

Weight disorders and anthropometric indices according to socioeconomic status of living place in Iranian children and adolescents: The CASPIAN-IV study

Maryam Bahreynian, Roya Kelishadi, Mostafa Qorbani¹, Mohammad Esmaeil Motlagh², Amir Kasaeian^{3,4}, Gelayol Ardalan⁵, Tahereh Arefi Rad⁶, Fereshteh Najafi³, Hamid Asayesh⁷, Ramin Heshmat⁸

Department of Pediatrics, Child Growth and Development Research Center, Research Institute for Primordial Prevention of Non-communicable Disease, Isfahan University of Medical Sciences, Isfahan, ¹Department of Community Medicine, School of Medicine, Alborz University of Medical Sciences, Karaj, ²Department of Pediatrics, Ahvaz University of Medical Sciences, Ahvaz, ³Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, ⁴Non-communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran, ⁵Department of School Health, Bureau of Population, Family and School Health, Ministry of Health and Medical Education, ⁶Department of Exercise Physiology, Science and Research Branch, Islamic Azad University, Tehran, ⁷Department of Medical Emergency, Qom University of Medical Sciences, Qom, ⁸Chronic Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran

Background: Excess weight in children and adolescents is a multi-factorial phenomenon and associated with earlier risk of obesity-related diseases. This study aims to assess the prevalence of weight disorders and the mean values of anthropometric indices according to regional, socioeconomic, and urban-rural variations among Iranian children and adolescents. **Materials and Methods:** This nationwide study was performed in 2011-2012 among a representative multi-stage cluster sample of 14,880 Iranian students aged 6-8 years. The World Health Organization (WHO) reference curves were used to define weight disorders. Abdominal obesity was defined as the waist-to-height ratio (WHtR) of more than 0.5. Iran was classified into four regions according to the socioeconomic status (SES). **Results:** The mean (95% confidence interval) of body mass index (BMI), waist circumference (WC), and hip circumference (HC) was 18.8 (18.7, 18.9) kg/m², 67.0 (66.7, 67.3) cm, and 80.8 (80.3, 81.2) cm, respectively. The prevalence of underweight was 12.2%. A total of 9.7%, 11.9%, and 19.1% of students overweight, obese, and abdominally obese, respectively. The highest mean of BMI, WC, wrist circumference, HC, and WHtR were related to the second high SES (North-northeast) area (19.2 [18.8, 19.5], 68.3 [67.3, 69.4], 14.8 [14.7, 15.0], 82.6 [81.1, 84.0], and 0.464 [0.460, 0.468]). In contrast, the lowest SES (Southeast) region had the lowest mean of these anthropometric indices (17.6 [17.1, 18.2], 63.2 [61.7, 64.8], 14.5 [14.2, 14.8], 76.9 [74.9, 79.0], and 0.439 [0.434, 0.444]). **Conclusion:** We found considerable differences in the prevalence of anthropometric measures throughout the country by SES of the region. Health policy making and implementing health strategies should consider SES of regions.

Key words: Anthropometric measures, obesity, socioeconomic status, underweight

How to cite this article: Bahreynian M, Kelishadi R, Qorbani M, Motlagh ME, Kasaeian A, Ardalan G, *et al.* Weight disorders and anthropometric indices according to socioeconomic status of living place in Iranian children and adolescents: The CASPIAN IV study. *J Res Med Sci* 2015;20:440-53.

INTRODUCTION

Different patterns of weight disorders including underweight and excess weight are accompanied with increased risk of adverse health consequences in later life. Long-term impacts of such disorders have been emerged even after 55 years of follow-up in longitudinal studies.^[1,2] The prevalence of childhood overweight and obesity has increased rapidly both in developed and developing countries; facing these populations with double burden of nutritional disorders.^[3-6] Childhood obesity has been recognized as a major public health crisis, due to the severe complications and the costly economic burden.^[4,7,8]

Thus, it highlights the necessity of implementing more effective monitoring programs for screening and prevention of such disorders.

The prevalence of childhood overweight and obesity is reported from 12% to more than 30% in developed countries, and from 2% to 12% in developing nations.^[7] The high prevalence of obesity in Middle Eastern countries is of special concern. Iran as a developing country experiencing epidemiological and nutrition transition has a double burden of nutritional disorders and is now part of the world obesity epidemic.^[9-13] A recent systematic review and meta-analysis revealed the increasing trend of overweight among Iranian young children with emphasize on providing the

Address for correspondence: Dr. Ramin Heshmat, Assistant Professor of Epidemiology, EMRC, Dr Shariati Hospital, North Karegar St, Tehran 14114, Iran. E-mail: rhesmat@tums.ac.ir

Received: 24-11-2014; **Revised:** 07-04-2015; **Accepted:** 26-05-2015

interventional preventive programs at national and regional levels.^[14] Previous nationwide studies have documented a double burden of nutritional disorders in Iranian pediatric population, e.g., overweight (8.8%), obesity (4.5%), and underweight (13.9%) have been observed in the same population.^[15]

Weight disorders are multi-factorial; socioeconomic status (SES) and geographic residence are of important determinants of such disorders.^[16-19] Although, regional and Urban-rural disparities might contribute to the unevenly distributed prevalence of overweight and obesity, the role of SES and the residence area (urban vs. rural) have been relatively little addressed.

The aim of this study was to estimate the underweight, overweight, and obesity prevalence of Iranian children and adolescents, and to report the mean level of anthropometric indices based on SES, and living area at national and provincial levels.

MATERIALS AND METHODS

Study population and sampling framework

A detailed methodology of the study is reported elsewhere,^[20] and herein we describe it in brief. This survey was conducted among 14,880 students, aged 6-18 years, and one of their parents living in urban and rural areas of 30 provinces in Iran. They were selected by multistage, cluster sampling method (48 clusters of 10 students in each province). In order to reach the favorite sample size, in each province; cluster sampling with same size clusters was applied. Stratification was performed in each province based on the residence area (urban/rural) and school grade (elementary/intermediate/high school). The sampling was proportional to size with equal sex ratio.

Iran was divided into four sub-national regions according to a previous study.^[21] In order to determine sub-national regions; combination of two criteria (geography and SES using principal component analysis) was used. Some variables from the 2006 census, including literacy, family permanent income (family assets), and employment rate were used to calculate SES index. In this classification, the lowest SES was related to Southeast and the highest SES was related to central regions. North-northeast and west regions are in the middle, respectively.

Anthropometric measurements

Trained personnel according to standardized techniques measured height, weight, and waist circumference (WC) by using calibrated equipment. Weight was recorded to the nearest 0.1 kg in light clothing. Height was measured without shoes to the nearest 0.1 cm. For assessment of overweight and obesity, body mass index (BMI) was

calculated as weight (kg) divided by height squared (m^2). WC was measured to the nearest 0.1 cm with a nonelastic tape applied at a point midway between the lower border of the rib cage and the iliac crest at the end of normal expiration. Hip circumference (HC) was measured at the level of the greater trochanter to the nearest 0.1 cm. Wrist circumference was recorded on the dominant hand by a tape measure (to the nearest 0.1 cm). Students were asked to put their hands on a flat surface. The tape meter was not very tight or very loose. Waist-to-height ratio (WHtR) was obtained as WC (cm) divided by height (cm).

Definition of terms

The World Health Organization (WHO) growth curve was used to categorize BMI.^[22] BMI was classified into underweight (BMI <5th percentile), normal weight (BMI between 5th and 85th percentiles), overweight (BMI between 85th and 95th percentiles), and obese (BMI ≥85th-95th percentiles). Abdominal obesity was defined WHtR >0.5.^[23]

Statistical analysis

Mean of continuous variables are expressed with 95% confidence interval (CI). Prevalence of overweight, obesity, and abdominal obesity are presented with 95% CI across region and provinces. Mean and prevalence of anthropometric measure were compared across sex, region, living place, and province. Data were analyzed using survey data analysis methods in the STATA Corp. 2011 (Stata Statistical Software: Release 12, Stata Corp LP. Package, College Station, TX, USA). Figures were plotted R software (version 2.13.00; R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

This national survey was conducted among 13,486 school students (6640 girls and 6846 boys) out of 14,880 invited subjects (response rate 90.6%) with a mean age of 12.47 (12.29, 12.64) years. A number of 10,191 of participants were from urban areas and 3295 from rural areas.

Overall, the mean (95%CI) height and weight of participants were 147.0 (146.5, 147.4) cm and 42.4 (42.0, 42.8) kg; respectively. The mean BMI, WC, and HC were 18.8 (18.7, 18.9) kg/m^2 , 67.0 (66.7, 67.3) cm, and 80.8 (80.3, 81.2) cm; respectively. The mean of WHtR and WC were 0.456 (0.454, 0.458) and 14.8 (14.7, 14.8) cm; respectively. The prevalence of underweight was 12.2% (11.5, 12.9). A total of 9.7% (9.1, 10.2) were overweight, and 11.9% (11.2, 12.6) were obese. Abdominal obesity was documented in 19.1% (18.2, 20.0) of students.

The mean values of anthropometric indices at national and regional level by sex and living place are shown in Table 1. In all regions, mean values of BMI, WC, HC, and WHtR

Table 1: The mean (95% CI) of anthropometric indices at national and regional level by sex and living place: The CASPIAN-IV study

Region	Height (cm)	Weight (kg)	BMI (kg/m ²)	WC (cm)	HC (cm)	WHtR	Wrist (cm)
Lowest SES (Southeast)							
Boy	146.8 (142.3-151.3)	39.8 (36.05-43.5)	17.6 (16.9-18.4)	63.9 (61.8-66)	76.7 (73.8-79.6)	0.436 (0.429-0.443)	14.7 (14.3-15.2)
Girl	141.9 (138.4-145.5)	37.2 (34.2-40.2)	17.6 (17-18.3)	62.6 (60.7-64.5)	77 (74.4-79.8)	0.441 (0.435-0.448)	14.3 (14-14.6)
Urban	148.8 (144.9-152.6)	42.4 (39.2-45.6)	18.5 (17.8-19.1)	66.1 (64.1-68.2)	80.9 (78.2-83.5)	0.445 (0.438-0.452)	14.8 (14.5-15.2)
Rural	138.6 (134.3-142.9)	33.4 (30.0-36.8)	16.6 (15.9-17.3)	59.7 (57.9-61.4)	72.0 (69.3-74.7)	0.431 (0.425-0.438)	14.1 (13.7-14.5)
Total	144.2 (141.2-147.2)	38.4 (35.9-40.9)	17.6 (17.1-18.2)	63.2 (61.7-64.8)	76.9 (74.9-79)	0.439 (0.434-0.444)	14.5 (14.2-14.8)
Second low SES (North-Northeast)							
Boy	147.8 (144.8-150.8)	43.3 (40.7-45.9)	19 (18.5-19.4)	68.9 (67.4-70.5)	81.2 (79.4-83)	0.467 (0.461-0.473)	15.0 (14.7-15.3)
Girl	146.6 (144.2-149.1)	43.2 (41-45.4)	19.4 (18.9-19.8)	67.7 (66.3-69)	84 (81.7-86.2)	0.461 (0.45-0.466)	14.6 (14.4-14.9)
Urban	149.6 (147.3-151.9)	45.7 (43.7-47.8)	19.7 (19.3-20.0)	70.0 (68.8-71.2)	84.4 (82.8-85.9)	0.468 (0.464-0.473)	15.0 (14.8-15.2)
Rural	141.0 (137.7-144.4)	36.6 (33.8-39.4)	17.8 (17.2-18.3)	63.8 (62.1-65.6)	77.9 (74.6-81.2)	0.453 (0.445-0.461)	14.4 (14.1-14.6)
Total	147.2 (145.3-149.1)	43.2 (41.5-44.9)	19.2 (18.8-19.5)	68.3 (67.3-69.4)	82.6 (81.1-84.0)	0.464 (0.460-0.468)	14.8 (14.7-15.0)
Second high SES (West)							
Boy	148 (147.1-150.8)	43.7 (42.1-45.2)	18.8 (18.5-19)	67.7 (66.7-68.7)	80.3 (79-81.5)	0.455 (0.451-0.459)	15.0 (14.9-15.2)
Girl	144.7 (143.2-146.1)	40.6 (39.4-41.8)	18.8 (18.5-19.1)	65.7 (65-66.5)	80.2 (79-81.4)	0.455 (0.451-0.459)	14.4 (14.3-14.6)
Urban	149.5 (148.1-150.9)	44.6 (43.5-45.7)	19.3 (19.0-19.5)	68.1 (67.4-68.8)	82.3 (81.4-83.3)	0.456 (0.453-0.459)	15 (14.8-15.1)
Rural	138.8 (136.5-141.2)	34.7 (33.0-36.5)	17.5 (17.0-17.9)	62.6 (61.4-63.8)	74.0 (72.4-75.7)	0.452 (0.446-0.458)	14.1 (13.9-14.3)
Total	146.8 (145.7-148.0)	42.2 (41.2-43.1)	18.8 (18.6-19.0)	66.7 (66.1-67.3)	80.3 (80.63-82.7)	0.455 (0.452-0.458)	14.8 (14.6-14.9)
Highest SES (Central)							
Boy	147.5 (145.2-149.8)	42.8 (40.8-44.9)	18.8 (18.4-19.1)	68.4 (67.1-69.7)	80 (78.4-81.4)	0.464 (0.459-0.468)	15 (14.7-15.1)
Girl	148.3 (146.4-150.3)	44.1 (42.4-45.9)	19.4 (19-19.8)	67.2 (66.2-68.3)	83.6 (82.1-85)	0.454 (0.449-0.458)	14.6 (14.4-14.8)
Urban	148.9 (147.2-150.5)	44.5 (43.0-45.9)	19.3 (19-19.5)	68.6 (67.7-69.5)	82.6 (81.4-83.7)	0.460 (0.457-0.464)	14.9 (14.7-15.0)
Rural	142.6 (138.6-146.6)	38.1 (34.9-41.3)	17.9 (17.3-18.6)	64.1 (62.3-65.9)	76.8 (74.3-79.3)	0.451 (0.444-0.457)	14.4 (14.0-14.7)
Total	147.9 (146.4-149.3)	43.5 (42.2-44.8)	19.0 (18.8-19.3)	67.9 (67.0-68.7)	81.7 (80.6-82.7)	0.459 (0.456-0.462)	14.8 (14.7-14.9)
National							
Boy	148.2 (147.1-149.2)	43.0 (42.2-43.9)	18.7 (18.6-18.9)	67.8 (62.2-68.4)	80.0 (79.3-80.8)	0.458 (0.455-0.461)	15.0 (14.9-15.1)
Girl	145.8 (144.9-146.6)	41.7 (41-42.4)	19 (18.8-19.1)	66.2 (65.7-66.7)	81.5 (80.8-82.2)	0.454 (0.452-0.457)	14.5 (14.4-14.6)
Urban	149.3 (148.9-149.9)	44.6 (44.1-45.2)	19.3 (19.2-19.4)	68.4 (68.0-68.8)	82.6 (82.1-83.1)	0.459 (0.457-0.461)	14.9 (14.87-15.0)
Rural	139.9 (138.4-141.5)	35.5 (34.3-36.7)	17.5 (17.2-17.8)	62.6 (61.9-63.4)	75.0 (73.8-76.1)	0.449 (0.445-0.45)	14.2 (14.1-14.3)
Total	147 (146.5-147.4)	42.4 (42.0-42.8)	18.8 (18.7-18.9)	67.0 (66.7-67.3)	80.8 (80.3-81.2)	0.456 (0.454-0.458)	14.8 (14.7-14.8)

BMI = Body mass index; WC = Waist circumference; HC = Hip circumference; WHtR = Waist to height ratio; SES = Socioeconomic status; CI = Confidence interval; CASPIAN-IV = Childhood and adolescence surveillance and prevention of adult noncommunicable disease-IV

were higher in urban than in rural residents, whereas, the highest mean of height and weight were in the highest SES (Central) region (147.9 [146.4, 149.3] and 43.5 [42.2, 44.8]; respectively) and second-high SES (North-Northeast) region (147.2 [145.3, 149.1] and 43.2 [41.5, 44.9] kg). In contrast, the lowest mean for these indices were related to lowest SES (Southeast) region (144.2 [141.2, 147.2] cm and 38.4 [35.9, 40.9], respectively). The highest mean of BMI, WC, wrist circumference, HC, and WHtR were related to second-high SES (North-Northeast) area (19.2 [18.8, 19.5], 68.3 [67.3, 69.4], 14.8 [14.7, 15.0], 82.6 [81.1, 84.0], and 0.464 [0.460, 0.468]). In contrast, the lowest SES (Southeast) region had the lowest mean of these anthropometric indices (17.6 [17.1, 18.2], 63.2 [61.7, 64.8], 14.5 [14.2, 14.8], 76.9 [74.9, 79.0], and 0.439 [0.434, 0.444]).

Figure 1 and Appendix 1 show the mean \pm standard error (SE) of anthropometric indices at the provincial level in Iranian children and adolescents.

Table 2 shows the prevalence of weight disorders status at national and regional level by sex and living place. In all regions, the prevalence of underweight was higher in rural than in urban area, whereas, the prevalence of overweight, obesity, and abdominal obesity was higher in urban than in rural residents. The highest prevalence of overweight, obesity, and abdominal obesity were in second high SES (North-Northeast) (10.7% [9.5,12.1], 13.9% [12.4, 15.6], 23% [20.6, 25.6]) followed by the highest SES (Central) region (10.6% [9.5, 11.6], 13% [11.8, 14.3], 21% [19.4, 22.8]), and the lowest prevalence was in the lowest SES (Southeast) region (5.9% [4.5, 7.6], 6.3% [4.7, 8.4], 9.5% [7.6,12.0]). In contrast, the lowest SES (Southeast) region had the highest prevalence of underweight (21.9% [19.0, 25.0]), and second high SES (North-Northeast) area had the lowest prevalence (10.4% [8.5, 12.7]). Figure 2 and Appendix 2 show the prevalence of weight disorders and abdominal obesity at the provincial level in Iranian children and adolescents.

Table 2: The prevalence (95% CI) of weight disorders and abdominal obesity at national and regional level by sex and living place: The CASPIAN-IV study

Region	Underweight	Overweight	Obesity	Abdominal obesity
Lowest SES (Southeast)				
Boy (n=533)	27.2 (22.8, 32.1)	6.2 (4.3, 8.9)	7.3 (4.9, 10.8)	9.5 (7.0, 12.8)
Girl (n=611)	17.2 (14.1, 20.9)	5.6 (3.9, 7.9)	5.4 (3.6, 8.1)	9.6 (6.9, 13.2)
Urban (n=633)	19.8 (16.3, 23.7)	7.4 (5.5, 9.9)	8.5 (6.4, 11.4)	12.7 (9.8, 16.4)
Rural (n=511)	24.5 (20, 29.6)	3.9 (2.2, 6.8)	3.5 (1.7, 7.3)	5.6 (3.8, 8.3)
Total (n=1144)	21.9 (19, 25)	5.9 (4.5, 7.6)	6.3 (4.704, 8.4)	9.5 (7.6, 12)
Second low SES (North-Northeast)				
Boy (n=1184)	10.4 (8.5, 12.7)	10.73 (9, 12.8)	15.2 (13.1, 17.6)	24 (20.5, 28)
Girl (n=1167)	9.9 (8, 12.3)	10.71 (9.1, 12.6)	12.6 (10.5, 15)	22 (18.9, 25.4)
Urban (n=1707)	9.3 (7.8, 11.1)	11.7 (10.3, 13.3)	15.3 (13.5, 17.3)	26.2 (23.4, 29.3)
Rural (n=644)	12.4 (9.6, 15.9)	8.1 (5.9, 11.1)	10.3 (7.7, 13.6)	14.6 (11, 19)
Total (n=2351)	10.2 (8.8, 11.8)	10.7 (9.5, 12.1)	13.9 (12.4, 15.6)	23 (20.6, 25.6)
Second high SES (West)				
Boy (n=3046)	11.7 (10.4, 13.2)	9 (8, 10.2)	12.9 (11.4, 14.6)	18.9 (17, 20.9)
Girl (n=2979)	11.4 (10, 12.9)	9.8 (8.7, 11.1)	10 (8.6, 11.5)	17.5 (15.7, 19.6)
Urban (n=4528)	10.8 (9.7, 12)	10.5 (9.6, 11.5)	12.7 (11.5, 14)	19.7(18.1, 21.4)
Rural (n=1497)	13.7 (11.5, 16.2)	6.1 (5, 7.6)	7.7 (6.1, 9.9)	13.7 (11.3, 16.5)
Total (n=6025)	11.5 (10.6, 12.6)	9.4 (8.7, 10.2)	11.5 (10.4, 12.6)	18.2 (16.9, 19.6)
Highest SES (Central)				
Boy (n=1996)	12.8 (11.1, 14.8)	9.6 (8.3, 11.01)	15.3 (13.5, 17.3)	23.5 (21.1, 26.2)
Girl (n=1806)	10.02 (8.6, 11.6)	11.6 (10.1, 13.2)	10.4 (9, 12.1)	18.3 (16.2, 20.5)
Urban (n=3208)	10.9 (9.7, 12.3)	11.1 (10, 12.3)	13.8 (12.4, 15.2)	22.2 (20.4, 24.1)
Rural (n=594)	14.5 (11.3, 18.3)	7.6 (5.7, 10)	8.9 (6.3, 12.6)	15 (12.1, 18.5)
Total (n=3802)	11.5 (10.3, 12.8)	10.6 (9.5, 11.6)	13 (11.8, 14.3)	21 (19.4, 22.8)
National				
Boy (n=6759)	13.03 (12.1, 14.1)	9.3 (8.6, 10)	13.6 (12.6, 14.6)	20.4 (19.1, 21.8)
Girl (n=6563)	11.3 (10.4, 12.2)	10.1 (9.3, 10.9)	10.2 (9.3, 11.1)	17.8 (16.6, 19.1)
Urban (n=10076)	11.2 (10.4, 11.9)	10.7 (10.1, 11.4)	13.2 (12.4, 14)	21.2 (20.1, 22.3)
Rural (n=3246)	15.3 (13.7, 17)	6.4 (5.6, 7.5)	7.8 (6.6, 9.2)	12.8 (11.3, 14.5)
Total (n=13322)	12.2 (11.5, 12.9)	9.7 (9.1, 10.2)	11.9 (11.2, 12.6)	19.1 (18.2, 20.0)

SES = Socioeconomic status; CI = Confidence interval; CASPIAN-IV = Childhood and adolescence surveillance and prevention of adult noncommunicable disease-IV

DISCUSSION

The current study presents the prevalence of weight disorders and the mean anthropometric indices by SES, living area, and gender in a large representative sample of Iranian students. We found a higher frequency of overweight, obesity, and abdominal adiposity in the highest socioeconomic regions. By contrast, underweight was documented as the most prevalent weight disorder in regions with low SES.

In all four regions, urban residents had greater values of mean of BMI, WC, HC, and WHtR, while underweight was the prevailing disorder among rural inhabitants. The high prevalence of overweight and obesity might reflect an indicator of greater vulnerability of study population to the health co-morbidities associated with being overweight or obese. This finding is consistent with that of some earlier results reported among adult and adolescent population.^[23-26]

It is well established that body weight status of an individual is affected by multiple underlying factors including a more complex interaction of environment and genetic. SES comprises the social environment, social norms, and media exposure, which could affect food preferences and consequently body weight.^[27]

In the present study, we found that the distribution pattern in the prevalence of weight disorders was remarkably different by SES of the living region. We found higher values in the mean of anthropometric measures including BMI, WC, HC, and WHtR in urban than rural neighbors in all SES regions. By socioeconomic classification of Iran into four distinct regions, highest mean values were related to high SES districts. By contrast, the lowest mean anthropometric indices including BMI, WC, wrist, HC, and WHtR was documented in low SES region. Urban-rural disparities in odds of being an overweight or obese individual, illustrated by both BMI and WC, were highlighted in previous research, both in adult,^[28] and pediatric population.^[27]

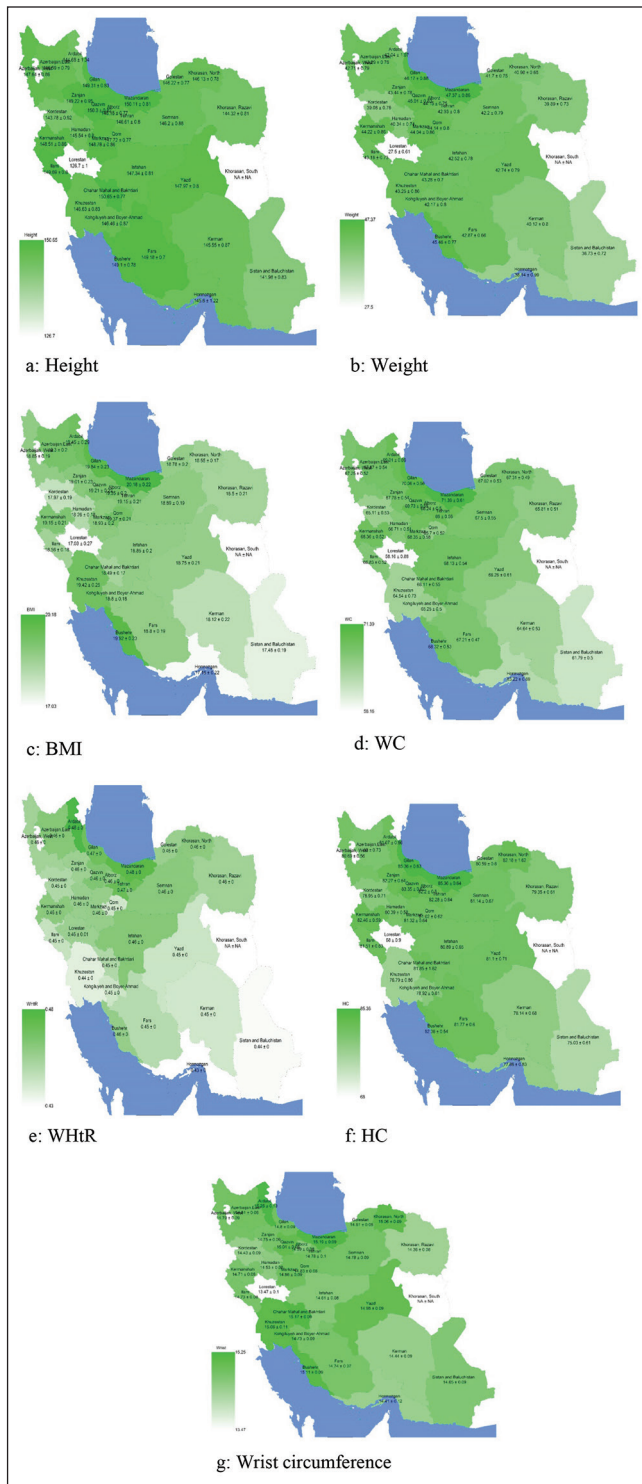


Figure 1: (a-g) The mean \pm standard error (SE) of anthropometric indices at provincial level. BMI = Body mass index, WC = Waist circumference, HC = Hip circumference; WHtR = Waist to height ratio

It could possibly be because of life style differences as urbanization accompanied with adherence to western-like diets and more sedentary activities.^[29,30]

In our study, the prevalence of overweight and obesity was at its highest level in high SES regions of the country and

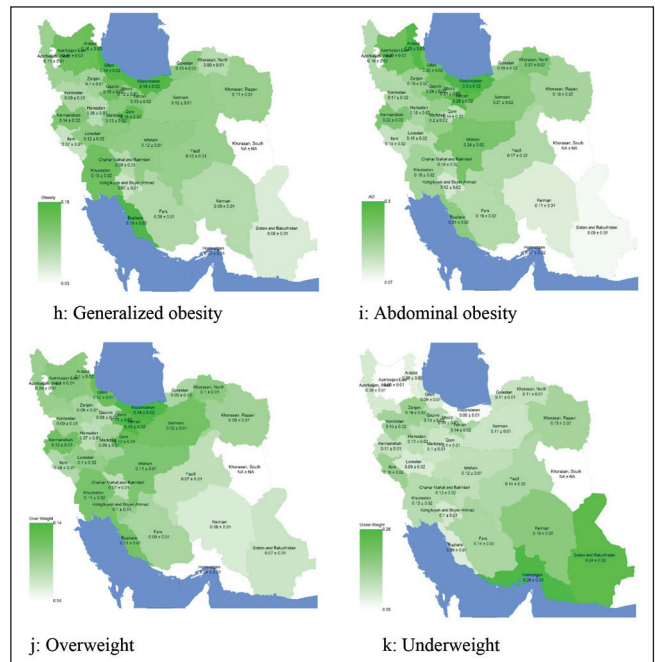


Figure 2: (h-k) Prevalence of weight disorders at provincial level

underweight was almost prevalent in rural than in urban areas. This finding is in line with some previous reports from the third national survey in China that the higher proportion of children with overweight and obesity were in geographic areas of Northern regions.^[24,31] Earlier studies have confirmed different patterns of overweight and obesity according to SES development.^[32,33] Higher SES position is less likely associated with childhood obesity in developed countries, whereas in developing nations as Indonesia, Brazil, and China children from households of higher SES are more likely to be obese compared to their lower SES counterparts.^[34-36] Various reasons as the local SES, process of industrialization, nutrition, physical activity, dietary habits, and the living condition might explain such differences.^[33]

Furthermore, higher risk of stunting and underweight due to environmental conditions including food insecurity, lower access to healthy foods, inadequate nutrition, and health knowledge has been reported in previous studies.^[37] Also, high prevalence of overweight and obesity might partly reflect the rapid changes in standards of living because of more urbanized industries, followed by epidemiologic and nutrition transition, and socioeconomic alterations.^[31,38]

Findings derived from the present study could be used to develop more effective health strategies, nutrition education and interventions for obesity prevention in the specific and diverse regions, SES, and urban vs. rural parts of the country.

This study has some limitations. First, the cross-sectional nature of the study does not allow us to conclude cause and effect relations. However, its nationwide representative

Appendix 1: The mean (95% CI) of anthropometric indices at provincial level by sex and living place: The CASPIAN-IV study

Province	Height (cm)	Weight (kg)	BMI (kg/m ²)	WC (cm)	WHR	HC (cm)	Wrist (cm)
Eastern Azerbaijan							
Boy	145.6 (138.6-152.6)	42.8 (36.8-48.7)	19.2 (18.2-20.2)	67.6 (64.0-71.2)	0.465 (0.452-0.478)	80.3 (75.7-84.8)	15 (14.3-15.6)
Girl	147.6 (141.8-153.5)	43.8 (38.6-49.1)	19.4 (18.3-20.5)	68.1 (64.8-71.4)	0.461 (0.449-0.473)	79.8 (73.9-85.6)	14.6 (14.2-15.1)
Urban	148.2 (143.3-153.1)	45 (40.6-49.3)	19.6 (18.8-20.4)	68.4 (65.7-71.1)	0.462 (0.451-0.472)	82.3 (78.8-85.8)	14.8 (14.4-15.3)
Rural	139.2 (129.2-149.2)	35.8 (28.5-43.0)	17.8 (16.6-18.9)	65.3 (60.4-70.3)	0.470 (0.454-0.485)	70.0 (59.9-80.1)	14.6 (13.7-15.5)
Total	146.6 (141.8-151.3)	43.3 (39.2-47.4)	19.3 (18.5-20.0)	67.9 (67.8-70.4)	0.463 (0.454-0.472)	80.0 (76.2-83.8)	14.8 (14.4-15.2)
Western Azerbaijan							
Boy	153.6 (146.4-160.8)	47.5 (41.3-53.7)	19.2 (18.3-20.2)	70.2 (66.6-73.7)	0.457 (0.445-0.469)	83.2 (79.6-86.8)	15.4 (14.8-16.0)
Girl	141.7 (136.5-147)	37.9 (33.7-42.2)	18.4 (17.5-19.4)	64.3 (61.9-66.7)	0.455 (0.446-0.464)	78.1 (74.5-81.8)	14.1 (13.6-14.6)
Urban	150.0 (143.7-156.3)	45.2 (39.8-50.7)	19.3 (18.4-20.2)	68.1 (65.1-71.1)	0.454 (0.445-0.464)	82.3 (78.9-85.8)	14.9 (14.4-15.5)
Rural	142.8 (135.5-150.2)	37.6 (32.4-42.8)	17.9 (17.0-18.7)	65.6 (62.1-69.0)	0.459 (0.447-0.472)	77.4 (73.3-81.5)	14.5 (13.8-15.1)
Total	147.6 (142.7-152.6)	42.7 (38.6-46.8)	18.8 (18.1-19.5)	67.2 (64.9-69.6)	0.456 (0.448-0.464)	80.7 (77.9-83.4)	14.8 (14.3-15.2)
Ardabil							
Boy	148.5 (133.9-163.1)	42.7 (32.2-53.2)	18.5 (17.2-19.7)	70.9 (65.1-76.8)	0.479 (0.464-0.495)	79.5 (72.7-86.3)	15.2 (14.2-16.3)
Girl	142.5 (133.9-151.0)	41.6 (35.4-47.8)	20.0 (18.5-21.6)	67.9 (64.9-70.8)	0.479 (0.463-0.496)	82.9 (78.3-87.6)	15.3 (14.6-16)
Urban	146.3 (138.2-154.3)	43.1 (37.2-49.1)	19.6 (18.2-20.9)	69.5 (66.3-72.7)	0.477 (0.464-0.490)	82.7 (78.5-86.9)	15.3 (14.7-16.0)
Rural	137.6 (117.9-157.3)	37.1 (24.3-50)	18.9 (17-20.8)	66.7 (60.5-72.7)	0.489 (0.463-0.516)	77.1 (67.8-86.4)	14.9 (13.8-15.9)
Total	144.7 (137.0-152.3)	42.0 (36.5-47.5)	19.4 (18.3-20.6)	69.0 (66.1-71.9)	0.479 (0.467-0.491)	81.7 (77.7-85.6)	15.2 (14.7-15.8)
Gilan							
Boy	150.5 (143.6-157.5)	46.5 (40.3-52.8)	19.6 (18.5-20.6)	71.1 (67.5-74.7)	0.472 (0.462-0.483)	84.1 (80.0-88.2)	15.1 (14.5-15.7)
Girl	147.8 (141.8-153.9)	45.7 (39.9-51.6)	20.1 (18.8-21.4)	68.8 (66-71.6)	0.465 (0.456-0.475)	86.8 (82.4-91.3)	14.4 (14-14.9)
Urban	150.2 (144.8-155.7)	47.4 (42.4-52.4)	20.1 (19.1-21.1)	70.3 (67.6-73.1)	0.468 (0.459-0.477)	86.0 (82.4-89.7)	14.8 (14.3-15.3)
Rural	146.1 (137.0-155.2)	42.0 (34.0-50.0)	18.9 (17.6-20.2)	69.1 (64.8-73.4)	0.473 (0.459-0.487)	83.0 (78.7-87.4)	14.7 (14-15.5)
Total	149.3 (144.6-154.0)	46.2 (41.8-50.45)	19.8 (19.0-20.6)	70.0 (67.7-72.4)	0.469 (0.462-0.477)	85.3 (82.3-88.4)	14.8 (14.4-15.2)
Mazandaran							
Boy	152.0 (145.5-158.6)	49.0 (42.7-55.3)	20.3 (19.3-21.4)	73.0 (69.8-76.2)	0.481 (0.468-0.495)	85.7 (82.1-89.2)	15.2 (14.6-15.8)
Girl	148.1 (142.5-153.8)	45.7 (40.2-51.1)	20.0 (18.9-21.1)	69.7 (66.1-73.3)	0.469 (0.456-0.482)	85.0 (80.5-89.5)	15.1 (14.6-15.7)
Urban	152.2 (147.4-157)	49.5 (44.8-54.3)	20.7 (19.8-21.5)	73.0 (70.4-75.7)	0.479 (0.470-0.489)	87.4 (84.2-90.6)	15.3 (14.9-15.8)
Rural	142.4 (132.5-152.3)	39.3 (30.8-47.7)	18.3 (17.2-19.5)	65.3 (60.1-70.4)	0.459 (0.434-0.484)	77.7 (72.6-82.7)	14.6 (13.9-15.3)
Total	150.1 (145.6-154.6)	47.4 (43.0-51.7)	20.2 (19.4-21)	71.4 (68.9-73.9)	0.475 (0.465-0.485)	85.4 (82.4-88.3)	15.2 (14.8-15.6)
Golestan							
Boy	145.3 (139.1-151.4)	40.4 (35.3-45.6)	18.4 (17.4-19.3)	66.1 (63.2-69)	0.455 (0.446-0.465)	78.4 (74.8-81.9)	14.9 (14.3-15.5)
Girl	147.4 (142.2-152.6)	43.3 (38.1-48.5)	19.3 (18.1-20.4)	68.2 (64.7-71.6)	0.461 (0.449-0.473)	83.4 (78.7-88.1)	14.7 (14.3-15.2)
Urban	149.7 (143.6-155.8)	45.9 (40.5-51.3)	19.7 (18.7-20.8)	69.7 (66.5-72.9)	0.465 (0.456-0.475)	84.8 (80.5-89)	15.1 (14.5-15.7)
Rural	141.7 (136.6-146.9)	36.3 (31.9-40.7)	17.6 (16.6-18.6)	63.5 (61.0-66.1)	0.448 (0.436-0.460)	75.2 (72.2-78.3)	14.4 (14.0-14.9)
Total	146.2 (142-150.5)	41.7 (37.9-45.5)	18.8 (18-19.6)	67.0 (64.7-69.3)	0.458 (0.450-0.466)	80.6 (77.6-83.6)	14.8 (14.4-15.2)
Northern khorasan							
Boy	145.2 (139.2-151.1)	39.4 (35.1-43.7)	18.1 (17.4-18.8)	67.6 (65-70.2)	0.467 (0.453-0.481)	78.9 (75.8-82.1)	15.3 (14.6-15.9)
Girl	147.4 (141.7-153.0)	43.0 (38.4-47.6)	19.1 (18.1-20.1)	66.9 (63.5-70.4)	0.454 (0.439-0.468)	86.5 (78.1-94.8)	14.8 (14.4-15.2)
Urban	149.5 (144.5-154.5)	43.9 (40.0-47.8)	19.0 (18.3-19.7)	70.1 (67.8-72.4)	0.470 (0.458-0.483)	82.9 (80-85.8)	15.3 (14.8-15.8)
Rural	136.8 (130.5-143.2)	32.9 (28.6-37.2)	17.3 (16.1-18.5)	59.5 (57.2-61.8)	0.436 (0.421-0.452)	80.2 (66.4-94)	14.3 (13.8-14.8)
Total	146.1 (141.8-150.5)	41 (37.6-44.3)	18.5 (17.9-19.2)	67.3 (65.1-69.5)	0.461 (0.451-0.472)	82.2 (77.9-86.5)	15.0 (14.6-15.5)
Khorasan razavi							
Boy	145.8 (136.7-154.9)	40.9 (33.1-48.7)	18.3 (17.0-19.7)	66.3 (61.5-71.0)	0.454 (0.442-0.467)	78.5 (72.6-84.5)	14.5 (13.7-15.3)
Girl	143.6 (138.4-148.8)	39.4 (35.3-43.4)	18.6 (17.7-19.4)	65.6 (63.3-67.8)	0.458 (0.449-0.466)	79.7 (76.3-83.2)	14.3 (13.8-14.7)
Urban	146.1 (140.9-151.4)	41.7 (37.4-46)	18.9 (18.1-19.7)	66.7 (64.3-69.1)	0.457 (0.449-0.465)	80.5 (77.2-83.8)	14.5 (14.0-15)
Rural	137.9 (129.4-146.4)	33.5 (26.9-40.1)	17.0 (15.7-18.4)	62.6 (58.3-67.0)	0.455 (0.437-0.472)	75.3 (68.7-81.9)	13.8 (13.1-14.5)
Total	144.3 (139.6-149)	39.9 (36.1-43.7)	18.5 (17.8-19.2)	65.8 (63.6-68)	0.457 (0.449-0.464)	79.3 (76.3-82.4)	14.3 (14-14.7)
Sistan va baluchestan							
Boy	144.4 (137.7-151.2)	38 (32.2-43.8)	17.5 (16.3-18.6)	61.7 (58.6-64.9)	0.428 (0.416-0.440)	74.8 (70.4-79.2)	14.9 (14.2-15.7)
Girl	140.0 (134.9-145.1)	35.7 (31.4-40.0)	17.5 (16.5-18.5)	61.8 (59.2-64.5)	0.442 (0.432-0.452)	75.2 (71.5-78.9)	14.4 (13.9-14.9)
Urban	146.5 (140.7-152.4)	40.7 (35.8-45.7)	18.3 (17.3-19.4)	64.3 (61.3-67.2)	0.439 (0.427-0.452)	78.8 (74.9-82.6)	15 (14.3-15.6)
Rural	137.1 (130.9-143.4)	32.5 (27.4-37.5)	16.5 (15.4-17.6)	59.2 (56.4-61.9)	0.432 (0.422-0.441)	71.1 (67.1-75.1)	14.3 (13.6-15)
Total	142 (137.5-146.5)	36.7 (33-40.5)	17.5 (16.7-18.3)	61.8 (59.6-63.9)	0.436 (0.428-0.444)	75 (72-78)	14.6 (14.2-15.2)

Appendix 1: (Continued)

Province	Height (cm)	Weight (kg)	BMI (kg/m ²)	WC (cm)	WHR	HC (cm)	Wrist (cm)
Hormozgan							
Boy	150.5 (140.5-160.6)	41.7 (33.9-49.4)	17.5 (16.2-18.7)	66.1 (61.2-71.0)	0.439 (0.427-0.451)	79.5 (73.6-85.4)	14.9 (14.0-15.8)
Girl	140.0 (132.5-147.5)	34.1 (28.4-39.9)	16.8 (15.6-18)	60 (56.1-63.9)	0.428 (0.415-0.441)	76.0 (70.2-81.8)	13.8 (13.2-14.4)
Urban	150.9 (140.5-161.4)	42.6 (34.0-51.0)	17.9 (16.4-19.3)	67.2 (61.3-73)	0.444 (0.431-0.458)	81.4 (74.4-88.4)	14.8 (13.8-15.8)
Rural	140.6 (131.7-149.5)	34.0 (27.8-40.2)	16.5 (15.4-17.5)	59.5 (56.2-62.9)	0.424 (0.415-0.433)	74.6 (69.4-79.8)	14.0 (13.2-14.7)
Total	145.6 (138.3-152.8)	38.1 (32.6-43.7)	17.1 (16.2-18.1)	63.2 (59.5-66.9)	0.434 (0.425-0.443)	77.9 (73.2-82.5)	14.4 (13.8-15.0)
Bushehr							
Boy	152.9 (146.6-159.2)	47.7 (42.0-53.3)	19.7 (18.7-20.7)	68.9 (65.8-72)	0.451 (0.438-0.463)	82.4 (78.9-85.9)	15.5 (14.9-16.1)
Girl	144.7 (139.9-149.4)	42.9 (38.4-47.3)	20.2 (19-21.3)	67.6 (65.3-70)	0.469 (0.456-0.481)	82.3 (79.1-85.6)	14.7 (14.2-15.1)
Urban	150.9 (146.6-155.2)	46.8 (42.9-50.7)	20.0 (19.2-20.8)	69.1 (67.1-71.1)	0.458 (0.449-0.468)	83.3 (80.9-85.8)	15.2 (14.8-15.6)
Rural	129 (117.6-140.3)	30.4 (26.6-34.2)	18.8 (16.1-21.5)	59.2 (56.2-62.2)	0.465 (0.418-0.513)	71.3(67.2-75.4)	13.7 (12.9-14.5)
Total	149.1 (144.6-153.6)	45.4 (41.6-49.3)	19.9 (19.1-20.7)	68.3 (66.3-70.4)	0.459 (0.449-0.468)	82.5 (79.9-84.8)	15.1 (14.7-15.5)
Khuzestan							
Boy	147.6 (140.4-154.8)	43.8 (37.3-50.3)	19.2 (17.9-20.5)	63.8 (59.2-68.3)	0.434 (0.407-0.461)	74.4 (69.0-79.7)	15.4 (14.5-16.3)
Girl	145.5 (140.5-150.5)	42.6 (37.4-47.8)	19.6 (18.3-21)	65.4 (60.2-70.6)	0.449 (0.420-0.477)	79.5 (72.8-86.3)	14.6 (14.2-15.1)
Urban	148.5 (143.8-153.2)	44.8 (40.5-49)	19.7 (18.8-20.5)	65.9 (62.6-69.1)	0.444 (0.425-0.463)	78.5 (74.4-82.6)	15.3 (14.7-15.8)
Rural	137.2 (128.4-146)	35.6 (25-46.3)	18.2 (15.1-21.4)	57.8 (47.6-68)	0.423 (0.355-0.491)	68.1 (55-81.3)	14 (13.0-15)
Total	146.6 (142.2-151.0)	43.2 (39.1-47.3)	19.4 (18.5-20.3)	64.5 (61.2-67.9)	0.441 (0.421-0.460)	76.8 (72.6-81.0)	15.0 (14.5-15.6)
Ilam							
Boy	150.3 (143.9-156.8)	43.6 (38.3-48.9)	18.5 (17.6-19.3)	66.7 (63.4-70.0)	0.444 (0.429-0.459)	80 (76-83.9)	15 (14.4-15.5)
Girl	148.9 (143.5-154.3)	42.7 (38.1-47.2)	18.7 (17.7-19.6)	66.9 (64.6-69.3)	0.450 (0.438-0.463)	83.3 (79.3-87.4)	14.4 (13.9-14.9)
Urban	152.1 (147.1-157.2)	45.5 (41.4-49.7)	19.1 (18.3-19.8)	68 (65.5-70.4)	0.447 (0.436-0.459)	83 (79.5-86.4)	14.9 (14.5-15.4)
Rural	137.3 (126.9-147.7)	31.5 (24.2-38.7)	16.0 (14.7-17.2)	61.1 (57.6-64.5)	0.445 (0.428-0.461)	74.1 (69.3-79.0)	13.6 (12.8-14.4)
Total	149.7 (144.9-154.5)	43.2 (39.3-47.1)	18.6 (17.8-19.3)	66.8 (64.6-69.1)	0.447 (0.437-0.457)	81.5 (78.4-84.6)	14.7 (14.3-15.1)
Kermanshah							
Boy	152.4 (145.4)	46.4 (39.8-52.9)	19.0 (17.9-20.2)	70.2 (67.2-73.2)	0.462 (0.450-0.474)	83.2 (79.2-87.2)	15.1 (14.5-15.7)
Girl	143.9 (137.3-150.4)	41.7 (35.9-47.4)	19.3 (18.1-20.5)	66.2 (63.4-68.9)	0.461 (0.450-0.471)	81.5 (77.3-85.7)	14.2 (13.8-14.7)
Urban	151.6 (146.1-157.1)	47.2 (42.2-52.1)	19.7 (18.8-20.6)	69.9 (67.6-72.2)	0.462 (0.453-0.472)	84.6 (81.5-87.7)	15 (14.6-15.4)
Rural	135.1 (127.2-143.0)	31.3 (26.1-36.6)	16.7 (15.7-17.7)	61.8 (58.5-65.0)	0.458 (0.441-0.474)	73.1 (69.2-76.9)	13.5 (12.8-14.3)
Total	148.5 (143.5-153.5)	44.2 (39.7-48.7)	19.1 (18.3-20)	68.4 (66.2-70.5)	0.461 (0.453-0.470)	82.4 (79.5-85.4)	14.7 (14.3-15.1)
Kurdistan							
Boy	147.3 (140.0-154.6)	41.7 (35.9-47.5)	18.2 (17.1-19.3)	66.3 (62.9-69.8)	0.450 (0.437-0.463)	80 (75.3-84.7)	14.8 (14.1-15.4)
Girl	139.4 (132.9-145.9)	35.8 (30.4-41.2)	17.7 (16.5-18.8)	63.5 (60.3-66.7)	0.456 (0.444-0.467)	77.6 (72.9-82.4)	14 (13.5-14.5)
Urban	146.2 (139.6-152.8)	41.5 (36.2-46.8)	18.5 (17.4-19.5)	67 (63.9-70.0)	0.459 (0.448-0.470)	81.3 (77.1-85.5)	14.6 (14.1-15.1)
Rural	138.6 (130.6-146.7)	33.7 (27.7-39.7)	16.8 (15.7-17.9)	61 (57.2-64.7)	0.440 (0.428-0.452)	73.8 (68.3-79.4)	14.0 (13.3-14.8)
Total	143.8 (138.5-149.1)	39.1 (34.8-43.3)	18 (17.1-18.8)	65.1 (62.6-67.6)	0.453 (0.444-0.461)	78.9 (75.4-82.4)	14.4 (14-14.8)
Hamedan							
Boy	146.5 (139.7-153.2)	41.4 (36.0-46.8)	18.5 (17.7-19.4)	68.6 (65.4-71.7)	0.468 (0.457-0.480)	80.6 (76.8-84.4)	14.8 (14.3-15.3)
Girl	144.5 (138.8-150.3)	39.2 (33.9-44.5)	18 (16.8-19.1)	64.7 (62.0-67.5)	0.448 (0.439-0.457)	80.1 (76.0-84.2)	14.2 (13.7-14.7)
Urban	148.0 (142.4-153.7)	42.8 (38.1-47.4)	18.7 (17.9-19.6)	68.1 (65.5-70.7)	0.460 (0.450-0.471)	81.7 (78.3-85.2)	14.7 (14.2-15.2)
Rural	139.0 (132.8-145.3)	34.0 (28.8-39.3)	17.0 (15.8-18.1)	63.1 (59.9-66.4)	0.453 (0.446-0.460)	76.9 (72.3-81.4)	14.0 (13.5-14.6)
Total	145.5 (140.9-150.1)	40.3 (36.4-44.2)	18.3 (17.5-19.0)	66.7 (64.5-68.9)	0.458 (0.451-0.466)	80.4 (77.5-83.3)	14.5 (14.1-14.9)
Zanjan							
Boy	153.6 (145.3-161.9)	47.5 (41.2-53.9)	19.7 (18.4-21.0)	69.8 (66.1-73.4)	0.458 (0.441-0.474)	82.4 (77.6-87.1)	15.2 (14.5-15.9)
Girl	145.9 (140.7-150)	40.3 (36.1-44.4)	18.4 (17.4-19.5)	66.3 (63.7-68.8)	0.457 (0.441-0.472)	82.2 (78.5-85.8)	14.4 (13.9-14.9)
Urban	154.3 (148.9-159.6)	47.7 (42.9-52.4)	19.5 (18.6-20.4)	70.8 (68.2-73.3)	0.459 (0.448-0.469)	86.7 (83.5-90)	15.2 (14.7-15.7)
Rural	140.7 (130.7-150.8)	36.5 (30.4-42.6)	18.2 (16.1-20.3)	62.8 (59.2-66.4)	0.454 (0.422-0.486)	74.9 (70.1-79.7)	14 (13.2-14.7)
Total	149.2 (143.8-154.6)	43.4 (39.4-47.5)	19.0 (18.0-20)	67.8 (65.4-70.1)	0.457 (0.443-0.471)	82.3 (79.1-85.4)	14.7 (14.3-15.2)
Markazi							
Boy	148.9 (142.1-155.7)	44.7 (38.6-50.8)	19.0 (18.0-20.0)	69.8 (66.2-73.4)	0.468 (0.460-0.475)	80.5 (76.6-84.3)	15.0 (14.4-15.6)
Girl	148.5 (141.9-155.1)	43.1 (37.5-48.7)	18.8 (17.7-19.8)	66.3 (63.3-69.3)	0.447 (0.438-0.456)	82.5 (77.8-87.2)	14.6 (14.1-15.2)
Urban	150.9 (145.4-156.4)	46.0 (41.0-51)	19.3 (18.5-20.2)	69.9 (66.9-72.9)	0.462 (0.455-0.469)	83.2 (79.7-86.6)	15.0 (14.5-15.5)
Rural	141.6 (130.7-152.4)	37.4 (29.1-45.6)	17.6 (16.3-18.9)	63.0 (59.1-66.9)	0.447 (0.432-0.463)	74.9 (69.2-80.6)	14.2 (13.4-15.0)
Total	148.8 (143.7-153.8)	44.0 (39.6-48.4)	18.9 (18.2-19.7)	68.3 (65.8-70.9)	0.459 (0.452-0.466)	81.3 (78.2-84.4)	14.8 (14.4-15.3)
Qazvin							

(Continued)

Appendix 1: (Continued)

Province	Height (cm)	Weight (kg)	BMI (kg/m ²)	WC (cm)	WHR	HC (cm)	Wrist (cm)
Boy	152.7 (145.6-159.7)	47.1 (40.7-53.5)	19.4 (18.2-20.6)	70.4 (66.9-74)	0.461 (0.451-0.472)	82.9 (78.9-86.9)	15.4 (14.8-16.0)
Girl	147.9 (143-152.8)	42.9 (38.1-47.6)	19.0 (17.9-20.1)	69.1 (65.6-72.4)	0.467 (0.453-0.481)	83.8 (79.4-88.2)	14.6 (14.2-15)
Urban	152.2 (147-157.4)	47 (42.0-51.3)	19.5 (18.5-20.5)	71.4 (68.4-74.3)	0.469 (0.459-0.479)	85 (81.4-88.6)	15.1 (14.7-15.6)
Rural	144.6 (137.9-151.3)	39.1 (33.7-44.5)	18.3 (17.1-19.5)	64.8 (62.0-67.5)	0.450 (0.433-0.467)	78.4 (74.2-82.5)	15 (14.0-15.2)
Total	150.3 (145.9-154.6)	45.0 (40.9-49.1)	19.2 (18.4-20.0)	69.7 (67.2-72.2)	0.464 (0.455-0.473)	83.3 (80.3-86.3)	15.0 (14.6-15.4)
Qom							
Boy	144.6 (137.6-151.5)	41.8 (35.5-48.1)	18.8 (17.6-20.0)	66.3 (62.4-70.2)	0.458 (0.444-0.472)	78.2 (73.7-82.7)	14.7 (14.1-15.3)
Girl	150.9 (145.9-155.8)	46.4 (41.7-51.2)	19.9 (18.9-20.1)	65.1 (62.9-67.2)	0.432 (0.425-0.438)	83.8 (80.0-87.6)	15 (14.6-15.4)
Urban	147.4 (142.8-152)	43.9 (39.7-48.1)	19.3 (18.5-20.2)	65.7 (63.4-68.1)	0.446 (0.437-0.455)	80.9 (77.6-84.1)	14.8 (14.4-15.2)
Rural	155.0 (154.6-155.5)	48.5 (45.3-51.7)	20.2 (18.9-21.5)	64.7 (62.5-67.0)	0.418 (0.403-0.433)	84.4 (79.5-89.2)	15.1 (14.8-15.4)
Total	147.7 (143.3-152.1)	44.1 (40.1-48.2)	19.4 (18.6-20.2)	65.7 (63.4-68)	0.445 (0.436-0.454)	81.0 (77.9-84.1)	14.8 (14.4-15.2)
Tehran							
Boy	147.7 (141.4-154.0)	43.3 (37.3-49.3)	19.0 (17.9-20.2)	69.8 (66.7-72.8)	0.473 (0.458-0.488)	81 (77.4-84.6)	15.2 (14.4-15.9)
Girl	145.4 (138.9-152.0)	42.5 (36.8-48.3)	19.3 (18.1-20.4)	68.1 (64.5-71.8)	0.468 (0.457-0.479)	83.6 (78.9-88.4)	14.4 (13.9-14.9)
Urban	146.2 (141.4-151.1)	42.7 (38.3-47.1)	19.1 (18.2-19.9)	68.9 (66.5-71.4)	0.471 (0.462-0.481)	82.3 (79.1-85.4)	14.7 (14.2-15.2)
Rural	154.6 (150.1-159.1)	48.1 (45.2-51.0)	20.2 (19.8-20.6)	70.1 (62.5-77.7)	0.451 (0.387-0.516)	82.6 (80-85.2)	15.6 (15-16.2)
Total	146.6 (141.9-151.3)	42.9 (38.7-47.2)	19.1 (18.3-19.9)	69 (66.6-71.4)	0.471 (0.461-0.480)	82.3 (79.2-85.3)	14.8 (14.3-15.3)
Semnan							
Boy	147 (139.7-154.2)	42.3 (36.2-48.5)	18.8 (17.7-19.9)	69.0 (65.0-73.1)	0.470 (0.457-0.483)	80.3 (75.5-85.0)	15.1 (14.5-15.8)
Girl	145.4 (138.6-152.3)	42.0 (36.4-47.7)	19 (17.9-20.0)	65.9 (63.0-68.9)	0.454 (0.445-0.463)	82 (76.9-87.1)	14.4 (13.9-14.9)
Urban	148.1 (142.9-153.3)	43.8 (39.4-48.2)	19.2 (18.4-20)	68.6 (66.0-71.2)	0.464 (0.455-0.472)	82.9 (79.3-86.4)	14.9 (14.4-15.3)
Rural	135.1 (122.0-148.2)	32.9 (5.1-43.0)	17.1 (15.3-18.9)	61 (54.7-67.3)	0.452 (0.427-0.478)	71 (62.2-79.8)	14.2 (13.0-15.5)
Total	146.2 (141.2-151.2)	42.2 (38.0-46.4)	18.9 (18.1-19.6)	67.5 (65-70)	0.462 (0.454-0.470)	81.1 (77.6-84.6)	14.8 (14.3-15.2)
Isfahan							
Boy	145.2 (138.7-151.7)	40.2 (34.7-45.8)	18.3 (17.3-19.2)	68.5 (65.2-71.7)	0.472 (0.460-0.483)	78.1 (74.2-82.0)	14.6 (14.0-15.2)
Girl	149.9 (144-155.8)	45.2 (39.9-50.6)	19.5 (18.5-20.6)	67.7 (64.7-70.7)	0.452 (0.441-0.464)	84.2 (79.8-88.5)	14.6 (14.2-15.0)
Urban	149.8 (145.0-154.6)	44.9 (40.6-49.1)	19.3 (18.5-20.1)	69.4 (67.1-71.8)	0.464 (0.454-0.474)	82.4 (79.2-85.7)	14.8 (14.4-15.2)
Rural	136.6 (126.3-146.8)	32.3 (24.6-40.0)	16.8 (15.4-18.2)	62.6 (57.5-67.6)	0.459 (0.446-0.472)	74.2 (67.9-80.5)	13.8 (12.9-14.7)
Total	147.3 (142.7-151.9)	42.5 (38.5-46.5)	18.8 (18.1-19.6)	68.1 (65.9-70.4)	0.463 (0.455-0.472)	80.9 (77.8-83.9)	14.6 (14.2-15)
Yazd							
Boy	147.6 (141.2-154)	41.7 (36.0-47.5)	18.2 (17.1-19.3)	66.2 (61.8-70.7)	0.447 (0.427-0.466)	79.3 (73.9-84.8)	15.1 (14.5-15.7)
Girl	148.5 (142.9-154.1)	44.1 (38.5-49.7)	19.5 (18.3-20.7)	66.3 (62.8-69.7)	0.446 (0.434-0.458)	83.5 (78.8-88.2)	14.7 (14.2-15.3)
Urban	148.7 (144.0-153.3)	43.3 (39.0-47.6)	18.9 (18.0-19.7)	66.7 (63.5-69.9)	0.447 (0.433-0.461)	81.7 (77.7-85.7)	15.0 (14.6-15.5)
Rural	142.9 (130-155.8)	38.4 (25.8-51.1)	17.7 (14.8-20.7)	63.3 (56.4-70.3)	0.442 (0.426-0.458)	76.6 (66.5-86.8)	14.5 (13.4-15.6)
Total	148 (143.6-152.4)	42.7 (38.7-46.8)	18.7 (17.9-19.6)	66.3 (63.1-69.2)	0.446 (0.434-0.459)	81.1 (77.3-84.9)	15 (14.5-15.4)
Kerman							
Boy	146.5 (139.2-153.8)	40.1 (33.8-46.4)	17.9 (16.7-19.2)	64.5 (61.3-67.7)	0.441 (0.431-0.452)	76.6 (71.7-81.5)	14.4 (13.9-15.0)
Girl	144.8 (138.7-150.9)	40.0 (34.8-45.4)	18.3 (17.1-19.4)	64.7 (61.5-68)	0.447 (0.436-0.459)	79.4 (74.7-84.0)	14.4 (13.9-15)
Urban	149.5 (143.9-155.2)	43.6 (38.7-48.5)	18.9 (17.8-19.9)	67.1 (64.2-70)	0.449 (0.440-0.459)	82.3 (78.3-86.2)	14.8 (14.3-15.3)
Rural	138.8 (131.0-146.6)	34.2 (27.4-40.9)	16.8 (15.4-18.2)	60.4 (57.1-63.7)	0.437 (0.424-0.449)	71.1 (66-76.2)	13.8 (13.2-14.4)
Total	145.5 (140.7-150.5)	40.1 (35.9-44.3)	18.1 (17.2-19.0)	64.6 (62.2-67.0)	0.445 (0.437-0.453)	78.1 (74.7-81.6)	14.4 (14.0-14.8)
Fars							
Boy	148.1 (141.5-154.8)	41.4 (36.0-46.7)	18.2 (17.3-19.1)	66.6 (63.5-69.8)	0.450 (0.441-0.459)	79.2 (75.6-82.8)	14.8 (14.2-15.3)
Girl	149.9 (145.6-154.3)	44 (40.3-47.6)	19.2 (18.3-20.1)	67.6 (65.4-69.8)	0.452 (0.439-0.465)	83.7 (79.5-87.8)	14.7 (14.3-15.0)
Urban	151.7 (147.4-155.9)	44.7 (41.1-48.3)	18.9 (18.3-19.6)	68.1 (66.0-70.3)	0.449 (0.441-0.457)	83.0 (79.7-86.3)	14.9 (14.5-15.2)
Rural	142.4 (135.7-149.2)	38 (32.4-43.5)	18.4 (16.6-20.1)	64.7 (61.2-68.1)	0.456 (0.434-0.478)	78.4 (72.8-84)	14.3 (13.8-14.9)
Total	149.2 (145.4-153)	42.9 (39.7-46.0)	18.8 (18.1-19.5)	67.2 (65.3-69.1)	0.451 (0.443-0.459)	81.8 (78.8-84.7)	14.7 (14.4-15.0)
Kohgiluyeh va Boyer-Ahmad							
Boy	146.1 (136.9-155.3)	42.2 (34.5-49.9)	18.5 (17.3-19.8)	65.6 (61.1-70.1)	0.449 (0.439-0.458)	77.9 (72.3-83.4)	15.0 (14.2-15.8)
Girl	146.7 (141.9-151.6)	42.1 (37.8-46.5)	19.0 (18.1-19.9)	64.9 (63-66.9)	0.443 (0.434-0.452)	79.8 (76.3-83.2)	14.5 (14.1-14.9)
Urban	149.9 (144.0-155.7)	45.3 (40.3-50.4)	19.4 (18.5-20.4)	66.6 (63.9-69.3)	0.444 (0.436-0.453)	81.5 (77.7-85.4)	14.9 (14.4-15.5)
Rural	140.3 (131.7-148.8)	36.4 (29.4-43.4)	17.6 (16.3-18.9)	62.8 (58.9-66.7)	0.448 (0.437-0.459)	74.2 (69.4-79)	14.3 (13.5-15.1)
Total	146.4 (141.4-151.5)	42.2 (37.9-46.5)	18.8 (18.0-19.6)	65.3 (62.9-67.5)	0.446 (0.439-0.452)	78.9 (75.7-82.1)	14.7 (14.3-15.2)
Lorestan							
Boy	127.6 (122.1-133.0)	27.4 (24-30.8)	16.6 (15.5-17.7)	59.4 (55.2-63.7)	0.465 (0.450-0.480)	68.7 (64.9-72.4)	13.5 (13-13.9)
Girl	125.6 (115.6-135.5)	27.6 (22.0-33.2)	17.5 (15.7-19.3)	56.5 (50.6-62.5)	0.448 (0.424-0.472)	67.1 (56.7-77.5)	13.5 (12.8-14.1)

Appendix 1: (Continued)

Province	Height (cm)	Weight (kg)	BMI (kg/m ²)	WC (cm)	WHR	HC (cm)	Wrist (cm)
Urban	128.1 (119.8-136.5)	29.1 (24.3-33.8)	17.6 (16.4-18.9)	59.8 (54.4-65.1)	0.464 (0.443-0.485)	69.5 (62.1-76.9)	13.8 (13.3-14.3)
Rural	122.7 (121.3-124.1)	23.0 (21.4-24.6)	15.3 (14.7-15.9)	53.6 (51.9-55.4)	0.439 (0.428-0.449)	63.7 (61.7-65.8)	12.6 (12.3-13)
Total	126.7 (120.4-133)	27.5 (23.7-31.3)	17.0 (15.9-18.1)	58.2 (54-62.3)	0.457 (0.441-0.473)	68.0 (62.4-73.6)	13.5 (13.0-13.9)
Chaharmahal va Bakhtiari							
Boy	154.6 (148.6-160.7)	47.0 (41.8-52.2)	19.0 (18.3-19.8)	70.7 (67.4-74)	0.457 (0.447-0.467)	84.7 (78-91.3)	15.6 (15.1-16.1)
Girl	145.5 (141-150)	38.5 (35.1-41.2)	17.8 (17.1-18.5)	64.8 (63-66.7)	0.446 (0.438-0.454)	78.2 (75.7-80.8)	14.6 (14.0-15.1)
Urban	154.9 (150.1-159.7)	46.8 (42.8-50.8)	19.0 (18.4-19.6)	70.1 (67.5-72.8)	0.453 (0.444-0.461)	85.7 (80.6-90.8)	15.5 (14.9-16.0)
Rural	140.9 (134.8-147.0)	35.2 (30.1-40.3)	17.3 (16.2-18.3)	63.5 (60.7-66.3)	0.451 (0.438-0.464)	73.1 (69.7-76.4)	14.4 (14-14.8)
Total	150.6 (146.4-154.9)	43.3 (39.7-46.8)	18.5 (17.9-19.0)	68.1 (65.9-70.3)	0.452 (0.445-0.459)	81.8 (77.8-85.9)	15.2 (14.7-15.6)
Alborz							
Boy	146.0 (138.5-153.6)	41.6 (35.3-47.9)	18.6 (17.6-19.7)	67.3 (63.1-70.8)	0.461 (0.452-0.470)	79.2 (74.7-83.7)	14.6 (13.9-15.3)
Girl	150.2 (145.9-154.4)	46.5 (42.3-50.6)	20.0 (19.1-21.0)	69.1 (67-71.3)	0.461 (0.450-0.471)	85.0 (81.9-88.1)	14.6 (14.2-14.9)
Urban	148.6 (143.6-153.7)	44.8 (40.2-49.4)	19.6 (18.7-20.5)	68.6 (66.2-71.0)	0.462 (0.454-0.470)	82.7 (79.3-86.2)	14.6 (14.2-15.0)
Rural	146.6 (138.1-155.1)	41.9 (34.8-49)	18.6 (17.2-19.9)	66.9 (62.8-70.9)	0.456 (0.444-0.469)	80.3 (75.2-85.5)	14.5 (13.8-15.3)
Total	148.2 (143.8-152.5)	44.1 (40.3-48.0)	19.3 (18.6-20.1)	68.2 (66.1-70.3)	0.461 (0.454-0.468)	82.2 (79.3-85.1)	14.6 (14.2-15)

BMI = Body mass index; WC = Waist circumference; HC = Hip circumference; WHtR = Waist to height ratio; CI = Confidence interval; CASPIAN-IV = Childhood and adolescence surveillance and prevention of adult noncommunicable disease-IV

Appendix 2: The prevalence (95% CI) of weight disorders and abdominal obesity at provincial level by sex and living place: The CASPIAN-IV study

Province	Underweight	Overweight	Obesity	Abdominal obesity
Eastern Azerbaijan				
Boy (n=247)	4.1 (2.1, 7.6)	9.7 (6.9, 13.5)	18.2 (13, 25)	27.3 (20, 36.1)
Girl (n=235)	6 (3.7, 9.5)	11.1 (7.2, 16.6)	12.8 (8.9, 17.9)	22.2 (14.8, 32)
Urban (n=393)	5.3 (3.4, 8.2)	11.7 (9.0, 15.1)	17.1 (13.2, 21.8)	24.6 (18.4, 32.1)
Rural (n=89)	3.4 (1.3, 8.4)	4.5 (1.6, 12)	9 (4.2, 18.3)	25.8 (15.9, 39.2)
Total (n=482)	5 (3.4, 7.3)	10.4 (7.9, 13.5)	15.6 (12, 19.9)	24.8 (19.3, 31.4)
Western Azerbaijan				
Boy (n=238)	8.8 (5.8, 13.2)	8.8 (5.7, 13.5)	12.2 (8.1, 18)	18.4 (12.7, 25.9)
Girl (n=238)	10 (3.7, 9.5)	10.1 (6.9, 14.5)	10.1 (7.2, 14)	14.2 (10.1, 19.8)
Urban (n=317)	10.1 (6.7, 15)	9.8 (6.7, 14)	13.4 (10, 18.1)	18.5 (13.5, 24.8)
Rural (n=159)	8.2 (4.7, 13.8)	8.8 (5.9, 12.9)	6.3 (4.3, 9.2)	12 (8, 17.6)
Total (n=476)	9.5 (6.8, 13)	9.5 (7.1, 12.5)	11.1 (8.5, 14.5)	16.3 (12.6, 20.9)
Ardabil				
Boy (n=80)	7.5 (3.3, 15.9)	2.5 (0.4, 5.1)	13.8 (7.1, 24.9)	8.8 (2.4, 27.3)
Girl (n=137)	8 (2.6, 22.4)	14.6 (9.9, 21.1)	7.5 (9.1, 31.1)	7.9 (3.7, 16.1)
Urban (n=177)	9 (3.989, 19.21)	9.6 (5.6, 16)	15.8 (8.6, 27.3)	10.1 (5.3, 18.4)
Rural (n=40)	2.5 (0.4, 13.3)	12.5 (4.1, 32)	17.5 (10.6, 27.4)	0
Total (n=217)	7.8 (3.6, 16.3)	10.1 (6.3, 16)	16.1 (9.8, 25.3)	8.2 (4.2, 15.6)
Gilan				
Boy (n=259)	10.4 (6.8, 15.8)	11.9 (8.7, 16.3)	20.5 (16.3, 25.3)	28.5 (21.9, 36.1)
Girl (n=220)	6.8 (4.4, 10.4)	12.3 (9.3, 16)	15.9 (11.5, 21.6)	21.4 (16.5, 27.1)
Urban (n=369)	7.9 (5.6, 11)	13 (10.4, 16.2)	17.3 (13.7, 21.7)	24.6 (19.5, 30.5)
Rural (n=110)	11.8 (5.9, 22.4)	9.1 (5.3, 15.1)	21.8 (16.3, 28.6)	27.3 (19.6, 36.5)
Total (n=479)	8.8 (6.3, 12)	12.1 (9.8, 14.9)	18.4 (15.2, 22)	25.2 (20.8, 30.2)
Mazandaran				
Boy (n=236)	5.5 (3.6, 8.4)	15.7 (10.9, 22)	20.3 (15.4, 26.4)	32.5 (24.4, 41.7)
Girl (n=232)	6 (3.7, 9.7)	12.6 (8.6, 17.8)	16.4 (12.2, 21.7)	28 (21.4, 35.7)
Urban (n=369)	6.2 (4.4, 8.8)	13.3 (9.9, 17.7)	20.6 (16.9, 24.9)	33.6 (28, 39.7)
Rural (n=99)	4 (1.8, 8.6)	17.2 (10.4, 27.1)	10.1 (4.7, 20.3)	18 (7.9, 36.1)
Total (n=468)	5.7 (4.2, 8)	14.1 (10.9, 18.1)	18.4 (14.9, 22.4)	30.3 (24.8, 36.4)
Golestan				
Boy (n=269)	11.9 (8, 17.4)	6.7 (4, 11)	12.3 (8, 18.4)	15.2 (10.67, 21.3)
Girl (n=210)	9.5 (5.9, 15)	10.5 (7, 15.4)	12.9 (8.4, 19.2)	23.8 (16.5, 33.1)
Urban (n=270)	9.3 (5.7, 14.7)	11.1 (8.1, 15.1)	16.3 (11.5, 22.6)	24.1 (17.9, 31.5)

(Continued)

Appendix 2: (Continued)

Province	Underweight	Overweight	Obesity	Abdominal obesity
Rural (n=209)	12.9 (8.7, 18.8)	4.8 (2.2, 10.2)	7.7 (4.5, 12.8)	12.4 (7.8, 19.4)
Total (n=479)	10.9 (7.9, 14.7)	8.4 (6, 11.5)	12.5 (9.2, 16.8)	19 (14.6, 24.4)
Northern khorasan				
Boy (n=270)	10.7 (6.9, 16.3)	10.4 (7.2, 14.8)	10 (6.7, 14.7)	25.9 (17, 37.4)
Girl (n=205)	11.2 (10.2, 20.7)	9.8 (6.3, 14.9)	7.3 (3.8, 13.6)	17.9 (9.8, 30.3)
Urban (n=349)	11.2 (7.1, 17.1)	10.6 (8, 13.9)	10 (6.9, 14.4)	29.4 (21.2, 39.3)
Rural (n=126)	10.3 (6, 17.2)	8.7 (4, 17.9)	5.6 (2.1, 13.7)	3.2 (.7, 12.8)
Total (n=475)	11 (7.6, 15.5)	10.1 (4, 17.9)	8.8 (6.2, 12.5)	22.4 (15.8, 30.8)
Khorasan razavi				
Boy (n=150)	14.7 (8.8, 23.5)	8.7 (4.5, 16.1)	12.7 (7.9, 19.7)	15.3 (9.4, 24.1)
Girl (n=300)	14.7 (10.2, 20.7)	9 (6.1, 13.1)	10.7 (6.8, 16.3)	19.3 (14.4, 25.4)
Urban (n=350)	12.3 (8.6, 17.2)	10.3 (7.3, 14.3)	12 (8.7, 16.3)	18.6 (14.3, 23.8)
Rural (n=100)	23 (14.7, 34)	4 (1.4, 11.2)	9 (2.9, 24.8)	16 (8.5, 28.1)
Total (n=450)	14.7 (11, 2.3)	8.9 (6.4, 12.3)	11.3 (8, 2.8)	18 (13.8, 23.1)
Sistan va baluchestan				
Boy (n=192)	29.2 (20.8, 39.3)	7.3 (3.9, 13.1)	5.2 (2.4, 10.9)	6.8 (3.6, 12.3)
Girl (n=233)	19.3 (14.3, 25.6)	6.4 (3.7, 11.1)	6 (3.2, 11.1)	10.6 (6.6, 16.4)
Urban (n=219)	21 (14.9, 28.8)	7.8 (4.5, 13.2)	9.132 (5.6, 14.6)	12.2 (8, 18.3)
Rural (n=206)	26.7 (18.5, 36.9)	5.8 (2.8, 11.8)	1.9 (.6, 6)	5.3 (2.8, 9.7)
Total (n=425)	23.8 (18.5, 3)	6.8 (4.4, 10.5)	1.9 (3.4, 9.1)	8.9 (6.1, 12.7)
Hormozgan				
Boy (n=142)	30.3 (22.6, 39.3)	7.1 (3.8, 12.6)	3.5 (1.4, 8.5)	9.9 (5.3, 17.6)
Girl (n=126)	20.6 (14.3, 25.6)	0.8 (.1, 5.2)	1.6 (.4, 5.8)	4.8 (1.3, 16.3)
Urban (n=129)	24 (17.6, 31.8)	7.8 (4.2, 13.8)	3.9 (1.5, 9.5)	13.2 (6.9, 23.7)
Rural (n=139)	27.3 (19.4, 37)	0.7 (.1, 4.8)	1.4 (.4, 5.2)	2.1 (.8, 5.9)
Total (n=268)	25.8 (20.39, 31.94)	4.1 (2, 8.1)	2.6 (1.2, 5.6)	7.5 (3.8, 14.1)
Bushehr				
Boy (n=249)	10.8 (7.7, 15)	10 (6.6, 14.9)	18.5 (13.2, 25.3)	18.8 (13.4, 3)
Girl (n=216)	6 (14.3, 25.56)	13 (9.3, 17.8)	19.9 (13.5, 28.4)	23.5 (16, 33.1)
Urban (n=427)	8.7 (6.3, 11.9)	11.5 (8.7, 14.9)	19 (14.7, 24.1)	20.8 (16.2, 26.4)
Rural (n=38)	7.9 (2.5, 22.4)	10.5 (5.5, 19.2)	21.1 (5.9, 53.12)	23.7 (6, 60)
Total (n=465)	8.6 (6.3, 11.6)	11.4 (8.8, 14.6)	19.1 (14.9, 24.3)	21 (16.3, 26.7)
Khuzestan				
Boy (n=222)	14.4 (9.2, 21.8)	11.7 (7.8, 17.2)	14.9 (8.7, 24.3)	15.3 (10.5, 21.6)
Girl (n=198)	10.6 (6.9, 16.1)	10.6 (6.8, 16.1)	15.7 (11.2, 21.5)	21.9 (14.8, 31.2)
Urban (n=351)	11.7 (8.1, 16.6)	12.5 (9.3, 16.8)	15.4 (11, 21.1)	18.6 (13.9, 24.4)
Rural (n=69)	17.4 (8.6, 32.1)	4.4 (1.9, 9.5)	14.5 (6.9, 28.1)	17.4 (9.56, 29.6)
Total (n=420)	12.6 (9, 17.4)	11.2 (8.3, 14.9)	15.2 (11.3, 20.2)	18.4 (14.1, 23.6)
Ilelam				
Boy (n=257)	15.6 (11.14, 21.3)	10.1 (6.6, 15.1)	7.4 (4.5, 11.9)	12.5 (8.1, 18.6)
Girl (n=220)	15.5 (10.3, 22.6)	5.9 (3.2, 10.6)	7.3 (3.5, 14.4)	15.9 (9, 26.5)
Urban (n=398)	13.8 (10.2, 18.4)	9.3 (6.6, 13)	8.5 (5.6, 12.8)	15.9 (11, 22.2)
Rural (n=79)	24 (14, 38.2)	2.5 (.8, 8.2)	1.3 (.2, 7.7)	5.1 (1.9, 13.3)
Total (n=477)	15.5 (11.9, 20)	8.2 (5.8, 11.4)	7.3 (4.8, 11.1)	14.1 (9.8, 19.7)
Kermanshah				
Boy (n=261)	11.1 (7.7, 15.7)	8.42 (5.8, 12.1)	13.8 (9.5, 19.6)	23.7 (17.1, 32.1)
Girl (n=219)	10.9 (6.8, 17.3)	15.5 (11.4, 20.8)	13.2 (8.7, 19.8)	21 (13.6, 30.9)
Urban (n=390)	10.5 (7.5, 14.6)	12.8 (9.8, 16.7)	14.1 (10.4, 18.8)	22.8 (16.8, 30.2)
Rural (n=90)	13.3 (7.8, 21.9)	6.7 (4.2, 10.5)	11.1 (5.3, 21.8)	21.1 (13.5, 31.6)
Total (n=480)	11 (8.3, 14.6)	11.7 (9, 14.9)	13.5 (10.2, 17.7)	22.5 (17.3, 28.7)
Kordestan				
Boy (n=262)	16.8 (11.6, 23.6)	7.6 (4.8, 11.9)	9.9 (5.3, 17.9)	15.7 (9.5, 24.8)
Girl (n=209)	12.4 (7.9, 19)	10.5 (6.6, 16.3)	8.6 (4.6, 15.5)	17.9 (13.1, 24.1)
Urban (n=323)	15.8 (11.4, 21.5)	10.8 (7.5, 15.3)	11.8 (7.2, 18.7)	19.4 (14, 26.5)

Appendix 2: (Continued)

Province	Underweight	Overweight	Obesity	Abdominal obesity
Rural (n=148)	12.8 (6.9, 22.6)	4.7 (2.4, 9.1)	4.1 (1.8, 8.8)	10.7 (5.6, 19.3)
Total (n=471)	14.9 (11.1, 19.6)	8.9 (6.4, 12.3)	9.3 (6, 14.4)	16.7 (12.3, 22.2)
Hamedan				
Boy (n=239)	12.1 (6.9, 20.5)	8.8 (5.7, 13.3)	13.8 (8.7, 21.3)	24.6 (17.4, 33.5)
Girl (n=230)	12.2 (7.6, 18.9)	6.1 (2.9, 12.3)	3 (1.3, 6.9)	10.4 (6.4, 16.5)
Urban (n=338)	12.1 (7.7, 18.7)	9.2 (6.1, 13.7)	10.4 (6.4, 16.4)	21.2 (15.3, 28.7)
Rural (n=131)	12.2 (6.3, 22.3)	3.1 (1, 8.7)	3.8 (1.8, 8.1)	8.4 (4.8, 14.3)
Total (n=469)	12.2 (8.3, 17.4)	7.5 (5, 11)	8.5 (5.4, 13.1)	17.7 (13, 23.6)
Zanjan				
Boy (n=192)	9.9 (5.7, 16.6)	7.8 (4.6, 13.1)	15.63 (10, 23.6)	20.8 (14.1, 23.6)
Girl (n=251)	20.3 (14, 28.5)	9.2 (5.9, 14.1)	6.4 (3.5, 11.5)	17.5 (12.1, 24.8)
Urban (n=279)	12.9 (8.5, 19.1)	10 (6.666, 14.84)	10.4 (7, 15.2)	21.2 (15.8, 27.9)
Rural (n=164)	20.8 (12.8, 31.7)	6.1 (3.461, 10.53)	10.4 (3.9, 24.9)	15.2 (7.4, 28.4)
Total (n=443)	15.8 (11.4, 21.4)	8.6 (6.1, 11.9)	10.4 (6.7, 15.7)	19 (14.1, 25)
Markazi				
Boy (n=277)	10.5 (7, 15.4)	9 (6.2, 13)	16.2 (12, 21.6)	24.8 (19.4, 31)
Girl (n=199)	10.1 (6.8, 14.6)	8.5 (5.4, 13.3)	7.5 (4.7, 11.8)	13 (8.5, 19.3)
Urban (n=367)	11.1 (8.3, 14.8)	9.5 (7, 12.9)	14.4 (10.9, 19)	22.2 (17.4, 27.8)
Rural (n=109)	7.3 (2.8, 17.8)	6.4 (3.5, 11.6)	6.4 (3.5, 11.6)	11.9 (7, 19.6)
Total (n=476)	10.3 (7.7, 13.7)	8.8 (6.6, 11.6)	12.6 (9.6, 16.4)	19.8 (15.8, 24.6)
Qazvin				
Boy (n=241)	12.5 (8.3, 18.2)	7.9 (4.7, 12.9)	19.9 (14.3, 27.1)	24.1 (17.7, 31.8)
Girl (n=238)	13 (8.1, 20.2)	7.1 (4.2, 11.8)	10.5 (6.7, 16.2)	23.4 (17.2, 31.1)
Urban (n=359)	12.5 (8.6, 17.9)	7.8 (5.1, 11.8)	16.2 (12.1, 21.2)	27.2 (21.8, 33.4)
Rural (n=120)	13.3 (8.2, 21)	6.7 (3.5, 12.4)	12.5 (5, 28.1)	13.3 (7.9, 21.6)
Total (n=479)	12.7 (9.4, 17.1)	7.5 (5.2, 10.7)	15.2 (11.4, 20.2)	23.8 (19.1, 29.1)
Qom				
Boy (n=235)	10.2 (6.3, 16.2)	9.8 (6.2, 15.2)	19.6 (13.9, 26.8)	19.3 (13.7, 26.6)
Girl (n=239)	9.6 (6.3, 14.4)	14.2 (10.2, 19.6)	13.4 (9.2, 19.1)	9.6 (6.7, 13.6)
Urban (n=454)	9.9 (7.1, 13.6)	12.1 (9.1, 16)	16.7 (12.9, 21.4)	14.4 (10.8, 19.1)
Rural (n=20)	10 (2.3, 34.5)	10 (2.3, 34.5)	10 (10, 10)	15 (9.2, 23.4)
Total (n=474)	9.9 (7.2, 13.5)	12 (9.1, 15.8)	16.5 (12.8, 21)	14.5 (10.9, 18.9)
Tehran				
Boy (n=238)	18.1 (11.9, 26.5)	13 (9.2, 18.1)	15.6 (12, 19.9)	30.4 (23.3, 38.7)
Girl (n=229)	10 (6.9, 14.4)	14 (9.7, 19.78)	10 (6.2, 15.9)	25.3 (18.5, 33.6)
Urban (n=447)	13.4 (9.7, 18.3)	13.9 (10.8, 17.6)	12.5 (9.6, 16.2)	28.1 (23.1, 33.6)
Rural (n=20)	30 (18, 45.6)	5 (1.2, 18.8)	20 (20, 20)	25 (4.9, 68.5)
Total (n=467)	14.1 (10.4, 18.9)	13.5 (10.5, 17.2)	12.9 (10, 16.4)	27.9 (23, 33.4)
Semnan				
Boy (n=236)	11 (6.9, 17.1)	11.4 (8.155, 15.8)	14.8 (8.8, 23.9)	24.4 (17, 33.7)
Girl (n=239)	10.5 (6.9, 15.6)	11.7 (8.6, 15.7)	8.4 (5.2, 13.1)	17.8 (13.2, 24.1)
Urban (n=406)	10 (7.207, 13.98)	12.3 (9.6, 15.6)	12.3 (8.3, 17.8)	23.1 (18, 29.1)
Rural (n=69)	10.5 (6.7, 28.7)	7.3 (4.4, 11.7)	7.2 (1.6, 26.8)	10 (3.6, 24.7)
Total (n=475)	10.7 (7.9, 14.5)	11.6 (9.2, 14.5)	11.6 (7.9, 16.6)	21.2 (16.6, 26.7)
Esfahan				
Boy (n=261)	12.3 (8.2, 17.9)	9.6 (6, 14.9)	13 (9.3, 17.9)	28.1 (21.4, 36)
Girl (n=217)	11 (8.3, 14.6)	12.4 (7.8, 19.3)	11.1 (6.9, 17.2)	18 (12.5, 25.1)
Urban (n=390)	10.3 (7.5, 13.9)	11.54 (8, 16.3)	12.6 (9.4, 16.7)	23.6 (18.2, 31)
Rural (n=88)	18.2 (11.2, 28.2)	8 (3.6, 16.7)	10.2 (5.1, 19.5)	23.3 (17.3, 30.8)
Total (n=478)	11.7 (8.9, 15.3)	10.9 (7.8, 15)	12.1 (9.3, 15.7)	23.5 (18.9, 29)
Yazd				
Boy (n=277)	17.7 (13, 23.7)	7 (4.4, 10.6)	11.6 (7.7, 16.9)	18.3 (12.4, 26.2)
Girl (n=199)	8 (4.6, 13.7)	8 (5.3, 12)	11.6 (9, 14.8)	14.5 (10.9, 19.1)
Urban (n=416)	12 (8.9, 16)	7.7 (5.6, 10.5)	12.5 (9.7, 15.9)	17.7 (13.4, 22.9)

(Continued)

Appendix 2: (Continued)

Province	Underweight	Overweight	Obesity	Abdominal obesity
Rural (n=60)	25 (12.4, 43.9)	5 (1.4, 16.2)	5 (1.4, 16.2)	10 (3.8, 23.9)
Total (n=476)	13.7 (10.2, 18)	7.4 (5.4, 10)	11.6 (9, 14.8)	16.7 (12.8, 21.6)
Kerman				
Boy (n=199)	23.1 (17.7, 29.6)	4.5 (2.159, 9.229)	12.1 (7.3, 19.2)	11.8 (7.7, 17.8)
Girl (n=252)	13.5 (9.5, 18.9)	7.1 (4.5, 11.2)	6.7 (3.8, 11.6)	11.1 (6.901, 17.4)
Urban (n=285)	16.8 (12.1, 22.9)	7 (4.6, 10.6)	10.2 (6.9, 14.8)	12.9 (8.7, 18.7)
Rural (n=166)	19.3 (14.4, 25.3)	4.2 (1.7, 10.2)	7.2 (3.1, 15.9)	8.9 (5.1, 15.1)
Total (n=451)	17.7 (14.1, 22)	6 (4, 8.8)	9.1 (6.4, 12.9)	11.4 (8.4, 15.5)
Fars				
Boy (n=202)	16.3 (10.8, 24)	7.4 (4.6, 11.8)	12.9 (9.2, 17.7)	14.7 (10.3, 20.7)
Girl (n=273)	12.5 (8.9, 17.2)	9.5 (6.9, 13)	6.6 (3.5, 12.1)	17.2 (11.7, 24.6)
Urban (n=347)	13.5 (9.9, 18.2)	8.4 (6.1, 11.3)	8.3 (5.8, 12)	16.4 (12.6, 21)
Rural (n=128)	15.6 (8.7, 26.5)	9.4 (5.4, 15.8)	11.7 (6, 21.7)	15.5 (7.2, 30.2)
Total (n=475)	14.1 (10.7, 18.4)	8.6 (6.6, 11.2)	9.3 (6.7, 12.7)	16.1 (12.3, 20.9)
Kohgiluyeh				
Boy (n=201)	9.5 (5.1, 16.8)	12.9 (8.3, 19.5)	8.5 (5.4, 1)	13.4 (9.1, 19.4)
Girl (n=247)	9.7 (6.3, 14.8)	6.9 (3.6, 12.9)	5.7 (2.9, 10.8)	11.2 (7, 17.5)
Urban (n=289)	7.6 (4.8, 11.9)	11.1 (7.6, 15.9)	8.3 (5.3, 12.7)	14.5 (10.4, 19.8)
Rural (n=159)	13.2 (7.7, 21.8)	6.9 (2.7, 16.5)	4.4 (2, 9.6)	8.1 (4.5, 14.3)
Total (n=448)	9.6 (6.7, 13.6)	9.6 (6.6, 13.8)	6.9 (4.6, 10.2)	12.2 (9.1, 16.3)
 Lorestan				
Boy (n=128)	11.7 (5.8, 22.2)	7.8 (4.6, 13.1)	10.9 (4.8, 23)	12.5 (6.3, 23.3)
Girl (n=99)	5.1 (2.2, 11)	12.1 (5.8, 23.6)	14.1 (5.5, 31.7)	19 (10.9, 31)
Urban (n=168)	8.9 (4.5, 17)	11.3 (7, 17.9)	15.5 (8.2, 27.2)	19.1 (12.5, 27.9)
Rural (n=59)	8.5 (4.1, 16.7)	5.1 (1.6, 15.3)	3.4 (0.9, 11.3)	5 (1.3, 17.8)
Total (n=227)	8.8 (5.1, 14.8)	9.7 (6.1, 15.2)	12.3 (6.5, 22.1)	15.4 (9.8, 23.3)
Chaharmahal Bakhtiari				
Boy (n=268)	12.3 (8.4, 17.7)	8.6 (5.6, 12.9)	10.5 (6.2, 17)	18.3 (13.3, 24.6)
Girl (n=207)	14 (9, 21.3)	5.8 (3.7, 9.1)	6.8 (3.9, 11.5)	12.5 (8.3, 18.5)
Urban (n=331)	10.6 (7.3, 15.1)	8.5 (5.9, 11.9)	9.7 (5.9, 15.4)	16.9 (12.5, 22.3)
Rural (n=144)	18.8 (12, 27.9)	4.9 (2.5, 9.3)	6.9 (4.1, 11.6)	13.2 (7.8, 21.4)
Total (n=475)	13.1 (9.8, 17.3)	7.4 (5.4, 10.1)	8.8 (6, 12.9)	15.8 (12.2, 20.2)
Alborz				
Boy (n=231)	10 (6.6, 14.7)	9.5 (7, 12.8)	12.5 (9, 17.2)	19 (13.4, 26.1)
Girl (n=247)	7.7 (5, 11.8)	15.5 (12, 19.7)	10.6 (7, 15.7)	23 (17.3, 29.8)
Urban (n=369)	7.9 (5.4, 11.3)	13 (10.4, 16.1)	12.7 (9.6, 16.7)	22.2 (17.1, 28.2)
Rural (n=108)	12 (7.4, 19)	11.1 (6.2, 19)	7.4 (4, 13.4)	17.3 (11.9, 24.5)
Total (n=477)	8.8 (6.6, 11.8)	12.6 (10.2, 15.4)	11.5 (8.9, 14.8)	21 (16.9, 25.9)

CI = Confidence interval; CASPIAN-IV = Childhood and adolescence surveillance and prevention of adult noncommunicable disease-IV

sample might increase the generalizability of the results to urban-rural students across the country. In addition, we used measured data of anthropometric indices instead of self-reported measurements.

We found a considerable difference in the prevalence of anthropometric measures according to the SES of the region at national and sub-national levels. Higher income areas had more proportion of overweight, obese, and centrally obese children while underweight was more prevalent in low SES parts. These results emphasize the importance of SES development in the prevalence of anthropometric disorders and could probably help for implementing and designing nutrition

and health education strategies specific to the SES of each geographic location.

ACKNOWLEDGMENTS

The authors would like to thank the large team working with this project, as well as the students, their parents and school principals who willingly participated in the study. The research project number was 188092.

AUTHOR'S CONTRIBUTIONS

RK and MB participated in study design and drafted the manuscript. RH and MQ participated in study design

and statistical analysis and drafted the manuscript. MM contributed in study design. GA contributed in study design and drafted the manuscript. HA and TA contributed to the data acquisition and drafted the manuscript. AK and FN participated in study design and drafted the manuscript.

REFERENCES

- Stein AD, Barros FC, Bhargava SK, Hao W, Horta BL, Lee N, *et al.* Birth status, child growth, and adult outcomes in low-and middle-income countries. *J Pediatr* 2013;163:1740-6.e4.
- Hoddinott J, Behrman JR, Maluccio JA, Melgar P, Quisumbing AR, Ramirez-Zea M, *et al.* Adult consequences of growth failure in early childhood. *Am J Clin Nutr* 2013;98:1170-8.
- Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. *Int J Pediatr Obes* 2006;1:11-25.
- Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity: Public-health crisis, common sense cure. *Lancet* 2002;360:473-82.
- WHO. Obesity, Preventing and Managing the Global Epidemic. Report of a WHO Consultation, June 3-5-1997. Geneva: World Health Organization; 2000.
- Rahmanian M, Kelishadi R, Qorbani M, Motlagh ME, Shafiee G, Aminaee T, *et al.* Dual burden of body weight among Iranian children and adolescents in 2003 and 2010: The CASPIAN-III study. *Arch Med Sci* 2014;10:96-103.
- Lobstein T, Baur L, Uauy R, IASO International Obesity TaskForce. Obesity in children and young people: A crisis in public health. *Obes Rev* 2004;5 Suppl 1:4-104.
- Visscher TL, Seidell JC. The public health impact of obesity. *Annu Rev Public Health* 2001;22:355-75.
- Ghassemi H, Harrison G, Mohammad K. An accelerated nutrition transition in Iran. *Public Health Nutr* 2002;5:149-55.
- Motlagh ME, Kelishadi R, Amirkhani MA, Ziaoddini H, Dashti M, Aminaee T, *et al.* Double burden of nutritional disorders in young Iranian children: Findings of a nationwide screening survey. *Public Health Nutr* 2011;14:605-10.
- Baygi F, Qorbani M, Dorosty AR, Kelishadi R, Asayesh H, Rezapour A, *et al.* Dietary predictors of childhood obesity in a representative sample of children in north east of Iran. *Zhongguo Dang Dai Er Ke Za Zhi* 2013;15:501-8.
- Mehrkash M, Kelishadi R, Mohammadian S, Mousavinasab F, Qorbani M, Hashemi ME, *et al.* Obesity and metabolic syndrome among a representative sample of Iranian adolescents. *Southeast Asian J Trop Med Public Health* 2012;43:756-63.
- Baygi F, Dorosty AR, Kelishadi R, Qorbani M, Asayesh H, Mansourian M, *et al.* Determinants of childhood obesity in representative sample of children in North East of Iran. *Cholesterol* 2012;2012:875163.
- Kelishadi R, Haghdoost AA, Sadeghirad B, Khajehkazemi R. Trend in the prevalence of obesity and overweight among Iranian children and adolescents: A systematic review and meta-analysis. *Nutrition* 2014;30:393-400.
- Kelishadi R, Ardalan G, Gheiratmand R, Majdzadeh R, Hosseini M, Gouya MM, *et al.* Thinness, overweight and obesity in a national sample of Iranian children and adolescents: CASPIAN Study. *Child Care Health Dev* 2008;34:44-54.
- Goyal RK, Shah VN, Saboo BD, Phatak SR, Shah NN, Gohel MC, *et al.* Prevalence of overweight and obesity in Indian adolescent school going children: Its relationship with socioeconomic status and associated lifestyle factors. *J Assoc Physicians India* 2010;58:151-8.
- Singh GK, Kogan MD, Van Dyck PC, Siahpush M. Racial/ethnic, socioeconomic, and behavioral determinants of childhood and adolescent obesity in the United States: Analyzing independent and joint associations. *Ann Epidemiol* 2008;18:682-95.
- Davis AM, Bennett KJ, Befort C, Nollen N. Obesity and related health behaviors among urban and rural children in the United States: Data from the national health and nutrition examination survey 2003-2004 and 2005-2006. *J Pediatr Psychol* 2011;36:669-76.
- Lioret S, Touvier M, Dubuisson C, Dufour A, Calamassi-Tran G, Lafay L, *et al.* Trends in child overweight rates and energy intake in France from 1999 to 2007: Relationships with socioeconomic status. *Obesity (Silver Spring)* 2009;17:1092-100.
- Kelishadi R, Ardalan G, Qorbani M, Ataie-Jafari A, Bahreynian M, Taslimi M, *et al.* Methodology and early findings of the fourth survey of childhood and adolescence surveillance and prevention of adult non-communicable disease in Iran: The CASPIAN-IV Study. *Int J Prev Med* 2013;4:1451-60.
- Farzadfar F, Danaei G, Namdaritabar H, Rajaratnam JK, Marcus JR, Khosravi A, *et al.* National and subnational mortality effects of metabolic risk factors and smoking in Iran: A comparative risk assessment. *Popul Health Metr* 2011;9:55.
- Zimmet P, Alberti G, Kaufman F, Tajima N, Silink M, Arslanian S, *et al.* The metabolic syndrome in children and adolescents. *Lancet* 2007;369:2059-61.
- Cook S, Auinger P, Li C, Ford ES. Metabolic syndrome rates in United States adolescents, from the national health and nutrition examination survey, 1999-2002. *J Pediatr* 2008;152:165-70.
- Dake FA. Obesity among Ghanaian women: Past prevalence, future incidence. *Public Health* 2013;127:590-2.
- Kimani-Murage EW, Kahn K, Pettifor JM, Tollman SM, Dunger DB, Gómez-Olivé XF, *et al.* The prevalence of stunting, overweight and obesity, and metabolic disease risk in rural South African children. *BMC Public Health* 2010;10:158.
- Fezeu L, Minkoulou E, Balkau B, Kengne AP, Awah P, Unwin N, *et al.* Association between socioeconomic status and adiposity in urban Cameroon. *Int J Epidemiol* 2006;35:105-11.
- Firestone R, Punpuing S, Peterson KE, Acevedo-Garcia D, Gortmaker SL. Child overweight and undernutrition in Thailand: Is there an urban effect? *Soc Sci Med* 2011;72:1420-8.
- Steyn NP, Nel JH, Parker WA, Ayah R, Mbithe D. Dietary, social, and environmental determinants of obesity in Kenyan women. *Scand J Public Health* 2011;39:88-97.
- Mbochi RW, Kuria E, Kimiywe J, Ochoa S, Steyn NP. Predictors of overweight and obesity in adult women in Nairobi Province, Kenya. *BMC Public Health* 2012;12:823.
- Zhang YX, Wang SR. Differences in development and the prevalence of obesity among children and adolescents in different socioeconomic status districts in Shandong, China. *Ann Hum Biol* 2012;39:290-6.
- National Task Force on Childhood Obesity, National Center for Women's and Children's Health, Ding ZY. National epidemiological survey on childhood obesity, 2006. *Zhonghua Er Ke Za Zhi* 2008;46:179-84.
- McLaren L. Socioeconomic status and obesity. *Epidemiol Rev* 2007;29:29-48.
- Zhang YX, Wang SR. Prevalence and regional distribution of childhood overweight and obesity in Shandong Province, China. *World J Pediatr* 2013;9:135-9.
- Ji CY, Cheng TO. Prevalence and geographic distribution of childhood obesity in China in 2005. *Int J Cardiol* 2008;131:1-8.
- Julia M, van Weissenbruch MM, de Waal HA, Surjono A. Influence of socioeconomic status on the prevalence of stunted growth and obesity in prepubertal Indonesian children. *Food Nutr Bull* 2004;25:354-60.

36. Zhang YX, Wang SR. Rural-urban comparison in prevalence of overweight and obesity among adolescents in Shandong, China. *Ann Hum Biol* 2013;40:294-7.
37. Mushtaq MU, Gull S, Khurshid U, Shahid U, Shad MA, Siddiqui AM. Prevalence and socio-demographic correlates of stunting and thinness among Pakistani primary school children. *BMC Public Health* 2011;11:790.
38. Gupta N, Goel K, Shah P, Misra A. Childhood obesity in developing countries: Epidemiology, determinants, and prevention. *Endocr Rev* 2012;33:48-70.

Source of Support: Nil, **Conflicts of Interest:** No conflict of interests.