Original Article

Population Attributable Fraction of Hypertension Associated with Obesity in Iran

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Abstract

Introduction: Prevalence of obesity has been increased in Iran over the recent decades. Little is known about fraction of hypertension attributable to obesity in Iran. This study aimed to determine the Population Attributable Fraction (PAF) of hypertension due to obesity across different provinces of Iran.

Materials and Methods: Data on prevalence of hypertension were extracted from Iranian Ministry of Health Non-Communicable Disease Risk Factor InfoBase. Measure of association between hypertension and obesity was extracted from Tehran Lipid and Glucose Study, for men and women separately. The extracted relative risks were used to calculate PAF of hypertension associated with obesity after age standardization of the reported prevalence of obesity across different provinces of Iran.

Results: In this study, PAF of hypertension associated with obesity observed in females; 25.6 (95% CI:18.9-30.1) was more than that of males; 24.6 (95% CI: 18.1-29.2), in males across different provinces, North-Khorasan had the highest PAF of hypertension due to obesity 24.6 (95% CI: 18.1-29.2), followed by Qom; 22.6 (95% CI: 16.5-26.7), and Hormozgan; 22.5 (95% CI: 16.5-26.6). In females, North-Khorasan province had the highest PAF; 25.6 (95% CI: 18.9-30.1) followed by Semnan 22.3 (95% CI: 16.5-26.3), Hormozgan 20.9 (95% CI: 15.5-24.6), as well as Qom 20.7 (95% CI: 15.5-24.6).

Conclusion: Prevalence of hypertension is relatively high in provinces of Iran and a sizable share of it is associated with obesity. It is recommended that health promotion programs focus on obesity in these provinces.

Keywords: Hypertension, Obesity, Prevalence, Population, Attributed fraction, Odds ratio

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Introduction

Hypertension is one of the most important chronic illnesses worldwide. It has been estimated that hypertension is the cause of 7.1 million deaths (equivalent to 13%) of the world mortality in 2010. It is also in charge of 4.4% of the Global Burden of Disease in 2010 [1].

Hypertension is one the major risk factors for cardiovascular diseases. It affects over one billion of the world's population and is the main underlying cause of stroke and heart attack [2, 3]. It has been estimated that by 2025 the prevalence of hypertension will be increased by 60% and the number of cases will rise to over 1.5 billion [1].

According to the 2009 National Survey of Non-Communicable Diseases Risk Factors in Iran, around 16% of the population between the ages of 15 to 64 had been diagnosed with hypertension [1].

Age, gender, ethnicity, smoking, obesity, and socio-economic conditions are among the most important risk factors associated with hypertension [4]. There is a strong correlation between weight and hypertension; as weight increases, the risk of hypertension increases by 2 to 6 times [5]. For every 10 kilograms increase in weight, systolic blood pressure increases by 2 – 3 mmHg [4]. Obesity can further predict hypertension in patients [5].

Obesity is a modifiable risk factor of cardiovascular diseases. Several studies have shown that weight loss, even moderate, can reduce systolic hypertension and cardiovascular risk consequently [6- 8].

Obesity, particularly central obesity, increases hypertension and consequently cardiovascular diseases by increasing formation of fatty streaks in coronary arteries and aorta [9]. The most prevalent effects of overweight and obesity on health include hypertension, dyslipidemia, and coronary heart disease [10]. In 2005, 937 million of adults had overweight around the world and the number of obese people was 396 million [11]. These numbers were doubled in comparison with 20 years ago [12]. For instance, in the Middle-East and North Africa, it was stated that over 60% of stroke cases were associated with hypertension [13].

Population Attributable Fraction (PAF) reveals how much of the disease burden in a certain population may be reduced if a risk factor is removed from the population. It implies that reducing prevalence of obesity as a risk factor of hypertension may reduce the burden of hypertension and its consequences. The prevalence of obesity in Iran is high and grows rapidly [1]. Little is known about PAF of hypertension due to obesity in Iran and its provinces. This study aimed to determine the population attributable fraction of hypertension

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related to obesity in different provinces of Iran in year 2009.

Materials and Methods

This epidemiological study represents PAF of hypertension related to obesity in Iran. In this study, prevalence of obesity in different provinces of Iran was also extracted according to age and gender from Iranian Ministry of Health Non-Communicable Disease Risk Factor InfoBase in 2009. Risk factors for non-communicable diseases' surveillance have been executed since 2004 with five stages at the provincial level (2004- 2009). I its prototype in 2004, had 89,404 samples with a systematic approach and multi-stage cluster sampling method chosen from the whole country.

Data collection included three steps as follows; step 1**:** collection of questionnaire-based information about tobacco consumption and physical inactivity. Step 2**:** collection of information about height, weight, and blood pressure. Step 3**:** biochemical measures including fasting blood sugar and fasting total cholesterol. Details of the methodology were published elsewhere [4]. Based on the standard definition, systolic hypertension higher than 140 mmHg and diastolic higher than 90mmHg were regarded as high hypertension [4]. BMI measurement is actually the ratio of weight (kg) to the square of height (m), if the ratio is more than 27, it will be in a direct relation to hypertension. Naturally, the range from 18.5 to 24.9 is called natural BMI and the one more than 25 is called overweight [4].

Measure of association (odds ratio) between obesity and hypertension or adjusted for confounding factors such as age, smoking, and education level were extracted from Tehran Lipid and Glucose Study (TLGS) in which 8647people in the age range of 20 to 70 years (3622 men and 5025 women) were selected by multistage random sampling [14]. Measure of association of hypertension due to obesity for men (OR=2.5, 95% CI: 1.8-3.4) and women (OR=2.8, 95% CI: 1.9-4.2), were extracted from TLGS to calculate PAF of hypertension associated with obesity. WHO method was then applied for age standardization of the prevalence of hypertension across different provinces [15] for three age groups of 35-44, 45-54, and 55-65 years .The following formula [16] was used to calculate PAF in different provinces of Iran. In the formula, P indicates prevalence of hypertension and OR indicates odds of hypertension associated with obesity [16]. Population attributable fraction (PAF) calculated based on the percentage was obtained with high and low confidence; all calculations were performed using Microsoft Excel sand entered to ARC GIS software to plot the relevant maps.

$$PAF = P \times \left(\frac{OR - 1}{OR} \right)$$

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Results

The highest population attributable fraction of hypertension due to obesity was reported in North Khorasan; 38.3% males and 42.7 % of females. PAF of hypertension associated with obesity in females had the highest rate in North-Khorasan province (25.6 %), followed by Gilan (24.4 %) and Semnan (22.3 %). In males, the highest PAF was observed in North-Khorasan province (24.6%), followed by Qom (22.6%), Hormozgan (22.5 %), Semnan (21.5%), and Fars (21.4%) (Figure 1).

Fig.1: Percentage of attributable hypertention in provinces of Iran, 2009

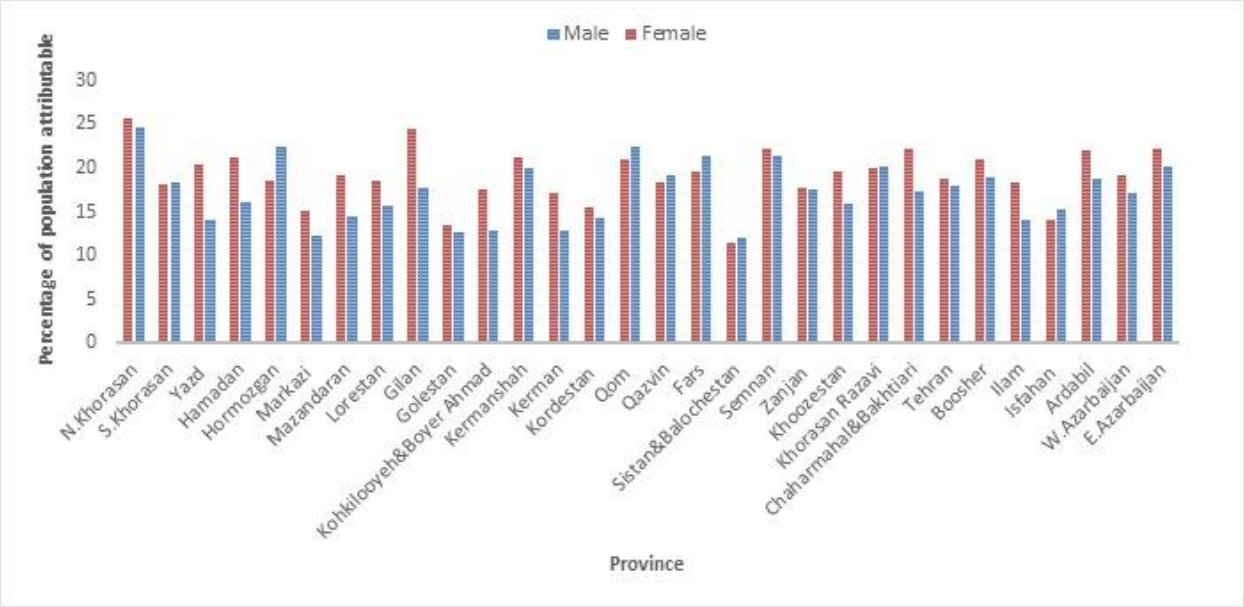

Table1: Hypertension attributable to obesity in provinces of Iran by gender, 2009

Province	Gender	Age-adjusted prevalence per 10^5	Percent population attributable fraction		
			Point estimates	Lower limit	Upper limit
East Azarbaijan	Male	31.4	20.2	14.9	23.9
	Female	37.2	22.3	16.5	26.3
West Azarbaijan	Male	26.6	17.1	12.6	20.3
	Female	32.1	19.2	14.2	22.6
Ardabil	Male	29.2	18.8	13.8	22.3
	Female	36.9	22.1	16.4	26.04
Isfahan	Male	24.1	15.4	11.4	18.3
	Female	23.6	14.1	10.5	16.7

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Province	Gender	Age-adjusted prevalence per 10^5	Percent population attributable fraction		
			Point estimates	Lower limit	Upper limit
Ilam	Male	21.8	14.06	10.3	16.6
	Female	30.7	18.4	13.6	21.6
Boosher	Male	29.4	18.4	13.9	22.4
	Female	35.1	21.07	15.6	24.7
Tehran	Male	27.9	17.9	13.2	21.3
	Female	31.4	18.8	13.9	22.2
Chaharmahal &Bakhtiari	Male	26.9	17.3	12.7	20.5
	Female	37.1	22.2	16.5	26.2
Khorasan Razavi	Male	31.5	20.2	14.9	24.01
	Female	33.2	19.9	14.7	23.4
Khoozestan	Male	24.8	15.9	11.7	18.9
	Female	32.8	19.6	14.5	23.1
Zanjan	Male	27.5	17.6	13.03	20.9
	Female	29.7	17.8	13.2	21
Semnan	Male	33.5	21.5	15.8	25.5
	Female	37.5	22.3	16.5	26.3
Sistan&Balochestan	Male	18.8	12.1	8.9	14.3
	Female	19.1	11.5	8.5	13.5
Fars	Male	33.3	21.4	15.8	25.4
	Female	32.8	19.6	14.5	23.1
Qazvin	Male	29.7	19.1	14.1	22.6
	Female	30.7	18.4	13.6	21.6
Qom	Male	35	22.5	16.5	26.6
	Female	31.2	20.9	15.5	24.6
Kordestan	Male	22.3	14.3	10.5	17.01
	Female	26	15.6	11.5	18.3
Kerman	Male	19.9	12.8	9.4	15.2
	Female	28.7	17.2	12.7	20.2
Kermanshah	Male	30.9	19.9	14.6	23.5
	Female	35.5	21.3	15.8	25.1
Kohkilooyeh &Boyer	Male	20.2	12.8	9.4	15.2
	Female	29.3	17.5	13.02	20.6

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Province	Gender	Age-adjusted prevalence per 10^5	Percent population attributable fraction		
			Point estimates	Lower limit	Upper limit
Ahmad					
Golestan	Male	19.8	12.7	9.3	15.1
	Female	22.3	13.4	9.9	15.7
Gilan	Male	27.7	22.3	16.5	26.3
	Female	40.6	24.4	18.08	28.7
Lorestan	Male	24.4	15.7	11.6	18.6
	Female	31	18.6	13.7	21.9
Mazandaran	Male	22.6	14.5	10.7	17.2
	Female	32.1	19.2	14.2	22.6
Markazi	Male	19.1	12.3	9.07	14.5
	Female	25.1	15.09	11.1	17.7
Hormozgan	Male	35.1	22.6	16.6	26.7
	Female	31	20.7	15.5	24.6
Hamadan	Male	25.2	16.2	11.9	19.2
	Female	35.3	21.2	15.7	24.9
Yazd	Male	21.8	14.06	10..3	16.6
	Female	33.9	20.3	15.06	23.9
S.Khorasan	Male	28.6	18.4	13.5	21.8
	Female	30.2	18.1	13.4	21.3
N.Khorasan	Male	38.3	24.6	18.1	29.2
	Female	42.7	25.6	18.9	30.1

In Figure 2, PAF of hypertension due to obesity was reported in males for different provinces. The highest PAF was observed in North Khorasan (24.6%) followed by Qom (22.6 %), and Hormozgan (22.5 %), Semnan (21.5 %), and Fars (21.4 %)

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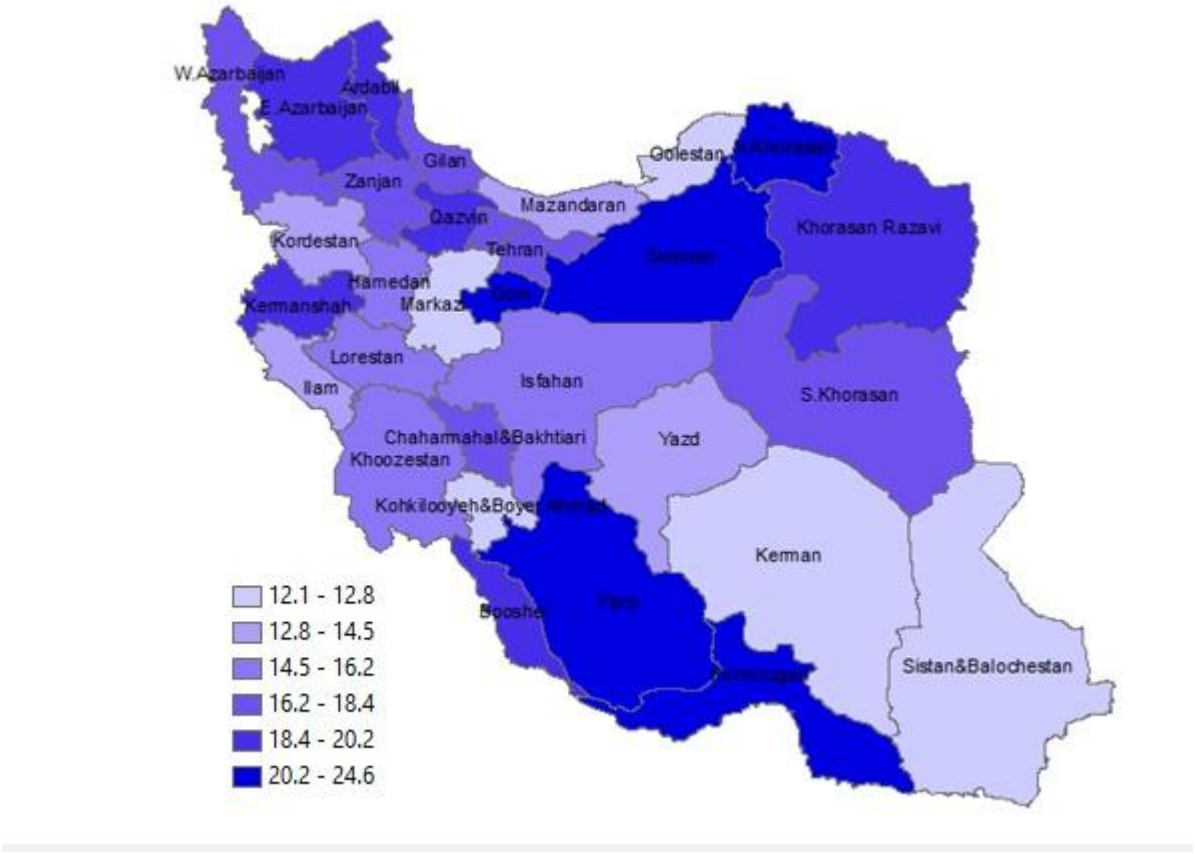
Fig. 2: Percentages of population attributable fraction of hypertension due to obesity by males in provinces of Iran, 2009



In Figure 3, PAF of hypertension due to obesity was reported in females for different provinces. The highest PAF belongs to North Khorasan (25.6%) followed by Gilan (24.4 %), Semnan (22.3 %), and East-Azerbaijan (22.3 %).

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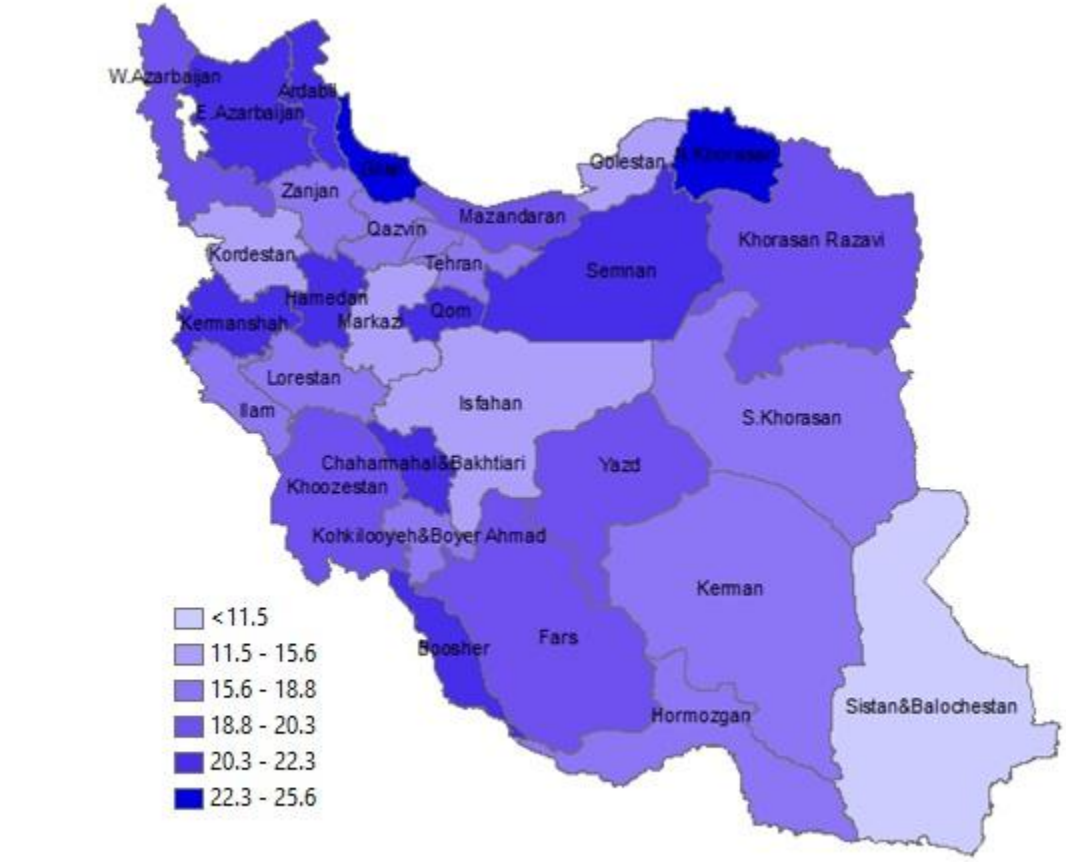
Fig. 3: Percentages of Population attributable fraction of hypertension due to obesity by females in provinces of Iran, 2009



Discussion

The highest PAF of hypertension attributable with obesity in males was observed in North Khorasan, Hormozgan, Qom, Fars, and Semnan, respectively. In Hormozgan, Qom, Fars, and Semnan the effect of industrial and urban development and change on life style and consequently on the rate of hypertension and obesity can be easily observed [17] .

According to this study for both genders, North-Khorasan had the highest population attributable fraction of hypertension associated with obesity.

In a study by Khalili et al., it was reported the crude incidence rate in males was about twice than that of females (11.9 vs. 6.5 per 1000 person-years). The PAF of hypertension, diabetes, high total cholesterol, and low-HDL cholesterol were 9.4%, 6.7%, 7.3%, and 6.1% in males and 17%, 16.6%, 12%, and 4.6% in females, respectively. High risk age for Iranian men and women were 42% and 22%, respectively. Well known modifiable risk factors explained about 40% and 50% of CHD burden

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in men and women, respectively and this incidence was comparable to those of the US population in their seventies. Well known modifiable risk factors explained about 40% and 50% of CHD burden in men and women, respectively. Aging, as a reflection of unmeasured or unknown risk factors bears the most burden of CHD, especially in men; indicating that more age-related health care is required for them [18] .

In a study by Hozawa and et al., it was reported during 12-years of follow-up, Hazard Ratio for cardiovascular mortality for pre-HT and HT, was 1.31 (95% CI=0.59-2.94) and 2.98 (95% CI=1.39-6.41) in middle-aged, and 1.03 (95% CI=0.62-1.70) and 1.65 (95% CI=1.02-2.64) in elderly respectively.

Another study conducted by Martiniuk et al., in which 15 countries were investigated with available data, the prevalence of hypertension was reported to range from 5-47% in males and 7-38% in females. Overally, the fraction of IHD attributable to hypertension ranged from 4-28% in males and 8-39% in females. [20].

Further, Flega et al., represented that PAF estimates ranged from 5% to 15% for all-cause mortality, -0.2% to 8% for all-cancer incidence, 7% to 44% for cardiovascular disease incidence, and 3% to 83% for diabetes incidence [23].

According, to the study carried out by Salem et al., overweight ad-obesity plays the most important role in PAF of hypertension due to various risk factors [21]. By awareness-increasing and prevention methods and also through weight control programs, obesity can be decreased [13].

Additionally, in a study conducted in Saudi Arabia, it was reported that obesity is strongly associated with diabetes, hypercholesterolemia, and hypertension, although its epidemic characteristics differ between males and females [22]. It has been stated that reducing obesity and overweight through change in life-style may reduce the rate of diabetes incident in the Iranian population significantly [24].

This study had several limitations. The prevalence data were from the 2009 national survey but the odds ratio came from Tehran Lipid and Glucose Study (TLGS). It is important to consider whether the exposure and outcomes were defined similarly for the PAF and the odds ratio, whether the odds ratio was suitable for the studied population, and whether PAF was calculated with correct methods. In general, PAFs for obesity may be best considered as an indicator of association with hypertension [22].

Conclusion

Prevalence of hypertension is relatively high in Iran and a sizable share of hypertension in its different provinces is associated with obesity. It is recommended that health promotion programs focus on obesity in the provinces with higher share of hypertension due to obesity.

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Acknowledgment

None .

Conflict of Interest

Authors have no conflicts of interests.

References

1. .Hojjatzade E, Samavat T. Guidelines Blood Pressure Measurement .Ministry of Health and Medical Education, Department of Health, Department of Non-Communicable Diseases. Moafaq Publishing, Tehran: 2012; 10-142. [Persian]
2. World Health Organization (WHO) [Internet]. Available from URL: www.who.int/iris/bitstream/10665/79059/1/who_dco_whd_2013.2_eng.pdf - 274.
3. NaderiAsiabar Z, Hojjatzade E. Blood Pressure Control Guidelines for Physicians . Seda Publishing. First Edition: 2000. [Persian].
4. Ghotbi M, Rafati M, Ahmadnia H. Principles of Disease Prevention and Care .Sepid Barge Baqe Ketab. Tehran: 2007. [Persian].
5. Nizami F, Farooqui MS, Munir SM, et al. Effect of fiber bread on the management of diabetes mellitus. Journal of College Physicians Surgeon Pakistan. 2004; 14(11): 673-676.
6. Eckel RH, Krauss RM. American Heart Association Call to Action: Obesity as a Major Risk Factor for Coronary Heart Disease. AHA Nutrition Committee. Circulation 1998; 21:2099-2100..
7. Mishra V, Arnold F, Semenov G, et al. Epidemiology of Obesity and Hypertension and Related Risk Factors in Uzbekistan. European Journal of Clinical Nutrition, 2006; 60:1355-1366.
8. Azizi F, Janghorbani M, Hatami H. Epidemiology and Control of Common Disease in Iran. Third Edition. Publications in Association with the Institute of Endocrinology and Metabolism, Khosravi: 2011. [Persian]
9. Linn S, Fulwood R, Ritkind B, et al. High density Lipoprotein Cholesterol Levels among US Adults by Selected Demographic and Socioeconomic Variables, The second national health and nutrition examination survey 1976-80. American Journal of Epidemiology.1989; 1129:281-94.
10. World Health Organization (WHO). Obesity: Preventing and Managing the Global Epidemic. Report of a WHO consultation. World Health Organ Tech Rep 2000; 894: 1(7) 1-253.
11. Kelly T, Yang W, Chen CS, et al. Global Burden of Obesity in 2005 and Projections to 2030. International Journal of Obstetric (Lond) 2008; 32(9):1431-7.
12. James PT, Rigby N, Leach R. The Obesity Epidemic, Metabolic Syndrome and Future Prevention Strategies. European Journal of Cardiovascular Prevention of Rehabilitation. 2004; 11(1):3-8.

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13. Tran J, Mirzaei M. The Population Attributable Fraction of Stroke Associated with High Bloob Pressure in the Middle East and North Africa. Journal of the Neurological Sciences, , 2011:308;135-138.

14. Memish ZA, Elbacheraoui CH, et al. Obesity and Associated Factors Kingdom of Saudi Arabia. Public Health Research, Practice and Policy.2013; 11(174):1-10

15. Ahmad OB, Boschi-Pinto C, Lopez AD, et al. 2001. Age Standardization of Rates: A new WHO standard. GPE Discussion Paper Series No. 31. Geneva: World Health Organization. URL: www.who.int/healthinfo/paper31.pdf (Accessed 7 May 2013).

16. Khosravishademani F, Soori H, Karami M, et al. Estimating of Population Attributable Fraction of Unauthorized Speeding and Overtaking on Rural Roads of Iran. Iranian Journal of Epidemiology . 2013; 8(4):9-11. [Persian].

17. Kengne A, Awah P Fezeu L, et al. The burden of high blood pressure and related risk factors in urban Sub-Saharan Africa: Evidences from Douala in Cameroon. African Health Sciences. 2007 Mar; 7(1): 38–44.

18. Khalili D, Sheikholeslami FH, Bakhtiyari M, et al. The incidence of coronary heart disease and the population attributable fraction of its risk factors in Tehran: a 10-year population-based cohort study. PLoS One. 2014: 27;9(8):10-1371

19. Hozawa A, Kuriyama S, Kakizaki M, et al. Attributable risk fraction of prehypertension on cardiovascular disease mortality in the Japanese population: the Ohsaki Study. American Journal of Hypertension. 2009; 22(3):267-72.

20. Martiniuk AL, Lee CM, Lawes CM, et al. Asia-Pacific Cohort Studies Collaboration. Hypertension: its prevalence and population-attributable fraction for mortality from cardiovascular disease in the Asia-Pacific region. Journal of Hypertension. 2007; 25(1):73-9.

21. Salem Z, Rezaeyan M. Check the blood pressure and its relationship with anthropometric indices at University of Medical Sciences. Rafsanjan University of Medical Sciences.2007; 7(3): 157-164 [Persian].

22. Dong J, Guo XL, Lu ZL, et al. Prevalence of overweight and obesity and their associations with blood pressure among children and adolescents in Shandong, China. BMC Public Health. 2014; 14:1080-1086

23. Flegal KM, Panagiotou OA, Graubard BI. Estimating population attributable fractions to quantify the health burden of obesity. Annals Epidemiology. 2015 25(3):201-7

24. Hosseinpanah F, Rambod M, Sarvghadi F, et al. Population Attributable Risk for Diabetes Associated to Obesity in Iranian Adults. Iranian Journal of Endocrinology and Metabolism. 2007; 9(1):91-97 [Persian]

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