

A nationwide report on blood pressure of children and adolescents according to socioeconomic status: The CASPIAN-IV study

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Background: Hypertension is a major leading factor for global burden of diseases. Blood pressure (BP) tracks from childhood to adulthood. So, it is important to investigate its affecting factors. In this study we aimed to compare the BP status in the Iranian pediatric population according to the socioeconomic status (SES) of their living area. **Materials and Methods:** In this nationwide study, a representative sample of 14,880 students, aged 6-18 years was chosen by multistage random cluster sampling from 30 provinces in Iran. Anthropometric indices and BP were measured. A validated questionnaire, including the questions of the World Health Organization Global School-based Student Health Survey was completed. Findings were compared across the four regions of the country, categorized based on their elevating SES: Southeast, north-northeast, west, and central. **Results:** Participants consisted of 13,486 children and adolescents, that is, a participation rate of 90.6%, composed of 49.2% girls and 75.6% urban residents. The mean (standard deviation) age of participants was 12.47 (3.36) years. The region with highest SES (central) had the lowest rate of high BP (HBP), that is, 3.0% (95% of confidence interval [CI]: 2.4-3.9), and the region with lowest SES (southeast) had the highest rate, that is, 7.4% (4.4-12.2). The mean (95% CI) values of systolic BP for the four regions from lowest to highest SES were 100.5 (99.6-101.3), 100.9 (100.3-101.4), 101.7 (101.3-102), and 101.7 (101.2-102.1) mmHg. The corresponding mean Diastolic BP values were as follows: 65.4 (64.6-66.1), 63.4 (62.9-63.8), 65.6 (65.3-65.8), and 64.4 (64.0-64.7) mmHg. **Conclusion:** We found significant differences in mean BP and the frequency of HBP according to the SES of the living area. Further studies are necessary to find the underlying factors resulting in such differences.

Key words: Adolescent, blood pressure, child, high blood pressure, socioeconomic status

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INTRODUCTION

High blood pressure (HBP) is the top global health burden risk factor.^[1] BP tracks from childhood to adulthood. Childhood obesity epidemic and lifestyle changes have resulted in increasing prevalence of HBP in the pediatric population.^[2,3] The strong relationship

of even early stages of HBP with environmental factors as air pollution, noise pollution, and smoking, as well as with obesity suggest that its prevalence will have a persistent rise.^[4]

Beside the effect of fetal programming process (Barker hypothesis)^[5] and aforementioned factors, other factors, including being born small for gestational age or preterm, determine the BP value in childhood,^[6]

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which will define adult BP level through the “tracking” phenomenon.^[7-10] Therefore, higher BP values in the pediatric age track into adulthood and would bring their long-term health consequences.

A number of studies worldwide have proposed the potential influence of living region on BP. For instance, the sixty percent higher prevalence of hypertension (HTN) in Europe compared with the United States and Canada,^[11] high prevalence of HTN in regions like South Asia,^[12] association of BP with different dietary habits in various regions with various sociodemographic circumstances,^[13] and the concordance of low air quality of some regions with cardio-metabolic risk factors such as HTN^[14] are some examples. Socioeconomic status (SES), especially education level has supposed to be affecting on cardiovascular health.^[15] A meta-analysis provided evidence for the association between HTN and SES in rural populations of low- and middle-income countries according to the geographical region.^[16] Another meta-analysis depicted such a relation at the global level.^[17] However, in accordance with now-a-days globesity, youth from all circumstances are susceptible to metabolic risk.^[18]

Iran is a large country of Middle East with diverse geographic, ethnic, economic and social specifications.^[19]

Until date, not many studies have focused on evaluating noncommunicable diseases risk factors including BP in the pediatric population of Iran. There is scarce information at national level on BP of children and adolescents and no data exists on the comparison of their BP status across different provinces/regions of the country and its correlation to the social, economic, and ecological factors. In most available studies, those parameters are estimated at individual levels. Such information would help to discover the most vulnerable areas helping policy makers to make proper decisions. This study aims to compare the BP status in the Iranian pediatric population according to the SES of their living area.

MATERIALS AND METHODS

Study design, population, and sampling

The Childhood and Adolescence Surveillance and Prevention of Adult Noncommunicable Disease (CASPIAN) study, is a national school based surveillance system inspired by World Health Organization (WHO) recommendations, which started on 2003 and has been conducted in four different surveys until 2012.^[20] Detailed methods of the fourth survey are presented elsewhere.^[21,22] In brief, CASPIAN-IV study was a national cross-sectional survey on 14,880 school students, aged 6-18 years. They were selected via multistage cluster random sampling from rural and urban areas of different cities in 30 provinces of the country. Stratification

was performed based on living areas (urban/rural) and school grade (elementary/intermediate/high school). The sampling was proportional to size with equal sex ratio. The number of samples in rural/urban areas and in each school grade was allocated proportionally to the population of students in each grade. Cluster sampling with equal clusters was used in each province to scope the required sample size (48 clusters of 10 students in each province). The students from other nationalities residing in Iran (such as Afghans) or the students who themselves or their parents did not agree to enter the study were not included. Other students were included regardless of their health status due to the epidemiologic nature of the study.

Questionnaires

Questionnaires were compiled with some modifications on the WHO Global School-based Student Health Survey program.^[20-23] The subjects filled out questionnaires in their schools under the supervision of trained staff and the presence of at least one parent.

Physical measurements

Anthropometric measures included height, weight and hip, waist and wrist circumferences. Then the body mass index (BMI), waist to hip and waist to height ratios were calculated.

Trained health professionals measured BP according to standard protocol^[24] and by using calibrated instruments. After enough rest, BP readings were taken twice from each person with 5 min interval. The readings at the first Korotkoff sound were considered as the systolic BP (SBP) and at the fifth sound as diastolic BP (DBP). The average of two measurements was recorded.

According to the fourth report of the working group (formerly task force) on BP control in children, commissioned by the National Heart, Lung, and Blood Institute of the National Institutes of Health of America, BP levels equal or more than the 95th percentile value for the age, sex, and height it was considered as HBP.^[24]

Quality control

In addition to training the data collection team, a detailed operation manual was developed and distributed to the team. A supervisor and a team of external evaluators monitored performance, and checked and calibrated equipment according to standardized protocols. The Context, Input, Process, and Product evaluation model was used to guide the evaluation of the project.^[20]

Country regions

According to a previous national study, the country provinces are grouped into four different regions:

Southeast, north-northeast, west and central. The regions are defined based on a combination of geography and SES. SES was measured using an index constructed from variables from the 2006 country census, including years of schooling, employment rates, and family properties. These characteristics were combined using principal component analysis. The principal components in combination with geography were used to divide the country into four large regions. The southeast region had the lowest, the north-northeast region the second low, the west region the second high and the central region the highest SES [Figure 1].^[19]

Ethical considerations

The study was approved by relevant regulatory organizations and institutional review boards. Written informed consent from parents and verbal assent from students were taken after the clear explanation. Data handled confidentially and de-identified. Each subject could withdraw his/her consent at any time.

Statistical analysis

STATA statistical software (Release 12. College Station, TX, USA: StataCorp LP) and survey data analysis methods were used for statistical analysis. Mean and 95% of confidence interval (CI) for quantitative measures and frequencies/prevalence rates with the same CIs were recorded for categorical variables. Analysis of variance and Chi-square tests were used for comparisons of BP across regions. $P < 0.05$ was considered as statistically significant. Plots of mean values of BP and prevalence rate of HBP distribution over the country were drawn using MapTools, SDMTTools and Plotrix packages by R software (version 2.15.1).^[25]

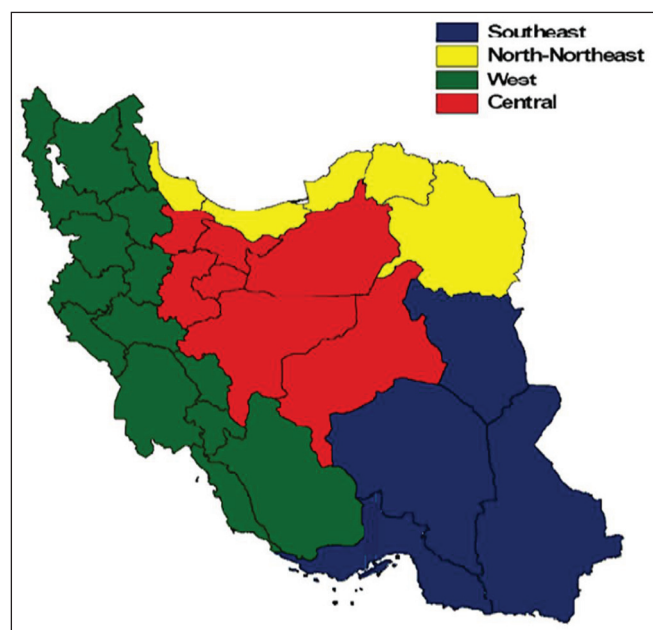


Figure 1: Country regions^[19]

RESULTS

In this nationwide survey, 13,486 out of 14,880 selected students completed the study (response rate of 90.6%). They consisted of 6640 girls (49.2%) and 6846 boys (50.8%) with one of their parents, 75.6% from urban areas. For this part of study, the data of 13,367 students was complete, 1148 students from southeast (lowest SES), 2358 from north-northeast (second low SES), 6038 from west (second high SES), and 3823 from central (highest SES) regions [Table 1], the mean SBP (95% CI) of total population studied was 101.5 (101.2-101.7) mmHg and the mean DBP was 64.8 (64.6-64.9) mmHg. Prevalence rate (95% CI) of high SBP, high DBP, and high SBP, and/or DBP in the total population studied was 0.9 (0.7-1.1), 3.0 (2.5-3.6) and 3.7 (3.2-4.3) percent, respectively.

The data according to the four Iran regions are presented in Table 1. It shows a significant difference in the prevalence rate of high SBP and/or DBP between four regions: Southeast area, the lowest SES region, with a prevalence rate of 7.4% (4.4-12.2) has the highest rate ($P = 0.004$). The prevalence rate of high DBP across these regions shows similar pattern of difference ($P = 0.001$), but the corresponding figure was not different for high SBP rate among these four regions ($P = 0.228$).

The distribution of mean SBP and DBP values, as well as the prevalence rate of HBP across provinces, is depicted in Figures 2-4, respectively. They demonstrate that except some areas, higher values of mean BP and frequency of HBP are accumulated in high SES regions (central, west, and north regions).

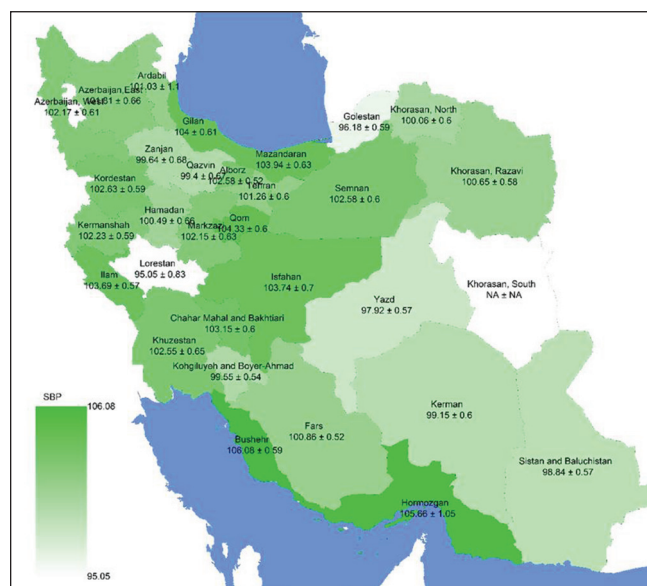


Figure 2: The mean of systolic blood pressure in Iranian children and adolescents at provincial level: The CASPIAN-IV study. Data are presented as mean \pm standard error

Table 1: Some anthropometric and blood pressure indices in national and regional level by sex and living area: the CASPIAN-IV study

Region: Category	n (%)	Age (years)	SBP (mm Hg) ^a	DBP (mm Hg) ^a	High SBP (%) ^b	High DBP (%) ^b	High SBP and/or DBP (%) ^b
Southeast							
Boys	539 (47)	12.7 (11.9-13.6)	101.8 (100.5-103)	65.3 (64.2-66.3)	0.9 (0.3-2.4)	5.9 (2.7-12.2)	7.2 (3.7-13.6)
Girls	609 (53)	12.1 (11.4-12.9)	99.4 (98.3-100.4)	65.4 (64.3-66.4)	0.4 (0.1-1.4)	7.5 (3.5-15.5)	7.7 (3.6-15.6)
Urban	630 (54.9)	13.0 (12.2-13.8)	102.4 (101.2-103.5)	66.5 (65.4-67.5)	0.7 (0.3-1.8)	6.6 (3.2-13.2)	7.3 (3.6-14.0)
Rural	518 (45.1)	11.7 (10.8-12.5)	98.2 (97.0-99.3)	64.0 (62.9-65)	0.5 (0.1-2.3)	6.9 (2.8-15.9)	7.7 (3.4-16.5)
Total	1148 (100) (8.6% of study population)	12.4 (11.8-13.0)	100.5 (99.6-101.3)	65.4 (64.6-66.1)	0.6 (0.3-1.4)	6.8 (3.9-11.5) [†]	7.4 (4.4-12.2) [†]
North-northeast							
Boys	1188 (50.3)	12.2 (11.7-12.7)	101.6 (100.8-102.3)	64.5 (63.8-65.1)	1.1 (0.5-2.2)	4.5 (2.7-7.3)	5.5 (3.5-8.5)
Girls	1170 (49.7)	12.7 (12.1-13.2)	100.3 (99.5-101.0)	62.2 (61.5-62.8)	0.4 (0.1-1.1)	1.1 (0.5-2.4)	1.6 (0.9-2.9)
Urban	1711 (72.5)	12.8 (12.4-13.3)	102.2 (101.5-102.8)	64.4 (63.8-64.9)	0.8 (0.4-1.6)	3.4 (2.1-5.4)	4.2 (2.8-6.3)
Rural	647 (27.4)	11.4 (10.7-12.0)	97.6 (96.6-98.5)	60.6 (59.7-61.4)	0.4 (0.1-1.9)	1.3 (0.4-3.9)	1.8 (0.7-4.3)
Total	2358 (100) (17.6% of study population)	12.4 (12.1-12.8)	100.9 (100.3-101.4)	63.4 (62.9-63.8)	0.7 (0.4-1.3)	2.8 (1.8-4.3) [†]	3.6 (2.4-5.1) [†]
West							
Boys	3050 (50.5)	12.5 (12.2-12.8)	103.5 (103.0-103.9)	66.6 (66.1-67.0)	1.3 (0.9-1.9)	3.3 (2.4-4.5)	4.2 (3.2-5.5)
Girls	2988 (49.5)	12.4 (12.1-12.7)	99.9 (99.4-100.3)	64.5 (64.0-64.9)	0.2 (0.1-0.5)	2.4 (1.5-3.7)	2.7 (1.8-4.0)
Urban	4536 (75.1)	12.9 (12.6-13.1)	103.0 (102.6-103.3)	66.2 (65.8-66.5)	0.9 (0.6-1.3)	3.0 (2.2-3.9)	3.7 (2.9-4.7)
Rural	1502 (24.9)	11.2 (10.7-11.7)	97.9 (97.2-98.5)	63.5 (62.9-64.0)	0.3 (0.1-0.7)	2.5 (1.3-4.8)	2.7 (1.5-5.0)
Total	6038 (100) (45.2% of study population)	12.4 (12.1-12.7)	101.7 (101.3-102)	65.6 (65.3-65.8)	0.8 (0.5-1.1)	2.8 (2.2-3.7) [†]	3.5 (2.8-4.3) [†]
Central							
Boys	2012 (52.7)	12.0 (11.6-12.4)	102.6 (101.9-103.2)	64.6 (64.1-65.0)	1.2 (0.8-2.0)	2.9 (2.1-4.1)	3.5 (2.6-4.8)
Girls	1811 (47.3)	12.8 (12.4-13.3)	100.7 (100.1-101.2)	64.3 (63.8-64.7)	1.2 (0.5-2.4)	1.7 (1.0-2.7)	2.5 (1.6-3.8)
Urban	3223 (84.4)	12.5 (12.2-12.9)	102.2 (101.7-102.6)	64.7 (64.3-65)	1.4 (0.9-2.2)	2.3 (1.7-3.2)	3.1 (2.4-4.1)
Rural	600 (15.6)	11.6 (10.8-12.4)	98.8 (97.7-99.8)	63.5 (62.5-64.4)	0.1 (0.0-1.1)	2.3 (1.0-4.9)	2.5 (1.1-5.1)
Total	3823 (100) (28.6% of study population)	12.4 (12.1-12.7)	101.7 (101.2-102.1)	64.4 (64.0-64.7)	1.2 (0.8-1.18)	2.3 (1.8-3.1) [†]	3.0 (2.4-3.9) [†]
National							
Boys	6789 (50.7)	12.3 (12.1-12.5)	102.7 (102.3-103.0)	65.5 (65.2-65.7)	1.2 (0.9-1.6)	3.6 (2.9-4.4)	4.5 (3.7-5.4)
Girls	6578 (49.3)	12.5 (12.3-12.7)	100.2 (99.8-100.5)	64.1 (63.8-64.3)	0.5 (0.3-0.9)	2.4 (1.8-3.3)	2.9 (2.2-3.8)
Urban	10100 (75.5)	12.8 (12.6-12.9)	102.6 (102.3-102.8)	65.4 (65.1-65.6)	1.0 (0.8-1.4)	3.1 (2.5-3.7)	3.8 (3.2-4.5)
Rural	3267 (24.5)	11.4 (11.1-11.7)	98.1 (97.6-98.5)	63.2 (62.8-63.5)	0.3 (0.1-0.6)	2.9 (1.9-4.5)	3.3 (2.2-4.9)
Total	13367 (100) (100% of study population)	12.4 (12.3-12.5)	101.5 (101.2-101.7)	64.8 (64.6-64.9)	0.9 (0.7-1.1)	3.0 (2.5-3.6)	3.7 (3.2-4.3)

^aMean (95% CI); ^bPrevalence (95% CI); [†]Significant difference ($P = 0.0048$); [‡]Significant difference ($P = 0.0018$). The difference between mean age and sex frequency was not significant between four regions ($P = 0.91$ and 0.68 respectively); The difference between living area frequency was significant between four regions ($P < 0.001$). CI = Confidence interval; CASPIAN = Childhood and adolescence surveillance and prevention of adult noncommunicable disease; SBP = Systolic blood pressure; DBP = Diastolic blood pressure

have intermediate SES and show intermediate prevalence rates of HBP between four regions.

In our study, the central part of the country, which has the highest SES and is the most industrialized and urbanized region, had the lowest rate of HBP. The overall higher level of SES may contribute to a better health status through better education, attitude and practice of residents, and better health facilities.^[17,18] On the other hand, the higher SES, could result in higher levels of BP through unhealthier lifestyle and environmental exposures. In this region, the overall effect has been toward the better health outcome. These can be explained by the interaction of SES, ethnic issues, environmental circumstances, as well as dietary and physical activity habits.^[34,35] They need to be investigated through following region-specific studies.

Study strengths and limitations

It is a large-scale epidemiologic study which covers different age groups, genders, SESs and ethnicities of Iranian pediatric population recruited through random cluster sampling. It provides sufficient information to delineate present situation. However, it is a cross-sectional survey and has its expected limitations such as being unable to reveal causality relationships.

CONCLUSION

The relatively high prevalence rate of HBP in the pediatric population of some areas of Iran deserves more attention. Due to the complex nature of contributing factors, it is necessary to design and conduct complementary research projects specific to every region.

Appendix 1: The mean (95% CI) and prevalence rate of HBP (95% CI) in provincial level by sex and living area: The CASPIAN-IV study

Province	SBP (mmHg)	DBP (mmHg)	High DBP (%)	High SBP (%)	High SBP and/or DBP (%)
Eastern Azerbaijan					
Boys (n=247)	101.5 (97.2, 105.9)	63.2 (59.8, 66.7)	3.4 (1, 11.3)	2.5 (0.9, 7.2)	4.7 (1.7, 12.1)
Girls (n=235)	102.1 (98.2, 106.0)	65.5 (62.6, 68.5)	0.9 (0, 3.4)	0.9 (0.22, 3.4)	1.7 (0.5, 5.5)
Urban (n=393)	102.2 (98.8, 105.6)	64.6 (62.1, 67.0)	2.3 (0.8, 7.2)	1.8 (0.7, 4.7)	3.4 (1.4, 7.9)
Rural (n=89)	99.8 (95.1, 104.4)	63.3 (57.0, 69.6)	1.3 (0.2, 7.7)	1.3 (0.2, 7.7)	2.5 (0.4, 14.8)
Total (n=482)	101.8 (98.8, 104.8)	64.4 (62.1, 66.6)	2.1 (0.8, 6)	1.7 (0.7, 4.1)	3.2 (1.4, 7.1)
Western Azerbaijan					
Boys (n=238)	105.9 (102.5, 109.3)	66.7 (63.2, 70.3)	4.6 (0.8, 6)	2.1 (0.8, 5.4)	6.2 (2.1, 17.3)
Girls (n=238)	98.4 (95.2, 101.5)	64.6 (61.5, 67.6)	5.4 (1.8, 15.6)	0	5.4 (1.8, 15.6)
Urban (n=317)	102.1 (98.8, 105.4)	65.4 (62.1, 68.7)	6 (2, 16.7)	1.3 (0.4, 4)	6.9 (2.6, 16.9)
Rural (n=159)	102.3 (97.6, 107)	66.2 (62.9, 69.5)	3.1 (1, 9)	0.6 (0.1, 4.2)	3.7 (1.2, 11.2)
Total (n=476)	102.2 (99.4, 104.9)	65.7 (63.2, 68.1)	5 (2, 11.9)	1 (0.4, 2.9)	5.9 (2.6, 12.5)
Ardabil					
Boys (n=80)	101.0 (90.9, 111.2)	65(58.8, 71.2)	8.8 (2.4, 27.3)	5 (1.8, 13.2)	10 (3.3, 26.7)
Girls (n=137)	101.0 (96.3, 105.8)	62.3 (57.1, 67.5)	7.9 (3.7, 16.1)	0.7 (0.1, 4.2)	8.6 (4.2, 17)
Urban (n=177)	102.7 (97.3, 108.1)	64.0 (59.4, 68.6)	10.1 (5.3, 18.4)	2.2 (0.7, 6.6)	10.6 (5.7, 18.9)
Rural (n=40)	93.5 (87.2, 99.8)	60 (53.7, 66.3)	0	2.5 (0.4, 13.3)	2.5 (0.4, 13.3)
Total (n=217)	101.0 (96.2, 105.8)	63.3 (59.3, 67.3)	8.2 (4.2, 15.6)	2.3 (0.9, 5.8)	9.1 (4.9, 16.3)
Gilan					
Boys (n=259)	104.9 (101.2, 108.6)	62.9 (59.6, 66.2)	3.1 (0.9, 10.4)	2.7 (1, 7.4)	5.8 (2.213, 14.2)
Girls (n=220)	102.9 (99.8, 106)	61.5 (58.8, 64.2)	1.8 (0.6, 5.6)	0.5 (0.1, 3.1)	2.3 (0.8631, 5.9)
Urban (n=369)	104.2 (101.4, 107.0)	62.4 (59.9, 64.9)	3.2 (1.3, 7.9)	1.6 (0.5, 4.8)	4.9 (2.2, 10.6)
Rural (n=110)	103.3 (98.1, 108.4)	61.7 (57.3, 66.1)	0	1.8 (0.3, 11.3)	1.8 (0.3, 11.3)
Total (n=479)	104.0 (101.5, 106.5)	62.2(60.0, 64.4)	2.5 (1, 6.2)	1.7 (0.6, 4.3)	4.2 (1.9, 8.7)
Mazandaran					
Boys (n=236)	105.0 (100.7, 109.3)	67.2 (64.7, 69.7)	2.9 (1.4, 6.2)	2.5 (1, 6.5)	5 (2.5, 10.1)
Girls (n=232)	102.8 (99.2, 106.5)	64.4 (61.7, 67.1)	1.3 (0.2, 8.8)	0	1.3 (0.2, 8.8)
Urban (n=369)	104.9 (101.8, 108)	66.1 (64.2, 68.0)	1.6 (0.7, 3.9)	1.6 (0.6, 4.3)	3 (1.3, 6.5)
Rural (n=99)	100.3(92.7, 107.9)	64.7 (59, 70.5)	4 (0.6, 22.8)	0	4 (0.6, 22.8)
Total (n=468)	103.9 (101, 106.9)	65.8 (63.9, 67.8)	2.1 (0.8, 5.3)	1.3	3.2 (1.5, 6.8)
Golestan					
Boys (n=269)	96.1 (92, 100.2)	62.0 (58.9, 65.2)	1.5 (0.5, 4.6)	0	1.5 (0.5, 4.6)
Girls (n=210)	96.3 (93, 99.6)	59.5 (56.6, 62.4)	0	0	0
Urban (n=270)	97.0 (93, 101.1)	62.1 (59.3, 64.9)	0.7 (0.2, 2.8)	0	0.7 (0.2, 2.8)
Rural (n=209)	95.1 (91.4, 98.7)	59.4 (55.8, 63.0)	1 (0.1, 6.4)	0	1 (0.1, 6.4)
Total (n=479)	96.2 (93.4, 99)	60.9 (58.7, 63.2)	0.8 (0.3, 2.7)	0	0.8 (0.3, 2.7)
Northern Khorasan					
Boys (n=270)	100.6 (97.7, 103.6)	68.0 (64.5, 71.6)	12.2 (6.1, 22.9)	0	12.2 (6.1, 22.9)
Girls (n=205)	99.3 (95.1, 103.5)	63.3 (59.9, 66.6)	2.4 (0.8, 7.1)	1.5 (0.4, 5.8)	3.9 (1.7, 8.5)
Urban (n=349)	102.2 (99.2, 105.2)	68.4 (65.6, 71.2)	10 (5.1, 18.7)	0.9 (0.2, 3.6)	10.8 (5.8, 19.3)
Rural (n=126)	94.2 (91.3, 97.0)	59.2 (54.7, 63.7)	2.4 (0.6, 8.9)	0	2.4 (0.6, 8.9)
Total (n=475)	100.1 (97.5, 102.6)	66 (63.3, 68.6)	8 (4.2, 14.6)	0.6 (0.1, 2.7)	8.6 (4.7, 15.1)
Khorasan Razavi					
Boys (n=150)	102 (97.6, 106.4)	61.1 (58.2, 64.2)	1.3 (0.9, 2)	0	1.3 (0.9, 2)
Girls (n=300)	100 (97.3, 102.6)	62.4 (59.2, 65.6)	0.7 (0.1, 4.6)	0.3 (0, 2.3)	1 (0.2, 4.2)
Urban (n=350)	101.2 (98.4, 104.0)	62.7(59.9, 65.6)	1.1 (0.4, 3)	0	1.1 (0.4, 3)
Rural (n=100)	98.6 (95.5, 101.6)	59.4 (56.1, 62.7)	0	1 (0.1, 6.5)	1 (0.1, 6.5)
Total (n=450)	100.6 (98.3, 103)	62 (59.7, 64.3)	0.9 (0.3, 2.4)	0.2 (0, 1.6)	1.1 (0.5, 2.7)
Sistanvabaluchestan					
Boys (n=192)	98.3 (94.5, 102.0)	65.3 (60.6, 70.0)	9.9 (4, 22.7)	0	9.9 (4, 22.7)
Girls (n=233)	99.3 (96.0, 102.6)	69.7 (64.0, 75.4)	18.5 (10.4, 30.9)	0	18.5 (10.4, 30.8)
Urban (n=219)	100 (95.9, 104.0)	69 (63.4, 74.5)	13.7 (6.2, 27.7)	0	13.7 (6.2, 27.7)

(continued)

Appendix 1: (Continued)

Province	SBP (mmHg)	DBP (mmHg)	High DBP (%)	High SBP (%)	High SBP and/or DBP (%)
Rural (n=206)	97.7 (94.5, 100.9)	66.4 (60.9, 72)	15.4 (7.1, 30.1)	0	15.4 (7.1, 30.1)
Total (n=425)	98.8 (96.2, 101.4)	67.7 (63.8, 71.6)	14.6 (11.5, 18.3)	0	14.6 (11.5, 18.3)
Hormozgan					
Boys (n=142)	109.3 (101.6, 117)	70.1 (64.4, 75.7)	9.1 (3.6, 21.1)	2.8 (0.9, 8.1)	13.3 (6, 27)
Girls (n=126)	101.6 (96.1, 107.1)	62.7 (59.4, 66.1)	0.8 (0.1, 5.2)	0.8 (0.1, 5.2)	1.6 (0.4, 6)
Urban (n=129)	106.8 (98.3, 115.4)	68.3 (62.0, 74.6)	7.7 (2.2, 23.3)	1.5 (0.4, 5.3)	10 (3.136, 27.6)
Rural (n=139)	104.5 (98.3, 110.8)	65.1 (60.3, 69.8)	2.9 (1.2, 6.6)	2.1 (0.5, 8.3)	4.6 (0.9, 20.3)
Total (n=268)	105.7 (100.4, 110.9)	66.6 (62.7, 70.5)	5.2 (2.1, 12.3)	1.8 (0.7, 4.9)	7.8 (3.5, 16.5)
Bushehr					
Boys (n=249)	107.6 (104.2, 111)	71.1 (68, 74.3)	3.2 (0.9, 10.7)	0.8 (0.2, 2.9)	3.6 (1.2, 10.6)
Girls (n=216)	104.3 (101.4, 107.3)	66.2 (63.6, 68.9)	1.8 (0.6, 5.7)	0.5 (0.1, 3.1)	1.8 (0.6, 5.7)
Urban (n=427)	106.6 (104.1, 109.1)	68.7 (66.3, 71.1)	2.8 (1.1, 6.9)	0.7 (0.2, 2)	36 (1.3, 7)
Rural (n=38)	100.1 (91.2, 109.0)	70.4 (65, 75.8)	0	0	0
Total (n=465)	106.1 (103.6, 108.5)	68.8 (66.6, 71.1)	2.6 (1, 6.3)	0.6 (0.2, 1.9)	2.8 (1.2, 6.4)
Khozestan					
Boys (n=222)	103.8 (99.7, 107.9)	62.6 (58.9, 66.2)	0.4 (0.1, 3.1)	1.8 (0.6, 5.6)	1.8 (0.6, 5.6)
Girls (n=198)	101.1 (97.2, 105)	65.8 (60.9, 70.7)	6.2 (1.2, 27)	0	6.2 (1.2, 27)
Urban (n=351)	103.1 (100.2, 106.1)	63.3 (59.9, 66.78)	0.9 (0.3, 2.4)	1.1 (0.4, 3.7)	1.7 (0.7, 4.1)
Rural (n=69)	100.1 (91.2, 109.0)	67.8 (57.1, 78.5)	14.5 (2, 58.8)	0	14.5 (2, 58.8)
Total (n=420)	102.5 (99.7, 105.3)	64.1 (60.6, 67.5)	3.1 (0.7, 13.5)	1 (0.3, 3.1)	3.9 (1.1, 13)
Ilam					
Boys (n=257)	105.6 (102.4, 108.7)	70.3 (67.5, 73.1)	3.5 (1.5, 7.6)	1.2 (2, 7.7)	4.6 (2.2, 9.6)
Girls (n=220)	101.4 (98.1, 104.8)	67.4 (63.9, 70.9)	5 (1.8, 12.9)	0.9 (0.1, 6.1)	5.9 (2.3, 14.1)
Urban (n=398)	104.0 (101.1, 107)	69.4 (66.6, 72.1)	4.5 (2.2, 8.9)	1.2 (0.3, 5)	5.8 (3.1, 10.6)
Rural (n=79)	101.8 (97.7, 106)	67 (63.1, 70.9)	2.5 (0.4, 14.7)	0	2.5 (0.4, 14.7)
Total (n=477)	103.7 (101.1, 106.2)	69 (66.6, 71.3)	4.2 (2.2, 7.9)	1 (0.3, 4.2)	5.2 (2.9, 9.3)
Kermanshah					
Boys (n=261)	103 (99.9, 106.0)	68.5 (66.1, 71)	2.7 (0.9, 7.3)	0.8 (0.2, 2.9)	3.8 (1.8, 7.9)
Girls (n=219)	101.3 (97.7, 105)	67 (64.6, 69.3)	0.9 (0.2, 3.4)	0.5 (0.1, 3.1)	1.4 (0.5, 3.9)
Urban (n=390)	103.3 (100.8, 105.9)	68.8 (66.9, 70.8)	2.1 (0.8, 5.2)	0.5 (0.1, 2)	2.8 (1.4, 5.7)
Rural (n=90)	97.4 (92.6, 102.1)	63.4 (60.9, 65.9)	1.1 (0.2, 6.9)	1.1 (0.2, 6.9)	2.2 (0.6, 7.4)
Total (n=480)	102.2 (99.9, 104.6)	67.8 (66.1, 69.6)	1.9 (0.7875, 4.398)	0.6 (0.2, 1.9)	2.7 (1.4, 5.1)
Kordestan					
Boys (n=262)	104.1 (100.6, 107.6)	66.7 (64.5, 68.9)	2.6 (0.934, 7.1)	2.5 (0.9, 5.8)	4.9 (2.3, 9.8)
Girls (n=209)	100.8 (98.4, 103.2)	64.29 (61.8, 66.6)	0.5 (0.1, 3.2)	0	0.5 (0.1, 3.2)
Urban (n=323)	105.2 (102.7, 107.8)	68.1 (66.4, 69.8)	2.1 (0.7, 5.9)	1.8 (0.7, 4.8)	3.9 (1.9, 8.2)
Rural (n=148)	96.9 (92.7, 101.2)	60.0 (57.0, 63.1)	0.7 (0.1, 4.4)	0	0.7 (0.1, 4.4)
Total (n=471)	102.6 (100.2, 105.1)	65.6 (63.7, 67.4)	1.7 (0.7, 4.3)	1.3 (0.5, 3.4)	2.9 (1.4, 5.9)
Hamedan					
Boys (n=239)	102.6 (98.9, 106.3)	67.4 (64.4, 70.5)	6.7 (3.3, 13.1)	1.7 (0.7, 4.1)	8 (4.4, 14.1)
Girls (n=230)	98.2 (95.1, 101.4)	66.1 (62.9, 69.3)	3.5 (1, 11.5)	0	3.5 (1, 11.5)
Urban (n=338)	103.9 (101.5, 106.4)	69.1 (66.9, 71.4)	5.3 (2.7, 10.1)	1.2 (0.5, 3)	6.2 (3.5, 11)
Rural (n=131)	91.5 (85.8, 97.2)	60.7 (55.5, 65.8)	4.5 (0.9, 20.3)	0	4.6 (0.9, 20.3)
Total (n=469)	100.5 (97.6, 103.4)	66.8 (64.3, 69.2)	5.1 (2.7, 9.5)	0.9 (0.3, 2.2)	5.8 (3.2, 10)
Zanjan					
Boys (n=192)	102.3 (97.3, 107.3)	64 (60.3, 67.7)	2.8 (1.1, 7)	0.5 (1, 3.6)	2.8 (1.1, 7)
Girls (n=251)	97.7 (95.1, 100.2)	62.1 (60.1, 64.2)	0.8 (0.2, 3)	0.4 (1, 2.7)	1.2 (0.4, 3.4)
Urban (n=279)	101.0 (97.4, 104.6)	62.5 (60.1, 64.8)	1.9 (0.7, 4.9)	0.7 (0.2, 2.8)	2.2 (1, 5.17)
Rural (n=164)	97.4 (92.5, 102.2)	63.6 (59.5, 67.7)	1.2 (0.3, 4.4)	0	1.2 (0.3, 4.4)
Total (n=443)	99.6 (96.7, 102.6)	62.9 (60.8, 65.1)	1.6 (0.7, 3.5)	0.5 (0.1, 1.8)	1.8 (0.9, 3.8)
Markazi					
Boys (n=277)	102.7 (98.5, 106.9)	68.6 (65.9, 71.3)	2.9 (1.3, 6.1)	1.8 (0.6, 5.4)	3.9 (2, 7.7)
Girls (n=199)	101.4 (97.9, 104.8)	66.1 (63.3, 68.9)	2 (0.6, 6)	0.5 (0.1, 3.4)	2 (0.7, 6)

(continued)

Appendix 1: (Continued)

Province	SBP (mmHg)	DBP (mmHg)	High DBP (%)	High SBP (%)	High SBP and/or DBP (%)
Urban (n=367)	103.2 (99.9, 106.5)	68.7 (66.3, 71.0)	3 (1.5, 5.7)	1.6 (0.6, 4.3)	3.8 (2, 6.9)
Rural (n=109)	98.5 (92.3, 104.8)	63.9 (60.2,67.6)	0.9 (0.1,5.9)	0	0.9 (0.1, 5.9)
Total (n=476)	102.1 (99.2, 105.1)	67.6 (65.5, 69.6)	2.5 (1.3, 4.7)	1.3 (0.5, 3.4)	3.1 (1.7, 5.6)
Qazvin					
Boys (n=241)	101.7 (96.8, 106.6)	65.2 (61.6, 68.7)	3.8(1.9, 7.5)	1.7 (0, 1.5)	5 (2.7, 9.3)
Girls (n=238)	97.1 (93.9, 100.2)	62.4 (60.1, 64.7)	2.5(0.8, 8.1)	0	2.5 (0.8, 8.1)
Urban (n=359)	99.7 (95.9, 103.6)	63.2 (63.2, 65.9)	2.5 (1.2, 5.1)	1.1 (0.3, 3.5)	3.4 (1.7, 6.4)
Rural (n=120)	98.3 (95.6, 101.1)	65.6 (62.6, 68.7)	5 (1.3, 18.2)	0	5 (1.3, 18.2)
Total (n=479)	99.4 (96.4, 96.4)	63.8 (61.7, 66)	3.1 (1.6, 6.3)	0.8 (0.3, 2.7)	3.8 (2, 7)
Qom					
Boys (n=235)	109.0 (105.5, 112.5)	69.8 (67.3, 72.3)	10.5 (6.2, 17.1)	2.5 (1.1, 5.7)	11.3 (6.8, 18.1)
Girls (n=239)	99.6 (97.3, 102.0)	62.8 (60.4, 65.3)	0.4 (0.1, 2.9)	1.3 (0.4, 3.6)	1.7 (0.5, 5.2)
Urban (n=454)	104.4 (101.9, 106.9)	66.3 (64.3, 68.4)	5.5 (3.1, 9.5)	1.8 (0.8, 3.6)	6.3 (3.8, 10.4)
Rural (n=20)	101.7 (89.6, 113.9)	66.2 (59.0, 73.5)	5 (1.2, 18.7)	5 (1.2, 18.7)	10 (2.3, 34.5)
Total (n=474)	104.3 (101.9, 106.8)	66.3 (64.3, 68.3)	5.4 (3.1, 9.3)	1.9 (1, 3.7)	6.5 (4, 10.5)
Tehran					
Boys (n=238)	101.9 (98.3, 105.4)	62.7 (59.4, 66)	1.3 (0.3, 5.2)	0.8 (0.1, 5.6)	1.7 (0.4, 7.4)
Girls (n=229)	100.6 (97.2, 104)	66.1 (63.4, 68.8)	1.3 (0.5, 3.8)	0.9 (0.3, 3.3)	2.2 (1, 4.7)
Urban (n=447)	101.1 (98.5, 103.7)	64.3 (62, 66.7)	1.3 (0.5, 3.3)	0.9 (0.3, 2.9)	2 (0.9, 4.5)
Rural (n=20)	104.5 (96.9, 112.1)	65 (59.4, 70.5)	0	0	0
Total (n=467)	101.2 (98.7, 103.8)	64.4 (62.1, 66.6)	1.3 (0.5, 3.1)	0.9 (0.3, 2.8)	1.9 (0.9, 4.3)
Semnan					
Boys (n=236)	102.7 (98.5, 106.9)	62.7 (59.4, 66.1)	0.9 (0.1, 5.6)	1.3 (0.3, 5.1)	1.2 (0.3, 5.1)
Girls (n=239)	102.4 (98.8, 106.0)	65.3 (63, 67.6)	0.4 (0.1, 2.9)	1.3 (0.2, 8.3)	1.7 (0.4, 7.4)
Urban (n=406)	103.4 (100.4, 106.4)	64 (61.6, 66.3)	0.7 (0.2, 3.1)	1.5 (0.5, 4.8)	1.7 (0.6, 4.9)
Rural (n=69)	97.6 (91.1, 91.2)	64.2 (60.1, 68.3)	0	0	0
Total (n=475)	102.6 (99.8, 105.3)	64.0 (61.9, 66.1)	0.6 (0.2, 2.6)	1.3 (0.4, 4.1)	1.5 (0.5, 4.2)
Isfahan					
Boys (n=261)	103.4 (99.0, 107.8)	64.9 (62.4, 67.4)	3 (1.3, 7)	1.9 (0.6, 5.8)	3.8 (1.7, 8.3)
Girls (n=217)	104.1 (100.6, 107.6)	66 (63.4, 68.6)	5 (1.9, 13)	5.5 (1.8, 15.4)	7.8 (3.4, 17.1)
Urban (n=390)	104.0 (100.6,107.5)	65.5 (63.3, 67.6)	3.6 (1.5, 8.2)	4.3 (1.9, 9.8)	5.6 (2.8, 11.2)
Rural (n=88)	102.5 (99, 106)	64.9 (61.8, 67.9)	5.5 (2, 1.2)	0	5.5 (2, 1.2)
Total (n=478)	103.7 (100.9, 106.6)	65.4 (63.5, 67.2)	4 (2, 7.6)	3.5 (1.5, 8.1)	5.6 (3, 10.1)
Yazd					
Boys (n=277)	97.4 (93.5, 101.4)	59.1 (56.4, 61.8)	0.4 (0.1, 2.5)	0.4 (0, 2.5)	0.4 (1, 2.5)
Girls (n=199)	98.5 (95.4, 101.7)	60.2 (58.2, 62.3)	0	0	0
Urban (n=416)	99.2 (96.7, 101.8)	60.3 (58.6, 62)	0.2 (0, 1.7)	0.2 (0, 1.7)	0.2 (0, 1.7)
Rural (n=60)	88.8 (80.7, 97.0)	54.7 (47.9, 61.4)	0	0	0
Total (n=476)	97.9 (95.3, 100.6)	59.6 (57.8, 61.4)	0.2 (0, 1.5)	0.2 (0.0293, 1.5)	0.2 (0, 1.5)
Kerman					
Boys (n=199)	100.1 (96.2, 103.9)	62.0 (58.9, 65.2)	0	0.5 (0.1, 3.3)	0.5 (0.1, 3.3)
Girls (n=252)	98.4 (95.2, 101.6)	63 (60.8, 65.2)	1.2 (0.2806, 4.795)	0.8 (0.2, 3)	1.2 (0.3, 4.8)
Urban (n=285)	102.3 (99.5, 105.0)	64 (61.5, 66.5)	1 (0.3, 4.3)	1 (0.3, 3.1)	1.4 (0.4, 4.4)
Rural (n=166)	93.8 (90, 97.7)	60.2 (57.6, 62.7)	0	0	0
Total (n=451)	99.1 (96.6, 101.7)	62.6 (60.7, 64.5)	0.6 (0.2, 2.8)	0.7 (0.2, 2)	0.9 (0.3, 2.8)
Fars					
Boys (n=202)	100.8 (97.1, 104.6)	64.7 (61.5, 67.9)	1 (0.3, 3.6)	0.5 (1, 3.3)	1.5 (0.5, 4.1)
Girls (n=273)	100.7 (98.4, 103.3)	65.5 (63.5, 67.5)	0.4 (0.1, 2.5)	0	0.4 (0.1, 2.5)
Urban (n=347)	100.9 (98.1, 103.6)	64.9 (62.9, 66.8)	0.9 (0.3, 2.6)	0.3 (0, 2)	1.1 (0.5, 2.9)
Rural (n=128)	100.8 (98, 103.6)	65.9 (61.9, 69.9)	0	0	0
Total (n=475)	100.8 (98.7, 103)	65.2 (63.4, 66.9)	0.6 (0.267, 1.9)	0.2 (0, 1.5)	0.9 (0.3, 2.1)
Kohgilouyeh					
Boys (n=201)	101.6 (97.7, 105.5)	66.5 (62.9, 70.1)	3 (1.3, 6.8)	0.5 (0.1, 3.4)	3 (1.3, 6.8)

(continued)

Appendix 1: (Continued)

Province	SBP (mmHg)	DBP (mmHg)	High DBP (%)	High SBP (%)	High SBP and/or DBP (%)
Girls (n=247)	97.9 (95.5, 100.2)	62.5 (60.2, 64.9)	1.2 (0.3, 4.9)	0	1.2 (0.3, 4.9)
Urban (n=289)	100.2 (97.3, 103.2)	64.8 (62.0, 67.6)	2.7 (1.3, 6)	0.3 (0.1, 2.4)	2.8 (1.3, 6)
Rural (n=159)	98.3 (94.8, 101.8)	63.4 (60, 66.9)	0.6 (0.1, 4.2)	0	0.6 (1, 4.2)
Total (n=448)	99.5 (97.3, 101.8)	64.3 (62.1, 66.5)	2 (1, 4.2)	0.2 (.,1.6)	2 (1, 4.2)
Lorestan					
Boys (n=128)	95.8 (93.0, 98.7)	62.0 (58.5, 65.6)	1.6 (0.4, 5.6)	0.8 (0.1, 5.2)	2.3 (0.9, 6.3)
Girls (n=99)	94.0 (88.5, 99.5)	62.4 (56.3, 68.6)	2 (0.6, 6.4)	0	2 (0.6, 6.4)
Urban (n=168)	96.3 (92.9, 99.7)	63.1 (59.6, 66.6)	0.6 (0.1, 3.7)	0.6 (1, 4.1)	1.2 (0.3, 4.2)
Rural (n=59)	91.5 (86.4, 96.5)	59.7 (51.8, 67.5)	5 (1.9, 12.5)	0	5 (1.9, 12.5)
Total (n=227)	95.0 (92.0, 98.0)	62.2 (58.8, 65.6)	1.8 (0.6, 5)	0.4 (1, 3.1)	2.2 (0.9, 5.3)
Chaharmahal and Bakhtiari					
Boys (n=268)	106.7 (103.6, 109.8)	68.8 (65.2, 72.5)	4.4 (1.7, 11.4)	0.4 (0.1, 2.6)	4.4 (1.7, 11.4)
Girls (n=207)	98.6 (95.1, 102.1)	59.7 (56, 63.4)	,5 (0.1, 3.2)	0	1 (0.3, 3.5)
Urban (n=331)	105.6 (102.9, 108.3)	66.1 (62.5, 69.6)	2.1 (0.6, 7.1)	0	2.4 (0.8, 7.1)
Rural (n=144)	97.5 (92.4, 102.7)	62.1 (56.6, 67.5)	4.1 (1, 15.3)	0.7 (1, 4.5)	4.1 (1, 15.3)
Total (n=475)	103.1 (100.5, 105.8)	64.8 (61.8, 67.8)	2.7 (1.1, 6.8)	0.2 (0, 1.5)	2.9 (1.2, 6.9)
Alborz					
Boys (n=231)	102.8 (100.0, 105.5)	64.2 (61.7, 66.6)	1.7 (0.7, 4.3)	0	1.7 (0.7, 4.3)
Girls (n=247)	102.4 (99.9, 104.9)	65.4 (63.4, 67.3)	2 (0.9, 4.4)	0.4 (1, 2.8)	2.4 (1.2, 4.8)
Urban (n=369)	102.9 (100.6, 105.2)	65.7 (63.9, 67.5)	2.1 (1.2, 4)	0.3 (0, 1.9)	2.4 (1.4, 4.3)
Rural (n=108)	101.4 (98.6, 104.3)	61.6 (58.9, 64.3)	0.9 (0.1, 5.8)	0	0.9 (0.1, 5.8)
Total (n=477)	102.6 (100.7, 104.4)	64.8 (63.2, 66.4)	1.9 (1, 3.4)	0.2 (0, 1.5)	2.1 (1.2, 3.6)

CI = Confidence interval; CASPIAN = Childhood and Adolescence Surveillance and Prevention of Adult Noncommunicable Disease; SBP = Systolic blood pressure; DBP = Diastolic blood pressure; HBP = High blood pressure

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Conflicts of interest

There are no conflicts of interest.

AUTHOR'S CONTRIBUTION

ZF: Contributions to concept/design, data interpretation, drafting of the manuscript, critical revision of the manuscript and approval of the article. RK: Contributions to concept/design, acquisition of data, data interpretation, drafting of the manuscript, critical revision of the manuscript and approval of the article. MEM, GA, RH: Contributions to concept/design, critical revision of the manuscript and approval of the article. AK, HA: Contributions to concept/design, data analysis/interpretation, critical revision of the

manuscript and approval of the article. MQ: Contributions to concept/design, data analysis/interpretation, drafting of the manuscript, critical revision of the manuscript and approval of the article.

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