Original Article

A comparison of obesity and some cardiovascular risk factors between male employees of gas refinery, petrochemical plant, and non-industrial workplaces

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Abstract

Background and purpose: It is likely that industrial workplaces increase the chance of developing obesity and cardiovascular disease risk factors in the employees. The aim of this study was to compare obesity and some health markers between male employees of gas refinery (first exposure group) and petrochemical staff (second exposure group) compared to non-industrial male employees of general population (non-exposure group).

***Method*:** Seventy five male employees of a petrochemical plant in Assaluyeh, eighty eight male employee of a gas refinery, and eighty six non-industrial male employees of the general population participated in this study. Weight, height, waist circumference, fasting blood glucose, blood pressure, and serum total cholesterol and triglyceride were measured in all the participants. Statistical analyses were performed using the SPSS Software, version 16 (SPSS Inc., Chicago, IL, USA).

***Results*:** The mean body mass index, waist circumference, fasting blood glucose, and serum triglyceride level were significantly higher in gas refinery staff compared to petrochemical employees, and non-industrial employees (P-values <0.01). The number of subjects suffering from obesity, abdominal obesity, hypertriglyceridemia, and high fasting blood glucose in the gas plant staff was significantly more than the petrochemical plant staff and non-industrial employees (P-values <0.01). However, mean blood pressure and hypertension in non-industrial employees were significantly higher than the other two groups (P-values<0.01).

***Conclusion*:** The results of this study showed that obesity, high fasting blood glucose and hypertriglyceridemia were significantly higher in gas refinery staff. It is recommended to develop a health promotion program for weight management and prevention of obesity in the industrial work place staff.

***Keywords*:** Occupational Health; Body weight; Occupational Diseases

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1. Introduction

Cardiovascular disease (CVD) is a major cause of mortality and morbidity around the world.Obesity, dyslipidemia, hypertension, hyperglycemia, and diabetes are common risk factors for the CVD. Obesity increases the likelihood of metabolic disorders and various diseases, particularly CVD (1-3). Some previous studies have suggested a need to develop programs to prevent obesity and improve the health of employees including employees in industrial workplaces (4). Evidences have shown that obesity is associated with lower work performance and the number of working days in the industrial staff. Absenteeism, illness, and financial losses associated with the illness were higher in the obese employees. Therefore, maintaining a healthy weight in the employees is not only important for the public health, but also should be a key priority for employers to improve the productivity of employees (5-8).Work place and working conditions can be effective on employees' life style, whilst inappropriate lifestyle is one of the most important risk factors for obesity and metabolic disorders (9, 10). Industrial work place settings may influence the lifestyle and subsequently the health of the employees. Evidences show that air pollution can increase the risk of insulin resistance, weight gain, and obesity (11-13). Air pollution is higher in some industrial work places, such as gas and petrochemical industries, which may increase the risk of developing the risk factors of CVD amongst the employees (14, 15). Pars Special Economic Zone in Assaluyeh is one of the most important industrial areas in Iran. The industrial zone, which is located in southern Iran and the Persian Gulf coasts, encompasses gas and petrochemical plants. The climate of this area is typically hot, or hot and humid in coastal areas, and hot and dry in the inner areas (16). In addition, the amount of air pollution in Assaluyeh is high and is increasing, which is due to the activity and development of petroleum and petrochemical companies. Employees of this industrial area are mostly young and middle-aged men. To the best of the researchers' knowledge, although weather and employment conditions in the mentioned areas can affect the health of employees, no research has so far been conducted and reported on the health conditions of these employees. Another industrial city of Iran is Sarakhs (Khorasan Province, Iran). Sarakhs is located in the north east of Iran and encompasses gas industry and refineries. Most employees of these gas refineries are also young and middle-aged men. Working conditions in the gas refineries can affect the lifestyle and health conditions of the employees. Air pollution in this industrial working place has been growing due to gaseous pollutants emissions from refineries. However, no study has so far been reported on the health conditions of the employees of the Iranian gas refineries. The aim of this study was to compare obesity and some health risk factors in the employees of gas refinery and petrochemical plant in Sarakhs and Assaluyeh with non-industrial male employees of general population.

2. Methods

The participated of this observational study were 88 male employees of a gas refinery (Sarakhs, Khorasan, Iran), 75 male employees of a petrochemical plant (Assaluyeh, Bushehr, Iran), and 86 non-industrial male employees of the general

population (Khorasan, Mashhad, Iran) with an average age of 35 years. The current study was conducted by the faculty of Medicine of the Mashhad University of Medical Sciences (MUMS), Mashhad, Iran. The ethical considerations of this research were in accordance with the ethical standards of ethics committee of MUMS. Hence, all individuals knowingly and voluntarily participated in this study and signed a consent form.

The participants were employed at the time of study (having a full time job; at least 37.5 hours per week), and were within the age range of 30-55 years old. They were apparently healthy without a history of chronic or systemic diseases and with a minimum duration of employment of 3 years or more. The non-industrial employees had administrative or service jobs in public non-industrial workplaces in Mashhad. The results of pre-employment health screening of the employees had confirmed their health status at the recruitment time. The participants who were unwilling to take part in the study, employees of the general population with self-employment status, and those who had chronic and systemic diseases or did not cooperate for anthropometric and biochemical assessment were excluded.

Anthropometric assessments including height, weight, and waist circumference were performed for all the participants. Demographic information like age and clinical history were also recorded using a checklist. Standing height (cm) was measured with a wall-mounted stadiometer without shoes. Maximum hip circumference and minimum waist circumference (between below the chest and above the navel) were measured as hip and waist circumferences (cm). Blood samples were also taken after 12 hours of fasting in the morning, and fasting blood glucose, serum triglyceride, in addition to total cholesterol were measured using routine laboratory protocols. Blood pressure was measured in a sitting position using the right arm in all participants considering a fifteen-minute rest before blood pressure measurements. All statistical analyses were performed using the SPSS Software, version 16 (SPSS Inc., Chicago, IL, USA). The normality of data was confirmed using the Kolmogorov-Smirnov test. Comparisons were performed using one-way ANOVA, Kruskal-Wallis, Post Hoc, Chi-square, and Pearson correlation tests, and P-value <0.05 was considered as statistically significant.

3. Results

Age was not statistically different in three groups ($p>0.05$, Table 1). BMI, waist circumference, fasting blood glucose, and triglyceride were significantly higher in the gas refinery employees than the other two groups (Table 1, p-values< 0.05).

Table 1. Comparison of basic and health characteristics in three study groups

Place / Parameter	Petrochemical Company Employees (n=75)	Gas Refinery Employees (n=88)	Non-industrial Employees (n=86)	*P-value (two-tailed)
Age (y)	35.57 ± 470	35.42 ± 3.63	36.04 ± 2.51	0.36
Weight (Kg)	79.60 ± 11.99	80.42 ± 10.84	73.05 ± 11.22	P<0.001
Height (cm)	175.52 ± 6.33	171.68 ± 5.89	171.45 ± 6.59	P<0.001
BMI (Kg/m^2)	25.75 ± 2.96	27.26 ± 3.24	24.87 ± 3.71	P<0.001
FBG (mg/dl)	85.94 ± 6.39	96.44 ± 23.41	83.98 ± 37.17	0.004
WC (cm)	93.28 ± 8.69	95.59 ± 7.72	90.31 ± 8.55	P<0.001
TC (mg/dl)	175.26 ± 30.57	181.00 ± 29.53	176.62 ± 35.50	0.487
TG (mg/dl)	127.00 (91.00-191.00)	139.50(97.75-196.50)	104.00 (77.50 -148.00)	0.001
Systolic BP(mmHg)	107.17 ± 10.86	111.06 ± 12.97	115.46 ± 11.84	P<0.001
Diastolic BP(mmHg)	68.69 ± 8.02	72.95 ± 9.90	77.56 ± 8.43	P<0.001

BMI, body mass index; FBG, fasting blood glucose; BP; blood pressure; TC, total cholesterol. Values are expressed as mean ± SD or median (Q1-Q3).
*** One-way ANOVA or Kruskal-Wallis test, depending on the normality of the data.**

Table 2. Comparison of health parameters between groups

Groups / Parameter	P-Value (two tailed)						
	BMI*	**WC***	**TG****	**TC***	**FBG***	**SBP***	**DBP***
Gas refinery staff & Non-industrial group	P < 0.001	P < 0.001	P < 0.001	P = 0.382	P = 0.009	P = 0.021	P = 0.001
Gas refinery staff & Petrochemical staff	P = 0.002	P = 0.076	P = 0.477	P = 0.223	P < 0.001	P = 0.047	P = 0.004
Petrochemical staff & Non-industrial group	P = 0.101	P = 0.032	P = 0.006	P = 0.797	P = 0.653	P < 0.001	P < 0.001

BMI, body mass index; WC, Waist circumference; FBG, fasting blood glucose; SBP, systolic blood pressure; DBP, Diastolic blood pressure ;TC, total cholesterol; TG, Triglyceride.
*** Independent sample t-test; ** Mann-Whitney test**

Based on the results of the study, BMI was significantly higher in the gas refinery employees than non-industrial staff (P<0.001) and petrochemical plant staff (P=0.002, Table 2). The prevalence of obesity (BMI ≥ 30) in gas refinery staff was also higher than the other groups (p=0.017, Table 3-4). At the same time, the prevalence of abdominal obesity in gas refinery staff was found to be significantly higher than the other groups (p=0.001, Tables 3-4).

Table 3. Frequency of health parameters in male employees of three groups

Place Parameter	Non-industrial group **(n=86)**	Gas Refinery **(n=88)**	Petrochemical Company **(n=75)**	*P-value **(two-tailed**
BM I ≥ 25	39 (45.3%)	67 (76.1%)	41 (54.7%)	P < 0.001
BM I ≥ 30	8 (9.3%)	20 (22.7%)	7 (9.3%)	P = 0.017
WC ≥ 94	30 (34.9%)	56 (63.6%)	34 (45.3%)	P = 0.001
Obesity (BM I ≥ 30 or WC ≥ 94)	30 (34.9%)	56 (63.6%)	35 (45.3%)	P = 0.001
TG ≥ 150	21 (24.4%)	38 (44.1%)	31(41.3%)	P = 0.018
FBG ≥ 100	4 (4.7%)	18 (20.5%)	3 (4.0%)	P < 0.001
Cholesterol ≥ 200	23 (26.7%)	22 (25.6%)	16 (21.3%)	P = 0.690
Systolic BP ≥ 130	14 (16.3%)	4 (4.5%)	5 (6.7%)	P = 0.023
Diastolic BP ≥ 85	13 (15.1%)	7 (8.1%)	1 (1.3%)	P = 0.003

Values are expressed as frequency and percent. BMI, body mass index; FBG, fasting blood glucose; BP; blood pressure; TC, total cholesterol * Kruskal-Wallis test (according to the non-normal distribution of data).

The findings also showed that serum triglyceride of gas refinery workers was significantly higher than other groups (Table1-2, p=0.001), and the prevalence of hypertriglyceridemia was significantly higher in gas refinery and petrochemical employees than non-industrial employees (P=0.007 and P=0.025; respectively, Table 4). However, there was observed no significant difference in the distribution of hypertriglyceridemia among gas refinery staff and petrochemical employees (p-value>0.05, Table 4). In contrast, blood pressure in non-industrial employees was documented to be significantly higher than employees of gas and petrochemical companies (P<0.001, Tables 1-4).

Table 4. Comparison of the frequency of health parameters between groups

Parameter **Groups**	***P-Value (two tailed)**						
	Obesity (BMI>30)	**Central Obesity** (WC ≥ 94cm)	**TG ≥150**	**FBG ≥ 100**	**TC ≥ 200**	**SBP ≥ 130**	**DBP ≥ 85**
Gas refinery staff & Non-industrial group	P=0.016	P<0.001	P=0.007	P=0.002	P=0.826	P=0.011	P=0.139
Gas refinery staff & Petrochemical staff	P=0.026	P=0.030	P=0.715	P=0.001	P=0.527	P=0.470	P=0.017
Petrochemical staff & Non-industrial group	P=0.951	P=0.134	P=0.025	P=0.001	P=0.400	P=0.088	P=0.001

Table 5. The correlations between BMI and health parameters

Employees / Parameter			Total Industrial Staff (Assaluyeh & Sarakhs)		Petrochem company (Assaluyeh)		Gas Refinery (Sarakhs)		Non-industrial (Mashhad)	
Pearson correlation p-value (2-tailed)	BMI	FBG	r = 0.27	P < 0.001	r = 0.34	P = 0.003	r = 0.22	P = 0.03	r = 0.01	P = 0.86
		TG	r = 0.27	P < 0.001	r = 0.33	P = 0.004	r = 0.22	P = 0.03	r = 0.20	P = 0.06
		TC	r = 0.17	P = 0.033	r = 0.10	P = 0.37	r = 0.18	P = 0.08	r = 0.39	P < 0.001
		Systolic BP	r = 0.29	P < 0.001	r = 0.26	P = 0.02	r = 0.28	P < 0.001	r = 0.24	P < 0.001
		Diastolic BP	r = 0.25	P = 0.001	r = 0.09	P = 0.43	r = 0.28	P < 0.001	r = 0.17	P = 0.10

BMI, body mass index; FBG, fasting blood glucose; TC, total cholesterol; BP, blood pressure.

As is illustrated in Table 5, the correlations between BMI and FBG, serum TG, and blood pressure in industrial employees were stronger than non-industrial employees.

4. Discussion

The results of the current research showed that the employees with obesity, hyperglycemia, and hypertriglyceridemia were significantly higher in number in gas refinery staff in comparison with the other group. In contrast, hypertension was higher in non-industrial employees. Tsai et al. in their study on 7139 industrial staff at Shell Oil Company in 1983, reported that obesity was associated with higher risk of all-causes mortality. They suggested that reducing obesity in industrial employees is useful to reduce rate of mortality and morbidity. The results of our study showed higher rate of obesity and positive correlations between obesity and serum FBG, TG and blood pressure in industrial workers. Thus, the prevention of obesity among industrial staff of Iran can be useful for developing the associated diseases with obesity and the subsequent mortality in future (17). Bhowmik et al. assessed the prevalence of obesity in 791 Bangladeshi male factory workers and its association with diabetes and hypertension (18). They reported a high prevalence of obesity (43.5%) and abdominal obesity (35%), and significant association between obesity and prevalence of diabetes and hypertension. In the current study, the prevalence of obesity was lower, but the prevalence of abdominal obesity was higher among the industrial employees (Table 2). Also, the associations between BMI and FBG, serum TG and blood pressure in industrial employees were found to be higher than non-industrial employees. Thus, the results of this research agree with the findings of Bhowmik et al.(18). Vangelova et al., assessed the prevalence of hypertension and dyslipidemia among male industrial workers (19). They suggested that excessive noise in the workplace is associated with hypertension, and hot environment is associated with hyperlipidemia among the employees (20). The industrial employees in the present study had exposure to a hot environment, and the prevalence of dyslipidemia among them was higher than those non-industrial workers. Therefore, the result of this study was found to be consistent with the result of the study of Vangelova study (19). Various Studies have shown that air pollution and chemical pollutants increase the risk of insulin resistance, dyslipidemia, and obesity (11, 12, 21, 22). In the current study, air pollution by chemical pollutants in the industrial work places was found to be high. Therefore, this may be effective in increasing the prevalence of obesity, hyperglycemia, and hypertriglyceridemia in the industrial employees. Mean blood

pressure and prevalence of hypertension in the industrial employees were observed to be significantly lower than non-industrial employees in this study. Stress was also documented to be an important cause of hypertension, and industrial employees may have less stress. Industrial employees in Iran have a generally better socio-economic status and receive more salary and facilities compared to general employee population. Meanwhile, evidences have shown that there is an association between socio-economic status and blood pressure levels (23-25). The main limitations of this study were small sample size, lack of assessment of all the biochemical parameters of dyslipidemia (including HDL and LDL), and lack of evaluation of employees life style (including physical activity and diet). Conducting studies with larger sample sizes and comparing the life styles of employees are recommended for future studies. Conducting furhter studies to find the causes of higher blood pressure among non-industrial employees is also suggested.

The results of this study showed that obesity, high fasting blood glucose, and hypertriglyceridemia were significantly higher among industrial staff. The results indicated that there was a need for a health promotion program for weight management and prevention of obesity among the industrial work place staff, and there is also a need for regular examination of FBG and TG in industrial workers.

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