DR. ZHAOGENG YANG (Orcid ID : 0000-0001-9949-8360)

PROF. JUN MA (Orcid ID : 0000-0003-3529-1808)

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The effect of overweight and obesity on high blood pressure in Chinese children and adolescents

Yanhui Dong[1] Catherine Jan[2]; Zhiyong Zou[1]; Bin Dong[1]; Zhenghe Wang[1]; Zhaogeng Yang[1], Yanhui Li[1]; Bo Wen[1]; Yinghua Ma[1], Yi Song[1]; Jun Ma[1], Susan M Sawyer[3,4,5]; George C. Patton[3,4,5]

Affiliations:

[1]Institute of Child and Adolescent Health **&** School of Public Health, Peking University, Beijing, 100191, China

[2]The George Institute for Global Health, School of Medicine, University of New South Wales, Sydney, New South Wales, Australia

[3]The University of Melbourne, Department of Paediatrics, Faculty of Medicine, Dentistry and Health Sciences, Parkville, Victoria 3010, Australia

[4]Murdoch Children's Research Institute, Parkville, Victoria 3052, Australia

[5]Centre for Adolescent Health, Royal Children's Hospital, Parkville, Victoria 3052, Australia

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Correspondence to: Prof. **Jun Ma**, and Prof. **Yi Song**, Institute of Child and Adolescent Health & School of Public Health, Peking University. No.38 Xueyuan Road, Haidian District, Beijing, China, 100191. Tel: +86-10-82801626, Fax: +86-10-82802861, Email: majunt@bjmu.edu.cn and songyi@bjmu.edu.cn.

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Study Importance Questions

- What is already known about this subject?

1. Hypertension burdens probably tended to be underestimated in both Chinese children and adults due to the overlooked population of ethnic minorities.

2. Obesity is well documented as a major contributor to hypertension in Children and adolescents, but its epidemic did not respond to a secular trend in blood pressure or hypertension risks with time.

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- What does your study add?

1. Hypertension prevalence in Chinese ethnic minorities' children and adolescents increased steadily, but turbulent in Han children and adolescents, but both Chinese ethnic minorities and Han are facing a greater risk of hypertension caused by overweight and obesity.
2. Growingly stronger effect of overweight and obesity on hypertension existed in ethnic minorities than Han children and adolescents.
3. A looming burden of hypertension will impose considerable burdens of cardiovascular diseases in adulthood for Chinese ethnic minorities in future.

Abstract

Objective: To compare the secular trends of high blood pressure (HBP) and the effects of overweight/obesity on HBP between Chinese ethnic minorities and Han children and adolescents.

Methods: Data were collected from 224,151 Chinese ethnic minorities and 664,094 Han children and adolescents aged 7-18 years during three successive national cross-sectional surveys (2005, 2010 and 2014). Logistic regression and population attributable risk analyses were used to evaluate the association between HBP and overweight/obesity.

Results: HBP prevalence in ethnic minorities increased from 4.8% in 2005 to 6.3% in 2014, which were significantly higher than those (4.1% to 5.5%), the turbulent HBP trends, in Han children and adolescents. Both ethnic minorities and Han children and adolescents experienced rapid increase in overweight and obesity, but the pace of growth for HBP, overweight and obesity was faster in ethnic minorities than their Han peers. Moreover, the effects of obesity on HBP in ethnic minorities presented sustained increase over time, but stable for Han.

Conclusions: Higher HBP prevalence, faster obesity increase and its stronger impact on HBP in Chinese ethnic minorities' children and adolescents predicted their looming burden of HBP, which implicate more attention to the cardiovascular disease risk in their adulthood in the future.

Key words: High Blood Pressure; Overweight; Obesity; Trends; Ethnic Children

Introduction

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Cardiovascular disease (CVD), principally stroke and coronary heart disease, remained the leading cause of death in China.[1] Hypertension or high blood pressure (HBP) is a well-recognized risk factor and the leading cause for CVD, which contribute to a significant portion of the global disease burden.[2-5] However, HBP in Chinese population probably tended to be underestimated in both children and adults population, because other than the Han, China also has 55 ethnic minorities, who make up nearly 8% of Chinese entire population and have exceeded 100 million by the year 2010.[6] Previous studies reported the high burdens of HBP in Chinese adults, fueling China as the highest burdens of stroke around the world.[7, 8] However, within China, ethnic minorities' adults were literally at higher risks of CVD and corresponding factors with higher HBP prevalence, whereas low awareness, control and treated control rate for HBP than their Han counterparts.[9, 10]

Many studies showed that HBP in adults derives from childhood, and childhood HBP significantly associates with increased risks of organ damage including coronary artery calcifications, ventricular hypertrophy, and increased carotid intima-media thickness.[11, 12] However, the previous studies mainly reported the HBP epidemic in Chinese Han children,[13, 14] and little focus on ethnic minorities. Allowed for the BP tracks from childhood to later life, moreover, studies were limited about the comprehensive assessment of HBP epidemiological status and trends in Chinese children and adolescents from ethnic minorities, and the comparison of HBP risk to their Chinese Han peers.

Among risk factors for HBP, obesity is well documented as a major contributor to HBP in the children and adolescents.[15] Obesity in children and adolescents is currently exhibiting a rapid growth across the globe, particularly in eastern Asia with the most rapid speed.[16] Previous studies found that the population attributable risk of HBP due to the explosive epidemic of obesity in Chinese Han children and adolescents steadily increased from 6.3% in 1995 to 19.2% in 2014.[17] However, studies only focused on Chinese Han might easily underestimate the HBP burdens and its long-term attributable risks to obesity among all Chinese children and adolescents.

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Hence, we used data from Chinese National Survey on Students' Constitution and Health (CNSSCH) in 2005, 2010, and 2014, which are a series of successive national cross-sectional surveys with representative children and adolescents from ethnic minorities in China. The objectives of the present study were to: (1) describe a panoramic view of Chinese childhood HBP trends and compare the HBP burdens between Chinese 24 ethnic minorities and Han children and adolescents over a 10-year period, (2) explore and compare the effects changes of obesity on HBP between Chinese ethnic minorities and Han children and adolescents.

Materials and Method

Study population

We used data from the 2005, 2010, and 2014 CNSSCH, the largest nationally representative survey of children and adolescents designed to investigate their health status in China. Investigations were conducted in 31 provinces (except for Hong Kong, Macao, and Taiwan). Apart from Han, there are a total of 55 ethnic minorities in China, and most of the ethnic minorities gathered in minority regions or prefectures, like the Ethnic Minority Autonomous Regions or Ethnic Minority Autonomous Prefectures, where we conducted the survey to collect the data of ethnic minorities' children and adolescents (**Figure 1**). The cumulative percentage of 24 ethnic minorities we sampled from 12 provinces in CNSSCH accounted for 83.21% of all the ethnic minorities in China,[6] which are: 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. Chinese Han children and adolescents were investigated in Chinese 30 provinces except for Tibet, Hong Kong, Macao and Taiwan. Each province conducted the investigations to collect the data of Han children at 3 socioeconomic status groups (ie, upper, moderate, and low) according to regional gross domestic product, total yearly income per capita, average food consumption per capita, natural growth rate of population, and the regional social welfare index. The flow of the participants' sampling was shown in **Figure S1**.

The sampling procedures in 24 ethnic minorities and Han, as previously described in detail,[18] were the same in all CNSSCH surveys at different time points. Briefly, all participants at each survey year were primary and high school students aged 7-18 years and were selected

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by stratified cluster sampling, that is, sampling took place in classes selected randomly from each grade in the selected schools. Survey sites (school) in each province remained stationary in three years. Strict inclusion and exclusion criteria for the all eligible participants were followed in the survey with permanent residence (participants and their parents were of the same origin and had lived in the local areas longer than one year), complete medical examination (no overt physical or mental disorders), and informed consents. Informed consent (i.e., written vs. verbal, active vs. passive) was obtained from both parents and children and adolescents before they participated in the study. This project was approved by the Medical Research Ethics Committee of Peking University Health Science Center (IRB00001052-13002).

Finally, the number of each age of children and adolescents needed to meet the minimum sample size of each ethnic group in the survey. The ratio of boy/girl in different nationalities approximately equaled to 1:1 in each survey. A total of 224,151 ethnic minority (73,650 in 2005; 75,142 in 2010; 75,359 in 2014) and 664,094 Chinese Han (234,421 in 2005; 215,319 in 2010; 214,354 in 2014) children and adolescents were in the present study.

Physical Examination

Participants in three surveys of CNSSCH with complete records on age, sex, nationality, and anthropometric evaluation including height (cm), weight (kg), systolic BP (mmHg) and diastolic BP levels were included in the analyses. All the measurements followed a standardized procedure by professionals who had passed the training course. Height and weight was measured to the nearest 0.1 cm and 0.1 kg with portable stadiometers and standardized scale, respectively. Body mass index (BMI) was calculated as body weight (kg) divided by height (m) squared (kg/m^2). Nutritional status with different BMI categories, including thinness, normal, overweight, and obesity, was classified using the sex-and age-specific BMI reference values developed by International Obesity Task Force (IOTF).[19, 20] BMI z scores were calculated according to the Centers for Disease Control Growth Charts (www.cdc.gov/growthcharts).[21]

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BP was measured according to the Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents, using an auscultation mercury sphygmomanometer with an appropriate cuff for children.[22] We chose an appropriate cuff with an inflatable bladder width according to their age. The child was seated comfortably for at least 10 minutes before the first reading. Children stood on a platform during BP measurement. SBP was determined by onset of the first Korotkoff sound (K1), and DBP was determined by the fifth Korotkoff sound (K5). An average of 3 BP measurements at a single visit was calculated for each child. Systolic HBP (SHBP) and diastolic HBP (DHBP) were defined as SBP and DBP greater than or equal to the referent age-, sex-, and height-specific 95th centile for children and adolescents aged 7 to 17 years, respectively, according to the National High Blood Pressure Education Program reference. SHBP and DHBP were also defined for adults aged 18 years as SBP/DBP ≥140/90 mm Hg. Thus, HBP was defined as SHBP or DHBP of children and adolescents.[22]

Statistical analysis

Descriptive statistics were calculated for all variables. Analyses of the comparison between ethnic minorities and Han at each survey year were conducted for HBP, SHBP and DHBP, as well as the prevalence gaps between two groups in both sexes. Ranks in HBP, SHBP and DHBP prevalence and the prevalence changes of each ethnic group between two adjacent survey years were analyzed to present the epidemiological features' changes. Polynomial regression models were run to investigate and compare the HBP, SHBP and DHBP prevalence across the BMI z-scores in both sexes of each survey year between ethnic minorities and Han adjusting for age and regions, and the results were presented graphically. In ethnic minorities and Han, we calculated the odds ratio (OR) and 95% confidence intervals of HBP, SHBP, and DHBP in thinness, overweight, and obesity groups compared with the normal group in 3 surveys form 2005 to 2014 after adjusting for age and height. A logistic regression model using the aflogit module for Stata was adopted to estimate the PAR (%) with corresponding 95% confidence intervals based on asymptotic approximations. Calculation of PAR (%) implies a theoretical causal relationship between HBP and overweight/obesity. We also used PAR (%) to estimate and compare the intervention effects on HBP if overweight and obesity were averted in ethnic minorities and Han children and

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adolescents theoretically. All analyses were performed with Stata V.14 software (College Station, Texas, USA).

Results

Study Sample

As shown in **Table 1**, a total of 888,245 children and adolescents participated in this study, with 224,151 children and adolescents from ethnic minorities and 664,094 Han children and adolescents. There was no difference in average age and the proportions of sex between ethnic minorities and the Han. The mean height, weight, BMI, and SBP, and DBP were lower in ethnic minorities than those in the Han at each survey year. The prevalence of overweight and obesity in ethnic minorities were about a half lower than that of Han at each survey year from 2005 to 2014. All the measurement indexes and the overweight and obesity prevalence increased over time among both ethnic minorities and Han children and adolescents.

Epidemiological features and trends of HBP

As shown in **Figure 2**, prevalence of HBP in children and adolescents from ethnic minorities increased from 4.8% in 2005 to 6.1% in 2010, then to 6.3% in 2014, higher than those in Han at each survey year (4.1%, 5.6% and 5.5%). Both boys and girls presented similar trends, but the prevalence gaps for HBP between ethnic minorities and Han decreased with time in boys, whereas increased in girls. Children and adolescents from ethnic minorities had lower prevalence of SHBP, but higher prevalence of DHBP. Compared to SHBP, higher prevalence gaps for DHBP between ethnic minorities and the Han caused the higher overall prevalence of HBP in ethnic minorities (**Table S1**). A large ethnic disparity in the prevalence of HBP and its ranks' changes existed in each ethnic group in **Figure3**. The levels of BP and prevalence of HBP, as well as its subtypes, varied greatly at each age group during the childhood and adolescence but showed highest prevalence at pre-puberty stage with similar pattern between 2005 and 2010, while the age disparities in HBP, SHBP and DHBP showed narrowing pattern, especially among Han students in 2014. (**Figure S2**). The prevalence of SHBP, DHBP and their ranks' changes in each ethnic group were presented in **Figure S3-S7**.

Impact of overweight and obesity on HBP

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As seen in **Figure 4**, in both sexes of ethnic minorities and the Han, the prevalence of HBP, SHBP and DHBP steadily increased with BMI groups. For example, in 2014, children and adolescents from ethnic minorities presented increasing prevalence of HBP from 4.1% in thinness group to 20.8% in obese group, and from 3.0% to 18.8% for Han children and adolescents.

Within each BMI group, the prevalence of HBP, SHBP and DHBP of ethnic minorities increased linearly from 2005 to 2014, whereas Han presented an increased trend between 2005 and 2010, but a decreased trend in 2014. In the group of thinness, normal BMI and overweight, the prevalence of HBP, SHBP and DHBP was higher in ethnic minorities than those in the Han children and adolescents. Compared to the Han, children and adolescents from ethnic minorities had a lower prevalence of HBP, SHBP and DHBP in obese group in 2005 and 2010 (**Table S2**). However, children and adolescents from ethnic minorities with higher BMI Z-Score witnessed an ever-increasing prevalence of HBP with time following an expanding gap for HBP prevalence between ethnic minorities and Han (**Figure 5**).

The association analyses presented the similar trends from 2005 to 2014 in **Figure 6**. Obviously, the impact of obesity on HBP, SHBP and DHBP increased steadily over time in ethnic minorities, but was stable over time in the Han children and adolescents, and ORs in ethnic minorities got close to those in Han in 2014. For example, the ORs of obesity on HBP in ethnic minorities presented sustained increase with time from 2.3 in 2005 to 3.9 in 2014, but a slight decline for Han from 5.6 in 2005 to 4.8 in 2014 (**Table S3**). **Figure 7** presents, in ethnic minorities, the PAR% for HBP due to overweight and obesity steadily increased from 9.6% in 2005 to 22.6% in 2014. In Han, the PAR% was 18.4% for HBP in 2005, and increased to 24.5% in 2014. During the 10 years, the increase of PAR% in ethnic minorities was larger than those in Han for HBP, SHBP and DHBP.

Discussion

This is the first study using nationally representative data to investigate the prevalence of HBP in both ethnical minorities and Han children and adolescents in China, and to compare the impact of obesity on HBP. Based on the nearly one million children and adolescents aged

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7 to 18 years from 2005 to 2014, we found that overall HBP prevalence was always significantly higher in ethnic minorities compared with Han from 2005 to 2014. Notably, ethnic minorities had a faster rise in the prevalence of HBP, overweight and obesity than those of Han. Furthermore, a growing impact of overweight and obesity on HBP gradually increases over time in both ethnic children and Han, but more impact occurred in ethnic minorities with faster growth of ORs and PAR% compared with Han. That means all the previous studies conducted only in Chinese Han, the overwhelming majority studies in fact,[13, 17, 23] underestimated the overall HBP burdens and its growth pace of entire Chinese children and adolescent population, and under-predicted the growing burden of chronic diseases in future adults.

Our findings are consistent with previous research in that the prevalence and secular trends of HBP in children and adolescents vary substantially across and within regions and countries. Some countries experienced downward trends whereas others experienced an upward trend. For example, South Korea, similar to the Korean in China with similar eating habits and health behaviors, witnessed important population declines in HBP from 1998 to 2008 in children 10 to 19 years of age.[24] Similar downward trends were also observed in other countries, such as Japan,[25] Iran,[26] Northern Ireland.[27] On the other hand, United Kingdom,[28] and Greece[29] experienced upward trends. HBP prevalence can fluctuate during different time periods. For example, U.S. reported that the trends in childhood HBP were downward from 1963 to 1988,[30, 31] then upward from the 1988-1994 period to the 1999-2000 period,[32] whereas remained stable between 1999-2000 and 2011-2012.[33, 34] Thus, inconsistent or turbulent secular trends for HBP in children and adolescents may occur in one country at different periods or different groups within a country substantially, just like what our study has found.

Our findings supported the evidence that the effect of overweight/obesity on HBP gradually strengthened over time in ethnic minorities than that in Han, accompanying higher HBP prevalence in obese population in ethnic group than Han in 2014. Among the multitudinous factors, overweight/obesity are well established determinants of childhood HBP, but whether blood pressure increased in response to the obesity epidemic and their associations

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strengthened or weaken were still a controversial area for additional study. Previous studies conducted in UK found that BMI explained only 14.9% to 15.3% of increases in SBP for children, and the BMI/SBP association appeared to become significantly weaker over time.[28] A study in Northern Ireland showed that the BP declines were not associated with changes in BMI.[27] Some other studies also found that BP values and HBP trends did not parallel with increase in BMI and obesity.[35] However, some observational studies reported that the secular changes in HBP prevalence were accompanied by increases in BMI or obesity. [30, 32]

These discordant trends in HBP and inconsistent results for association between HBP and obesity for ethnic minorities and Han may be due to different determinants for HBP trends and obesity/HBP associations, such as living environment, dietary habits, healthy educational disparities and socioeconomic status. Firstly, China is a multi-ethnic country and people have their specific living environment and dietary habits, which could affect their blood pressure and its association with obesity. For example, the Korean live in the northeast region of China with more than 6 months in duration with temperature below freezing, Tibetan, Monguor and Sala lived in the Qinghai-Tibet Plateau, the highest place in the world, with low oxygen concentration and temperature, the Mongolians are traditional nomadic ethnicities and they live in the Inner Mongolian Plateau, the second highest plateau in China northeast regions with high latitudes and low temperature, and Most of the Qiang people live in mountainous areas where outdoor activities are impractical in cold winter season. Surveys in ethnic minorities above found that the frequency and amount of meat intake among children and adolescents were much higher than their Han counterparts.[36] Due to the unique religious belief, the intake of animal food such as beef and mutton in Hui, Tibet, Uyghur and Kazak ethnic minorities is high, with the per capita daily exceeding 100g, and the salt intake in ethnic minority residents is relatively high, especially for Kazak and Uyghur with the average salt intake over 20g,[37] both of which may cause HBP in children and adolescents.[38, 39] Living environment with prolonged periods of hypoxia and low temperature can also contribute to HBP.

Secondly, socioeconomic factors, like socioeconomic deficiencies in childhood, seem to modify this association between BMI status trends and HBP trends, and are associated with

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increased cardiovascular disease burden.[40] Most ethnic minorities in China were indeed located in economically underdeveloped areas with great disparities for social macroeconomic indicators compared to the Han.[41] The global rising trends in children's and adolescents' BMI have plateaued in many high-income countries at high levels, but have accelerated in parts of Asia.[16] Most developed countries have witnessed a downward or turbulent HBP trends, possibly due to a weaker association with obesity and stronger effects from other factors.[24] So there may be a time-lag for obesity epidemic and HBP trends between ethnic minorities and Han in China. Furthermore, educational levels, especially health education, in ethnic minorities areas were still lagging behind compared to other areas. For example, several Chinese ethnic minorities had higher hypertension prevalence while very low awareness, treatment and control rates.[42] All these factors might partly explain the discordant trends in HBP and difference of association of BMI with HBP between ethnic minorities and Han children and adolescents, as well as the huge heterogeneity in HBP within ethnic groups.

Our study has some potential implications. Firstly, researches about HBP epidemiological features and secular trends from Chinese ethnic minorities are scarce. Chinese ethnic minorities faced a great challenge in higher risk of CVD due to HBP, even though their obesity level was still lower compared to Han. Furthermore, the increasing effect of overweight/obesity on HBP in Chinese ethnic minorities predicted the looming burden of HBP, whereas which is easily overlooked or tough to be controlled in time. Discovery of HBP secular trends in Chinese ethnic minorities in early time would help us to formulate prevention and control measures which were not limited to obesity control, focusing on the comprehensive intervention strategies including lifestyle interventions and socioeconomic improvements. Secondly, although the population of ethnic minorities only accounted for about 8% among whole population in China, still 106.43 million people are ethnic minorities according the national population census in 2010,[6] which exceeded most middle countries in the world. Moreover, Chinese ethnic minorities were distributed widely across the world particularly with similar habits. For example, most ethnic minorities in western China, like the Naxi, Lisu, Hani and Qiang, had similar lifestyles and behaviors to peers in Vietnam, Laos, Thailand, and Burma. The Uighur and Hui had similar features to Muslims all

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over the world. The Kazak had a lot of similar characteristics to Kazakhstan, and the Mongol to Mongolia, the Korean to North and South Korean. However, it is scarce in these countries mentioned above for HBP trends in children and adolescents. Thus, due to the differences in religion, culture, lifestyle, diet, genetic background, and socioeconomic status in ethnic minorities within China, the diversity of trends of HBP burdens and its association with obesity may provide valuable information for making appropriate policies in preventing CVD burdens for inhabitant residents in ethnic minorities' areas and other corresponding countries. In addition, ethnic minorities in China are usually regarded as a whole when policies released or interventions implementing in spite of different residence where they were. Our results help policy makers re-examine or reconsider the disparities within ethnic groups in terms of policy implementations.

Our study has several limitations. Firstly, there are 55 ethnic minorities in China, but we only used data from 24 ethnic minorities, because the population of children and adolescents in other ethnic minorities was not enough to meet the requirements of investigation and the population in 24 ethnic minorities (83.21%) is close to the whole children and adolescents in all the ethnic minorities in China. Secondly, the present results adopted the classical BP criteria developed in American children in 2004 [22] and we did not use the US updated BP criteria in children [43], but the criteria in 2004 were wide spread applied by researcher, which is easy to directly compare our results to other studies. Latest studies demonstrated that the associations between HBP with BMI and other medical and behavioral factors remained unchanged using the US updated BP criteria, so our results would not be affected by different BP definitions.[44] Thirdly, some living environments and lifestyle factors, such as air quality of residence, individual physical activity, energy intake, sodium and potassium intake, are associated with the risk of HBP and might further explain the changing trends of childhood HBP, were not collected in these surveys.

Conclusion

In conclusion, our study revealed that HBP prevalence in children and adolescents from ethnic minorities in China increased steadily from 2005 to 2014, but HBP prevalence in Han children and adolescents was more turbulent in the context of explosive growth of obesity

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from 2005 to 2014. Both Chinese ethnic minorities and Han are facing a greater risk of HBP caused by overweight and obesity, and a dramatic increase in attribution of HBP by overweight/obesity over time. However, Chinese ethnic minorities had higher prevalence of HBP, growingly stronger effect of overweight/obesity on HBP, more increase for attributions of PAR% than Han children and adolescents, which predicted a looming burden of HBP and potential considerable burdens of CVD in their adulthood in the future. Thus, routine intensive BP surveillance, early specific interventions, and additional epidemiological studies assessing a wider range of risks or protective factors related to BP in ethnic minorities are warranted.

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Figure legends:

Figure 1. Geographical distribution of 24 Chinese ethnic minorities in the surveys

(Note: A total of 30 provinces except for Hong Kong, Macao, and Taiwan province were investigated to collect data of Han children and adolescents. A total of 12 provinces with different colors in map, where gathered with Ethnic Minority Autonomous Regions or Ethnic Minority Autonomous Prefectures, were investigated to collect data of 24 ethnic minorities' children and adolescents.)

Figure 2. Trends in prevalence of high blood pressure (HBP, A, B, C), systolic HBP (SHBP, D, E, F) and diastolic HBP (DHBP, G, H, I) and their prevalence gap between ethnic minorities and Han from 2005 to 2014 in China

(**Note**: Red and blue lines represented the trends of HBP, SHBP, and DHBP prevalence in 2005, 2010 and 2014 in ethnic minorities and Han, respectively. Yellow bars represented the prevalence gap between ethnic minorities and Han in each survey year.)

Figure 3. The ranks of prevalence and prevalence changes for HBP in Han and each ethnic minority from 2005 to 2014 in China

Note: Ranks of HBP prevalence and the prevalence changes between two adjacent survey years in each ethnic group and Han were presented. The blue dotted lines presented the decreased trends in ranking orders of each ethnic group, and red dotted lines represented the increased or constant in ranking order. Blue boxes with each ethnic group and Han presented the decreased trends in prevalence, red boxes for increased trends in prevalence, and green boxes for basic status in 2005.

Figure 4. Changes and comparison for the prevalence of high blood pressure (HBP, A, B, C), systolic HBP (SHBP, D, E, F) and diastolic HBP (DHBP, G, H, I) between ethnic minorities and Han in difference BMI groups in both sexes from 2005 to 2014 in China

Figure 5. The fitted prevalence of (HBP, A, B, C), systolic HBP (SHBP, D, E, F) and diastolic HBP (DHBP, G, H, I) in both sexes in each ethnic minority and Han from 2005 to 2014 in China

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Figure 6. The comparison for effect of BMI categories on high blood pressure (HBP, A, B, C), systolic HBP (SHBP, D, E, F) and diastolic HBP (DHBP, G, H, I) between ethnic minorities and Han in both sexes from 2005 to 2014 in China

(**Note:** The odds ratio (OR) and 95% confidence intervals of HBP, SHBP, and DHBP in thinness, overweight, and obesity groups compared with the normal group in 3 surveys form 2005 to 2014 after adjusting for age and height.)

Figure 7. The changes of in population attributable risk (PAR%) for high blood pressure (HBP; A), systolic HBP (SHBP, B) and diastolic HBP (DHBP, C) in each ethnic minority and Han from 2005 to 2014 in China

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Table 1. The basic information of different survey years in ethnic minorities and Han

Survey Years	2005	2010	2014
Sample size, N			
Ethnic minorities	73650	75142	75359
Han	234421	215319	214354
N for gender (boys, %)			
Ethnic minorities	50.0	50.2	49.9
Han	50.2	50.0	50.0
Age, year, mean(SD)			
Ethnic minorities	12.5(3.4)	12.5(3.4)	12.5(3.4)
Han	12.5(3.5)	12.5(3.5)	12.5(3.4)
Height, cm, mean(SD),			
Ethnic minorities	145.0(16.6)	145.7(16.4)	147.2(16.2)
Han	149.7(16.3)	150.7(16.1)	151.8(15.9)
Difference	4.7(4.6,4.9)	5.0(4.9,5.2)	4.6(4.5,4.8)
Weight, kg, mean(SD)			
Ethnic minorities	38.6(13.1)	39.3(13.4)	41.0(14.0)
Han	42.1(14.3)	43.4(14.5)	45.1(15.1)
Difference	3.6(3.4,3.7)	4.0(3.9,4.1)	4.1(4.0,4.3)
BMI, mean(SD)			
Ethnic minorities	17.7(2.9)	17.9(3.1)	18.3(3.3)
Han	18.2(3.3)	18.5(3.3)	19.0(3.6)
Difference	0.5(0.5,0.5)	0.6(0.6,0.6)	0.7(0.7,0.7)
SBP, mmHg, mean(SD)			
Ethnic minorities	100.3(12.1)	100.1(12.8)	102.5(12.8)
Han	102.8(12.1)	104.1(12.4)	104.8(12.8)
Difference	2.5(2.4,2.6)	4.0(3.9,4.1)	2.3(2.2,2.4)
DBP, mmHg, mean(SD)			
Ethnic minorities	63.8(10.3)	64.7(9.9)	65.2(10.0)
Han	63.9(10.1)	64.9(9.9)	65.4(9.7)
Difference	0.1(0.0,0.2)	0.2(0.1,0.2)	0.3(0.2,0.4)
OW&OB prevalence, %(95%CI)			

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Ethnic minorities	4.3(4.2,4.5)	6.5(6.4,6.7)	9.4(9.2,9.7)
Han	10.4(10.2,10.5)	13.1(12.9,13.2)	17.7(17.5,17.8)
POR	0.4(0.4,0.4)	0.5(0.5,0.5)	0.5(0.5,0.5)

Note: OW&OB, overweight and obesity. POR represented population odds ratios of ethnic minorities vs Han.

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Figure 1

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Figure 2

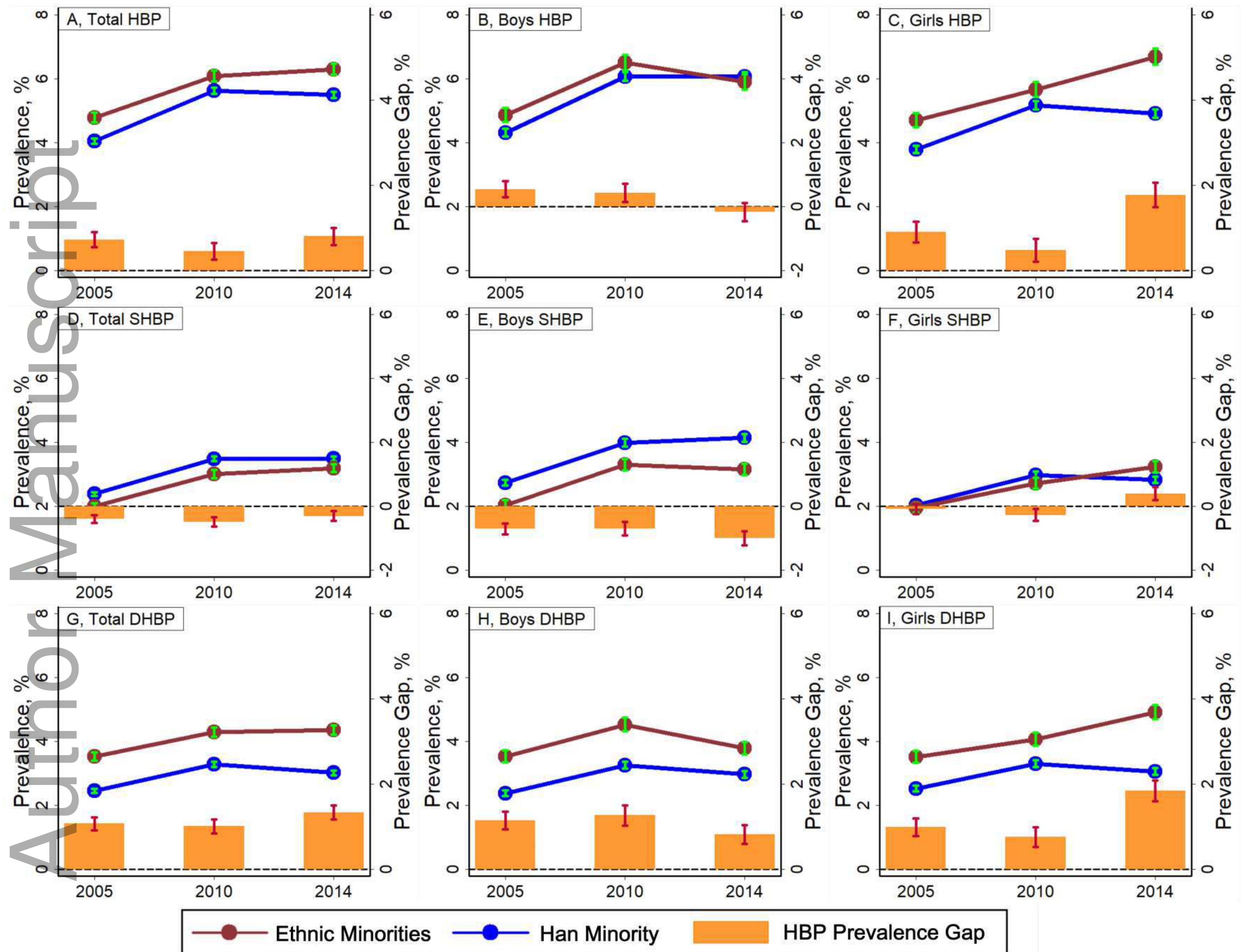

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Figure 3

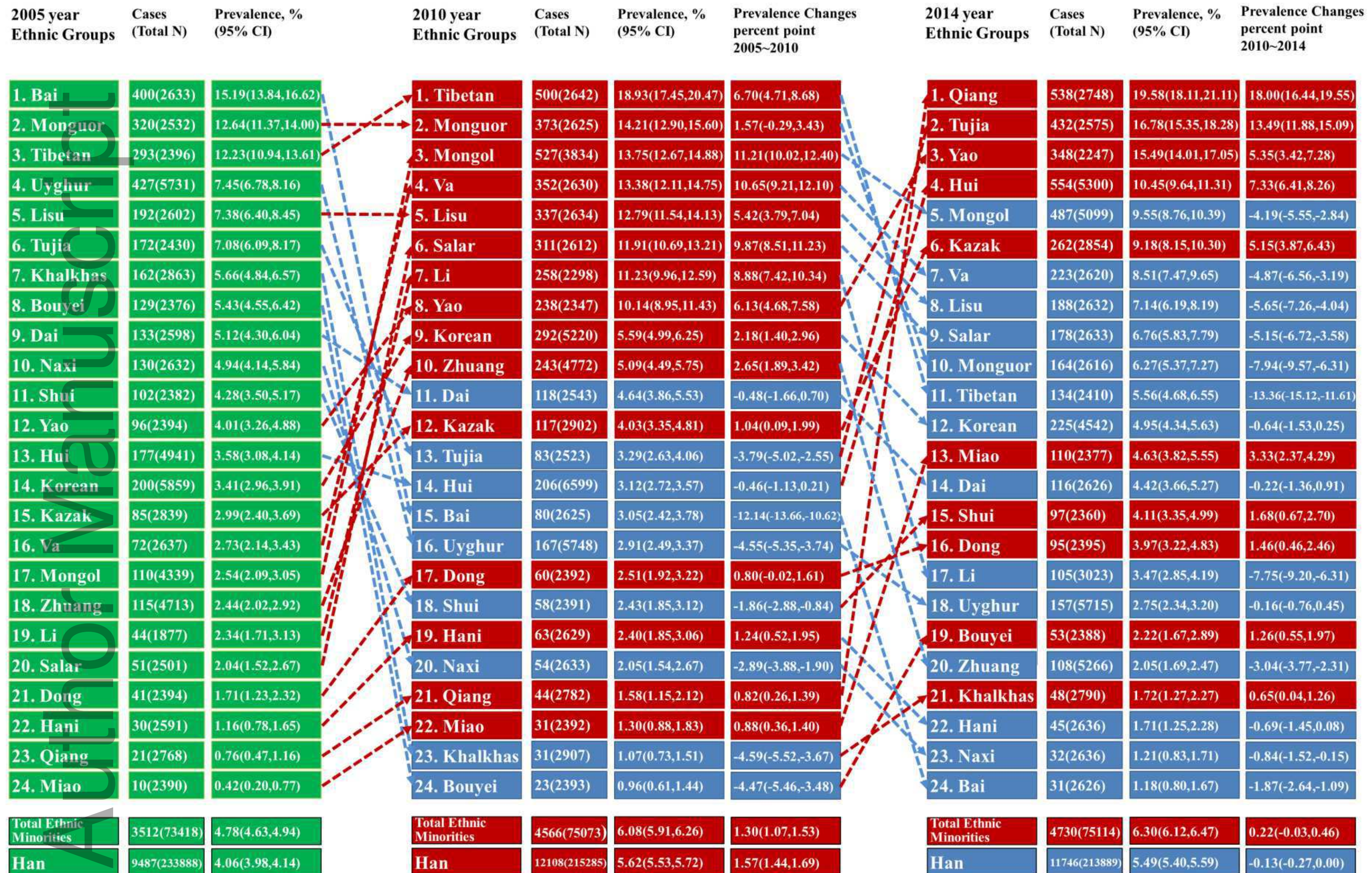

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Figure 4

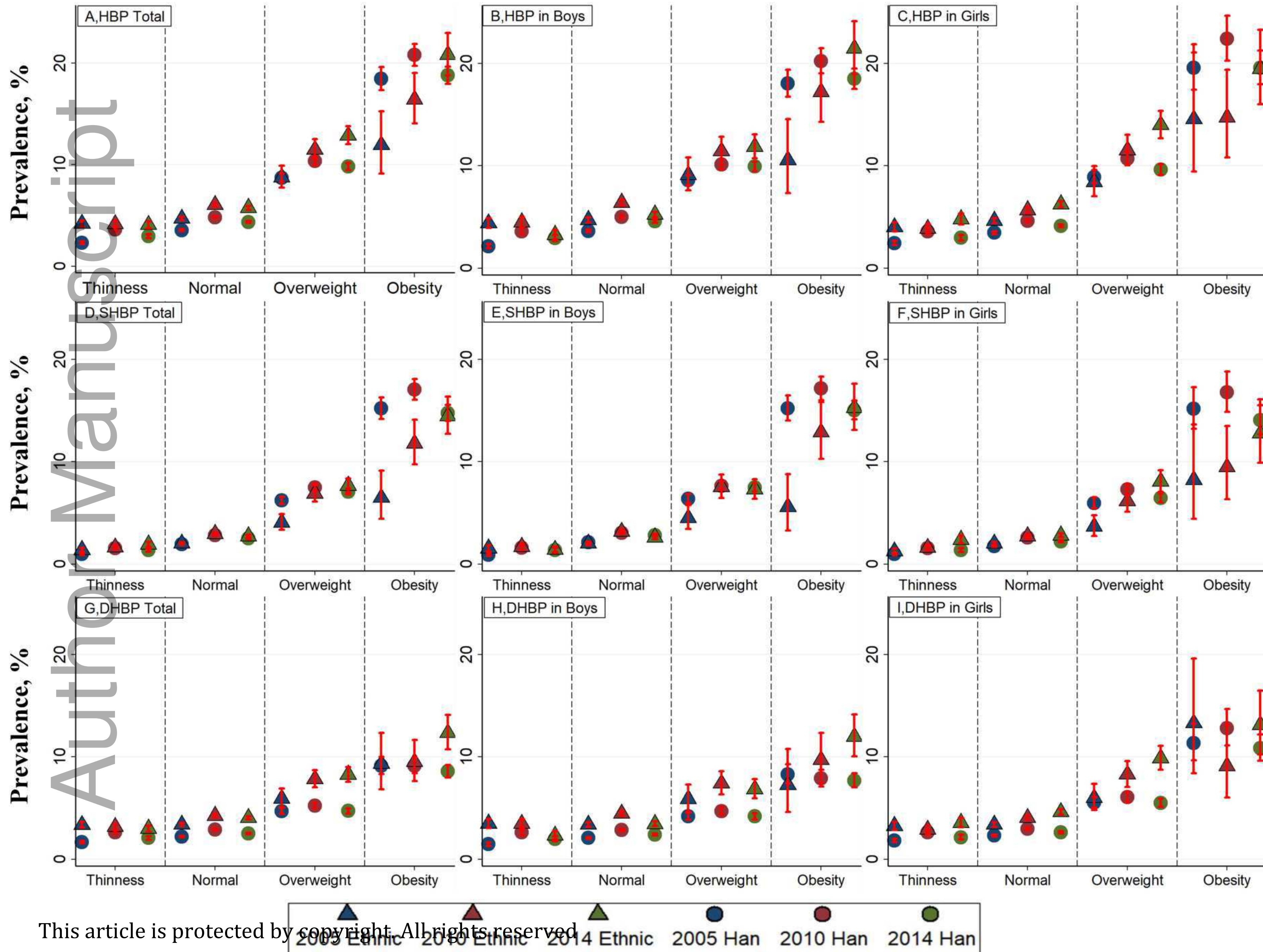

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Figure 5

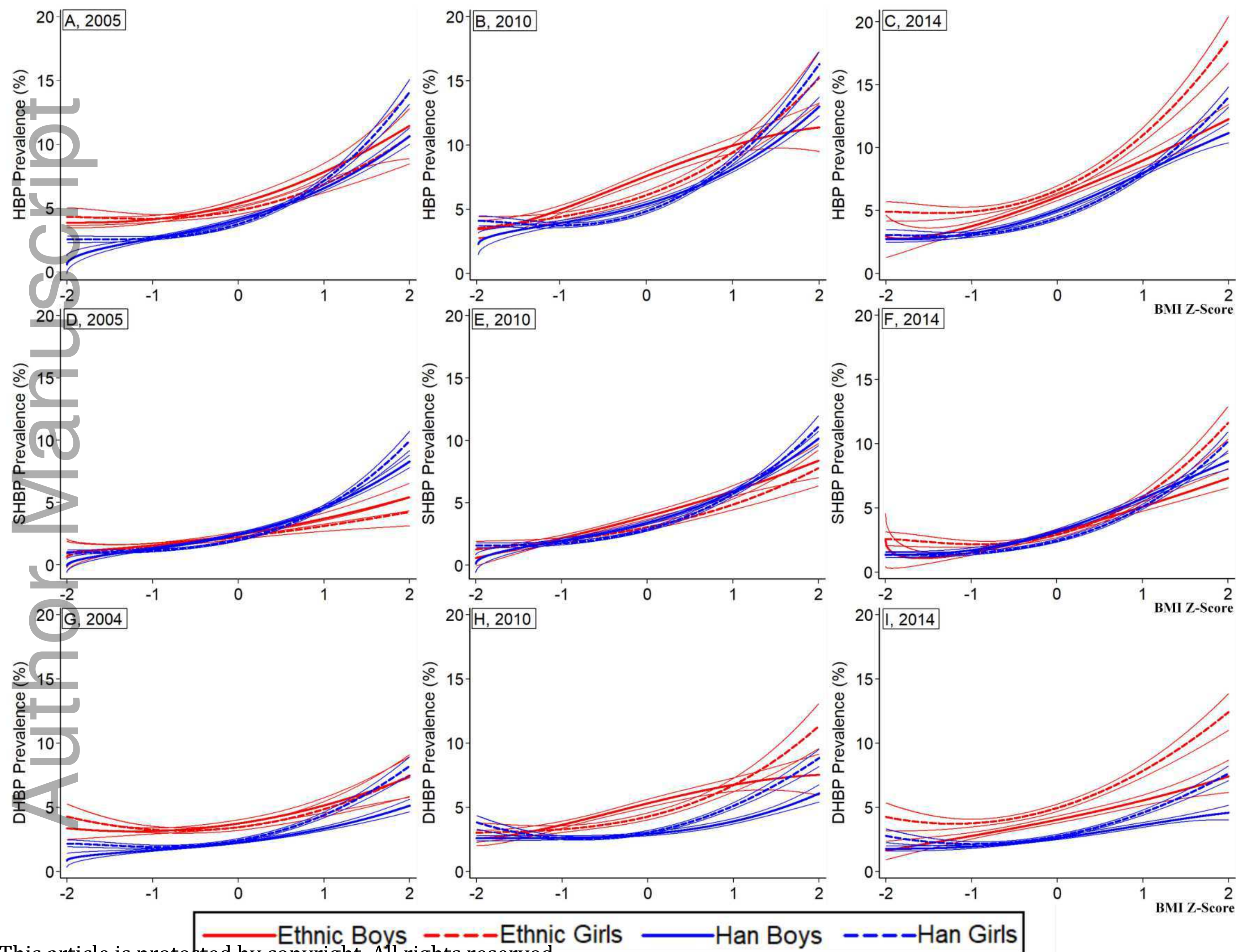

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Figure 6

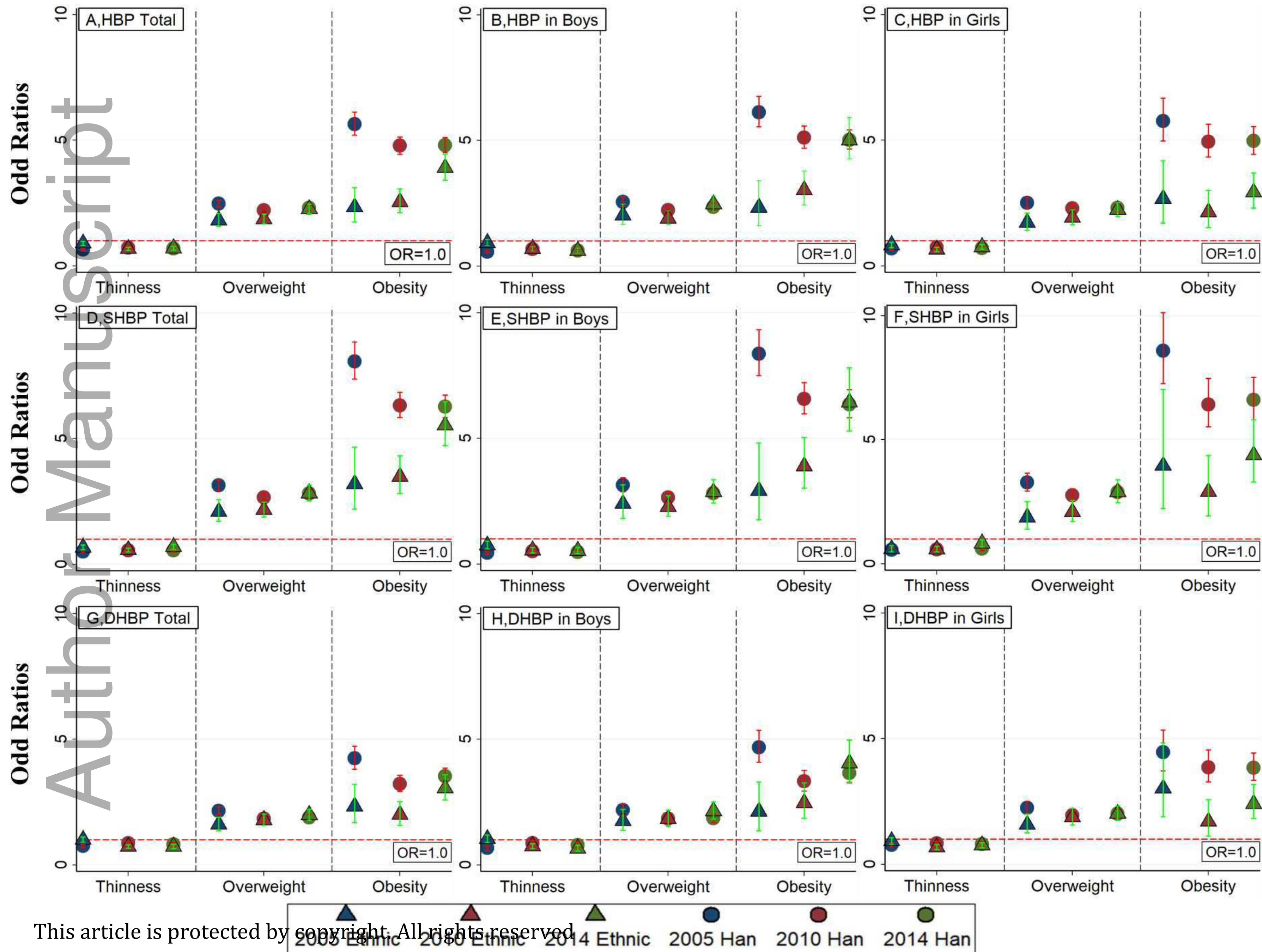

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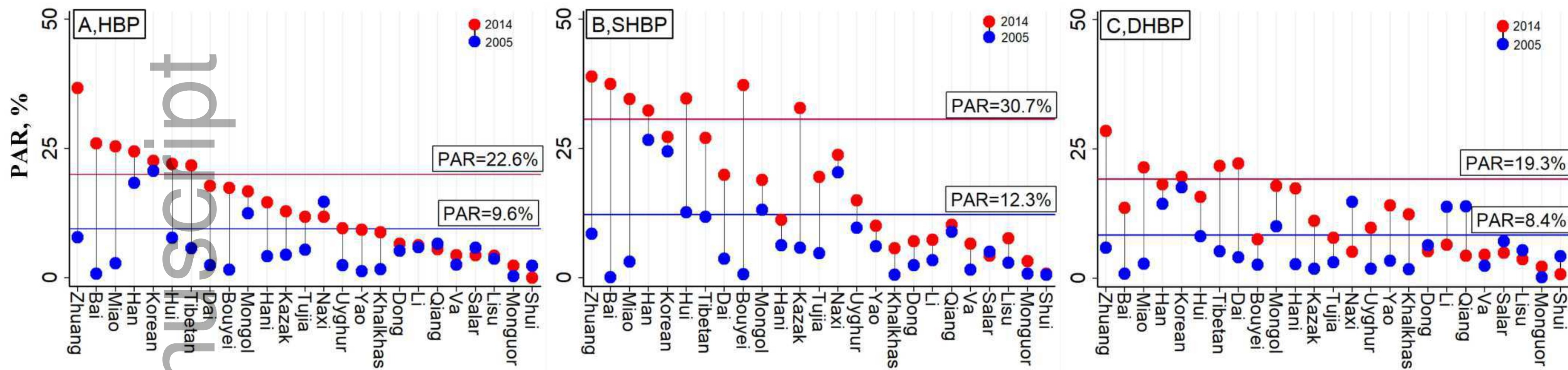
Figure 7



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