, Bai, Tujia, Hani, Kazak, Dai, Li, Lisu, Va, Shui, Naxi, Khalkhas, Monguor, Qiang and Salar (**Figure S1**).

Participants in this study were eligible if they and their parents were considered to have the same ethnicity and had lived in the local area for longer than one year. All eligible students underwent a complete medical examination before the national survey to ensure that they had no overt physical disorders. The sex ratio approximated 1:1 in each survey. According to the sample size formula of stratified cluster sampling design, within the primary sampling units of Han children and adolescents, namely every age from 7 to 18 years of boys or girls in the urban or rural areas, at least 50 Han ethnicity children, the minimum sample size, were included in the survey and sampling yielded equal numbers of 3 socioeconomic indicators groups. Thus, the sample weight remained consistent in each age, sex, region

(urban/rural), city (three socioeconomic indicator groups at sub-province level) and province for children aged 7-18 years in each survey year. The minimum effective sample sizes for overweight and obesity, and thinness in children of each ethnic minority were 2506 and 1596, respectively. Thus the sample size among ethnic minorities in our study was appropriately representative for investigating the disease prevalence of overweight and obesity, and thinness. A total of 664 094 Chinese Han (234 421 in 2005; 215 319 in 2010; 214 354 in 2014) and 224 151 ethnic minority (73 650 in 2005; 75 142 in 2010; 75 359 in 2014) children and adolescents with complete records on age, sex, nationality, height and weight were included in the analyses (**Figure S2**). Across the three time periods, the percentage of the Han population and the total population of the ethnic minority groups was 91.98% and 8.02%, respectively. The cumulative percentage of the 24 ethnic minority groups within the CNSSCH accounted for 83.21% of all of the ethnic minorities in China. (**Table S1**).

This project was approved by the Medical Research Ethics Committee of Peking University Health Science Center (IRB00001052-13002). Data were collected from schools across China. School principals determined the process for gaining informed parental consent (i.e., written vs. verbal, active vs. passive) with informed consent obtained from students and their parents. Participant information was anonymized and de-identified before analysis. The investigation and analysis were carried out following the rules of the Declaration of Helsinki.

Measures

Height (cm) and weight (kg) were measured following a standardized procedure by trained professionals. Height was measured to the nearest 0.1 cm with portable stadiometers and weight was measured to the nearest 0.1 kg with a standardized scale. All participants were required to wear only light clothing and stand erect, barefoot and at ease while being measured. Both the stadiometers and scales were calibrated before use and similar instruments were used in measurement at all survey sites. Body mass index (BMI) was calculated as body weight (kg) divided by height (m) squared (kg/m^2). Different BMI categories, including severe and moderate thinness, overweight, mild and severe obesity, were classified using the sex-and age-specific BMI reference values developed by the International Obesity Task Force (IOTF, **Table S2**) [36-38], an internationally accepted definition of children's nutritional status. Data on per capita gross domestic product (GDP) of each ethnic autonomous region from 2005 to 2014 were collected from the statistical yearbooks of China from the National Bureau of Statistics of the People's Republic of China [14,39,40]. The GDP per capita in the Han was calculated based on the national average GDP per capita. The GDP per capita in each other ethnic group was categorized into four strata according to the international universal cutoff points of country affluence established by the World Bank in 2013 as follows: Stratum One (≤1035 US dollars), Stratum Two (1036-4085 US dollars), Stratum Three (4086-12616 US dollars) and Stratum Four (>12616 US dollars) [41]. These four strata were equivalent to the level of economic development of the different ethnic groups, and represented four categories as following: lower-income regions,

lower-middle-income regions, upper-middle-income regions, and high-income regions (see **Figure S3**).

Statistical analysis

The distributions of severe thinness, thinness, overweight obesity and severe obesity in the 25 ethnic groups were presented graphically. Subgroup analyses were conducted by four age groups: 7 to 9 years; 10 to 12 years; 13 to 15 years; and 16 to 18 years. Scatter plots were adopted to analyze the changes of distribution characteristics for thinness, overweight, and obesity from 2005 to 2014 among the 25 ethnic groups, weighting their GDP per capita category. Differences in nutritional status among the different ethnic groups between 2005 CNSSCH and the subsequent years were tested with comparison method of least significant difference in χ^2 test. Differences for the changes of prevalence and proportions between two adjacent survey years were tested by Cochran's Q test. To assess ethnic disparities at each time point, we used logistic regression to estimate the prevalence odds ratios (OR) for thinness, overweight and obesity in the 24 ethnic minority groups versus Han Chinese with adjustment for age, height and urban-rural area. All analyses were performed using Stata version 15.0 software.

Results

Trends and common features of nutritional transition in Han and ethnic minorities

Figure 1 shows the trends of prevalence of thinness, overweight and obesity in Chinese Han and the combined 24 ethnic minority groups of children and adolescents from 2005 to 2014. The prevalence of thinness decreased significantly over the 10 year period from 18.6% to 13.1% for the Han and 20.4% to 17.1% for ethnic minority students, respectively. Meanwhile, the prevalence of overweight and obesity increased over the 10-year period from 10.4% to 17.7% for the Han and 4.3% to 9.2% for ethnic minority students, respectively. Both Han and ethnic minority students showed a rapid transition from thinness to overweight across the decade. Moreover, the speed of nutritional transition accelerated over time, especially in 2010-2014. During the five year period from 2010-2014, the decrease in thinness and the increase in overweight and obesity were larger than in the previous five years. There were also similar trends at the extremes, with decreasing severe thinness and increasing severe obesity in both sexes in the Han and ethnic minorities across the decade. The combined proportion of severe thinness and severe obesity remained nearly stable over time, with a greater proportion with severe thinness than severe obesity (**Table S3**). Subgroup analysis by age group in both Han and ethnic minority students showed a similar nutritional transition from thinness to overweight and obesity, but the prevalence difference was of different magnitude. The youngest age group (7-9 years) showed the largest increase in the prevalence of overweight and obesity, while the largest decrease in the prevalence of thinness was in the 10-12-yr-olds and the 13-15-yr-olds (**Table S4**).

Difference of nutritional transition patterns between Han and ethnic minorities

The speed of the nutritional transition from thinness to overweight and obesity was faster in the Han students than in ethnic minority students. Thus, the decrease in thinness and the increase in overweight and obesity in Han students were larger than in the ethnic minorities (**Table 1**). Meanwhile, the prevalence of thinness and severe thinness in Han students was significantly lower, but the prevalence of both overweight and obesity in Han remained higher than in the ethnic minority students across the decade (**Table S3**). However, the prevalence odds ratio of ethnic minority students versus Han students for nutritional status showed a greater burden of thinness in ethnic minority students. The difference between ethnic minority and Han students widened steadily over time, with an increase in the prevalence odds ratio from 1.13 in 2005 to 1.37 in 2014. The same trend was apparent for severe thinness in both boys and girls. In contrast, the initial burden of overweight and obesity was low in ethnic minority students, but the gap between ethnic-group and Han students gradually decreased over time, with an increase in the prevalence odds ratio from 0.39 in 2005 to 0.47 in 2014. There was a similar trend for severe obesity in both boys and girls (**Table 2**).

As shown in **Figure 2**, compared with the Han children and adolescents, students from some ethnic minority groups, such as the Dais and Lis, had a higher prevalence of thinness and proportion with severe thinness, while the Mongolian and Kazak students had a lower thinness prevalence and proportion of severe thinness. Almost all ethnic minority groups had higher prevalence ORs than the Han for thinness and severe thinness except for the Koreans,

Kazaks and Mongolians. For example, in 2014, the prevalence ORs of thinness in the Li and Dai compared to the Han students were 3.46 and 3.20, while the prevalence ORs of severe thinness were 3.65 and 3.60, respectively (**Figure 3**). Although the prevalence of thinness and severe thinness in the Han students and most ethnic minority groups declined steadily over the decade, less consistent trends were apparent in the Bouyeis, Zhuangs, Dongs, Khalkhas and Tibetans. These groups had a significant increase from 2005 to 2010 but a small decrease across the most recent period.

The prevalence of overweight and obesity and the proportion of severe obesity were lower in students from most ethnic minority groups than in the Han students across the three surveys, except for the Koreans, Mongolians and Kazaks. The Koreans had the highest prevalence of overweight and obesity across the three waves, and the proportion with obesity was also the highest of any group from 2010 to 2014. (**Table S5 and Table S6**). Only Koreans had a higher risk for overweight and obesity when compared to the Han students, with prevalence ORs of 1.52 in 2005 and 1.64 in 2014. The lowest prevalence ORs for overweight and obesity were in Shui students, which were low in 2005 and remained low in 2014 (**Figure 3**). The prevalence ORs for ethnic minority groups compared to the Han students for thinness and obesity (including severe thinness and obesity), did not change much across the different survey years (**Table S7 and Table S8**).

The association between nutritional transition and increase in GDP per capital

As shown in **Figure 4**, across the Han and 24 ethnic minority groups, students from the ethnic groups with a high prevalence of thinness were more likely to demonstrate a low prevalence of overweight and obesity, and vice versa. As a whole, all ethnic groups across the four economic strata seemed to follow a pattern in which a rapid transition from thinness to overweight and obesity occurred which was highly associated with the increase of GDP per capita. The ethnic groups in stratum three and four tended to suffer from a high burden of overweight and obesity, but the ethnic groups in stratum one and two continued to have a relatively high burden of thinness. Notably, the ethnic groups in the economic transition periods from stratum two to stratum three are experiencing a double burden of thinness and overweight, a pattern seen in the Naxi, Tibeten and Zhuang groups. This contrasts with the Koreans, Kazakhs and Mongolians in stratum three and four whose prevalence of overweight and obesity was high in 2005, increasing further in 2014, with a low burden of thinness declining steadily over this period. Their GDP per capita remained high in each survey year. In contrast, the Lisu and Dais in stratum one and two showed a relatively high prevalence of thinness and low prevalence of overweight and obesity over this time.

Discussion

The lifelong health effects make growth and nutrition across childhood and adolescence an essential area for health policy, particularly in the context of rapid shifts in the food environment that occurs with economic development. Chinese children and adolescents from

both the Han and ethnic minority groups have had a rapid nutritional transition from thinness to overweight and obesity over past decade, but that the speed of the shift has been slower in ethnic minority compared to Han students. We also found that different levels of economic development were associated with different nutritional problems. Ethnic minority students in less economically developed areas had nutritional problems similar to the low and lower middle income countries of Sub-Saharan Africa or Central Asia, where the major nutritional problem were still underweight[41]. Ethnic minorities in stratum three and four, equivalent to upper-middle-income countries and high-income countries such as Central and Eastern Europe or North America, had prominent overweight and obesity. Ethnic minority students in the period of transition from stratum two to three were confronted with the double burden of under-nutrition and over-nutrition [19]. It is therefore essential for nutritional interventions to differ according to the stage of local economic development.

We found that the nutritional status of children and adolescents was highly associated with GDP per capita regardless of ethnic status. This is similar to findings elsewhere. Global analyses of nutritional status found that the mean BMI in children has plateaued with high economic levels since 2000, especially in many high-income countries, but the areas of the East, South and Southeast Asia showed a continuing acceleration for mean BMI [19]. For example, recent data from the National Health and Nutrition Examination Survey (NHANES) of US showed that the prevalence of obesity seen in 2009-2010 did not change compared with 2007-2008 [42], which was also seen in Germany [43], Greece [44], Denmark [45], and other

countries[45]. However, at the same time, lots of LMICs are facing the rapid nutritional transition from underweight to overweight, such as Brazil, Egypt, Nigeria and Indonesia [46,47]. It seems that there was a time lag for the nutritional transition between developed countries and some LMICs, so did in Chinese Han and ethnic minority children and adolescents.

The experience of children and adolescents in stratum three or four, such as the Han, Koreans, Kazakhs and Mongolians, showed that the transition from thinness to overweight and obesity can be so rapid that the policies and strategies might lag behind the change. China attached great importance to the implementation of the Millenium Development Goals (MDGs), and by the end of the MDGs in 2015 made significant progress in eradicating much poverty and hunger [48-50]. During this period, customized nutrition and socioeconomic improvement programs, and obesity interventions might have played a role in the rapid transition from under-nutrition to over-nutrition, especially in areas with low socioeconomic status in China [51]. The nutritional policy “the standard amount of nutritional supply for a student’s lunch”, for example, issued by Ministry of Health in 1998 aimed to prevent malnutrition and helped to reduce the risk of some nutritional diseases in ethnic minority areas and Han rural areas [52]. Other policies, such as “free compulsory education in rural areas” issued by the State Council in 2005 provided rural students free access to compulsory education will have increased the disposable income of rural families [53]. However, the diversified patterns of nutritional transition in different ethnic minorities will require specific

interventions and strategies including the food culture each ethnic minority. Thus, when to improve under-nutrition and develop the nutritional improvement programs during the period of transition in ethnic minority areas, health education in nutrition, strategies of dietary diversity and food security need to be appropriately strengthened so as to prevent the polarization or the epidemic of overweight and obesity in the future[54].

Our findings carry several policy implications. Firstly, all ethnic groups in China are confronted by rapid shifts in energy intake and expenditure linked to economic development so that double-duty actions will be needed to both reduce undernutrition while simultaneously preventing overweight and obesity. The timing of this transition in GDP per capita, may provide a reference point for other settings, such as about US$ 4000. Secondly, thinness and severe thinness remain a major problem for most ethnic minorities suggesting that the policy focus will retain a greater emphasis on undernutrition for these groups, particularly in rural areas. Even so, there is a need to rapidly implement policies to address the looming burden of overweight and obesity. These are likely to be multifaceted and emphasise both the promotion of healthy and diverse diets as well as greater physical activity.

There are several limitations to be noted. First, there are 55 ethnic minorities in China but only 24 ethnic minority groups were included in our study. The population of children and adolescents in other ethnic minorities was not high enough for adequately powered study, and the 24 included ethnic minorities are over 80% of the population of school-aged children in all Chinese ethnic minorities. Thirdly we used BMI as an indicator of obesity but it does not

distinguish between lean and fat mass. Other more precise measures such as dual energy X-ray absorptiometry and MRI could better measure fat mass but are infeasible in large surveys. Finally, the GDP per capita used in the present study was not defined at the individual level, raising a possibility of measurement error bringing a misspecification of the association between economic and nutritional status.

In summary, we found that all Chinese ethnic groups are facing a rapid nutritional transition bringing a shift from thinness as the predominant problem to overweight/obesity over the course of a single decade. Differences in nutritional status still persist across groups with thinness, particularly in rural areas, remaining a major problem for many ethnic minorities. In the Chinese setting, moving to GDP per capita of greater than about US$4000 per annum brought a heightened risk for overweight and obesity and indicates the point at which policies need to rapidly shift from a sole focus on undernutrition to the implementation of double duty actions.

Conflict of Interest: None of the authors has a conflict of interest to disclose.

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Legends for figures

Figure 1. Prevalence of thinness, overweight and obesity, and their components in Chinese Han and ethnic minorities by sex and survey year

Note: OW&OB represents overweight and obesity. * *P* at 2010 or 2014 survey year was considered as statistically significant compared with 2005 by chi-square test. The statistical significant difference ($P<0.01$) was pointed in different colors with red dots (severe thinness and mild obesity), blue dots (mild thinness and overweight) and green dots (severe obesity). A fast nutritioanl transion shifting from thinness to overweight/obesity over time from 2005 to 2014 occurred in both Han and ethnic minorities children and adolescents.

Figure 2. Prevalence of thinness and overweight and obesity, and the proportion of their severe proportion (severe thinness and obesity) in Chinese Han students and 24 ethnic minority groups, from 2005 to 2014.

Note: OW&OB represents overweight and obesity. Maroon bars represent the prevalence of thinness (A, B and C) and overweight/obesity (D, E and F), respectively. Blue rhombus symbols represent the proportions of severe thinness in thinness (A, B and C) and obesity in overweight/obesity (D, E and F), respectively. Different survey years was presented from figure A to F, A and D for 2005, B and E for 2010, C and F for 2014. Red lines represent the average prevalence of thinness or OW&OB in 24 Chinese ethnic minority groups. Blue lines represent the average proportion of obesity in OW&OB in 24 Chinese ethnic minority groups.

Figure 3. Prevalence ORs (95% CI) of Chinese students from 24 ethnic minority groups versus the Han for thinness, overweight and obesity, and their severe components (severe thinness and obesity) for each survey year.

Note: OW&OB represents overweight and obesity. Red rhombus symbols represent the POR of each ethnic minority in 2014. Light grey symbols and dark grey symbols represent the POR of each ethnic minority in 2005 and 2010, respectively. Red lines represent the reference line (POR=1). POR showed in figure was adjusted for age, height, urban/rural and school. Almost all ethnic minorities had higher PORs for thinness and sever thinness, whereas lower PORs for overweight and obesity vursus Han children and adolescents.

Figure 4. The evolution of the nutritional transition from thinness to overweight and obesity accompanied by the GDP per capita changes among the Chinese Han and 24 ethnic minority groups of students, for each survey year.

Note: OW&OB represents overweight and obesity. Maroon dots represent the minority whose change was significant and higher than the average line (thinness or OW&OB) compared to the former survey. Four strata represented four categories of ethnic minorities with different levels of economic development based on the GDP per capita (GDP-PC) classification established in 2013 by the World Bank. The dashed lines represent the average prevalence of thinness and OW&OB in students from the 24 ethnic minority groups in the survey year.

During the nutritional transition from thinness to overweight and obesity in Chinese children, students within the ethnic minority groups with higher GDPs per capita continued to lead this transition, with a higher prevalence of overweight/obesity and lower prevalence of thinness.

Table 1. Prevalence difference (PD) for thinness, overweight and obesity, and their components in Chinese Han and ethnic minorities between two adjacent survey points (2005-2010 and 2010-2014)

Groups	Boys, (PD,%, 95%CI)		Girls, (PD,%, 95%CI)		Total, (PD,%, 95%CI)	
	2005-2010	2010-2014	2005-2010	2010-2014	2005-2010	2010-2014
Han						
Thinness	2.9(2.6,3.2)*	2.8(2.5,3.1)*	2.0(1.7,2.3)*	3.3(3.0,3.6)*	2.4(2.2,2.7)*	3.0(2.8,3.3)*
Mild Thinness	2.3(2.0,2.5)*	2.2(1.9,2.4)*	1.4(1.1,1.7)*	2.4(2.1,2.7)*	1.9(1.7,2.1)*	2.3(2.1,2.5)*
Severe Thinness	0.6(0.5,0.7)*	0.6(0.5,0.8)*	0.6(0.4,0.8)*	0.9(0.7,1.1)*	0.6(0.5,0.7)*	0.8(0.7,0.9)*
OW&OB	3.5(3.3,3.8)*	5.5(5.1,5.8)*	1.9(1.6,2.1)*	3.7(3.5,4.0)*	2.7(2.5,2.9)*	4.6(4.4,4.8)*
Obesity	1.0(0.9,1.2)*	1.7(1.6,1.9)*	0.2(0.1,0.3)*	0.9(0.8,1.0)*	0.6(0.5,0.7)*	1.3(1.2,1.4)*
Mild Obesity	0.9(0.7,1.0)*	1.4(1.2,1.6)*	0.3(0.2,0.3)*	0.7(0.6,0.8)*	0.6(0.5,0.6)*	1.0(0.9,1.1)*
Severe Obesity	0.1(0.1,0.2)*	0.3(0.3,0.4)*	0.0(0.0,0.0)	0.2(0.1,0.2)*	0.1(0.0,0.1)*	0.3(0.2,0.3)*
Minority						
Thinness	0.9(1.4,0.3)*	3.0(2.5,3.5)*	0.3(0.3,0.9)	3.1(2.5,3.6)*	0.3(0.1,0.7)	3.0(2.6,3.4)*
Mild Thinness	0.9(1.4,0.3)*	2.2(1.7,2.6)*	0.3(0.2,0.9)	1.9(1.4,2.4)*	0.6(0.2,1.0)*	2.0(1.7,2.4)*
Severe Thinness	0.0(0.0,0.0)	0.8(0.6,1.1)*	0.6(0.3,0.9)*	1.2(0.9,1.5)*	0.3(0.1,0.5)*	1.0(0.8,1.2)*
OW&OB	2.6(2.2,2.9)*	3.4(3.1,3.8)*	1.5(1.2,1.8)*	2.3(1.9,2.6)*	2.0(1.8,2.2)*	2.8(2.6,3.1)*
Obesity	0.7(0.5,0.8)*	1.1(0.9,1.3)*	0.3(0.2,0.4)*	0.5(0.4,0.6)*	0.5(0.4,0.6)*	0.8(0.7,0.9)*
Mild Obesity	0.6(0.5,0.7)*	0.9(0.7,1.1)*	0.3(0.2,0.4)*	0.4(0.3,0.5)*	0.4(0.4,0.5)*	0.7(0.5,0.8)*
Severe Obesity	0.1(0.0,0.2)	0.2(0.1,0.3)*	0.0(0.0,0.0)	0.1(0.1,0.2)*	0.1(0.0,0.1)	0.2(0.1,0.2)

* * *

Note: * $P<0{\cdot}01$ indicated the statistically significant difference for the prevalence difference (PD) between two years intervals according to the Cochran's Q test. PD is obtained by calculating the difference between two years intervals (2005 to 2010 and 2010 to 2014). Between each two survey years, the nutritional transition speed was faster in Han than that in ethnic minorities with a larger decrease in thinness and a larger increase in overweight/obesity (prevalence difference between two survey years) in Han than those in the ethnic groups.

Table 2. Prevalence odds ratio (95% CI) of students from 24 Chinese ethnic minority groups versus Han students for thinness, overweight and obesity, and their components by sex, for each survey year.

Variables	Boys (Prevalence, %, 95% CI)			Girls (Prevalence, %, 95% CI)			Total (Prevalence, %, 95% CI)		
	2005	2010	2014	2005	2010	2014	2005	2010	2014
Thinness	1.22(1.19,1.26)	1.45(1.40,1.49)	1.52(1.47,1.57)	1.05(1.02,1.08)	1.21(1.18,1.25)	1.27(1.23,1.30)	1.13(1.10,1.15)	1.31(1.29,1.34)	1.37(1.34,1.40)
Mild Thinness	1.24(1.20,1.28)	1.43(1.39,1.48)	1.53(1.47,1.58)	1.06(1.02,1.09)	1.16(1.12,1.19)	1.23(1.19,1.27)	1.14(1.11,1.17)	1.28(1.25,1.31)	1.36(1.33,1.39)
Severe Thinness	1.10(1.03,1.17)	1.35(1.27,1.44)	1.36(1.27,1.46)	1.00(0.95,1.06)	1.30(1.24,1.37)	1.29(1.22,1.37)	1.04(1.00,1.09)	1.32(1.27,1.37)	1.32(1.27,1.38)
OW&OB	0.30(0.29,0.32)	0.37(0.36,0.39)	0.41(0.39,0.42)	0.54(0.51,0.57)	0.58(0.55,0.61)	0.57(0.55,0.59)	0.39(0.38,0.40)	0.45(0.44,0.46)	0.47(0.46,0.48)
Overweight	0.32(0.30,0.34)	0.39(0.37,0.41)	0.43(0.41,0.44)	0.57(0.54,0.61)	0.59(0.56,0.62)	0.59(0.56,0.61)	0.42(0.40,0.44)	0.47(0.45,0.49)	0.49(0.48,0.51)
Obesity	0.28(0.25,0.31)	0.38(0.35,0.41)	0.45(0.42,0.48)	0.39(0.33,0.46)	0.55(0.49,0.63)	0.56(0.51,0.62)	0.31(0.28,0.34)	0.42(0.39,0.45)	0.48(0.46,0.51)
Mild Obesity	0.27(0.24,0.31)	0.37(0.34,0.41)	0.45(0.42,0.49)	0.40(0.33,0.48)	0.55(0.49,0.63)	0.55(0.49,0.61)	0.30(0.27,0.34)	0.42(0.39,0.45)	0.48(0.46,0.51)
Severe Obesity	0.35(0.27,0.45)	0.42(0.34,0.51)	0.46(0.39,0.54)	0.36(0.24,0.53)	0.60(0.46,0.83)	0.63(0.50,0.79)	0.35(0.28,0.44)	0.46(0.39,0.54)	0.51(0.44,0.58)

Note: Adjusted for age, height, urban/rural and school; OW&OB represented overweight and obesity. The comparisons of PORs between ethnic minorities and Han children for nutritional status indicated that the thinness burdens were high in ethnic groups, but overweight/obesity burdens were low in ethnic groups. And the gaps of thinness between ethnic groups and Han children were widening steadily over time from 2005 to 2014. But the gaps of overweight/obesity burdens between ethnic groups and Han children were decreasing gradually

over time from 2005 to 2014.

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Title: Ethnicity, socio-economic status and the nutritional status of Chinese children and adolescents: findings from three consecutive national surveys between 2005 and 2014

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Short title: Childhood nutrition transition

Number of supplementary figures：3

Number of supplementary Tables：6

Figure S1. The distribution of 24 ethnic minorities sampled in China at each survey year.

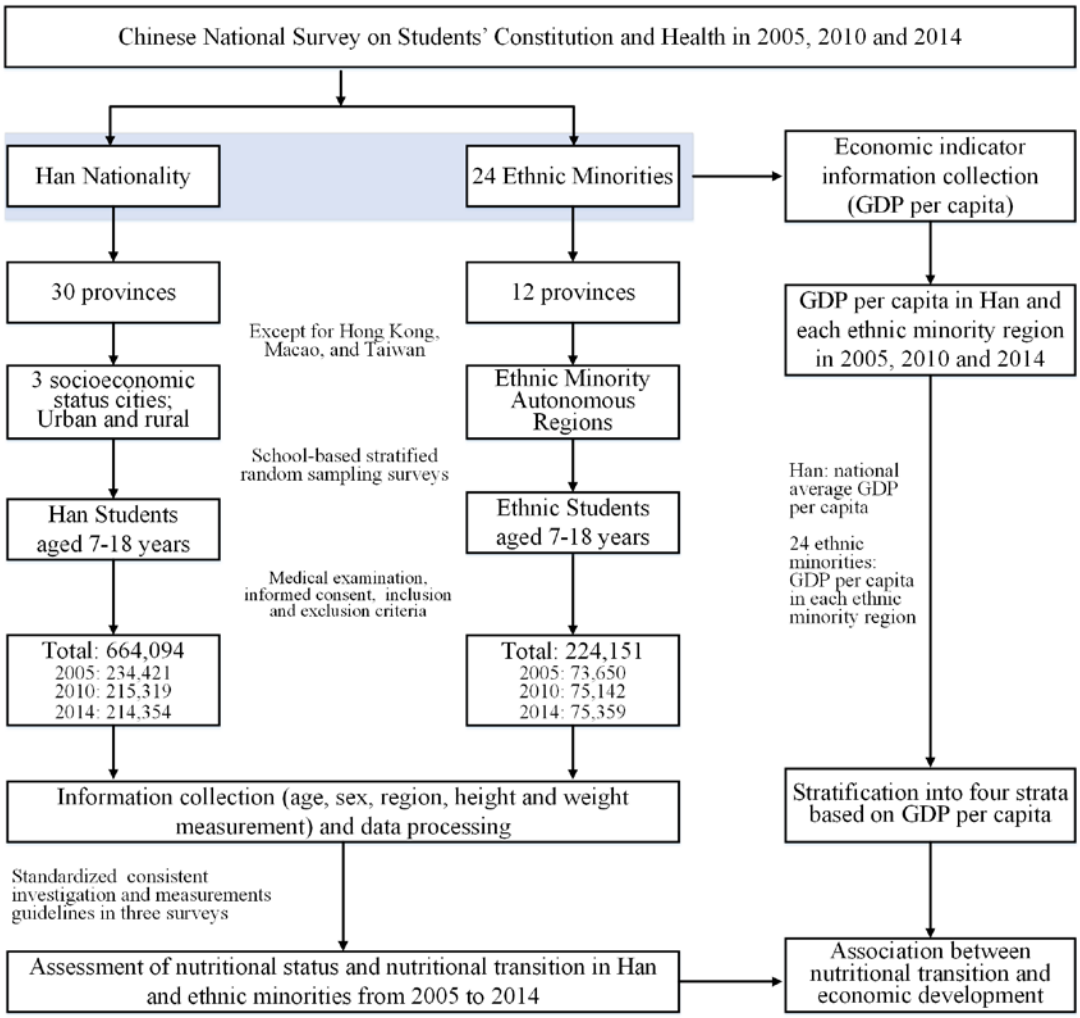

Figure S2. Flow chart of data from the Chinese National Survey on Students' Constitution and Health

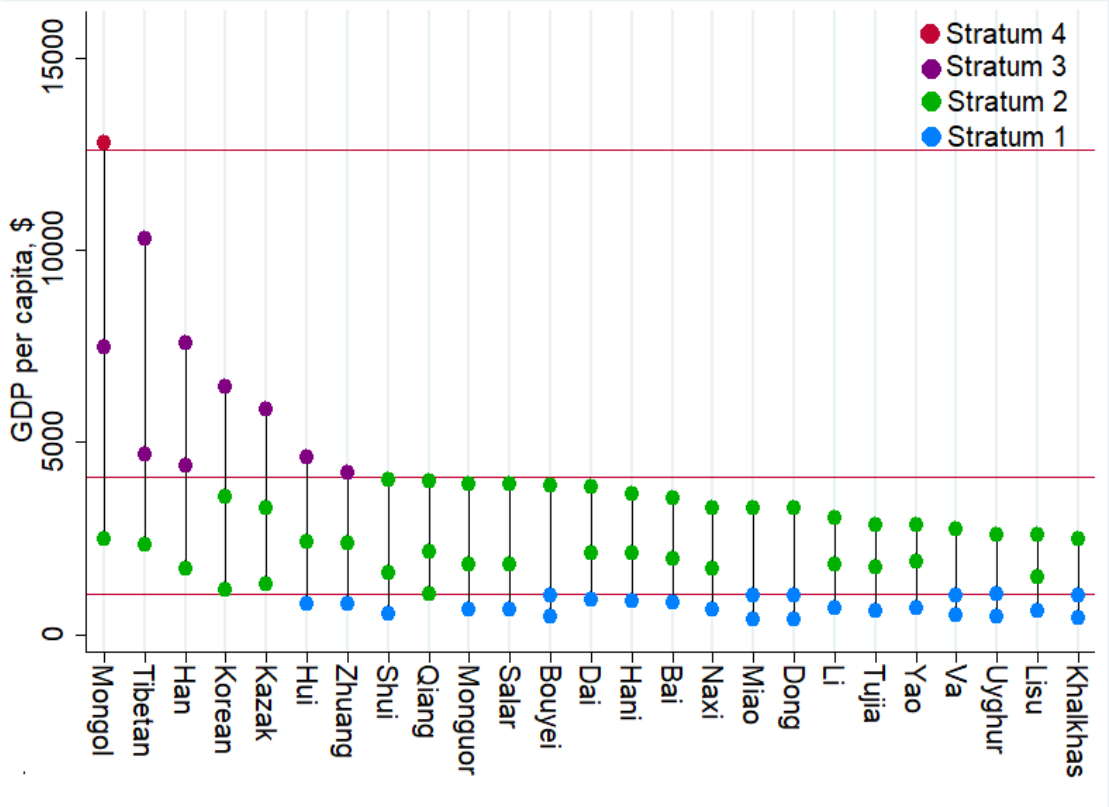

Figure S3. The changes of GDP per capita in 25 ethnic groups from 2005 to 2014

Note: Four strata represent four categories of ethnic groups with different levels of economic development based on the international universal cutoff points of country affluence established by the World Bank in 2013. Red dots represent the stratum four (>12616 US dollars) where minorities with high income; Purple dots represent the stratum three (4086-12616 US dollars) where the minorities with upper middle income; Green dots represent the stratum two (1036-4085 US dollars) where minorities with lower middle income; Blue dots represent the stratum one (≤1035 US dollars) where minorities with lower income. Red lines represent the international thresholds of US dollars of four strata.

Table S1. The distribution, sample size and average age of Chinese Han and 24 ethnic minorities in CNSSCH

Nationality	Source province/ region	National Census [a]				Sample Size in CNSSCH			Mean Age in CNSSCH		
		Number (millions)	Minority Population Ranking	Percentage (%)	Cumulative Percentage (%)	2005	2010	2014	2005	2010	2014
Han [b]	30 Provinces	1220.85	1	91.98	100.00	234421	215319	214354	12.5±3.5	12.5±3.5	12.5±3.4
Total Minority	-	106.43 [c]	-	8.02 [c]		73650	75142	75359	12.5±3.4	12.5±3.4	12.5±3.4
Zhuang	Guangxi	16.93	2	15.91	15.91	4807	4772	5267	12.5±3.5	12.5±3.5	12.5±3.4
Hui	Ningxia	10.59	3	9.95	25.86	4946	6600	5308	12.5±3.4	12.3±3.4	12.7±3.4
Uyghur	Xinjiang	10.07	4	9.46	35.32	5755	5748	5740	12.5±3.5	12.5±3.5	12.5±3.5
Miao	Guizhou	9.43	5	8.86	44.18	2392	2392	2394	12.5±3.5	12.5±3.5	12.5±3.5
Tujia	Hunan	8.35	7	7.85	52.02	2431	2525	2592	12.5±3.4	12.5±3.4	12.5±3.4
Tibetan	Tibet	6.28	8	5.90	57.93	2397	2642	2418	12.5±3.4	12.4±3.4	12.5±3.4
Mongol	Inner Mongolia	5.98	9	5.62	63.54	4343	3834	5107	12.7±3.4	12.8±3.5	12.5±3.4
Dong	Guizhou	2.88	10	2.71	66.25	2398	2393	2398	12.5±3.5	12.5±3.5	12.5±3.5
Bouyei	Guizhou	2.87	11	2.70	68.95	2376	2393	2395	12.4±3.4	12.5±3.4	12.5±3.5
Yao	Guangxi	2.80	12	2.63	71.58	2400	2347	2251	12.5±3.5	12.5±3.4	12.5±3.4
Bai	Yunnan	1.93	13	1.81	73.39	2636	2625	2627	12.5±3.5	12.5±3.4	12.5±3.4
Korean	Jilin	1.83	14	1.72	75.11	5877	5249	4546	12.5±3.4	12.5±3.5	12.3±3.3
Hani	Yunnan	1.66	15	1.56	76.67	2591	2629	2637	12.5±3.5	12.5±3.5	12.5±3.5
Li	Hainan	1.46	16	1.37	78.04	1881	2333	3034	12.5±3.3	12.6±3.4	12.5±3.4
Kazak	Xinjiang	1.46	17	1.37	79.41	2842	2902	2868	12.5±3.4	12.5±3.5	12.5±3.5
Dai	Yunnan	1.26	18	1.18	80.60	2598	2543	2626	12.5±3.4	12.3±3.3	12.5±3.4
Lisu	Yunnan	0.70	20	0.66	81.26	2606	2634	2638	12.5±3.5	12.5±3.5	12.5±3.5
Va	Yunnan	0.42	24	0.39	81.65	2638	2630	2639	12.5±3.5	12.5±3.5	12.5±3.5
Shui	Guizhou	0.41	25	0.39	82.04	2382	2391	2391	12.5±3.4	12.5±3.5	12.5±3.5
Naxi	Yunnan	0.33	26	0.31	82.35	2633	2633	2636	12.5±3.5	12.5±3.5	12.5±3.5
Qiang	Sichuan	0.31	27	0.29	82.64	2769	2782	2762	12.5±3.5	12.5±3.5	12.5±3.5
Monguor	Qinghai	0.29	28	0.27	82.91	2574	2625	2620	12.6±3.4	12.6±3.4	12.5±3.4
Khalkhas	Xinjiang	0.19	31	0.18	83.09	2871	2908	2825	12.5±3.5	12.5±3.4	12.5±3.5
Salar	Qinghai	0.13	34	0.12	83.21	2507	2612	2640	12.5±3.5	12.4±3.4	12.4±3.4

Note: [a] According to the Sixth National Census in 2010. [b] The investigation for Han children included Chinese 30 provinces except for Tibet, Taiwan, Hong Kong and Macao. [c] The information of population and percentage covered all ethnic minorities (55) in China according to the Sixth National Census in 2010.

Table S2. International cut-off points for body mass index (BMI) for thinness, overweight and obesity and their mild and severe components by sex for exact ages between 7 and 18 years developed by International Obesity Task Force (IOTF), kg/m^2

Age	Boys					Girls				
	Thinness		Overweight and Obesity			Thinness		Overweight and Obesity		
	Severe Thinness	Mild Thinness	Overweight	Mild Obesity	Severe Obesity	Severe Thinness	Mild Thinness	Overweight	Mild Obesity	Severe Obesity
7.0	12.42	14.04	17.92	20.59	23.08	12.26	13.86	17.75	20.39	22.88
7.5	12.41	14.08	18.16	21.06	23.83	12.27	13.93	18.03	20.89	23.65
8.0	12.42	14.15	18.44	21.56	24.61	12.31	14.02	18.35	21.44	24.50
8.5	12.45	14.24	18.76	22.11	25.45	12.37	14.14	18.69	22.04	25.42
9.0	12.50	14.35	19.10	22.71	26.40	12.44	14.28	19.07	22.66	26.39
9.5	12.57	14.49	19.46	23.34	27.39	12.53	14.43	19.45	23.31	27.38
10.0	12.66	14.64	19.84	23.96	28.35	12.64	14.61	19.86	23.97	28.36
10.5	12.77	14.80	20.20	24.54	29.22	12.78	14.81	20.29	24.62	29.28
11.0	12.89	14.97	20.55	25.07	29.97	12.95	15.05	20.74	25.25	30.14
11.5	13.03	15.16	20.89	25.56	30.63	13.15	15.32	21.20	25.87	30.93
12.0	13.18	15.35	21.22	26.02	31.21	13.39	15.62	21.68	26.47	31.66
12.5	13.37	15.58	21.56	26.45	31.73	13.65	15.93	22.14	27.04	32.33
13.0	13.59	15.84	21.91	26.87	32.19	13.92	16.26	22.58	27.57	32.91
13.5	13.83	16.12	22.27	27.26	32.61	14.20	16.57	22.98	28.03	33.39
14.0	14.09	16.41	22.62	27.64	32.98	14.48	16.88	23.34	28.42	33.78
14.5	14.35	16.69	22.96	28.00	33.29	14.75	17.18	23.66	28.74	34.07
15.0	14.60	16.98	23.29	28.32	33.56	15.01	17.45	23.94	29.01	34.28
15.5	14.86	17.26	23.60	28.61	33.78	15.25	17.69	24.17	29.22	34.43
16.0	15.12	17.54	23.90	28.88	33.98	15.46	17.91	24.37	29.40	34.55
16.5	15.36	17.80	24.19	29.15	34.19	15.63	18.09	24.54	29.55	34.64
17.0	15.60	18.05	24.46	29.43	34.43	15.78	18.25	24.70	29.70	34.75
17.5	15.81	18.28	24.73	29.71	34.71	15.90	18.38	24.85	29.85	34.87
18.0	16.00	18.50	25.00	30.00	35.00	16.00	18.50	25.00	30.00	35.00

Table S3. The prevalence of thinness, overweight and obesity, and their components in Chinese Han and ethnic minorities by sex and survey year.

Variables	Boys			Girls			Total		
	2005	2010	2014	2005	2010	2014	2005	2010	2014
Han									
Thinness	16.7	13.9*	11.0*	20.4	18.4*	15.1*	18.6	16.1*	13.1*
Mild Thinness	13.4	11.1*	9.0*	15.5	14.1*	11.7*	14.5	12.6*	10.3*
Severe Thinness [a]	3.3(19.8)	2.7(19.6)*	2.1(18.8)*	4.9(23.8)	4.3(23.3)*	3.4(22.4)*	4.1(22.0)	3.5(21.7)*	2.7(20.9)*
OW&OB	13.1	16.7*	22.1*	7.6	9.5*	13.2*	10.4	13.1*	17.7*
Obesity	2.9	3.9*	5.6*	1.1	1.3*	2.2*	2.0	2.6*	3.9*
Mild Obesity	2.4	3.3*	4.7*	0.9	1.1*	1.8*	1.6	2.2*	3.3*
Severe Obesity [b]	0.5(3.7)	0.6(3.8)*	1.0(4.4)*	0.2(2.8)	0.2(1.9)*	0.4(2.7)*	0.4(3.4)	0.4(3.1)*	0.7(3.8)*
Ethnic Minority									
Thinness	19.7	18.9*	15.9*	21.2	21.5	18.4*	20.4	20.2	17.1*
Mild Thinness	16.1	15.2*	13.1*	16.3	16.0	14.1*	16.2	15.6*	13.6*
Severe Thinness [a]	3.6(18.4)	3.6(19.3)	2.8(17.7)*	4.9(23.0)	5.5(25.6)*	4.3(23.5)*	4.3(20.8)	4.6(22.6)*	3.6(20.8)*
OW&OB	4.4	6.9*	10.4*	4.3	5.7*	8.0*	4.3	6.3*	9.2*
Obesity	0.8	1.5*	2.6*	0.4	0.7*	1.2*	0.6	1.1*	1.9*
Mild Obesity	0.7	1.2*	2.2*	0.4	0.6*	1.0*	0.5	0.9*	1.6*
Severe Obesity [b]	0.2(3.9)	0.3(3.9)	0.5(4.3)*	0.1(1.8)	0.1(1.8)	0.2(2.8)*	0.1(2.9)	0.2(2.9)*	0.3(3.7)*

Note: *P<0.01. The prevalence at 2010 or 2014 survey year was compared with 2005 by chi-square test. OW&OB represents overweight and obesity.

[a] the numbers within brackets and out of brackets represent the prevalence of severe thinness and its proportion in thinness, respectively.

[b] the numbers within brackets and out of brackets represent the prevalence of severe obesity and its proportion in overweight and obesity, respectively.

Table S4. Subgroup analyses by age group of nutritional transition in both Han and ethnic minorities from 2005 to 2014

Groups	Prevalence, %						Prevalence Difference, %			
	Han			Minority			Han		Minority	
	2005	2010	2014	2005	2010	2014	2005-2010	2010-2014	2005-2010	2010-2014
OWOB										
7-9	11.9	15.3*	20.3*	4.7	7.9*	10.3*	3.4	5.0*	3.2	2.4*
10-12	13.0	16.7*	22.1*	4.7	7.9*	11.9*	3.7	5.4*	3.1	4.1*
13-15	9.8	12.3*	16.4*	4.4	5.9*	8.5*	2.5	4.1*	1.4	2.7*
16-18	6.8	7.9*	11.8*	3.4	4.6*	7.0*	1.1	3.8*	1.1	2.4*
Severe Obesity										
7-9	0.8	0.9*	1.5*	0.3	0.4*	0.7*	0.2	0.5*	0.2	0.3*
10-12	0.3	0.4*	0.5*	0.1	0.2*	0.3*	0.1	0.1	0.0	0.1
13-15	0.2	0.2	0.4*	0.1	0.1	0.2*	0.0	0.2*	0.0	0.2*
16-18	0.1	0.1	0.3*	0.0	0.1*	0.1*	0.0	0.2*	0.1	0.0
Thinness										
7-9	18.7	16.9*	13.5*	21.9	20.7*	19.1*	1.8	3.4*	1.2	1.6*
10-12	18.5	15.4*	11.7*	23.4	22.9*	17.2*	3.1	3.8*	0.5	5.7*
13-15	17.4	14.0*	11.1*	18.5	18.4*	14.4*	3.4	2.8*	0.1	4.0*
16-18	19.6	18.2*	16.1*	18.0	18.1*	16.4*	1.4	2.1*	-0.1	1.7*
Severe Thinness										
7-9	4.0	3.6*	2.8*	4.4	4.6*	4.2*	0.4	0.8*	-0.2	0.4*
10-12	4.0	3.3*	2.4*	4.8	5.3*	3.2*	0.7	0.9*	-0.5	2.1*
13-15	4.0	2.9*	2.1*	4.0	4.2*	2.8*	1.0	0.9	-0.2	1.5*
16-18	4.4	4.1*	3.7*	3.8	3.8	3.5*	0.3	0.5*	0.0	0.2*

Note: *P<0.05. The prevalence at 2010 or 2014 survey year was compared with 2005 by chi-square test. The statistical significant difference for the prevalence difference (PD) between two years intervals was assessed according to the Cochran's Q test. OW&OB represents overweight and obesity.

Table S5. The prevalence of thinness and severe thinness, and its proportion in Chinese Han and 24 ethnic minorities by survey year.

Nationality	Thinness			Severe Thinness			Proportion[#]		
	2005	2010	2014	2005	2010	2014	2005	2010	2014
Han	18.6	16.1*	13.1*	4.1	3.5*	2.7*	22.0	21.7	20.9*
Dai	41.8	38.3*	32.5*	12.4	10.5*	9.2*	29.6	27.5	28.3
Bouyei	36.6	22.3*	24.7*	9.6	4.3*	4.8*	26.1	19.3*	19.3*
Li	34.3	40.6*	34.2	9.6	12.5*	9.3	28.0	30.7	27.2
Bai	31.8	32.9	22.7*	7.8	8.7	5.4*	24.4	26.5	24.0
Zhuang	30.8	30.3	19.3*	7.7	7.4	4.1*	25.1	24.3	21.0*
Monguor	30.0	16.7*	23.7*	6.4	2.4*	5.4	21.2	14.6*	22.7
Salar	29.3	28.1	21.3*	7.0	10.0*	5.7	24.0	35.7*	26.6
Dong	29.3	28.7	18.1*	6.2	7.0	3.3*	21.2	24.5	18.5
Shui	24.6	24.6	16.2*	4.2	5.2	2.5*	16.9	21.1	15.2
Naxi	21.6	20.2	17.9*	4.5	3.9	4.0	20.7	19.1	22.3
Yao	19.8	15.9*	15.6*	3.6	2.1*	3.5	18.1	13.4	22.5
Miao	19.1	16.8*	12.4*	4.1	2.6*	1.4*	21.7	15.7*	11.5*
Lisu	18.7	18.1	16.5*	2.5	2.7	2.5	13.3	15.1	15.4
Hani	18.4	15.5*	16.8	2.4	2.5	2.5	13.0	16.4	14.9
Qiang	17.4	12.4*	16.5	3.0	1.6*	2.5	17.0	13.0	15.2
Uyghur	17.3	18.6	13.8*	3.2	3.6	2.1*	18.3	19.2	15.3
Tibetan	16.1	25.2*	18.4	2.6	6.4*	3.3	16.3	25.4*	18.2
Hui	15.6	20.0*	16.5	2.7	4.6*	3.7*	17.3	23.1*	22.2*
Tujia	15.2	12.5*	16.0	2.5	2.2	3.5	16.3	17.7	21.6
Va	14.0	8.2*	11.1*	2.4	1.1*	1.6*	17.3	13.9	14.0
Korean	10.9	9.4*	8.8*	2.1	2.1	1.7	19.5	22.4	19.8
Kazak	9.0	9.0	7.1*	1.2	1.6	1.3	12.9	17.3	17.7
Khalkhas	8.6	21.4*	12.9*	1.0	4.6*	2.4*	11.3	21.4*	18.7*
Mongol	8.2	8.7	6.0*	0.9	1.5*	0.8	10.9	16.8*	12.7

Note: *P<0.01. The prevalence at 2010 or 2014 survey year was compared with 2005 by chi-square test. # represents the proportion of severe thinness in thinness.

Table S6. The prevalence of OW&OB and Obesity, and its proportion in Chinese Han and 24 ethnic minorities by survey year.

Nationality	OW&OB			Obesity			Proportion		
	2005	2010	2014	2005	2010	2014	2005	2010	2014
Han	10.4	13.1*	17.7*	2.0	2.6*	3.9*	19.2	20.0*	22.2*
Korean	15.0	20.9*	26.2*	2.9	5.8*	7.9*	19.5	27.7*	30.1*
Kazak	7.4	9.6*	17.9*	1.2	1.4	3.4*	15.7	14.4	18.9
Mongol	7.2	13.3*	18.6*	0.6	2.6*	4.3*	8.7	19.4*	23.1*
Tibetan	6.0	6.9	9.8*	1.0	0.9	1.7*	16.0	13.7	16.9
Naxi	6.0	9.0*	9.0*	0.8	1.7*	2.3*	14.0	19.3	25.2*
Hui	4.6	8.4*	12.6*	0.5	1.3*	2.2*	11.1	15.0	17.4*
Tujia	4.4	9.3*	13.6*	0.8	1.6*	2.8*	17.6	17.1	20.7
Uyghur	3.4	5.1*	8.4*	0.2	0.4	1.6*	6.2	8.5	19.0*
Qiang	3.2	5.9*	6.7*	0.1	0.6*	0.9*	4.5	9.8	14.0*
Li	3.2	2.2	2.4	0.9	0.5	0.3*	26.7	21.6	13.5
Yao	3.2	5.3*	7.8*	0.9	0.9	1.7*	27.6	16.8	22.2
Zhuang	3.1	4.9*	10.0*	0.5	1.1*	2.3*	16.7	21.9	22.7
Khalkhas	3.0	2.5	4.1*	0.1	0.2	0.3	2.4	6.8	6.9
Bai	2.9	5.3*	8.6*	0.3	1.1*	1.6*	11.7	21.6	18.1
Miao	2.9	4.3*	8.6*	0.5	0.8	1.2*	18.8	19.4	13.5
Dong	2.3	5.1*	7.5*	0.2	0.9*	1.5*	9.3	17.4	19.4
Hani	2.2	3.6*	3.5*	0.2	0.4	0.8*	8.6	11.7	22.6*
Salar	1.8	2.5	3.6*	0.2	0.2	0.3	10.9	9.1	9.4
Va	1.7	4.3*	6.4*	0.1	0.5*	0.9*	6.7	11.4	14.7
Lisu	1.5	1.7	3.0*	0.3	0.2	0.7	22.5	8.7	23.1
Bouyei	1.5	2.8*	4.7*	0.2	0.3	1.0*	11.4	10.6	20.4
Monguor	1.2	2.1*	1.9	0.2	0.0*	0.2	18.8	0.0*	8.2
Dai	1.2	2.5*	5.8*	0.1	0.2	1.3*	9.4	7.9	21.7
Shui	0.5	0.7	1.8*	0.0	0.0	0.2	9.1	0.0	11.9

Note: *P<0.01. The prevalence at 2010 or 2014 survey year was compared with 2005 by chi-square test. #represents the proportion of obesity in OW&OB. OW&OB represents overweight and obesity.

Table S7. POR with 95% CI of Chinese 24 ethnic minorities versus Han for thinness and severe thinness at each survey year

Nationality	Thinness			Severe Thinness		
	2005	2010	2014	2005	2010	2014
Li	2.30(2.09,2.53)*	3.56(3.28,3.87)*	3.46(3.21,3.73)*	2.50(2.14,2.92)*	3.93(3.47,4.45)*	3.65(3.22,4.14)*
Dai	3.16(2.92,3.42)*	3.23(2.98,3.50)*	3.20(2.95,3.48)*	3.32(2.95,3.74)*	3.25(2.86,3.70)*	3.60(3.15,4.12)*
Bouyei	2.53(2.33,2.75)*	1.49(1.36,1.65)*	2.18(1.99,2.40)*	2.48(2.16,2.85)*	1.24(1.02,1.51)*	1.78(1.47,2.15)*
Monguor	1.88(1.73,2.05)*	1.05(0.94,1.16)	2.07(1.89,2.27)*	1.60(1.36,1.87)*	0.69(0.54,0.88)*	2.03(1.71,2.41)*
Bai	2.05(1.89,2.23)*	2.55(2.35,2.77)*	1.95(1.78,2.14)*	1.98(1.72,2.29)*	2.64(2.30,3.03)*	2.05(1.73,2.43)*
Salar	1.82(1.67,1.98)*	2.03(1.87,2.22)*	1.80(1.64,1.98)*	1.77(1.52,2.07)*	3.08(2.70,3.50)*	2.15(1.82,2.54)*
Zhuang	1.95(1.83,2.08)*	2.26(2.12,2.41)*	1.59(1.49,1.71)*	1.97(1.76,2.19)*	2.20(1.97,2.46)*	1.51(1.31,1.74)*
Tibetan	0.84(0.76,0.94)*	1.75(1.61,1.92)*	1.50(1.36,1.67)*	0.63(0.49,0.82)*	1.89(1.61,2.21)*	1.24(0.99,1.54)
Dong	1.82(1.66,1.99)*	2.09(1.91,2.29)*	1.46(1.32,1.63)*	1.56(1.32,1.84)*	2.08(1.78,2.44)*	1.23(0.98,1.54)
Naxi	1.21(1.10,1.33)*	1.32(1.20,1.45)*	1.45(1.31,1.60)*	1.10(0.92,1.33)	1.11(0.91,1.36)	1.48(1.21,1.80)
Hani	0.99(0.90,1.10)	0.96(0.86,1.06)	1.35(1.21,1.49)*	0.58(0.45,0.74)*	0.72(0.57,0.92)*	0.92(0.72,1.17)
Lisu	1.01(0.91,1.11)	1.15(1.04,1.27)*	1.31(1.18,1.46)*	0.60(0.47,0.77)*	0.78(0.61,0.98)*	0.93(0.73,1.19)
Qiang	0.92(0.84,1.02)	0.74(0.66,0.83)*	1.31(1.18,1.45)*	0.72(0.58,0.89)*	0.45(0.34,0.61)*	0.91(0.72,1.16)
Hui	0.81(0.75,0.88)*	1.30(1.22,1.38)*	1.31(1.22,1.41)*	0.65(0.55,0.77)*	1.34(1.19,1.50)*	1.35(1.17,1.56)*
Shui	1.43(1.30,1.57)*	1.70(1.55,1.86)*	1.29(1.15,1.44)*	1.02(0.83,1.25)	1.51(1.26,1.81)*	0.90(0.70,1.17)
Tujia	0.79(0.70,0.88)*	0.74(0.66,0.84)*	1.27(1.14,1.41)*	0.59(0.46,0.77)*	0.63(0.48,0.82)*	1.28(1.04,1.59)*
Yao	1.09(0.98,1.20)	0.99(0.88,1.10)	1.23(1.09,1.38)*	0.87(0.70,1.08)	0.60(0.45,0.80)*	1.30(1.03,1.62)*
Uyghur	0.92(0.86,0.99)*	1.19(1.11,1.27)*	1.06(0.99,1.15)	0.77(0.67,0.90)*	1.02(0.89,1.18)	0.77(0.64,0.92)*
Khalkhas	0.41(0.36,0.47)*	1.42(1.30,1.55)*	0.98(0.88,1.10)	0.23(0.16,0.34)*	1.32(1.11,1.58)*	0.88(0.69,1.12)
Miao	1.04(0.94,1.15)	1.05(0.94,1.17)	0.94(0.83,1.06)	1.01(0.83,1.24)	0.75(0.58,0.96)*	0.51(0.37,0.72)*
Va	0.71(0.64,0.80)*	0.47(0.40,0.54)*	0.83(0.73,0.93)*	0.58(0.46,0.75)*	0.32(0.22,0.46)*	0.56(0.41,0.77)*
Korean	0.54(0.49,0.58)*	0.54(0.49,0.59)*	0.64(0.58,0.71)*	0.51(0.43,0.61)*	0.60(0.49,0.72)*	0.63(0.51,0.79)*
Kazak	0.43(0.38,0.49)*	0.51(0.45,0.58)*	0.51(0.44,0.58)*	0.28(0.20,0.39)*	0.43(0.32,0.58)*	0.45(0.33,0.63)*
Mongol	0.39(0.35,0.44)*	0.49(0.44,0.55)*	0.43(0.38,0.48)*	0.21(0.16,0.29)*	0.41(0.31,0.53)*	0.27(0.20,0.38)*

Note: *P<0.01. The POR in 24 ethnic minorities at different survey year was compared with Han. POR showed in table was adjusted for age, height, urban/rural and school.

Table S8. POR with 95% CI of Chinese 24 ethnic minorities versus Han for OW&OB and obesity at each survey year

Nationality	OW&OB			Obesity		
	2005	2010	2014	2005	2010	2014
Korean	1.52(1.41,1.64)*	1.77(1.65,1.89)*	1.64(1.53,1.76)*	1.50(1.38,1.62)*	1.53(1.42,1.65)*	1.40(1.29,1.51)*
Mongol	0.68(0.60,0.76)*	1.05(0.95,1.15)	1.07(0.99,1.15)	0.78(0.69,0.88)*	1.05(0.94,1.16)	1.05(0.97,1.14)
Kazak	0.69(0.60,0.79)*	0.70(0.62,0.80)*	1.02(0.93,1.12)	0.72(0.62,0.84)*	0.76(0.67,0.87)*	1.07(0.96,1.19)
Tujia	0.40(0.33,0.49)*	0.68(0.59,0.78)*	0.73(0.65,0.82)*	0.41(0.34,0.51)*	0.71(0.62,0.83)*	0.76(0.67,0.86)*
Hui	0.41(0.36,0.47)*	0.60(0.55,0.65)*	0.68(0.63,0.74)*	0.46(0.40,0.53)*	0.65(0.59,0.72)*	0.74(0.67,0.81)*
Zhuang	0.28(0.24,0.33)*	0.34(0.30,0.39)*	0.51(0.47,0.56)*	0.29(0.24,0.35)*	0.34(0.29,0.39)*	0.52(0.47,0.58)*
Tibetan	0.55(0.46,0.65)*	0.49(0.42,0.57)*	0.50(0.44,0.58)*	0.58(0.48,0.70)*	0.54(0.46,0.63)*	0.56(0.48,0.64)*
Naxi	0.55(0.46,0.64)*	0.66(0.58,0.75)*	0.46(0.40,0.53)*	0.59(0.50,0.70)*	0.67(0.58,0.78)*	0.45(0.39,0.53)*
Miao	0.26(0.20,0.32)*	0.30(0.24,0.36)*	0.44(0.38,0.51)*	0.26(0.20,0.34)*	0.31(0.25,0.38)*	0.51(0.43,0.59)*
Bai	0.26(0.21,0.32)*	0.37(0.31,0.44)*	0.44(0.38,0.50)*	0.29(0.23,0.37)*	0.37(0.31,0.45)*	0.48(0.41,0.55)*
Uyghur	0.30(0.26,0.34)*	0.36(0.32,0.40)*	0.42(0.39,0.47)*	0.35(0.31,0.41)*	0.42(0.37,0.48)*	0.46(0.41,0.51)*
Yao	0.28(0.22,0.35)*	0.37(0.31,0.45)*	0.39(0.34,0.46)*	0.26(0.20,0.33)*	0.40(0.33,0.48)*	0.41(0.34,0.48)*
Dong	0.20(0.15,0.26)*	0.35(0.29,0.42)*	0.38(0.32,0.44)*	0.23(0.17,0.30)*	0.37(0.31,0.46)*	0.40(0.34,0.48)*
Qiang	0.28(0.23,0.35)*	0.41(0.35,0.48)*	0.33(0.29,0.39)*	0.34(0.28,0.43)*	0.48(0.40,0.56)*	0.39(0.33,0.45)*
Va	0.15(0.11,0.20)*	0.30(0.25,0.36)*	0.32(0.27,0.37)*	0.18(0.13,0.24)*	0.34(0.28,0.42)*	0.36(0.31,0.43)*
Dai	0.11(0.08,0.15)*	0.17(0.13,0.21)*	0.28(0.24,0.34)*	0.12(0.09,0.18)*	0.20(0.15,0.26)*	0.30(0.25,0.36)*
Bouyei	0.13(0.09,0.18)*	0.19(0.15,0.24)*	0.23(0.19,0.28)*	0.14(0.10,0.21)*	0.22(0.17,0.28)*	0.24(0.20,0.30)*
Khalkhas	0.26(0.21,0.33)*	0.17(0.14,0.22)*	0.20(0.16,0.24)*	0.32(0.26,0.40)*	0.21(0.16,0.26)*	0.25(0.21,0.30)*
Salar	0.16(0.12,0.22)*	0.17(0.13,0.22)*	0.17(0.14,0.21)*	0.18(0.13,0.25)*	0.20(0.16,0.26)*	0.21(0.17,0.26)*
Hani	0.20(0.15,0.26)*	0.25(0.20,0.30)*	0.17(0.14,0.21)*	0.23(0.17,0.30)*	0.28(0.22,0.35)*	0.18(0.14,0.22)*
Lisu	0.13(0.10,0.18)*	0.12(0.09,0.16)*	0.14(0.11,0.18)*	0.13(0.09,0.19)*	0.14(0.10,0.19)*	0.15(0.11,0.19)*
Li	0.28(0.22,0.37)*	0.15(0.11,0.20)*	0.12(0.09,0.15)*	0.26(0.19,0.35)*	0.15(0.11,0.20)*	0.13(0.11,0.17)*
Monguor	0.11(0.08,0.15)*	0.14(0.11,0.19)*	0.09(0.07,0.12)*	0.11(0.08,0.16)*	0.19(0.14,0.24)*	0.11(0.08,0.15)*
Shui	0.04(0.02,0.07)*	0.05(0.03,0.08)*	0.08(0.06,0.11)*	0.05(0.02,0.09)*	0.06(0.04,0.10)*	0.10(0.07,0.14)*

Note: *P<0.01. The POR in 24 ethnic minorities at different survey year was compared with Han. POR showed in table was adjusted for age, height, urban/rural and school. OW&OB represents overweight and obesity.

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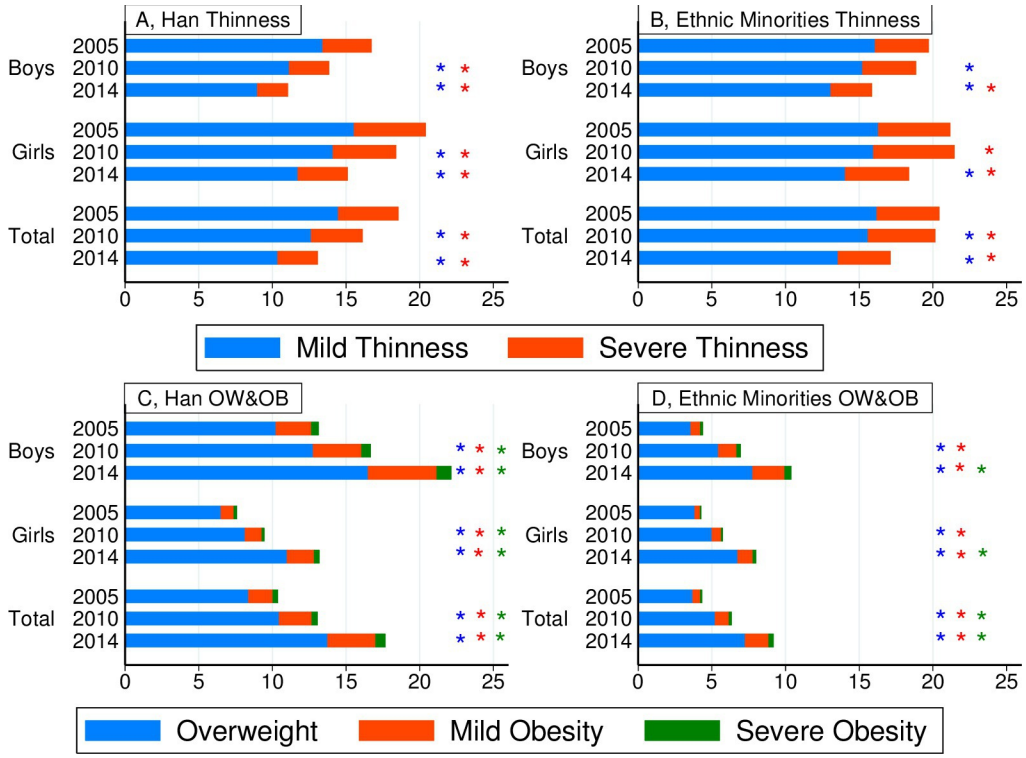

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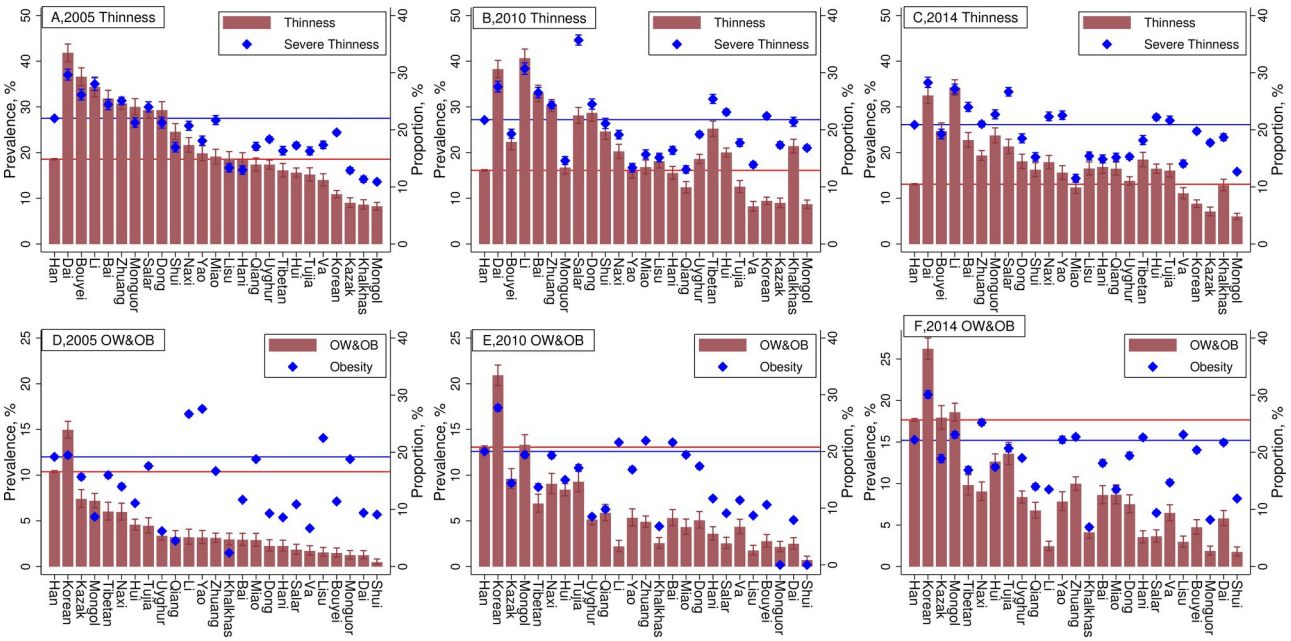

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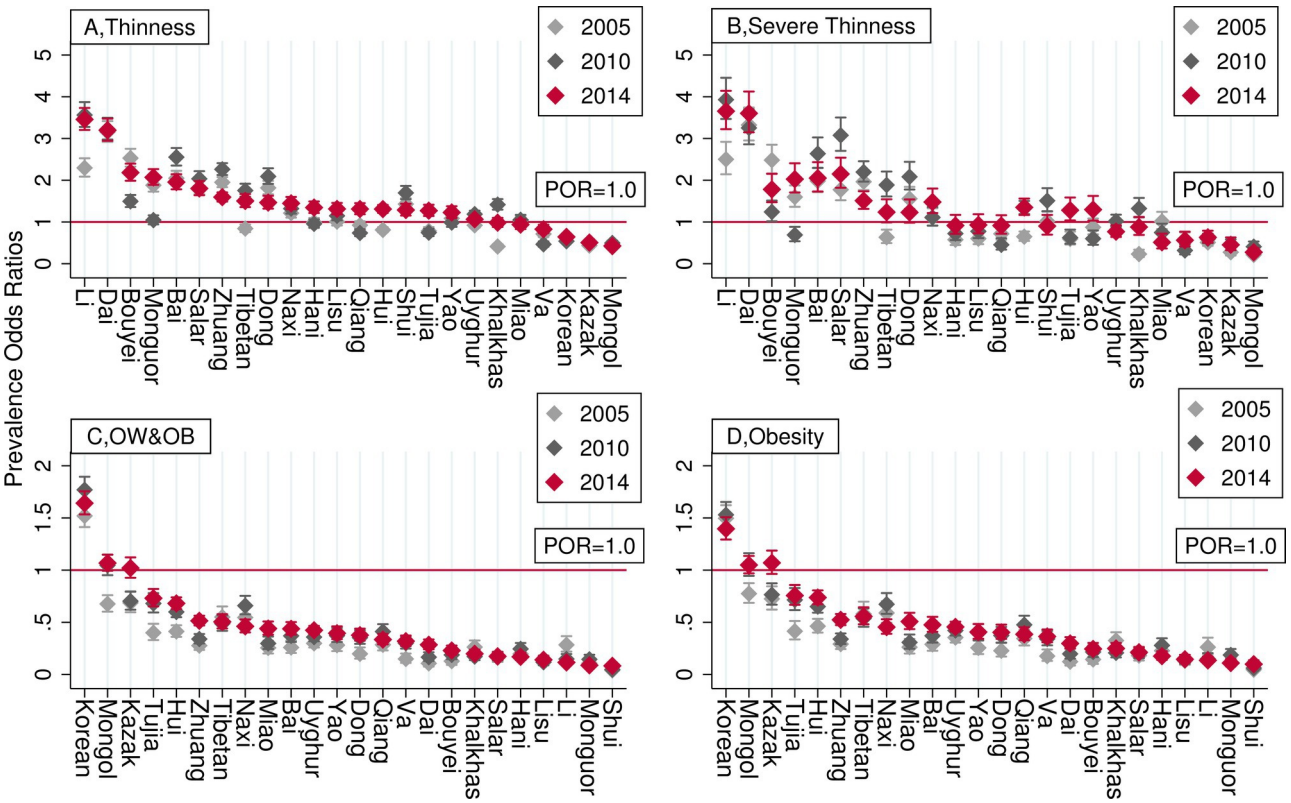

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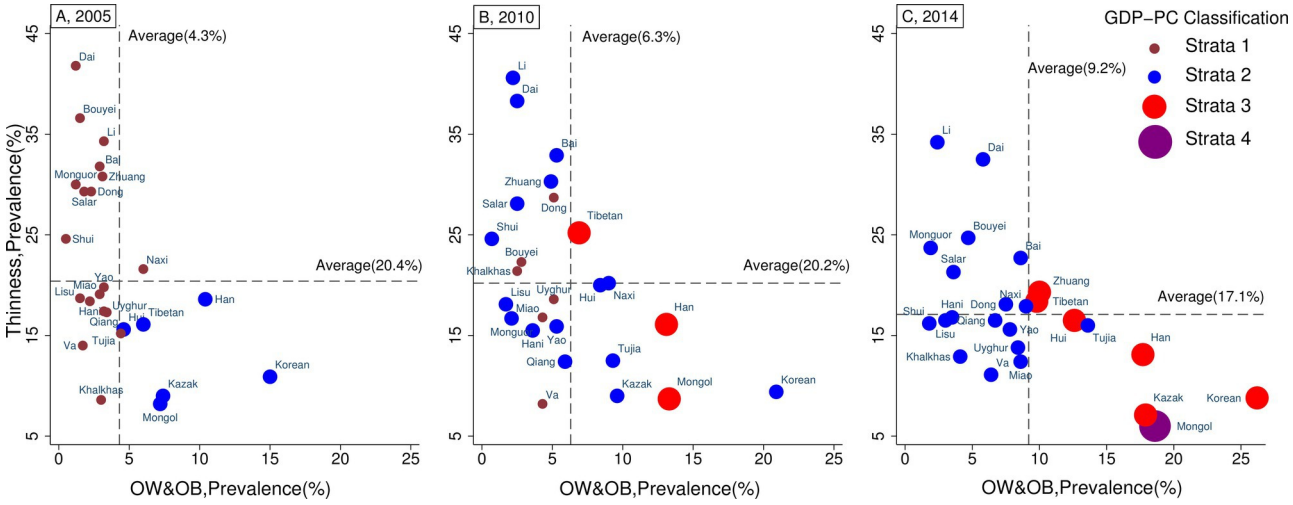

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Table 1. Prevalence difference (PD) for thinness, overweight and obesity, and their components in Chinese Han and ethnic minorities between two adjacent survey points (2005-2010 and 2010-2014)

Groups	Boys, (PD,%, 95%CI)		Girls, (PD,%, 95%CI)		Total, (PD,%, 95%CI)	
	2005-2010	2010-2014	2005-2010	2010-2014	2005-2010	2010-2014
Han						
Thinness	2.9(2.6,3.2) *	2.8(2.5,3.1) *	2.0(1.7,2.3) *	3.3(3.0,3.6) *	2.4(2.2,2.7) *	3.0(2.8,3.3) *
Mild Thinness	2.3(2.0,2.5) *	2.2(1.9,2.4) *	1.4(1.1,1.7) *	2.4(2.1,2.7) *	1.9(1.7,2.1) *	2.3(2.1,2.5) *
Severe Thinness	0.6(0.5,0.7) *	0.6(0.5,0.8) *	0.6(0.4,0.8) *	0.9(0.7,1.1) *	0.6(0.5,0.7) *	0.8(0.7,0.9) *
OW&OB	3.5(3.3,3.8) *	5.5(5.1,5.8) *	1.9(1.6,2.1) *	3.7(3.5,4.0) *	2.7(2.5,2.9) *	4.6(4.4,4.8) *
Obesity	1.0(0.9,1.2) *	1.7(1.6,1.9) *	0.2(0.1,0.3) *	0.9(0.8,1.0) *	0.6(0.5,0.7) *	1.3(1.2,1.4) *
Mild Obesity	0.9(0.7,1.0) *	1.4(1.2,1.6) *	0.3(0.2,0.3) *	0.7(0.6,0.8) *	0.6(0.5,0.6) *	1.0(0.9,1.1) *
Severe Obesity	0.1(0.1,0.2) *	0.3(0.3,0.4) *	0.0(0.0,0.0)	0.2(0.1,0.2) *	0.1(0.0,0.1) *	0.3(0.2,0.3) *
Minority						
Thinness	0.9(1.4,0.3)*	3.0(2.5,3.5) *	0.3(0.3,0.9)	3.1(2.5,3.6) *	0.3(0.1,0.7)	3.0(2.6,3.4) *
Mild Thinness	0.9(1.4,0.3) *	2.2(1.7,2.6) *	0.3(0.2,0.9)	1.9(1.4,2.4) *	0.6(0.2,1.0) *	2.0(1.7,2.4) *
Severe Thinness	0.0(0.0,0.0)	0.8(0.6,1.1) *	0.6(0.3,0.9) *	1.2(0.9,1.5) *	0.3(0.1,0.5) *	1.0(0.8,1.2) *
OW&OB	2.6(2.2,2.9) *	3.4(3.1,3.8) *	1.5(1.2,1.8) *	2.3(1.9,2.6) *	2.0(1.8,2.2) *	2.8(2.6,3.1) *
Obesity	0.7(0.5,0.8) *	1.1(0.9,1.3) *	0.3(0.2,0.4) *	0.5(0.4,0.6) *	0.5(0.4,0.6) *	0.8(0.7,0.9) *
Mild Obesity	0.6(0.5,0.7) *	0.9(0.7,1.1) *	0.3(0.2,0.4) *	0.4(0.3,0.5) *	0.4(0.4,0.5) *	0.7(0.5,0.8) *
Severe Obesity	0.1(0.0,0.2) *	0.2(0.1,0.3) *	0.0(0.0,0.0)	0.1(0.1,0.2) *	0.1(0.0,0.1) *	0.2(0.1,0.2) *

Note: * $P<0{\cdot}01$ indicated the statistically significant difference for the prevalence difference (PD) between two years intervals according to the Cochran's Q test. PD is obtained by calculating the difference between two years intervals (2005 to 2010 and 2010 to 2014). Between each two survey years, the nutritional transition speed was faster in Han than that in ethnic minorities with a larger decrease in thinness and a larger increase in overweight/obesity (prevalence difference between two survey years) in Han than those in the ethnic groups.

Table 2. Prevalence odds ratio (95% CI) of students from 24 Chinese ethnic minority groups versus Han students for thinness, overweight and obesity, and their components by sex, for each survey year.

Variables	Boys (Prevalence, %, 95% CI)			Girls (Prevalence, %, 95% CI)			Total (Prevalence, %, 95% CI)		
	2005	2010	2014	2005	2010	2014	2005	2010	2014
Thinness	1.22(1.19,1.26)	1.45(1.40,1.49)	1.52(1.47,1.57)	1.05(1.02,1.08)	1.21(1.18,1.25)	1.27(1.23,1.30)	1.13(1.10,1.15)	1.31(1.29,1.34)	1.37(1.34,1.40)
Mild Thinness	1.24(1.20,1.28)	1.43(1.39,1.48)	1.53(1.47,1.58)	1.06(1.02,1.09)	1.16(1.12,1.19)	1.23(1.19,1.27)	1.14(1.12,1.17)	1.28(1.25,1.31)	1.36(1.33,1.39)
Severe Thinness	1.10(1.03,1.17)	1.35(1.27,1.44)	1.36(1.27,1.46)	1.00(0.95,1.06)	1.30(1.24,1.37)	1.29(1.22,1.37)	1.04(1.00,1.09)	1.32(1.27,1.37)	1.32(1.26,1.38)
OW&OB	0.30(0.29,0.32)	0.37(0.36,0.39)	0.41(0.39,0.42)	0.54(0.51,0.57)	0.58(0.55,0.61)	0.57(0.55,0.59)	0.39(0.38,0.40)	0.45(0.43,0.46)	0.47(0.46,0.48)
Overweight	0.32(0.30,0.34)	0.39(0.37,0.41)	0.43(0.41,0.44)	0.57(0.54,0.61)	0.59(0.56,0.62)	0.59(0.56,0.61)	0.42(0.40,0.44)	0.47(0.45,0.49)	0.49(0.48,0.51)
Obesity	0.28(0.25,0.31)	0.38(0.35,0.41)	0.45(0.42,0.48)	0.39(0.33,0.46)	0.55(0.49,0.63)	0.56(0.51,0.62)	0.31(0.28,0.34)	0.42(0.39,0.45)	0.48(0.46,0.51)
Mild Obesity	0.27(0.24,0.31)	0.37(0.34,0.41)	0.45(0.42,0.49)	0.40(0.33,0.48)	0.55(0.48,0.63)	0.55(0.49,0.61)	0.30(0.27,0.34)	0.42(0.39,0.45)	0.48(0.45,0.51)
Severe Obesity	0.35(0.27,0.45)	0.42(0.34,0.51)	0.46(0.39,0.54)	0.36(0.24,0.53)	0.60(0.43,0.83)	0.63(0.50,0.79)	0.35(0.28,0.44)	0.46(0.38,0.54)	0.51(0.45,0.58)

Note: Adjusted for age, height, urban/rural and school; OW&OB represented overweight and obesity. The comparisons of PORs between ethnic minorities and Han children for nutritional status indicated that the thinness burdens were high in ethnic groups, but overweight/obesity burdens were low in ethnic groups. And the gaps of thinness between ethnic groups and Han children were widening steadily over time from 2005 to 2014. But the gaps of overweight/obesity burdens between ethnic groups and Han children were decreasing gradually over time from 2005 to 2014.