ORIGINAL REPORT

Relationship between the Pattern of Coronary Artery Disease Risk Factors and Lipid Ratios with Five Groups of Body Mass Index in 28566 Healthy Adults

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Received: 17 Jan. 2011; Received in revised form: 12 Jun. 2011; Accepted: 29 Jun. 2011

Abstract- Pattern of the coronary artery disease (CAD) risk factors across body mass index (BMI) categories remains uncertain. There is a different threshold of obesity for increasing cardiovascular hazard across populations, accordingly recognition and management of obesity and overweight can guide better control of CAD epidemic in the national level. To determine the discrepancy in the prevalence of CAD risk factors across five BMI categories. A population based survey of 28566 participants recruited to medical screening of taxi drivres in Tehran (MSTDT) was designed. According to a standardized protocol data on CAD risk factors were obtained by taking medical history, examination and laboratory tests. After adjustment for age, sex, literacy, smoking, systolic blood pressure (SBP), fasting blood sugar (FBS), and LDL-C/HDL-C ratio, these CAD risk factors of diastolic blood pressure (DBP)>90 mmHg, hypertriglyceridemia, high triglyceride/ HDL-C ratio, hypercholesterolemia, and high cholesterol/HDL-C ratio were increased significantly across five incremental categories of BMI. Prevalence of DBP> 90 mmHg, hypertriglyceridemia, hyper cholesterolemia and ratios of cholesterol/ HDL-C and TG/HDL-C increased considerably across five groups of BMI. This pattern is different from previous research and our results endorsed more features of pattern of CAD risk factors across BMI categories.

Acta Medica Iranica, 2011; 49(11): 730-736.

Keywords: Coronary artery disease; Risk assessment; Body mass index; Lipid ratios

Introduction

It has been demonstrated that obesity is associated with incremental risk of cardiovascular disease (CVD), hypertension, diabetes, mortality, disability and arthritis (1). Accordingly, recommendations for keeping a lower body mass index (BMI) have been logical and could have discrepancies across different level of BMIs. Pattern of the CVD risk factors across BMI levels remains uncertain (1). In the epidemic situation of coronary artery disease (CAD) of our time, recognition the trend of CAD risk factors over BMI categories can guide more precise dedication of preventive strategies toward maintaining desirable BMI. A multiethnic cohort study of 6814 individuals revealed the incremented prevalence of CAD risk factors and an increased burden of subclinical vascular disorders in over weight or obese adults (2).

Adverse impacts of overweight on CAD risk factors including hypertension and high cholesterol levels are an independent effect (3), which increased the complexity of relationships (4-7) and interactions between CAD risk factors. To determine the pattern of CAD risk factors across five different BMI categories we performed a survey involving 28566 initially healthy adults.

Patients and Methods

Study design

A population based cross sectional survey of participant recruited to medical screening of taxi drivers in Tehran (MSTDT) was conducted.

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Study population

28566 initially healthy adult people among ten medical clinics allocated to the medical screening project.

Inclusion criteria: Adult persons without coronary artery disease were eligible to participate in the study. History of coronary artery disease excluded individuals from the study. Examiners in ten medical clinics were physicians who educated based upon a uniform protocol according to American Heart Association guidelines.

Risk factor determination

According to a standardized protocol of, taking medical history, examination and laboratory tests we obtained information on, age, height, weight, literacy, smoking, blood pressures, lipid profile, blood sugar, blood cell counts and urinalysis.

Equipment which was used for height and weight measurement was similar for all ten clinics. For weight measurement a balance beam scale, and a rafter square was applied to obtain an accurate height measurement.

BMI classification

Refer to national institute of health (NIH) classification, BMI which was obtained by dividing weight (Kg) by the square of height (Meter) categorized into: <18.5, 18.5-24.9, 25-29.9, and30-39.9 and ≥ 40 as underweight, normal, over weight, obese, and extreme obesity, respectively.

Laboratory Testing

Total cholesterol and triglyceride level were conducted by calorimetric method. Fasting plasma analyses were performed enzymatic ally.

Statistical analysis

After processing the data obtained from participants on different CAD risk factors statistical analysis made use SPSS V14 for 28566 validated data. Univariate analysis was conducted using Pearson chi2 test, fisher exact test, and analysis of variances. Means and standard deviations were calculated and frequency tables were derived.

Multivariate analysis

Polynomial regression was conducted to assess multivariate adjusted differences in pattern of CAD risk factors across different BMI categories. Statistical differences across BMI groups were considered significant at $P<0.05$.

Ethical issues

This study was reviewed by Tehran municipality health center. Oral consent was obtained from the participants at the entry of the screening program.

Funding

This large scale study was supported by a grant from Tehran municipality health center.

Table 1. Frequency of participant categorical characteristics across five groups of BMI

Variables		BMI< 18.5 N= 469	BMI=18.5-24.9 N= 12009	BMI=25-29.9 N=12160	BMI=30-39.9 N=3829	BMI≥ 40 N=99	*P*
Gender	Female (%)	98.5	98.3	98.5	97.5	96	0.001
	Male (%)	1.5	1.7	1.5	2.5	4	
Smoker (%)		26.1	25.3	20.9	19.3	14.8	0.001
Systolic blood pressure > 140 mmHg (%)		1.7	1.7	2.6	4.3	10.3	0.001
Diastolic blood pressure > 90mmHg (%)		0.2	0.8	1.6	2.6	8.2	0.001
Systolic blood pressure > 120mmHg (%)		8.3	13.9	20.6	27.5	47.4	0.001
Diastolic blood pressure > 80mmHg (%)		2.8	5.5	10	13.3	28.9	0.001
Fasting blood sugar >126 Mg/dl (%)		1.5	5	7.6	9	20.4	0.001
Cholesterol >200 Mg/dl (%)		19.1	29.5	37.2	36	44.4	0.001
Triglyceride > 200 Mg/dl (%)		5.4	15.6	26.1	28.3	27.3	0.001
Cholesterol >170 Mg/dl (%)		48.7	62.8	69.9	69.7	73.7	0.001
HDL-C < 45 Mg/dl (%)		61.5	69.7	73.2	75.3	61.0	0.001
LDL-C> 130 Mg/dl (%)		13	23.2	26.6	26.3	34.2	0.001
Age decades	< 31 y (%)	23.5	16.3	12.3	12.4	21.4	0.001
	30-40y (%)	24.7	27.4	26.9	28.9	31.6	
	40-50y (%)	27.1	27.6	30.4	31	26.5	
	50-60y (%)	17.7	21.1	22.6	20.9	19.4	
	> 60y (%)	7	7.6	7.7	6.7	1	
literacy	Illiterate (%)	2.9	2.7	2.8	2.7	0	0.001
	Primary school (%)	22.9	23.7	24.8	27.7	7.5	
	High school (%)	65.6	66.4	65.2	63.3	72.3	
	More (%)	8.6	7.0	7.1	6.2	2.2	

Results

Distributions and univariate analysis

Table 1 demonstrated the distribution of categorical characteristics of 28566 individuals across five groups of BMI. Prevalence of CAD risk factors in table 1 across five successive BMI categories showed a statistically significant difference. Substantial increasing trend of CAD risk factors occurred with increase BMI level.

Trends and likelihood ratios

The prevalence of systolic blood pressure (SBP)>140 mmHg, diastolic blood pressure (DBP)>90 mmHg, SBP>120 mmHg, DBP>80 mmHg, fasting blood sugar (FBS)>126 Mg/dl, cholesterol>200 Mg/dl, triglyceride (TG)>200 Mg/dl, cholesterol>170 Mg/dl, and LDL-C>130 Mg/dl increased significantly across five BMI groups. Linear by linear associations have shown a significant increasing trend in the prevalence of CAD risk factors (P<0.05) across BMI groups.

Likelihood ratio of increase in prevalence of different CAD risk factors with increasing BMI calculated and presented in table 2.

Trend of CAD risk factors presented as continuous variables depicted in table 3. Mean level of risk factors incremented across five BMI groups (P=0.001), aside from HDL-C level.

We observed a statistically significant increasing linear trend concerning mean level of these CAD risk factors across BMI categories: SBP, DBP, FBS, and cholesterol, TG, LDL-C/HDL-C ratio and TG/HDL-C ratio.

Multivariate analysis

Polynomial regression model was conducted to calculate multivariate adjusted change of CAD risk factor across five groups of BMI.

Table 4 presented parameter estimation after adjustment for age, sex, literacy, smoking, SBP, FBS and LDL-C/HDL-C ratio. This table comprises the strength of association between increment in level of the risk factors with increasing BMI level in the term of odds ratios (OR) and calculated 95% confidence intervals (95% CI).

Table 2. Likelihood ratios of increase in prevalence of risk factors across five BMI groups

Factors	Likelihood ratios	Significance level
Systolic Blood Pressure>140 mmHg	90.93	0.001
Diastolic Blood Pressure>90 mmHg	102.19	0.001
Systolic Blood Pressure >120 mmHg	478.70	0.001
Diastolic Blood Pressure >80 mmHg	347.79	0.001
Fasting Blood Sugar>126 Mg/dl	153.66	0.001
Cholesterol> 200 Mg/dl	224.79	0.001
Triglyceride> 200 Mg/dl	600.86	0.001
cholesterol> 170 Mg/dl	217.74	0.001
LDL-C>130 Mg/dl	67.86	0.001

mmHg:milimeter Hg,Mg/dl:Miligram per deciliter ,LDL-c:low density lipoprotein ,BMI:body mass index

Table 3. Trend in different factors across BM I groups

Variables	BMI< 18.5 N= 469 Mean SD (95% CI)	BMI= 18.5-24.9 N= 12009 Mean SD (95% CI)	BMI= 25-29.9 N= 12160 Mean SD (95% CI)	BMI= 30-39.9 N= 3829 Mean SD (95% CI)	BMI≥ 40 N= 99 Mean SD (95% CI)	*P*
Systolic blood pressure(mmHg)	111.97±12.84 (110.81-113-14)	115.48±11.95 (115.27-115.70)	118.35±12.12 (118.13-118.56)	120.70±13.28 (120.28-121.13)	125.10±15.69 (121.94-128.27)	0.001
Diastolic blood pressure(mmHg)	73.25±8.19 (72.51-73.99)	74.64±8.25 (74.49-74.78)	76.53±8.12 (76.38-76.68)	77.78±8.36 (77.52-78.05)	80.41±10.24 (78.35-82.48)	0.001
Fasting blood sugar(Mg/dl)	89.93±24.05 (87.74-92.12)	94.46±28.39 (92.12-94.97)	98.66±33.45 (98.06-99.26)	99.29±33.9 (98.21-100.37)	108.63±40.73 (100.47-116.8)	0.001
Cholesterol(Mg/dl)	173.96±32.86 (170.97-176.95)	185.59±38.03 (184.91-186.27)	193.42±39.3 (192.72-194.12)	193.15±38.74 (191.92-194.38)	197.7±42.4 (189.24-206.15)	0.001
HDL-C(Mg/dl)	43.18±10.99 (42.08-44.29)	41.12±10.31 (40.91-41.33)	40.16±9.79 (39.96-40.36)	39.86±10.25 (39.49-40.22)	43±8.15 (44.15-44.85)	0.001
LDL-C(Mg/dl)	102.58±27.65 (99.81-105.36)	111.27±32.119 (110.62-111.93)	114.39±33.38 (113.70-115.08)	113.85±34.02 (112.63-115.08)	117.96±37 (109.37-126.56)	0.001
Triglyceride (Mg/dl)	123.72±51.28 (119.04-128.40)	152.26±78.41 (150.85-153.67)	181.67±97.41 (179.93-183.41)	187.85±100.28 (184.66-191.05)	201.81±139.28 (174.03-229.59)	0.001
Age (year)	41.81±12.22 (40.7-42.92)	43.35±11.62 (43.14-43.56)	44.34±34 (44.14-44.54)	43.69±10.76 (43.35-44.04)	39.93±9.93 (37.94-41.93)	0.001
Total cholesterol/HDL-C ratio	4.17±1.11 (4.05-4.2)	4.64±1.22 (4.61-4.66)	4.9±1.24 (4.87-4.93)	4.94±1.38 (4.89-4.99)	4.74±1.13 (4.49-5.00)	0.001
LDL-C/ HDL-C ratio	2.51±0.89 (2.42-2.60)	2.84±0.98 (2.82-2.86)	2.96±0.99 (2.94-2.98)	2.97±1.15 (2.93-3.01)	2.83±0.99 (2.60-3.06)	0.001
Triglyceride/ HDL-C ratio	3.26±1.63 (3.09-3.42)	4.04±2.47 (3.99-4.09)	4.79±2.98 (4.73-4.85)	4.95±3.00 (4.84-5.06)	5.06±3.65 (4.23-5.89)	0.001

Table 4. Adjusted parameters estimated across five BMI groups

Parameters	Significance level	Odds ratio	95% confidence interval
Cholesterol(Mg/dl)	0.023	27.02	(11.11-100)
Triglyceride(Mg/dl)	0.028	55.56	(10.00-65.02)
Diastolic blood pressure ≥ 90 mmHg	0.001	200	(29.87-234)
Cholesterol/HDL-C ratio	0.045	19.60	(2.64-25)
Triglyceride/ HDL-C ratio	0.029	41.66	(10.98-200)

Accordingly strongest associations were observed between DBP>90 mmHg, TG level, TG/HDL-C ratio, cholesterol, and cholesterol/ HDL-C ratio with increment in BMI level.

Discussion

In this large scale population based unique study of initially healthy adults we endorsed a significant increment in the prevalence and mean level of CAD risk factors across 5 increasing BMI categories. These findings are consistent with other reported trends of CAD risk factors in all BMI groups (1).

The prevalence of overweight and obesity in our investigation was 56.3% (42.6% overweight and 13.7% obesity) whereas in the Multi-Ethnic Study of Atherosclerosis (2) the prevalence of overweight was reported over 60% and the prevalence of obesity was higher than 30%, Gregg EW et al also reported a prevalence of 62.2% overweight and obesity for 1999-2000 NHANES (1).

We found that increment in BMI were associated with adverse effects on CAD risk factors in the term of odds ratio (OR) and likelihood ratio (LR) including: DBP>90 mmHg OR=200 and LR=102.19, TG OR=55.5 and LR=600.86, cholesterol OR=27.02 LR=224.79.

We observed a strong association between increase in lipid ratios with increment in BMI level in the term of OR: Cholesterol/ HDL-C ratio OR=19.6 and TG/HDL-C ratio OR=41.

Overweight persons demonstrated higher prevalence of DBP> 90 mmHg, high level of cholesterol, TG and ratios of cholesterol/HDL-C and TG/HDL-C with 2 times, 1.26 fold, 1.67 times, 1.05 fold, and 1.18 fold more than normal weight individuals respectively. Among obese case, incremental rate of 3.25, 1.22, 1.81, 1.06 and 1.22 related to DBP>90 mmHg, high level of cholesterol and TG, ratios of cholesterol HDL-C and TG/ HDL-C were detected, respectively.

The results of this research now demonstrate that overweight as like as obesity is associated with a higher prevalence of CAD risk factors. Thus in addition to obesity, overweight individual (7) might be considered at higher risk of CAD than in previous evidences (1-3,5).

Previous research (7) has shown that prevalence of hypertension, hypercholesterolemia and diabetes mellitus was higher among overweight and obese group whereas we found a multivariate adjusted increase in prevalence of DBP>90 mmHg, high level of cholesterol and TG, and higher level of cholesterol/ HDL-C and TG/HDL-C ratios among overweight and obese person. Therefore preventive strategy particularly, at childhood and in young individuals can curb the effect of overweight and obesity on CAD risk factors.

The lowest level of BMI is associated with lower level of CAD risk factors prevalence that resulted in lower risk of CAD presentation and stroke (8-9). Our results endorsed more features of the pattern of CAD risk factors in all BMI categories that are consequences of: First adjustment for gender, age, literacy, smoking, FBS, SBP, HDL-C, and LDL-C. Second, we examined CAD risk factors across five categories of BMI. Previous evidences in this era have shown prevalence and incidence of CAD risk factors across three levels of BMI (1-4,7).

Management of obesity is extremely difficult, thus providing more precise protocol of diet, physical activity and medical treatment according to BMI groups can guide implication of more efficacious strategy and lower rate of relapse in overweight and obesity.

Along with the prevalence of overweight and obesity of 56.3% in our population, prevalence of physical inactivity of 87% (10) needs urgent management.

Our findings support the pivotal idea of need for development on risk stratification and risk modification models. In the epidemic situation of CAD, advanced models of risk evaluation including both conventional, (11-17) and novel (18-25) CAD risk factors can guide to design more efficient control measures.

Previous studies have shown that the consequences of overweight and obesity are diabetes mellitus, hypertension and hypercholesterolemia (26,27). They recommend that reduction of 500kcal/day or more should be assigned to individuals with overweight and obesity until reaching normal BMI (26). A randomized

controlled trial on 605 myocardial infarction (MI) patients admitting Mediterranean diet or a western diet illuminated a 68% risk reduction in mortality and non fatal MI in patients admitted the Mediterranean diet after 46 months of follow up (26). In addition to dietary advice of consuming high fiber, and polyunsaturated fat, the other strategy for reaching optimal body weight is appropriate physical activity. Physical inactivity demonstrated a significant correlation with dysmetabolic situation in women (28).

Functional capacity was significantly lower among women suffering from metabolic syndrome across all BMI categories (28). Lower physical activity was associated with incremental prevalence of CAD risk factors and angiographic findings for CAD (23), and higher hazard of adverse CAD endpoints at intermediate follow up period. Previous research suggested that physical activity might be preferred to obesity for evaluating the CAD hazard (28).This study illuminated that, there was no statistically significant relationship between different measures of obesity of BMI, waist-hip ratio, waist-height ratio, and waist circumference with coronary artery steno sis. Whereas increasing BMI category was associated with higher prevalence of CAD risk factors (28) in both females and males (29).

Obesity was recognized as a population health threat throughout the world. Despite a more than enough evidence based information support of CAD risk factors treatment and management, these guidelines are not being performed at effective levels.

According to the findings that aggressive treatment of CAD risk factors would decline the rate of revascularizations, and similar efficacy of revascularization and medical treatment in known stable CAD patients (30), we can suggest more aggressive treatment guidelines for managing CAD risk factors including hypertension, diabetes mellitus, high level of cholesterol, tobacco use and obesity (30,31).

There are different thresholds of obesity for increasing cardiovascular hazard across populations. Hence recognition and management of obesity and overweight with concomitant CAD risk factors can guide better control of CAD epidemic in the national level.

Despite the epidemic condition of CAD in our region, non detection and under treatment of the CAD presentations and risk factors are evident. Such a burden of overweight and obesity associated with the prevalence of CAD risk factors detected in this study supports strategy of risk modification at national level. In conclusion, prevalence of DBP> 90 mmHg, hypertriglyceridemia, hyper cholesterolemia and ratios of cholesterol/ HDL-C and TG/HDL-C increased considerably across five groups of BMI. This pattern is different from previous research and our results endorsed more features of pattern of CAD risk factors across BMI categories.

Accordingly we suggest that the risk stratification and risk modification models could be updated based upon age groups and new features of relationships between risk factors.

Acknowledgement

This research was supported by a grant from the Tehran Municipality Health Center titled as MSTDT in 2007.

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