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Original Article

A comparison of body mass index and percent body fat as predictors of cardiovascular risk factors☆

Hosein Sheibani [a, b, 1], Habibollah Esmaeili [c, 1], Maryam Tayefi [d, e], Maryam Saberi-Karimian [e], Susan Darroudi [f], Mohsen Mouhebati [g], Mohmoud Reza Azarpazhooh [g], Ghasemali Divbands [h], Gordon A. Ferns [i], Mohammad Safarian [e, j, *], Majid Ghayour-Mobarhan [e, g, **]

[a] Vice-chancellery of Treatment, Shahroud University of Medical Science, Shahroud, Iran
[b] Imam Hossein Center for Education, Research and Treatment, Shahroud University of Medical Science, Shahroud, Iran
[c] Determinants of Health Research Center, Mashhad University of Medical Sciences, Mashhad, Iran
[d] Clinical Research Unit, Mashhad University of Medical Sciences, Mashhad, Iran
[e] Metabolic Syndrome Research Center, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
[f] Student Research Committee, Department of Modern Sciences and Technologies, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
[g] Cardiovascular Research Center, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
[h] Nuclear Medicine Research Center, Mashhad University of Medical Sciences, Mashhad, Iran
[i] Brighton & Sussex Medical School, Division of Medical Education, Falmer, Brighton, Sussex, BN1 9PH, UK
[j] Department of Nutrition, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

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ABSTRACT

Background: Cardiovascular disease (CVD) is an important cause of global mortality and morbidity. Body mass index (BMI) is the measure of adiposity that is used most frequently in CVD risk algorithms.
Aims: We aimed to assess the relationship between several CVD risk factors (RFs) and percent body fat (PBF), and to compare the predictive values obtained using PBF for these cardiovascular RFs with the values obtained using BMI. The CVD RFs included, hypertension (HTN), diabetes mellitus (DM) and the presence of dyslipidemia (DLP).
Methods and materials: The data were derived from the MASHAD study, a cohort study of 9704 volunteers, aged 35–65 years and living in the city of Mashhad. Based on BMI and PBF values, subjects were classified into 4 groups; group 1 (low or normal BMI and PBF, N = 1670), group 2 (low or normal BMI but high PBF, N = 992), group 3 (high BMI and low or normal PBF, N = 837), and group 4 (high BMI and PBF, N = 6245). Chi-square, covariance and logistic regression were used to analyze the data at a significance level of 0.05.
Results: There was an increasing trend from group 1 to group 4 for the mean values of all CVD RFs and their prevalence. There were significant differences in the frequency of a low HDL-C, this was substantially higher in Group 3 (38.6% in Group 3 versus 12.2% in Group 2); the frequency of a high serum TG (24% in Group 3 versus 9.9% in Group 2) and the frequency of dyslipidemia overall (56.2% in Group 3 and 28.8% in Group 2) (P-value<0.001 for all comparisons). The frequency of hypertension (22.9% in Group 3 versus 16.2% in Group 2) and IFG (8.5% in Group 3 versus 5.0% in Group 2) were also substantially higher in Group 3 compared to Group 2 (P-value<0.001 for both comparisons). All the mean values for the RFs were higher in group 3 from group 2 except HDL-C. When Group 1 was used as a reference and calculated OR of any RF for any group 2–4 rather than group 1, OR for all RF in group 3 was higher from group 2.

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* Corresponding author. Department of Nutrition, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, 99199-91766, Iran.
** Corresponding author. Metabolic Syndrome Research Center, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, 99199-91766, Iran.
E-mail addresses: safarianm@mums.ac.ir (M. Safarian), ghayourm@mums.ac.ir (M. Ghayour-Mobarhan).
[1] Equal first author.

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Conclusion: The differences in frequency, means and OR of RFs between Groups 2 and 3 showed a differential impact of a high BMI or high PBF. Compared to PBF, BMI may be a better predictor for several RFs for CVD.

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1. Introduction

Cardiovascular disease (CVD) is the most common cause of mortality and morbidity globally [1,2]. It is predicted that by 2025, the rate of death attributable to CVD will exceed death caused by other conditions [3,4]. Obesity is associated with several abnormalities in metabolism; it may also be associated with CVD, diabetes mellitus, and joint problems [5–7]. The prevalence of obesity is increasing rapidly in most countries [8].

The measurement of body fat has been traditionally limited to simple assessments, such as waist circumference, waist-to-hip ratio and body mass index (BMI). Due to its ease of measurement and calculation, BMI is the most widely used diagnostic tool to identify weight problems within a population. However, because of the difficulty of BMI to discriminate between body fat and lean mass, its diagnostic performance is limited in intermediate ranges of body weight; it cannot accurately categorize individuals who have a normal body weight with too much body fat but too little muscle and those who have an excessive body weight with little excessive body fat but a high muscle mass [9,26]. Furthermore BMI is age, sex and race dependent [11,12].

Percent body fat (PBF) is defined as the proportion of an individual's fat mass compared to body weight. Previous studies have shown that PBF reflects body composition more accurately than BMI [10,13]. A higher PBF and/or BMI often indicates a higher level of CVD risk [14]. However, the relationship between PBF and BMI is not linear [15,16]. A high PBF does not necessarily mean a high BMI, and vice versa. Thus, it is quite important to determine the CVD risk accurately in individuals who have a normal PBF but a high BMI or a high PBF but a normal BMI. In other words, it is necessary to evaluate whether BMI or PBF predicts CVD risk factors more accurately.

2. Material and methods

2.1. Subjects

The data were derived from the MASHAD STUDY, a cohort study conducted on 9704 volunteers, aged 35–65 years and living in the city of Mashhad in northeastern Iran, and sampled using a randomized cluster sampling technique, to ensure a representative sample; demographic and laboratory data were collected for all recruits) [17].

2.2. Measurement of body composition and categorizations of PBF and BMI

BMI was calculated using the following equation: BMI = body weight/height^2 (kg/m^2). PBF was measured using the a bipolar bioimpedence analyser (BIA). Before measurement, all subjects underwent an overnight fast (14 h) and were prohibited from vigorous activities within 12 h of measurement. The measurements were performed strictly according to manufacturer instructions.

Obesity was recorded if a subject had a BMI $\geq$30 kg/m^2 (both male and female) or PBF $\geq$25% (male) or $\geq$30% (female) according to Asian BMI criteria [18] and the U.S. National Institutes of Health criterion standards for PBF [19].

2.3. Measurement and definition of cardiovascular risk factors

The critical values of cardiovascular risk factors were designated as follows according to the 2017 American Diabetes Association Standards of Medical Care in Diabetes (New ADA 2017 Standards of Medical Care in Diabetes) [20], the JNC8 (eighth joint national committee) (2014 guideline for management of Blood pressure) [21], and 3rd report of NCEP (2002) (National Cholesterol Education Program) for dyslipidemia [22]; hypertension: SBP $\geq$140 mmHg and/or DBP $\geq$90 mmHg(42); hyperglycemia fasting blood glucose (FBG) $\geq$100 mg/dL (5.6 mM); IFG: FBG = 100–126 mg/dl, DM: FBG=>126 mg/dl, dyslipidemia: TC $\geq$ 240 mg/dL (6.2 mM), and/or TG $\geq$ 200 mg/dL (1.90 mM) and/or LDL-C $\geq$160 mg/Dl (4.1 mM) and/or HDL-C <35 mg/dL (0.9 mM), high TC/HDL Ratio = total cholesterol/HDL-C=>5 and high non HDL-C: (total cholestrol-HDL cholesterol) (NHC) $\geq$150 mg/dl (1.7 Mm). Gender and age were also considered as confounding risk factors on the present study.

2.4. Statistical analysis

Initially, subjects were divided into 4 groups according to BMI and PBF; group1 (normal BMI and PBF), group 2 (normal BMI and high PBF), group 3 (high BMI and normal PBF), and group 4 (high BMI and PBF); then, numerical risk factors and frequency of nominal and categorical risk factors were compared between the 4 groups by covariance analysis, followed by chi square (or Fisher's exact test) analysis with risk estimate phase.

The odds ratio (OR) of cardiovascular risk factors in groups 2, 3, and 4 were analyzed using a multivariate logistic regression model and compared with group 1, as a reference.

3. Results

3.1. General characteristics and metabolic parameters of the study subjects in relation to the categorization by BMI and PBF

Of the total of 9704 subjects included in the analysis, 39.9% were male. The majority of subjects categorized in the 4th group were women; the majority of group 2 subjects were female and the majority of group 3 subjects were male. The proportion of smokers was highest in group 4 and lowest in group 2. There appeared to be no difference in the proportion of subjects with a family history of coronary artery diseases among the four groups. BMI was the highest in group 4 and the lowest in group 1.

Data are reported as number with percent in parentheses or means ± SD. P values were obtained from comparisons among the four groups. The chi-square test was used to analyze categorical variables and ANOVA was used to analyze numerical variables. The level of significance was 0.05. In a row, different symbols indicate statistically significant differences. **Group 1** (both normal BMI and PBF): BMI <25 kg/m^2 and PBF <25% (male) or <30% (female); **group 2** (normal BMI but abnormal PBF): BMI <25 kg/m^2 and PBF $\geq$25% (male) or $\geq$30% (female); **group 3** (abnormal BMI but normal PBF): BMI $\geq$25 kg/m^2 and PBF <25% (male) or <30% (female); **group 4**

(both abnormal BMI and PBF): BMI ≥25 kg/m^2 and PBF ≥25% (male) or ≥30% (female) (see Table 1).

3.2. Cardiovascular risk factors of the study subjects

After separation of subjects into the 4 groups, comparisons were made, according to BMI and PBF levels due to the counter effects of BMI and PBF, and the complexity of the results, was undertaken between the 4 groups using covariance analysis. The results of this are shown in Tables 2 and 3. PBF and BMI are dominant independent variables in the second and the third groups; consequently, comparing these two groups is in effect comparing BMI and PBF.

3.2.1. he mean of continuous cardiovascular risk factors of subjects by group (according to BMI and PBF levels)

Means and standard deviation obtained for all numerical RFs in relation to groups (according to BMI and BFP), the results of which are shown in Table 2.

For all RF values, there was an increasing trend from group 1 to group 4, apart from HDL-C which showed a decreasing trend. Apart from HDL-C, the means of all risk factors were higher in group 3 compared with group 2.

3.2.2. Comparison of cardiovascular numerical risk factors between the groups (according to BMI and PBF levels)

The difference in mean values for CVD RFs between all groups (6 comparisons) were compared, the results of which are shown in Table 3.

The mean differences between 2nd and 3rd groups were statistically significant for all RFs, apart from FBG and LDL-C. High BMI and PBF were associated with increased means of cardiovascular risk factors and association of both in one person (group 4) lead to maximum RFs means; however, high BMI rather than high PBF (group 3) were associated with higher mean values for the RFs (group 2).

3.2.3. Comparison of categorical risk factors' frequency rate in the specified groups (according to BMI and PBF levels)

Table 4 shows the results of chi-square test for comparing the dependent variables frequencies between 4 study groups. There were significant differences in the frequency of all CVD risk factors, these were substantially higher in Group 3 comparing with Group 2 (P-value<0.001 for all comparisons).

The subjects in Group 4 had the highest BMI and PBF, and the majority of risk factors were found more frequent in this group, followed by group 3 and group 2, apart from the presence of diabetes mellitus and LDL-c ≥160(mg/dl). The differences in frequency of RFs between Groups 2 snd 3 shows the differential impact of a high BMI or high PBF. These group comparisons show some interesting findings. There were significant differences in the frequency of low HDL-C, this being substantially higher in Group 3 (38.6% versus 12.2%); the frequency of a high serum TG (24% in Group 3 versus 9.9% in Group 2) and the frequency of dyslipidemia overall (56.2% in Group 3 and 28.8% in Group 2). The frequency of hypertension (22.9% in Group 3 versus 16.2% in Group 2) and IFG (8.5% in Group 3 versus 5.0% in Group 2) were also substantially higher in Group 3 compared to Group 2.

3.2.4. 4: BMI and PBF-based comparison of risk factors' Odd Ratio in four groups

Group 1 was used as the reference group to evaluate the OR of risk factors with respect to BMI and PBF. Group 4 had the highest OR for the presence of RFs, followed by Group 3 and, finally, Group 2.

According to Table 5 for the majority of risk factors the Odd Ratio was highest in Group 4 and followed by Group 3 and then Group 2, apart from the prevalence of diabetes mellitus, and serum total cholesterol and LDL-C. BMI was therefore associated with a higher Odds Ratio for all risk factors apart from TC, DM and LDL-C.

Fig. 1 provides a simpler demonstration of the above explanation. Odds Ratio for majority of risk factors is higher in the Group 3 when compared with Group 2.

When Group 1 was used as the reference group and compared OR for any RF in groups 2–4 rather than it. Group 4 had the highest OR for the presence of RFs, followed by Group 3 and, finally, Group 2. Risks for any of the cardiovascular risk factors according to subject groups classified by body mass index (BMI) and percent body fat (PBF). Low BMI and PBF was set as a reference. Low BMI and PBF = BMI <25 kg/m^2, and PBF <25% (male) or <30% (female); low BMI and high PBF = BMI <25 kg/m^2, and PBF ≥25% (male) or ≥30% (female); high BMI and low PBF = BMI ≥25 kg/m^2 and PBF <25% (male) or <30% (female); high BMI and PBF = BMI ≥25 kg/m^2 and PBF ≥25% (male) or ≥30% (female). 95%CI = 95% confidence interval.

4. Discussion

The differences in frequency of RFs between Groups 2 (low or normal BMI but high PBF) and 3 (high BMI and low or normal PBF) shows the differential impact of a high BMI or high PBF. The comparisons between these groups was clearly interesting. There were significant differences in the frequencies of low HDL-C, high serum

Table 1
General characteristics and metabolic parameters of the study subjects in relation to the categorization by BMI and PBF.

Variables	Group1(NL BMI & PBF) (N = 1670)	Group2(Normal BMI & abnormal PBF)(N = 992)	Group3(abnormal BMI & NL PBF) (N = 837)	Group4(abnormal BMI & PBF) (N = 6245)	P Value
Gender					
Male	1331(79.7%)	101(10.1%)	767(91.6%)	1645(26.5%)	<0.001
Female	339(20.3%)	891(89.9%)	70(8.4%)	4600(73.5%)	<0.001
Age group					
35–44	689(20.3%)	396(39.9%)	409(48.8%)	2484(34.9%)	<0.001
45–54	651(37.5%)	357(36%)	311(37.2%)	2383(41.3%)	<0.001
55–65	330(19.7%)	239(24.1%)	117(14%)	1378(23.9%)	<0.001
Life style					
Smoking	285.8(15.5%)	89.3(9%)	152.3(18.2%)	1373.9(22%)	<0.001
Phisical activity level	324(19.4%)	181.5(18.3%)	146.4(17.5%)	1049.3(16.8)	0.653
Family history	197(11.8%)	129(13%)	104.6(12.5%)	793.2(12.7%)	0.615
Age(years)	47.42 ± 8.43	48.06 ± 8.43	45.68 ± 7.43	48.71 ± 8.13	<0.001
BMI(Kg/m^2)	21.77 ± 2.08	23.54 ± 1.17	27.24 ± 2.36	30.33 ± 3.70	<0.001
PBF(%)	19.86 ± 4.88	33.90 ± 4.01	23.40 ± 2.08	39.47 ± 7.77	<0.001

Table 2
Cardiovascular numerical risk factors' means of the study subjects in relation to the classification by BMI and PBF levels.

Variables	Group1(Norm al BMI&PBF)(N = 1670)	Group2(Normal BMI&abnormal PBF) (N = 992)	Group3(abnorm al BMI&NL PBF)(N = 837)	Group4(abnor malBMI&PBF)(N = 6245)	P-Value
SBP(mmhg)	116.85 ± 15.92	117.46 ± 17.94	123.27 ± 16.67	124.02 ± 20.02	<0.001
DBP(mmhg)	75.60 ± 12.17	76.57 ± 11.02	79.94 ± 10.62	80.74 ± 11.86	<0.001
FBG(mg/dl)	86.38 ± 35.60	91.56 ± 43.76	92.43 ± 35.65	94.33 ± 39.81	<0.001
LDL-c(mg/dl)	114.61 ± 33.50	115.61 ± 35.13	117.36 ± 33.61	118.74 ± 35.05	<0.001
HDL-c(mg/dl)	44.47 ± 10.60	43.20 ± 9.76	40.67 ± 8.47	40.83 ± 10.28	<0.001
TC(mg/dl)	183.43 ± 38.20	186.43 ± 40/03	193.13 ± 37.58	193.50 ± 38.94	<0.001
TC/HDL	4.25 ± 1.13	4.48 ± 1.12	5.91 ± 1.11	4.88 ± 1.14	<0.001
TG(mg/dl)	110.77 ± 93.49	127.75 ± 82.79	158.76 ± 109.98	155.56 ± 92.19	<0.001
NHC(mg/dl)	138.77 ± 36.57	143.41 ± 38.59	152.43 ± 35	152.61 ± 36.76	<0.001

Data are reported as means ± SD. P values were obtained from comparisons among the four groups. In a row, different symbols indicate statistically significant differences. **Group 1** (both normal BMI and PBF): BMI <25 kg/m^2 and PBF <25% (male) or <30% (female); **group 2** (normal BMI but abnormal PBF): BMI <25 kg/m^2 and PBF ≥25% (male) or ≥30% (female); **group 3** (abnormal BMI but normal PBF): BMI ≥25 kg/m^2 and PBF <25% (male) or <30% (female); **group 4** (both abnormal BMI and PBF): BMI ≥25 kg/m^2 and PBF ≥25% (male) or ≥30% (female).
SBP: Systolic blood pressure/**DBP:** Diastolic blood pressure/**FBG:** Fasting plasma glucose/**LDL-c:** Low dencity lipoprotein/**HDL-cholesterol:** High density lipoprotein/**TC:** Total cholesterol/**TG:** Triglycerid/**NHC:** Non HDL Cholestrol/.

Table 3
Covariance analysis results in effect of the groups on cardiovascular numerical risk factors with control of age and sex variables (Mean Difference using pairwise comparisons).

Variables	GROUP 1with2	GROUP 1with3	GROUP 1with4	GROUP 2with3	GROUP 2with4	GROUP 3with4
SBP(mmhg)	0.430(+0.623)	<0.001(+6.40)	<0.001(+7.15)	<0.001(+5.78)	<0.001(+6.53)	0.306(+0.747)
DBP(mmhg)	0.056(+0.970)	<0.001(+4.34)	<0.001(+5.13)	<0.001(+3/37)	<0.001(+4.16)	0.093(+0.791)
FBG (mg/dl)	0.003(+5.18)	0.001>(+6.04)	<0.001(+7.95)	0.668(+0.870)	0.042(+2.76)	0.237(+1.89)
LDL-c(mg/dl)	0.492(+1.05)	0.063(+2.79)	<0.001(+4.08)	0.341(+1.71)	0.002(+3.65)	0.655(+0.63)
HDL-c(mg/dl)	0.002(-1.27)	<0.001(-3.79)	<0.001(-3.64)	<0.001(-2.52)	<0.001(-2.37)	0.686(+0.153)
TC(mg/dl)	0.050(+3.34)	<0.001(+10.01)	<0.001(+10.28)	<0.001(+6.66)	<0.001(+6.91)	0.864(+0.272)
TC/HDL	<0.001(+0.231)	<0.001(+0.660)	<0.001(+0.625)	<0.001(+0.429)	<0.001(+0.393)	0.440(-0.036)
TG(mg/dl)	<0.001(+17.28)	<0.001(+48.71)	<0.001(+45.31)	<0.001(+31.43)	<0.001(+28.02)	0.376(-3.40)
NHC(mg/dl)	0.004 (+4.61)	<0.001(+13.81)	<0.001(+13.93)	<0.001(+9.19)	<0.001(+9.31)	0.936(+0.121)

Groups 1–4 are identified in previous tables. Data are reported as p values and mean difference (in parentheses) between the two specified groups. The P value was obtained from the co variance test.
SBP: Systolic blood pressure/**DBP:** Diastolic blood pressure/**FBG:** Fasting plasma glucose/**LDL-c:** Low dencity lipoprotein/**HDL-c:** High dencity lipo protein/**TC:** Total cholesterol/**TG:** Triglycerid/**NHC:**Non HDL Cholestrol/**Group1:** low or normal BMI and PBF/**group2:** low or normal BMand high PBF/**Group3:** high BMI and low or normal PBF/**Group4:** high BMI and PBF.

Table 4
Comparison of the frequency rate of RFs within the 4 groups (according to BMI and PBF levels).

Variables	Group1(NL BMI&PBF)(N = 1670)	Group2(Normal BMI&abnormal PBF)(N = 992)	Group3(abnorm al BMI&NL PBF)(N = 837)	Group4(abnor mal BMI&PBF)(N = 6245)	p-value
SBP*140(mmhg)	124(7.7%)	107(11.3%)	98(12.1%)	1122(19%)	<0.001
DBP*90(mmhg)	183(11.4%0	114(12%)	165(20.3)	1322(22.4%)	<0.001
HTN	230(14.3%)	153(16.2%)	186(22.9%)	1633(27.7%)	<0.001
IFG	85(5.3%)	48(5.0%)	71(8.5%)	636(10.7%)	<0.001
DM	76(4.8%)	86(9.0%)	72(8.9%)	611(10.4%)	<0.001
LDL-c ≥ 160(mg/dl)	126(7.9%)	98(10.4%)	64(7.9%)	715(12.2%)	<0.001
HDL-c ≤ 35(mg/dl)	348(21.9%)	115(12.2%)	312(38.6%)	1178(20%)	<0.001
TC ≥ 240(mg/dl)	102(6.4%)	91(9.6%)	65(8%)	744(12.7%)	<0.001
TC/HDL ≥ 5	446(28%)	221(23.4%)	420(52%)	2252(38.3%)	<0.001
TG ≥ 200(mg/dl)	149(9.2%)	94(9.9%)	194(24%)	178(20%)	<0.001
DLP	532(33.6%)	272(28.8%)	454(56.2%)	2532(43.1%)	<0.001
NHC ≥ 150(mg/dl)	546(34.3%)	369(39%)	369(45.7%)	2951(50.2%)	<0.001

Data are reported as number with percent in parentheses (number of abnormal subjects/number of subjects in group × 100). P values were obtained from comparisons among the four groups using a chi-square test.
SBP: Systolic blood pressure/**DBP:** Diastolic blood pressure/**FBG:** Fasting plasma glucose/**LDL-c:** Low dencity lipoprotein/**HDL-c:** High dencity lipo protein/**TC:** Total cholesterol/**TG:** Triglycerid/**NHC:** Non-HDL Cholestrol/**DLP:** Dyslipidemia/**DM:** Diabetus mellitus/**IFG:**Impaired fasting plasma glucose(FBG = 100–126 mg/dl)/**HTN:**Hypertention/**Group1:**low or normal BMIandPBF/**group2:**low or normal BMand high PBF/**Group3:** high BMI and low or normal PBF/**Group4:** high BMI and PBF/**DLP:** LDL≥160 or HDL≤35 orTC≥240 or TG ≥ 200/.

TG and dyslipidemia overall, these being substantially higher in Group 3. Moreover, the frequency of hypertension and IFG were also substantially higher in Group 3 compared to Group 2.

Former studies have had similar objectives as the present study (comparison of BMI and PBF predictive effect for cardiovascular risk factors) and the results of these have been inconsistent. Jacob et al.

Table 5
Odd Ratio and P-value for any risk factors in groups 2–4 rather than 1st group.

Variables	Group1(NL BMI&PBF)(N = 1670)	Group2(Normal BMI&abnormal PBF) (N = 992)	Group3(abnorm al BMI&NL PBF)(N = 837)	Group4(abnor mal BMI&PBF) (N = 6245)	Groups setup according to their Odd ratio
SBP˃140(mmhg)	1	1.520(0.003)	1.641(0.001)	2.574(<0.001)	4>3 > 2>1
DBP˃90(mmhg)	1	1.063(0.632)	1.983(<0.001)	2.244(<0.001)	4>3 > 2>1
HTN	1	1.151(0.215)	1.778(<0.001)	2.288(<0.001)	4>3 > 2>1
IFG	1	0.761(0.411)	1.989(0.062)	2.886(<0.001)	4>3 > 2>1
DM	1	1.995(<0.001)	1.951(<0.001)	2.314(<0.001)	4>2 > 3>1
LDL-c ≥ 160(mg/dl)	1	1.345(0.036)	1.001(0.996)	1.611(<0.001)	4>2 > 3>1
HDL-c ≤ 35(mg/dl)	1	0.495(<0.001)	2.249(<0.001)	0.896(0.111)	3 > 4>2 > 1
TC ≥ 240(mg/dl)	1	1.555(0.003)	1.278(0.137)	2.117(<0.001)	4>2 > 3>1
TC/HDL ≥ 5	1	0.783(0.010)	2.781(<0.001)	1.596(<0.001)	3>4 > 2>1
TG ≥ 200(mg/dl)	1	1.093(0.524)	3.129(<0.001)	2.482(<0.001)	3>4 > 2>1
DLP	1	0.797(0/089)	2.534(<0.001)	1.496(<0.001)	3>4 > 2>1
NHC ≥ 150(mg/dl)	1	1.225(0.017)	1.610(<0.001)	1.932(<0.001)	4>3 > 2>1

SBP: Systolic blood pressure/**DBP:** Diastolic blood pressure/**FBG:** Fasting plasma glucose/**LDL-c:** Low dencity lipoprotein/**HDL-c:** High dencity lipo protein/**TC:** Total cholesterol/**TG:** Triglycerid/**NHC:** Non-HDL Cholestrol/**DLP:** Dyslipidemia/**DM:** Diabetus mellitus/**IFG:** Impaired fasting plasma glucose(FBG = 100–126 mg/dl)/**HTN:** Hypertention/**Group1:** low or normal BMIandPBF/**group2:** low or normal BMand high PBF/**Group3:** high BMI and low or normal PBF/**Group4:** high BMI and PBF/**DLP:** LDL≥160 or HDL≤35 orTC≥240 or TG ≥ 200.

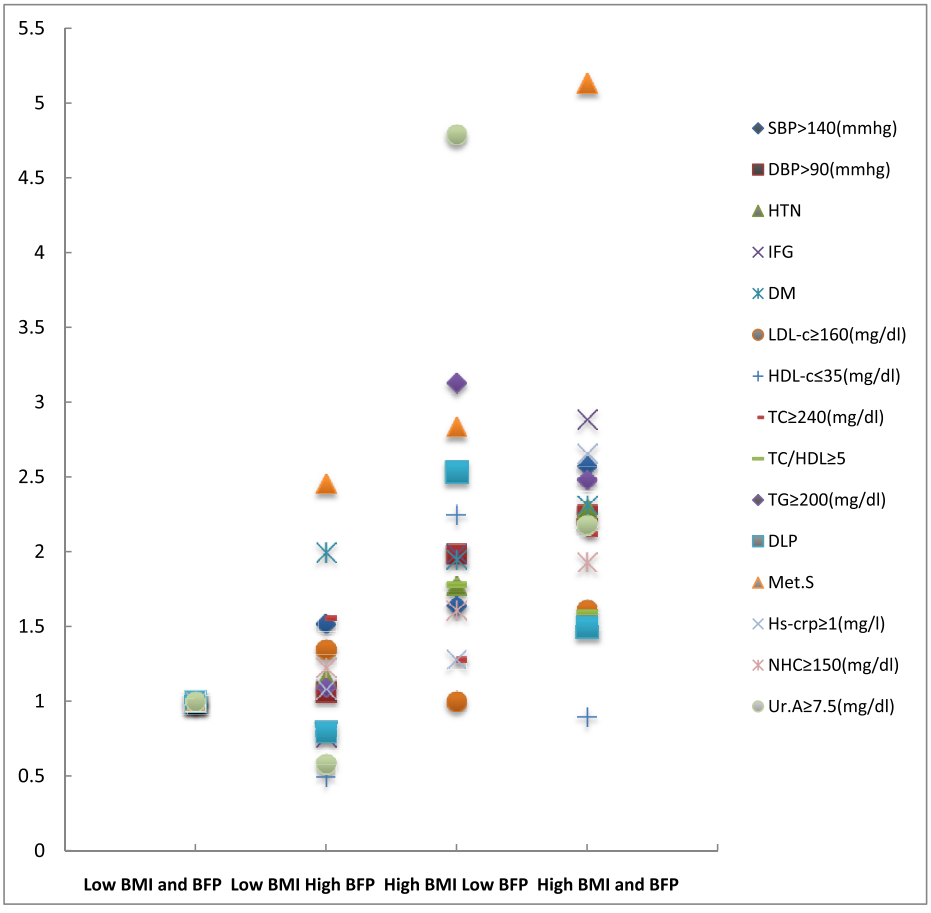

Fig. 1. Comparison of Odds Ratios for risk factors in Groups 2, 3, and 4 compared to Group 1.

[23], reported that the correlation coefficient between BMI and PBF among Lebanese females aged 12 -8 years was 0.83. The results of this current study were similar to several of these previous reports for some risk factors, but differed for some others. The findings of the present study are inconsistent with the study of Zeng et al. [24], but consistent with the results of Bohn et al. [25]. Zeng et al. have assesed the relationship of body composition with cardiac function and arterial compliance among 325 healthy adults in China. They have suggested that BIA can be applied for predicting the risk of CVD. They have reported that there is an association between the

BFR and arterial function, systolic and diastolic cardiac function. BFR was significantly lower in subjects with normal systolic function compared to those with defective arterial compliance [24]. These controversial results may be because of different sample size or ethnicity used. Bohn et al. have evaluated the association between BF and cardiovascular RFs in 3327 children and adolescents and to examine whether BF is better appropriated than BMI. Their results showed that there are no differences between BMI and BF regarding their correlation with other cardiovascular RFs [25].

In a cohort study by Lichtash et al., it has been shown that PBF displays fewer correlations with cardiometabolic RFs compared to BMI among 698 Mexican Americans [26]. Schulze et al. have found that waist circumference and BMI were more strongly associated than body adiposity index (BAI) with insulin sensitivity and diabetes mellitus risk [27]. According to the results of the study of Scheuing et al. [13], the predictive value of BMI and PBF was the same, and the predictive value of BMI and PBF for some of cardiovascular risk factors was the similar too, in the present study.

Our findings were consistent with the study of Bovet study et al. [28], but not with that of Mirhosseini et al. [29]. Mirhosseini et al. have assessed indices of adiposity and their association with cardiovascular RFs in 477 adolescent girls (aged 15–18 years). Their results showed that all anthropometric indices had a significant correlation with total and regional BFP. FBG levels was increased in subjects with high fat free mass compared to the subjects with low fat free mass. Most of cardiovascular RFs, especially SBP and DBP and TG level, were significantly higher in group with high body fat compared to the normal and low body fat groups [29]. The existed inconsistency with our results could be explained by the population samples including age and gender. Whilst, Bovet et al. have shown that all obesity indices are associated with cardiovascular risk factors, excluding FBG in men and LDL-C in women. Their results have proven that BMI can predict the single or combined cardiovascular risk factors [28].

The main strength points of the present study include the large sample size and the evaluation of a large number of variables affecting CVD risk. However, like all other researches, the results of the present study turned out to be consistent with some and inconsistent with some other formerly conducted studies. Since the technique used in the present study for assessing PBF, which might be less accurate compared to the multipolar device, this might be one of the main causes of our findings; thus, doing further research with different techniques might provide varying findings in comparison with what the present study showed.

5. Conclusion

Compared to PBF, BMI can be a better predictor of CVD RFs in Iranian population.

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