Obesity and risk of hypercholesterolemia in Iranian northern adults

**Gholamreza Veghari[(1)], Mehdi Sedaghat[(2)], Hamidraza Joshghani[(3)],
Samieh Banihashem[(2)], Pooneh Moharloei[(2)], Abdolhamid Angizeh[(2)],
Ebrahim Tazik[(2)], Abbas Moghaddami[(2)]**

Original Article

Abstract

BACKGROUND: The main aim of this study was to evaluate the association between serum cholesterol level and body mass index (BMI) in northern Iran.

METHODS: This was a cross-sectional study carried out on the 1995 subjects (997 males and 998 females) aged 25-65 years that were selected using multistage cluster sampling method. Plasma cholesterol was measured in the morning after a 12-hour fasting and was determined by auto-analyzer. Hypercholesterolemia (HC) was defined by a total plasma cholesterol level over 200 mg/dl. Weight and height were measured and BMI 25-29.9 kg/m² and ≥ 30 kg/m² was classified overweight and obesity, respectively.

RESULTS: Mean of age was 44.2 ± 11.5 years (44.3 ± 11.5 in men and 44.1 ± 11.2 in women) and plasma total cholesterol level was 203.1 ± 41.8 mg/dl. The HC was detected in 49.1% with higher rate in women (57.0%) than men (44.7%). In men at age 25-35 years, the odds ratio was 3.42 (1.60-7.29) in obese group and 1.90 (1.03-3.50) in overweight group compared to normal weight. In women, at age 35-45 years, the risk of HC in obese group was 3.01 (1.58-5.73) and in overweight group it was 2.06 (1.58-5.73), while in men aged 35-45 years the relative risk was 4.03 (2.22-7.34) in overweight and 3.58 (1.77-7.25) in obese group. In women after age 45 years, higher BMI was not a risk factor for HC.

CONCLUSION: There was a positive association between BMI and serum cholesterol level. In early middle age, obese individuals were at risk of HC more than overweight subjects. In men, after age 35 years, the risk of HC increased in overweight group while in women there was no statistically significant association between BMI and HC.

Keywords: Serum Cholesterol Level, Adult, Body Mass Index, Gender, Iran

Introduction

In middle-age, serum cholesterol level is well known as a risk factor for cardiovascular disease (CVD).[1] World Health Organization (WHO) reported that the prevalence of hypercholesterolemia (total cholesterol ≥ 6.5 mmol/l or taking lipid-lowering drugs) is varied across populations from 3% to 53% in men, and from 4% to 40% in women.[2] Some factors such as life style, diet, smoking, BMI (Body Mass Index), gender, physical activity and age are associated with plasma cholesterol level.[2-5]

The relationship between BMI and risk of CVD is well established in some studies[6-8] whereas the negative correlation was shown between serum cholesterol level and height in others.[9,10] BMI is positively associated with serum cholesterol level in middle-age men in Helsingborg, Sweden and the changing in cholesterol levels over the six-year follow-up was significantly related to the changing in BMI and WHR.[11] Alterations in lipid and lipoprotein concentrations and changing the CVD risk factors was seen in some studies.[12-15] In Framingham study,[16] the mortality and morbidity due to CVD was estimated by determining of plasma cholesterol levels in young and adult people. The risk of CVD death among subjects with high serum cholesterol was approximately 5-fold more than of those individuals having low serum cholesterol level and 10% decline of serum cholesterol decreased 30% in mortality rate due to it.[17]

1- Assistant Professor, Ischemic Disorders Research Center, School of Medicine, Golestan University of Medical Sciences, Golestan, Iran
2- Deputy of Health, Golestan University of Medical Sciences, Golestan, Iran
3- Associate Professor, Department of Clinical Biochemistry, Golestan University of Medical Sciences, Golestan, Iran
Correspondence to: Gholamreza Veghari, Email: grveghari@yahoo.com

Golestan province is in the north of Iran (south east of Caspian Sea). Of 1.6 million people in this area, 66.4% are 15-64 years old. 43.9% and 56.1% people live in urban and rural areas, respectively. Agriculture is the main job in rural area and different ethnic groups such as Fars (native), Turkman and Sisstani live in this region.[18] The aim of this study was to evaluate the association between serum cholesterol level and BMI in men and women among 25-65 years old people in northern Iran.

Materials and Methods

We established a cross-sectional study with a sample of 1995 cases (997 men and 998 women with equal age) of urban and rural area, aged 25-65 years living in 11 districts in Golestan, Iran, situated at the south east of Caspian Sea. With assumption of 25% obesity rate,[3] a confidence level of 95% and a maximum marginal error about 0.02, the sample size was calculated 1800 subjects. For more efficiency the sample size was raised to 1995 subjects. We conducted a multistage cluster sampling techniques by 100 clusters with equal size of 20 subjects. In the first stage, the clusters were chosen randomly using systematic sampling technique based on postal code in urban areas and family health number in Primary Health Centers in rural areas. In the second stage, we randomly selected 20 subjects in each cluster. All family members in blocks (a complex of building) who were 25-65 years old were included in our study. Weight was measured with light clothing and without shoes and height was measured standing up with head, back and buttock on the vertical land of the height-gauge.

BMI was calculated as weight (kg) / height (m)^2 and World Health Organization classification was applied. BMI of 25.0-29.9 kg/m^2 was classified as overweight, BMI of 30.0 to 39.9 kg/m^2 was classified as obese and BMI equal to or greater than 40 kg/m^2 was classified as pathologic obese.[19]

For measuring of serum cholesterol level, blood sample was taken in the morning after 12 hours fasting. Serum cholesterol was measured by commercial kits (Pars Azmoon, Karaj, Iran) using auto-Analyzer. Plasma hypercholesterolemia (HC) was defined by a total plasma cholesterol level over 200 mg/dl.[20]

Quantitative and qualitative data are presented as mean ± standard deviation and frequently (%), respectively. SPSS software (version 16.0; SPSS Inc., Chicago, IL., USA) was used for the statistical analysis. Pearson's correlation coefficient was employed to determine correlation between BMI and serum cholesterol level. ANOVA and post-hoc Tukey's test were used to compare the means. Logistic regression analysis was applied to estimate the odds ratio (OR) of HC risk according to the BMI ranges. P-value under 0.05 was considered as statistically significant. This study approved by Ethical Research Committee and consent was received from all participants. Pregnant women, those on cholesterol lowering drugs and those who were unwilling to participate in this study were excluded from the study.

Results

The characteristics of subjects are presented in table 1. Mean of age and serum cholesterol level were 44.2 ± 11.3 years (44.3 ± 11.5 in men and 44.1 ± 11.2 in women) and 203.1 ± 41.8 mg/dl (196.7 ± 39.5 in men and 209.4 ± 42.9 women), respectively. The obesity and overweight were seen in 29.5% and 33.9%, respectively. HC was detected in 49.1% of population and was more in women (57.0%) than men (44.7%).

The serum cholesterol levels and BMI in age and sex groups are presented in table 2. The serum cholesterol level tended to increase with BMI and ANOVA test showed significant differences in all age groups (P < 0.001) in both genders. In men, the post-hoc Tukey test done for pair-waise comparison between three BMI ranges revealed a statistically significant differences in the mean cholesterol between normal and overweight as weel as between normal and obese people in all age groups (P < 0.05). There was no statistically signiifcant differences in the mean cholesterol between overweight and obese groups. In women, the post-hoc Tukey test showed a significant difference in the mean cholesterol based on overweight in all age groups and in the whole population, except in 45-55 years age groups (P < 0.05). This test was significant between normal weight and obese in all age groups and in total (P < 0.05). However, this relationship was not seen between overweight and obese people in all age groups and in total population.

The odds ratio was estimated for HC based on BMI and age by logistic regrision. Normal weight (BMI < 25 kg/m^2) was considered as reference. In men, the results of logistic regrision analysis showed that the risk of HC before age 35 years in obese group was more than overweight. At age 25-35 years, the risk of HC was 3.42 (1.60-7.29) in obese group and in overweight it was 1.90

(1.03-3.50) compared to normal subjects [Odds ratio (95% Confidence Interval)]. In contrary, in over 35 years, the relative risk of HC in overweight men [4.03 (2.22-7.34)] was more than obese men [3.587 (1.77-7.25)].

In women, the relative risk of HC among those aged under 45 years, in obese was more than overweight. Hence, the odds ratio at age 25-35, in

obese was 4.05(2.07-7.90) and in overweight was 3.71(1.91-7.18). In 35-45 year age group in obese, the risk was 3.01(1.58-5.73) and in overweight was 2.06(1.58-5.73).

In women, the odds ratio of HC in obese was 2.75(2.00-3.77) and in overweight was 2.11(1.52-2.94). After age 45, the odds ratio for HC was not significant.

Table 1. The characteristics of subjects with respect to gender (N = 1995)

	Men	Women	Total	P
	Mean ± SD	Mean ± SD	Mean ± SD	
N (%)	997 (50)	998 (50)		
Age (year)	44.3 ± 11.5	44.1 ± 11.2	44.2 ± 11.3	0.700
Serum cholesterol (mg/dl)	196.7 ± 39.5	209.4 ± 42.9	203.1 ± 41.8	0.001
Body mass index (Kg/m2)	26.0 ± 4.8	28.7 ± 6.3	27.3 ± 5.8	0.001

*Numbers represent mean ± standard deviation;
SD: Standard deviation

Table 2. Serum cholesterol level and body mass index based on age and gender

Age group (Year)		No	Body mass index status	Cholesterol mg/dl Mean ± SD	P*	OR (CI 95%)	P§
25-35	Men	119	Normal	178.6 ± 33.2	0.001	(1)	-
		84	Overweight	188.9 ± 38.3		1.90(1.03-3.50)	0.040
		39	Obese	202.6 ± 33.8		3.42(1.60-7.29)	0.001
	Women	106	Normal	177.5 ± 32.8	0.001	(1)	-
		71	Overweight	202.1 ± 42.3		3.71(1.91-7.18)	0.001
		68	Obese	204.3 ± 33.1		4.05(2.07-7.90)	0.001
35-45	Men	114	Normal	185.9 ± 43.8	0.001	(1)	-
		85	Overweight	208.2 ± 36.6		4.03(2.22-7.34)	0.001
		48	Obese	211.5 ± 41.6		3.58(1.77-7.25)	0.001
	Women	62	Normal	184.9 ± 38.3	0.001	(1)	-
		71	Overweight	206.5 ± 37.6		2.06(1.58-5.73)	0.041
		114	Obese	213.2 ± 36.9		3.01(1.58-5.73)	0.001
45-55	Men	91	Normal	189.4 ± 37.3	0.002	(1)	-
		92	Overweight	208.5 ± 35.3		2.37(1.31-4.30)	0.004
		64	Obese	207.5 ± 35.2		1.93(1.01-3.69)	0.047
	Women	52	Normal	204.1 ± 34.7	0.001	(1)	-
		65	Overweight	208.3 ± 37.6		0.98(0.47-2.05)	0.967
		123	Obese	218.4 ± 43.4		1.64(0.84-3.19)	0.142
55-65	Men	111	Normal	187.4 ± 39.6	0.001	(1)	-
		95	Overweight	213.2 ± 42.3		2.92(1.65-5.16)	0.001
		39	Obese	209.5 ± 25.9		2.73(1.28-5.79)	0.009
	Women	66	Normal	217.8 ± 44.8	0.001	(1)	-
		96	Overweight	233.3 ± 48.1		1.48(0.73-2.97)	0.270
		83	Obese	235.0 ± 41.6		1.81(0.86-3.81)	0.117
Total	Men	438	Normal	185.0 ± 38.6	0.001	(1)	-
		356	Overweight	205.1 ± 39.2		2.78(2.08-3.72)	0.001
		191	Obese	207.8 ± 34.8		2.82(1.99-4.01)	0.001
	Women	286	Normal	193.2 ± 40.6	0.001	(1)	-
		304	Overweight	214.3 ± 44.0		2.11(1.52-2.94)	0.001
		388	Obese	217.9 ± 40.6		2.75(2.00-3.77)	0.001

* ANOVA   § Logistic regression

Discussion

The association between hypercholesterolemia and BMI in men and women was not the same. In early middle-age the risk of HC in obese people was more than overweight people while in older age this relation was increased in overweight men without significant differences in women.

The association between serum cholesterol levels and BMI based on age and gender was reported in other studies. Serum cholesterol level increased with age.[21] BMI and waist circumference were positively associated with total serum cholesterol and non-HDL cholesterol level and inversely associated with HDL cholesterol.[11] Alteration in serum cholesterol levels was related to lifestyle factors in some areas.[22,23]

In pubertal children, total serum cholesterol level was negatively associated with height.[24] In Gostynski et al. study, the prevalence of hypercholesterolemia increased with age and compared with women, it was significantly increased more in men at age 24-46 years.[25] The association between hypercholesterolemia and BMI became significantly weaker in high age groups while it was not significant in female aged 50-64 years. A study in white Americans[26] revealed that changing in BMI from 21.1 to 30.0 kg/m² were associated with a higher total serum cholesterol level up to 23 mg/dl. Relationship between BMI and serum cholesterol level was not significant at menopause age.[21] The relationship between dyslipidemia and BMI, waist circumference and age was seen in Turkish adult men.[27]

Similar to mentioned studies, we found the obesity and overweight as the risk factors for HC that was steeper in early middle-age while in women was weaker than men. The insignificant association between BMI and serum cholesterol level in menopause women was shown in other studies.[21,25] Moreover, different ethnic groups live in northern Iran and inherent factors may influence changing of serum cholesterol level. The variation of serum cholesterol level among ethnic groups should be considered in future studies. Due to the changes in life style in Iran as a developing country in nutrition transition phase,[28] we recommend to establish an educational planning to control obesity and HC especially in early middle-age. Food behavior, weight gain control and serum cholesterol treatment was not assessed and they were limitations of our study.

Conclusion

HC is a major health problem in the Iranian northern adults and BMI is a risk factor for it. In early middle-age, obese subjects more than overweighed subjects were in the risk of HC, while in men, this pattern altered after age 35 years. In women, obesity and overweight was not a risk factor for HC in older middle-age.

Acknowledgments

Conflict of Interests

Authors have no conflict of interests.

References

1. Kones R. Primary prevention of coronary heart disease: integration of new data, evolving views, revised goals, and role of rosuvastatin in management. A comprehensive survey. Drug Des Devel Ther 2011; 5: 325-80.
2. Tolonen H, Keil U, Ferrario M, Evans A. Prevalence, awareness and treatment of hypercholesterolaemia in 32 populations: results from the WHO MONICA Project. Int J Epidemiol 2005; 34(1): 181-92.
3. Morikawa Y, Nakagawa H, Miura K, Soyama Y, Ishizaki M, Kido T, et al. Effect of shift work on body mass index and metabolic parameters. Scand J Work Environ Health 2007; 33(1): 45-50.
4. Oanca ME, Azoicai D, Manole A, Ivan A. Contributions to the knowledge of clinical and epidemiological features of essential arterial hypertension in Moldavia, Romania. Rev Med Chir Soc Med Nat Iasi 2007; 111(4): 1012-6.
5. Kolovou GD, Anagnostopoulou KK, Damaskos DS, Mihas C, Mavrogeni S, Hatzigeorgiou G, et al. Gender influence on postprandial lipemia in heterozygotes for familial hypercholesterolemia. Ann Clin Lab Sci 2007; 37(4): 335-42.
6. Wattanakit K, Lutsey PL, Bell EJ, Gornik H, Cushman M, Heckbert SR, et al. Association between cardiovascular disease risk factors and occurrence of venous thromboembolism. A time-dependent analysis. Thromb Haemost 2012; 108(3): 508-15.
7. Hashemipour M, Soghrati M, Malek Ahmadi M, Soghrati M. Anthropometric indices associated with

dyslipidemia in obese children and adolescents: a retrospective study in Isfahan. ARYA Atheroscler 2011; 7(1): 31-9.

8. Rheaume C, Leblanc ME, Poirier P. Adiposity assessment: explaining the association between obesity, hypertension and stroke. Expert Rev Cardiovasc Ther 2011; 9(12): 1557-64.

9. Hebert PR, Rich-Edwards JW, Manson JE, Ridker PM, Cook NR, O'Connor GT, et al. Height and incidence of cardiovascular disease in male physicians. Circulation 1993; 88(4 Pt 1): 1437-43.

10. Kannam JP, Levy D, Larson M, Wilson PW. Short stature and risk for mortality and cardiovascular disease events. The Framingham Heart Study. Circulation 1994; 90(5): 2241-7.

11. Henriksson KM, Lindblad U, Agren B, Nilsson-Ehle P, Rastam L. Associations between body height, body composition and cholesterol levels in middle-aged men the coronary risk factor study in southern Sweden (CRISS). Eur J Epidemiol 2001; 17(6): 521-6.

12. Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. Circulation 2002; 106(25): 3143-421.

13. Sarwar N, Danesh J, Eiriksdottir G, Sigurdsson G, Wareham N, Bingham S, et al. Triglycerides and the risk of coronary heart disease: 10,158 incident cases among 262,525 participants in 29 Western prospective studies. Circulation 2007; 115(4): 450-8.

14. Freiberg JJ, Tybjaerg-Hansen A, Jensen JS, Nordestgaard BG. Nonfasting triglycerides and risk of ischemic stroke in the general population. JAMA 2008; 300(18): 2142-52.

15. Labreuche J, Touboul PJ, Amarenco P. Plasma triglyceride levels and risk of stroke and carotid atherosclerosis: a systematic review of the epidemiological studies. Atherosclerosis 2009; 203(2): 331-45.

16. D'Agostino RB, Grundy S, Sullivan LM, Wilson P. Validation of the Framingham coronary heart disease prediction scores: results of a multiple ethnic groups investigation. JAMA 2001; 286(2): 180-7.

17. Jousilahti P, Vartiainen E, Pekkanen J, Tuomilehto J, Sundvall J, Puska P. Serum cholesterol distribution and coronary heart disease risk: observations and predictions among middle-aged population in eastern Finland. Circulation 1998; 97(11): 1087-94.

18. Nourolahi T. 2006 National Population and Housing Census in Iran [Online]. 2009; Available from: URL:

http://www.ancsdaap.org/cencon2009/Papers/Iran/Iran_slides.pdf/

19. WHO. Obesity: Preventing and Managing the Global Epidemic. Geneva, Switzerland: World Health Organization; 2000.

20. Costa J, Borges M, Oliveira E, Gouveia M, Carneiro AV. Incidence and prevalence of hypercholesterolemia in Portugal: a systematic review. Part III. Rev Port Cardiol 2003; 22(6): 829-36.

21. Akahoshi M, Soda M, Nakashima E, Tsuruta M, Ichimaru S, Seto S, et al. Effects of age at menopause on serum cholesterol, body mass index, and blood pressure. Atherosclerosis 2001; 156(1): 157-63.

22. Hubert HB, Eaker ED, Garrison RJ, Castelli WP. Life-style correlates of risk factor change in young adults: an eight-year study of coronary heart disease risk factors in the Framingham offspring. Am J Epidemiol 1987; 125(5): 812-31.

23. Ledoux M, Lambert J, Reeder BA, Despres JP. A comparative analysis of weight to height and waist to hip circumference indices as indicators of the presence of cardiovascular disease risk factors. Canadian Heart Health Surveys Research Group. CMAJ 1997; 157(Suppl 1): S32-S38.

24. Kouda K, Nakamura H, Fan W, Takeuchi H. Negative relationships between growth in height and levels of cholesterol in puberty: a 3-year follow-up study. Int J Epidemiol 2003; 32(6): 1105-10.

25. Gostynski M, Gutzwiller F, Kuulasmaa K, Doring A, Ferrario M, Grafnetter D, et al. Analysis of the relationship between total cholesterol, age, body mass index among males and females in the WHO MONICA Project. Int J Obes Relat Metab Disord 2004; 28(8): 1082-90.

26. Denke MA, Sempos CT, Grundy SM. Excess body weight. An under-recognized contributor to dyslipidemia in white American women. Arch Intern Med 1994; 154(4): 401-10.

27. Erem C, Hacihasanoglu A, Deger O, Kocak M, Topbas M. Prevalence of dyslipidemia and associated risk factors among Turkish adults: Trabzon lipid study. Endocrine 2008; 34(1-3): 36-51.

28. Ghassemi H, Harrison G, Mohammad K. An accelerated nutrition transition in Iran. Public Health Nutr 2002; 5(1A): 149-55.

www.mui.ac.ir