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The association between smoking and obesity in Iranian adult population: A Study based on third national surveillance of the risk factors of the noncummunicable diseases (SuRFNCD-2007)

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ABSTRACT

Smoking and smoking cessation are presumed to have associations with body weight and central adiposity. This study aims to investigate the relationship between these factors in a large sample of the Iranian adult population. We collected the data regarding smoking status, weight, height and waist circumference (WC) from 5287 Iranian individuals aged 15-64 years who participated in the third national surveillance of risk factors of non-communicable diseases (SuRFNCD) in March 2007. The BMI and WC values were investigated in smoker, ex-smoker and never-smoker groups using univariate and multivariate analyses. In the univariate analysis, ex-smokers had significantly higher rate of general obesity (p=0.002), central obesity (P<0.001), mean BMI (p<0.001) and mean WC (p<0.001) compared to the current smoker group. Although smokers had significantly lower rate of obesity (p=0.003) and mean BMI (p<0.001) compared to non-smokers, they had significantly higher WC (p=0.016). Interestingly, among female subjects, smokers had higher rate of obesity (p=0.006) and BMI (p=0.006) than non-smokers, while ex-smokers were not more obese than smokers. However, smoking status was not independently associated with obesity or central obesity in the multivariate regression analysis. Since smoking seems to be associated with higher risk of central obesity, the misleading notion that smoking causes weight loss should be avoided. Iranian women should be more cautious if they tend to stay slim by the false belief that smoking induces weight loss.

1. Introduction

Smoking and obesity are important preventable risk factors of non-communicable diseases in the world and particularly, in Iran (Esteghamati et al., 2010; Meysamie et al., 2010). Smoking and obesity can together increase the risk of cerebrovascular, cardiovascular and systemic atherosclerotic diseases (Honjo et al., 2010). Life expectancy of overweight smokers is estimated to be 13 years lower than normal weight non-smokers (Peeters et al., 2003). According to available body of evidence, smoking is presumed to be associated with central adiposity despite decreased weight (Barrett-Connor and Khaw, 1989). Significant changes in both waist circumference (WC) and waist-to-hip ratio (WHR) along with lipid profile disturbances have been seen among smokers (Caks and Kos, 2009; Meysamie

Table 1. Prevalence of central obesity in different smoking strata divided by participant characteristics; Iran 2007

		Central obesity -IR				
		Smoker	Ex-smoker	Nonsmoker	p	
Gender	Male	38.8% (34.1%-43.8%)	50.6% (41.7%-59.4%)	36.1% (33.2%-39.1%)	S vs. ES ES vs. NS S vs. NS	0.021 0.002 0.335
	Female	47.3% (32.2%-62.8%)	75.3% (41.9%-92.8%)	34.8% (32.5%-37.1%)	S vs. ES ES vs. NS S vs. NS	0.199 0.038 0.094
	p	0.283	0.237	0.490		
Habitant	Rural	31.7% (23.7-40.8)	38.6% (25.6-53.5)	29.8% (26.7-33.1)	S vs. ES ES vs. NS S vs. NS	0.367 0.173 0.660
	Urban	42.3% (37.0-47.9)	58.2% (47.7-68.1)	37.7% (35.5-40.0)	S vs. ES ES vs. NS S vs. NS	0.009 <0.001 0.111
	p	0.036	0.024	<0.001		
Age	=<40	34.2% (28.5-40.3)	39.0% (24.2-56.0)	26.1% (24.0%-28.3%)	S vs. ES ES vs. NS S vs. NS	0.544 0.061 0.006
	>40	47.5% (40.4%-54.7%)	60.8% (51.6%-69.3%)	64.8% (62.1%-67.4%)	S vs. ES ES vs. NS S vs. NS	0.027 0.405 <0.001
	p	0.004	0.016	<0.001		
Obesity	Non Obese	31.7% (27.4%-36.2%)	39.5% (30.5%-49.2%)	23.8% (22.1%-25.6%)	S vs. ES ES vs. NS S vs. NS	0.116 <0.001 <0.001
	Obese	95.1% (88.3%-98.0%)	100.0% (---)	89.7% (86.9%-92.0%)	S vs. ES ES vs. NS S vs. NS	<0.001 <0.001 0.278
	p	<0.001	<0.001	<0.001		
Total		39.3% (34.7%-44.0%)	52.3% (43.7%-60.8%)	35.4% (33.6%-37.2%)	S vs. ES ES vs. NS S vs. NS	0.009 <0.001 0.116

S: Smoker**; ES:** Es-smoker**; NS:** Non-smoker

et al., 2012). Not only smoking increases central fat accumulation, but also is usually clustered with some other risk factors like poor diet, alcohol consumption and low physical activity (Chiolero et al., 2008), which may lead to weight gain. On the other hand, smoking can cause weight loss by increasing daily energy expenditure by 10% (Hofstetter et al., 1986), and reducing appetite (Chiolero et al., 2008). However, contributing pathophysiologic factors in the association between smoking and obesity are yet to be elucidated (Chiolero et al., 2008). Additionally to quit smoking by itself may affect metabolic processes in the human body. Some explanations have been presented, for example it has been shown that pancreatic β-cell secretion increases in response to decreased fasting insulin sensitivity shortly after smoking cessation (Stadler et al., 2014). Also, decreased level of Neuropeptide-Y (NPY) in smoking and its increase after cessation was found to correlate with body weight, WC and BMI. NPY plays a major role in energy homeostasis (Hussain et al., 2012).

Although several researchers have addressed this topic in our country, there is no national representative data regarding the association between smoking and obesity in Iran. Thus, we aimed to clarify this association in the adult population of Iran.

2. Material and methods

The third national surveillance of risk factors of non-communicable Diseases (SuRFNCD) was conducted in March 2007 and included 5.287 non-institutionalized individuals aged 15-64 years. The survey was devised in accordance with the STEPs guidelines of the WHO (Esteghamati et al., 2009b). Study sample consisted of clusters of 10 men and 10 women who lived in adjacent residents which were randomly chosen according to the postal codes. Verbal consents were obtained before recording the data. Interviewers asked information about tobacco use among other questions and measured weight, height and WC of the participants in addition to some other examinations. Weight and height were measured using portable calibrated digital weighing scale and portable inflexible measurement tapes. WC was measured using constant-tension tape device, halfway between the lowest border of the ribs (the mid rib 12) and the upmost part of the hip (iliac crest) on the midle axillary line, at the end of normal expiration while the arms were extended and aligned with body.

Table 2. Prevalence of central obesity in different smoking strata divided by participant characteristics; Iran 2007

		Central obesity -IDF				
		Smoker	Ex-smoker	Nonsmoker	p	
Gender	Male	25.6% (21.5%-30.2%)	42.2% (34.0%-50.9%)	26.0% (23.6%-28.6%)	S vs. ES ES vs. NS S vs. NS	<0.001 <0.001 0.869
	Female	70.3% (55.0%-82.1%)	94.2% (66.7%-99.2%)	58.8% (56.3%-61.3%)	S vs. ES ES vs. NS S vs. NS	0.376 0.213 0.178
	p	<0.001	0.036	<0.001		
Habitant	Rural	19.6% (13.1-28.3)	32.4% (20.8-46.7)	39.3% 36.0-42.6)	S vs. ES ES vs. NS S vs. NS	0.046 0.278 <0.001
	Urban	31.5% (26.7-36.7)	51.6% (41.4-61.7)	47.0% (44.7-49.2)	S vs. ES ES vs. NS S vs. NS	<0.001 0.389 <0.001
	p	0.007	0.018	<0.001		
Age	=<40	23.3% (18.4%-29.1%)	36.8% (23.1%-53.1%)	35.7% (33.5%-38.0%)	S vs. ES ES vs. NS S vs. NS	0.046 0.875 <0.001
	>40	35.8% (29.6%-42.6%)	51.6% (42.4%-60.7%)	73.2% (70.8%-75.4%)	S vs. ES ES vs. NS S vs. NS	0.005 <0.001 <0.001
	p	0.002	0.085	<0.001		
Obesity	Non Obese	19.2% (15.8%-23.1%)	32.2% (23.9%-41.7%)	33.9% (32.0%-36.0%)	S vs. ES ES vs. NS S vs. NS	0.002 0.699 <0.001
	Obese	91.8% (81.3%-96.6%)	96.2% (77.4%-99.5%)	95.2% (91.4%-97.3%)	S vs. ES ES vs. NS S vs. NS	0.775 0.929 0.486
	p	<0.001	0.008	<0.001		
Total		39.3% (34.7%-44.0%)	52.3% (43.7%-60.8%)	35.4% (33.6%-37.2%)	S vs. ES ES vs. NS S vs. NS	0.009 0.001 0.116

S: Smoker**; ES:** Es-smoker**; NS:** Non-smoker

2.1. Authropometric measurements

We defined the obesity status by Body Mass Index (BMI), determined as weight (Kg)/height (m^2). We considered BMI level ≥30 kg/m^2 as obesity and BMI level in the 25-30 kg/m^2 range as overweight. Central obesity was defined with 3 different available criteria: WC ≥90 cm for both genders according to optimal cut-off for Iranian citizens (Esteghamati et al., 2009a); WC ≥80 for women and WC ≥94 cm for men according to the International Diabetes Federation (IDF) criteria (Alberti et al., 2005); and WC ≥88 cm in females and ≥102 cm in males according to National Cholesterol Education Program-Third Adult Treatment Panel (ATP III) criteria (2001). Current cigarette smokers who had smoked at least 7 cigarettes during the week before recruitment were defined zas smokers. We defined Ex-smokers as those who had not smoke for at least one year. Nonsmokers were those who hadn't smoked.

2.2. Statistical analysis

Statistical analysis was conducted by complex sample survey analysis using SPSS statistical package (V20) and STATA Portable (V12). Total prevalence rates were presented with 95% confidence intervals (CI 95%). We used two proportion and two mean comparison tests based on complex sample survey analysis. Finally adjusted Odds Ratios based on complex sample logistic regression analysis were calculated via multivariate analysis.

2.3. Ethics

This study has been ethically approved by Iranian Ministry of Health, Treatment, and Medical Education as a national study (SuRFNCD-2007).

3. Results

The analysis included the data of 5227 adults for this study excluding 60 participants without valid BMI values from the original database. Out of all, 2631 were male comprising 733 smokers, 166 Ex-smokers and 1795 nonsmokers; and 2596 were female comprising 52 smokers, 11 Ex-smokers and 2533 non-smokers.

The prevalence of central obesity in different smoking strata with Iranian central obesity criteria in Table 1, with IDF criteria in Table 2 and with ATP3 criteria in Table 3.

Based on ATP III criteria, the total prevalence of abdominal obesity was 13.5%, 23.0% and 27.4% among smokers, ex-smokers and nonsmokers, respectively (p<0.001). According to the IDF criteria

Table 3. Prevalence of central obesity in different smoking strata divided by participant characteristics; Iran 2007

		Central obesity -ATP3				
		Smoker	Ex-smoker	Nonsmoker	p	
Gender	Male	11.5% (8.5%-15.4%)	18.3% (12.7%-25.5%)	9.8% (8.4%-11.4%)	S vs. ES ES vs. NS S vs. NS	0.024 <0.001 0.294
	Female	47.3% (32.2%-62.8%)	86.1% (55.3%-96.9%)	40.7% (38.3%-43.2%)	S vs. ES ES vs. NS S vs. NS	0.101 0.039 0.390
	p	<0.001	<0.001	<0.001		
Habitant	Rural	5.5% (3.3-8.9)	13.1% (6.2-25.4)	23.8% (20.9-27.0)	S vs. ES ES vs. NS S vs. NS	0.009 0.020 <0.001
	Urban	16.8% (12.8-21.7)	27.3% (19.2-37.1)	28.9% (27.0-30.8)	S vs. ES ES vs. NS S vs. NS	0.014 0.711 <0.001
	p	<0.001	0.013	0.005		
Age	=<40	9.0% (6.3%-12.8%)	18.0% (8.2%-35.0%)	19.5% (17.7%-21.4%)	S vs. ES ES vs. NS S vs. NS	0.031 0.774 <0.001
	>40	20.7% (15.0%-27.9%)	26.2% (19.2%-34.5%)	52.2% (49.3%-55.2%)	S vs. ES ES vs. NS S vs. NS	0.228 <0.001 <0.001
	p	<0.001	0.210	<0.001		
Obesity	Non Obese	5.5% (3.9%-7.6%)	10.2% (5.6%-17.6%)	15.3% (13.9%-16.9%)	S vs. ES ES vs. NS S vs. NS	0.024 0.075 <0.001
	Obese	71.8% (57.8%-82.5%)	69.3% (49.9%-83.7%)	84.0% (80.2%-87.2%)	S vs. ES ES vs. NS S vs. NS	0.836 0.074 0.053
	p	<0.001	<0.001	<0.001		
Total		13.5% (10.5%-17.2%)	23.0% (16.7%-30.7%)	27.4% (25.8%-29.0%)	S vs. ES ES vs. NS S vs. NS	0.003 0.208 0.001

S: Smoker**; ES:** Es-smoker**; NS:** Non-smoker

a similar pattern was seen (28.1% in smokers vs. 44.7 in non-smokers, p<0.001). Abdominal obesity based on Iranian cut-offs was significantly more prevalent among Ex-smokers (52.3%) than smokers (39.3%) and nonsmokers (35.4%), p<0.001. Female ex-smokers had significantly higher prevalence of central obesity compared to non-smokers (86.1% vs. 40.7%, p=0.039 based on ATP III criteria, 75.3% vs. 34.8%, p=0.038 based on Iranian cut-offs). However, this difference despite seen was not significant between ex and current smokers.

Table 4 shows the prevalence of obesity according to BMI definitions in different smoking strata. Ex-smokers had the highest prevalence of obesity (22.0%), and smokers had the lowest (12.1%), (p=0.002). Obesity was also significantly (p<0.001) more prevalent among Ex-smoker males than smoker and nonsmoker males. Among female participants, Obesity was significantly more prevalent (p=0.006) in smokers (38.8%) than non-smokers (22.4%). The pattern of BMI in different smoking strata is depicted in Fig. 1.

Information on the mean WC is provided in Table 5. Mean WC differed significantly (p<0.001) between Ex-smokers (91.6; CI 95%=89.2-94.0) and smokers (86.2; CI 95%=85-87.5). This amount was 84.6 (CI 95% 84.0-85.1) for nonsmokers, with a significant difference (P=0.016) from the mean for smokers. In females, mean WC was significantly higher (p=0.021) in smokers (89.9, CI 95%=85.3-94.5) than nonsmokers

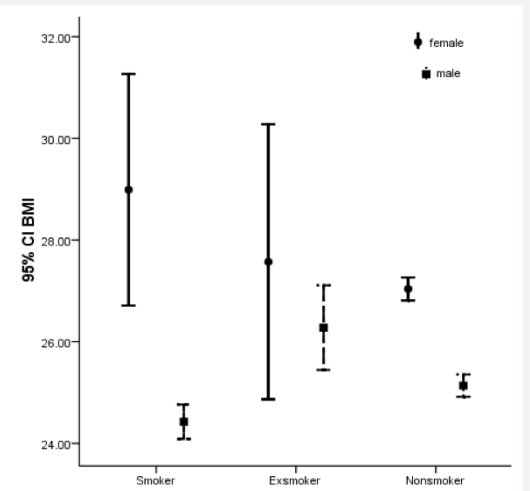

Fig. 1. The pattern of body mass index in males and females between different smoking strata

Table 4. Prevalence of obesity in different smoking strata divided by participant characteristics; Iran 2007

		Obesity				
		Smoker	Ex-smoker	Nonsmoker	p	
Gender	Male	10.5% (7.7%-14.3%)	21.8% (15.5%-29.9%)	11.1% (9.3%-13.1%)	S vs. ES ES vs. NS S vs. NS	<0.001 <0.001 0.727
	Female	38.8% (25.3%-54.4%)	25.1% (5.9%-64.1%)	22.4% (20.6%-24.3%)	S vs. ES ES vs. NS S vs. NS	0.277 0.773 0.006
	p	<0.001	0.737	<0.001		
Habitant	Rural	7.6% (4.5%-12.7%)	16.2% (7.7%-31.1%)	14.0% (11.8%-16.6%)	S vs. ES ES vs. NS S vs. NS	0.025 0.606 0.004
	Urban	13.9% (10.2%-18.6%)	24.5% (16.8%-34.2%)	19.0% (17.4%-20.7%)	S vs. ES ES vs. NS S vs. NS	0.008 0.136 0.024
	p	0.013	0.175	0.001		
Age	=<40	10.3% (7.3%-14.5%)	21.0% (10.9%-36.5%)	12.9% (11.4%-14.6%)	S vs. ES ES vs. NS S vs. NS	0.015 0.063 0.155
	>40	14.9% (9.8%-22.0%)	22.7% (15.6%-31.9%)	32.2% (29.7%-34.8%)	S vs. ES ES vs. NS S vs. NS	0.074 0.024 <0.001
	p	0.108	0.790	<0.001		
Total		12.1% (9.2%-15.7%)	22.0% (15.8%-29.9%)	17.5% (16.2%-18.9%)	S vs. ES ES vs. NS S vs. NS	0.002 0.133 0.003
		Overweight				
		Smoker	Ex-smoker	Nonsmoker		p
Gender	Male	31.8% (27.6%-36.4%)	32.8% (24.9%-41.7%)	31.4% (28.7%-34.3%)	S vs. ES ES vs. NS S vs. NS	0.826 0.740 0.875
	Female	21.0% (11.6%-35.0%)	33.5% (11.9%-65.2%)	30.7% (28.6%-32.9%)	S vs. ES ES vs. NS S vs. NS	0.263 0.798 0.079
	p	0.063	0.953	0.688		
Habitant	Rural	25.7% (17.8%-35.7%)	25.8% (13.3%-44.1%)	26.0% (23.3%-28.9%)	S vs. ES ES vs. NS S vs. NS	0.989 0.976 0.944
	Urban	33.4% (28.9%-38.3%)	35.7% (26.9%-45.7%)	33.2% (31.1%-35.3%)	S vs. ES ES vs. NS S vs. NS	0.645 0.582 0.937
	p	0.112	0.224	<0.001		
Age	=<40	26.8% (21.5%-32.8%)	23.4% (11.7%-41.4%)	28.2% (26.1%-30.3%)	S vs. ES ES vs. NS S vs. NS	0.616 0.456 0.634
	>40	38.4% (32.5%-44.6%)	38.7% (30.1%-48.0%)	40.2% (37.3%-43.1%)	S vs. ES ES vs. NS S vs. NS	0.955 0.748 0.593
	p	0.004	0.055	<0.001		
Total		31.2% (27.2%-35.6%)	32.8% (25.3%-41.3%)	31.0% (29.3%-32.8%)	S vs. ES ES vs. NS S vs. NS	0.710 0.642 0.928

S: Smoker**; ES:** Es-smoker**; NS:** Non-smoker

(84.2, CI 95%=83.5-84.9). Mean WC was 86.0 (CI 95% 84.7-87.3) for smoker males and 85.0 (CI 95% 84.3-85.8) for nonsmoker males, but 90.9 (CI 95% 88.6-93.3) for ex-smoker males, which is significantly higher than smoker and non-smoker groups (p=0.001).

As presented in Table 6, mean BMI was also calculated for all subgroups and yielded similar significant differences. Ex-smokers had significantly higher BMI than smokers (p=0.001), and smokers had significantly lower BMI than non-smokers (p=0.001). Smoker females had significantly higher BMI than non-smokers females (p=0.006) and ex-smoker males had significantly higher BMI than smoker males (p=0.001).

While in under 40 age group the mean BMI value and prevalence of obesity are significantly higher in ex-smokers than smokers (p=0.024 and 0.015

Table 5. Mean Body mass index and waist circumference among study subjects

		BMI				
		Smoker	**Ex-smoker**	**Nonsmoker**	**p**	
Gender	**Male**	24.3 (23.8-24.7)	26.1 (25.1-27.2)	24.5 (24.2-24.7)	S vs. ES ES vs. NS S vs. NS	0.001 0.001 0.523
	Female	28.5 (26.0-30.9)	27.9 (24.6-31.3)	26 (25.7-26.2)	S vs. ES ES vs. NS S vs. NS	0.854 0.308 0.006
	p	<0.001	0.381	<0.001		
Habitant	**Rural**	23.6 (22.8-24.3)	24.7 (23.4-26.0)	24.4 (24.1-24.7)	S vs. ES ES vs. NS S vs. NS	0.165 0.717 0.050
	Urban	24.9 (24.3-25.5)	26.9 (25.6-28.2)	25.7 (25.5-25.9)	S vs. ES ES vs. NS S vs. NS	0.003 0.051 0.007
	p	0.006	0.039	<0.001		
Age	**=<40**	24 (23.5-24.6)	26.1 (23.8-28.5)	24.5 (24.2-24.7)	S vs. ES ES vs. NS S vs. NS	0.024 0.076 0.206
	>40	25.3 (24.6-26.0)	26.3 (25.5-27.1)	28.1 (27.8-28.4)	S vs. ES ES vs. NS S vs. NS	0.146 0.002 0.001
	p	0.011	0.859	<0.001		
Obesity	**Non Obese**	23.3 (22.9-23.6)	24.2 (23.6-24.8)	23.5 (23.4-23.7)	S vs. ES ES vs. NS S vs. NS	0.038 0.120 0.191
	Obese	33.4 (32.3-34.5)	33.6 (31.4-35.8)	33.7 (33.4-34.0)	S vs. ES ES vs. NS S vs. NS	0.847 0.904 0.544
	p	<0.001	<0.001	<0.001		
Total		24.5 (24.1-25.0)	26.3 (25.2-27.3)	25.3 (25.1-25.5)	S vs. ES ES vs. NS S vs. NS	0.001 0.062 0.001
		Waist circumference				
		Smoker	**Ex-smoker**	**Nonsmoker**	**p**	
Gender	**Male**	86 (84.7-87.3)	90.9 (88.6-93.3)	85 (84.3-85.8)	S vs. ES ES vs. NS S vs. NS	0.001 <0.001 0.203
	Female	89.9 (85.3-94.5)	100.9 (91.5-110.3)	84.2 (83.5-84.9)	S vs. ES ES vs. NS S vs. NS	0.051 0.002 0.021
	p	0.111	0.033	0.107		
Habitant	**Rural**	83.7 (81.6-85.8)	87.9 (84.7-91.1)	82.5 (81.6-83.4)	S vs. ES ES vs. NS S vs. NS	0.036 0.024 0.342
	Urban	87.2 (85.8-88.7)	93.2 (90.2-96.2)	85.4 (84.8-86.0)	S vs. ES ES vs. NS S vs. NS	0.001 <0.001 0.027
	p	0.008	0.030	<0.001		
Age	**=<40**	84.7 (83.1-86.3)	88.8 84.1-93.5)	81.7 (81.0-82.3)	S vs. ES ES vs. NS S vs. NS	0.095 0.005 0.001
	>40	88.7 (86.8-90.6)	93.4 (91.1-95.7)	93.8 (93.1-94.4)	S vs. ES ES vs. NS S vs. NS	0.011 0.796 0.001
	p	0.002	0.078	<0.001		
Obesity	**Non Obese**	83.8 (82.7-84.8)	87.1 (85.0-89.2)	81 (80.5-81.5)	S vs. ES ES vs. NS S vs. NS	0.010 <0.001 <0.001
	Obese	104.7 (102.5-106.8)	107.7 (103.3-112.2)	101.4 (100.5-102.3)	S vs. ES ES vs. NS S vs. NS	0.171 0.006 0.027
	p	<0.001	<0.001	<0.001		
Total		86.2 (85.0-87.5)	91.6 (89.2-94.0)	84.6 (84.0-85.1)	S vs. ES ES vs. NS S vs. NS	<0.001 <0.001 0.016

S: Smoker**; ES:** Es-smoker**; NS:** Non-smoker

Table 6. Multivariate Logistic regression analysis for central obesity based on IDF criteria and Iranian cut-offs

Parameter	IDF criteria		IR criteria	
	p	OR (CI 95%)	p	OR (CI95%)
Age >40 vs. =<40	0.001	2.935 (2.487-3.463)	0.003	3.13 (2.688-3.645)
Smoker vs. non-smoker	0.115	0.835 (0.638-1.094)	0.085	1.046 (0.814-1.344)
Ex-smoker vs. non-smoker	0.089	1.455 (0.941-2.250)	0.074	1.181 (0.729-1.914)
Female vs. male	0.002	7.379 (6.019-9.046)	0.01	0.554 (0.463-0.663)
Urban vs. rural	0.068	1.127 (0.927-1.370)	0.091	1.063 (0.891-1.269)
Normal vs. obese	< 0.001	0.009 (0.005-0.014)	< 0.001	0.003 (0.001-0.006)
Normal vs. overweight	< 0.001	0.058 (0.048-0.071)	< 0.001	0.068 (0.056-0.081)

respectively), these significant differences do not exist in the over 40 age group. Also, the prevalence of obesity and the mean BMI value is not significantly different between smokers and non-smokers in the under 40 age group.

Table 6 demonstrates results of a multivariate logistic regression analysis of the relationship between prevalence of central obesity and covariates. Table 7 demonstrates similar information about the prevalence of obesity. Table 6 shows that the only independent predictors of central obesity are age more than 40 years, female sex and obesity. Table 7 shows that the only independent predictors of obesity are urban residency, female sex and central obesity.

Table 7. Multivariate Logistic regression analysis for general obesity based on IDF criteria and Iranian cut-offs

Parameter	p	OR (CI 95%)
Age >40 vs. =<40	0.075	1.124 (0.936-1.351)
Smoker vs. non-smoker	0.256	0.931 (0.686-1.263)
Ex-smoker vs. non-smoker	0.122	1.438 (0.877-2.358)
Female vs. male	0.001	3.425 (2.800-4.189)
Urban vs. rural	0.032	1.299 (1.057-1.597)
Central obese vs. normal	< 0.001	31.969 (24.494-41.725)

4. Discussion

In the present study, we found that average BMI and WC values were higher among ex-smokers. Prevalence of obesity and central obesity were also higher among ex-smokers than smokers. The result is consistent with previous studies reporting higher prevalence of obesity and central obesity among ex-smokers and weight gain after abstinence from smoking (Klesges et al., 1997; Ferrara et al., 2001; Filozof et al., 2004; Janzon et al., 2004; Sulander et al., 2007; Chiolero et al., 2008; Matsushita et al., 2011; Aubin et al., 2012). Pisinger and Jorgensen (2007) reported an almost 4 cm increase in WC of ex-smokers compared to smokers, after one year follow up, which is comparable with our findings (Table 3).

Smokers had significantly higher WC than non-smokers; 86.2 cm (CI 95%, 85-87.5) for smokers vs. 84.6 cm (CI 95%, 84.0-85.1) for non-smokers; while the rate of obesity and the mean BMI value were significantly lower in smokers. This finding indicates that although smoking leads to weight loss, it is associated with higher rates of central adiposity, which is an even more prominent risk factor for cardiovascular diseases (Mendelson et al., 2008; Dhaliwal and Welborn, 2009). Therefore it is necessary to consider smoking as a dual risk factor for cardiovascular disease, and not to be misled by the weight loss it causes. Saarni et al. (2009) reported the same results in their study of 4296 Finnish twins, concluding that smoking is a risk factor for central obesity but not for general obesity. Kim et al. (2012) also reported that although smokers have lower mean BMI values than never smokers, they tend to show more abdominal and visceral obesity. The CT-measured visceral obesity of 4656 Korean men was significantly higher in the smoker group in the study of Lee et al. (2012). Yet some studies have failed to find a positive relationship between smoking and central obesity (Clair et al., 2011; de Oliveira Fontes Gasperin et al., 2014).

When comparing the mean BMI and general obesity estimates between smokers and nonsmokers, gender played a discriminative role. Therefore, among men, smoking was correlated with a lower risk of obesity and lower BMI, whereas among females, smoking was linked with higher risk of obesity and BMI. These results are in agreement with with the results of Cooper et al. (2003) and Saarni et al. (2009). Stice et al. (2015) also reported that female smokers gained more weight than non-smokers (2.9 Kg vs. 0.9 kg) after 2 years of follow-up. This finding is partly because of riskier life style among female smokers which is accompanied by more alcohol consumption and lower physical activity leading to weight gain (Rabaeus et al., 2013). Considering the settings of our study design we could not determine whether smoking by itself caused the higher BMI levels or general obesity.

We also found that the mean BMI value and the prevalence of obesity is significantly higher in under 40 ex-smokers compared to smokers; which is not true about the over 40 age group. This indicates that smoking cessation is more likely to cause weight gain in younger smokers which make them the target for national screening programs. These findings are concordant with Locatelli et al. (2014), but opposed to results of Kasteridis and Yen (2012).

Considering lower BMI and weight among smokers

vs nonsmokers, the role of age should be mentioned, as in under 40 population smoking was not associated with less body weight. Mackay et al. (2013) reported the same age-related pattern in their recent study. Since losing weight is one of the main motivations of young new smokers (Jang et al., 2012; Penzes et al., 2012; Hong and Johnson, 2013), it is crucial to run educational campaigns targeted at younger population in order to inform them that smoking does not guarantee persistent decreased weight.

As discussed, smoking cessation is associated with higher BMI, weight, and central obesity. Thus, in order to assure that beneficial effects of smoking cessation are not attenuated by weight gain and central obesity (Sulander et al., 2007; Inoue et al., 2011; Travier et al., 2012; Komiyama et al., 2015) and to omit the discouraging outlook of weight gain on smokers dissuading them from quitting (Chiolero et al., 2008; Bush et al., 2014; Veldheer et al., 2014; Landrau-Cribbs et al., 2015) we strongly recommend interventions to prevent weight gain and central obesity be included in smoking cessation strategies. Another important finding of our study is that, unlike men, female ex-smokers have lower rate of obesity and BMI value than female smokers. This indicates that smoking cessation in females may not be followed by weight gain. Therefore, female smokers who are discouraged by the concept of gaining weight in case of quitting should be informed that if they quit smoking they will not face the fear of becoming more obese (John et al., 2005).

As smoking is associated with weight gain and central obesity among females, this fact negates the common belief that smoking is a way to lose weight or stay thin among lots of females (Honjo and Siegel, 2003; Penzes et al., 2012; White, 2012). On the other hand, smoking and the correlated general and central obesity are major predictors of cardiovascular and metabolic disorders (Manson et al., 2000; Saarni et al., 2009) and they subsequently decrease life expectancy (Peeters et al., 2003).

Furthermore, smoking cessation is correlated with weight gain and central obesity which in turn put ex-smokers at greater risk of the cardiovascular diseases (Mendelson et al., 2008; Dhaliwal and Welborn, 2009). Smoking prevention seems to be the best option to reduce prevalence of smoking and related morbidities (Saarni et al., 2009). It should be noted that although smoking cessation may lead to weight gain and central obesity, evidence indicate that the benefits of smoking cessation exceed its disadvantages, and smoking cessation does decrease the risk of CVD events (Clair et al., 2013).

However, our multivariate logistic regression analyses showed that smoking status is not an independent predictor of central or general obesity. Confounding factors such as age, sex and general/central obesity may have caused us to overestimate the effect of smoking or smoking cessation on central/general obesity. This issue suggests the necessity of conducting further studies of prospective design in order to better elucidate the causal effect of smoking and smoking cessation on obesity and central obesity.
One of the limitations of this study as a cross-sectional study was that the causal and temporal relationship between different variables could not be established. Another limitation of this study is that we didn't control the confounding effect of some other variables, such as physical activity and diet. We also did not stratify the smoker group based on their amount of exposure, so that light, moderate and heavy smokers were all put into a single group.

Higher prevalence of abdominal and general obesity along with higher mean BMI and WC among Ex-smokers highlights the need to carry out screening measures in this mainly aged high risk population. The authors would like to conclude that, smoking is correlated with higher prevalence of obesity and increased BMI among women and the youth, making to smoke to stay slim a false belief in these fractions of Iranian population. Therefore, we recommend targeted educational interventions at women and young adults, with the aim of informing them that if they intend to lose weight or stay slim, smoking is not a safe option. Female smokers should also be assured that they will not gain more weight if they try to quit smoking.

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