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Original Article

Is Neighborhood With a Steel Factory Associated With Cardiovascular Disease Risk Factors?

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Abstract

Background and aims: Staying adjacent to steel plants may raise the chance of cardiovascular disease (CVD) risk factors for their inhabitants. The present study aimed to compare some CVD risk factors in the residents of a city adjacent to the steel plant as the exposed city in comparison with the residents of a control city in the Isfahan province.

Methods: In a cross-sectional study in 2021, the data related to the prevalence rate of hypertension (HTN), diabetes mellitus (DM), Hyperlipidemia, overweight, and obesity were collected in the over 30 years old inhabitants who were living in Chamgordan as the exposed city and Ferydounshahr as the control city and underwent cardiovascular risk assessment. The data were gathered from the Iranian electronic health file system by the census sampling method.

Results: Among the more than 30 years old population who stayed in the exposed and the control cities, the prevalence rates of CVD risk factors were as HTN (20.53% and 16.54%), DM (10.32% and 7.13%), and overweight and obesity (32.55% and 27.07%), respectively. There were no significant statistical differences between the exposed and control cities regarding HTN ($P=0.471$), DM ($P=0.447$), and overweight and obesity ($P=0.355$). However, hyperlipidemia was significantly more prevalent in the exposed city by 11.53% in comparison with 0.45% in the control city ($P=0.001$).

Conclusion: Except for hyperlipidemia, there was no significant statistical difference in the prevalence rates of HTN, DM, overweight, and obesity between the exposed and the control cities.

Keywords: Hypertension, Diabetes mellitus, Hyperlipidemia, Overweight, Air pollution, Steel industry

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Introduction

Cardiovascular diseases (CVDs) are the most important non-communicable disease leading to major disability-adjusted life years (DALYs).[1] Numerous risk factors have been identified for CVDs. The most important risk factors are hypertension (HTN), diabetes mellitus (DM), hyperlipidemia, overweight and obesity, family history, lifestyle and nutrition, and environmental factors such as industrial pollutants.[2,3]

Studies have shown that long-term exposure to air pollutants such as sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone (O_3), and airborne particles (Suspected particulate matter = PM) increases the risk of hospitalization, exacerbation of asthma attacks, and CVD risk factors, including HTN, DM, obesity, and metabolic syndrome.[4-6] PM air pollution increases the progression of atherosclerosis and other chronic CVDs. Life expectancy reduces following long-term exposure to a high level of concentrations of ambient $PM_{2.5}$.[7] It is estimated that 2%-9% of all deaths are due to air pollution with PM.[8] It has also been demonstrated that air pollution with fine particles is the seventh risk factor that causes the most DALYs in the Iranian population.[9,10]

Steel plants are often considered the main contributor to heavy air pollution that influences the local population. The previous study in Italy reported that the region near the steel plants experiences an excess of up to 22% death rate due to cancers, and an excess of up to 40% in lung diseases.[11] However, there is a concern that dwelling in a city adjacent to a steel factory how much imposes on the residents the adverse effects of air pollution on their health status.

The present study measured the frequency of some CVD risk factors, including HTN, DM, hyperlipidemia, overweight, and obesity, among people over 30 years old who live in a city near a steel plant in comparison with the residents of another city not having air pollution due to proximity to workshops or industrial factories in the same province as a *case report*.

Materials and Methods

In this cross-sectional study in 2021, the frequency of CVD risk factors such as HTN, DM, hyperlipidemia, overweight, and obesity was collected from above 30 years old inhabitants from two cities (Chamgordan and Ferydounshahr) in Isfahan province in central Iran.

Chamgordan is considered the exposed city with a population of 17436. It is located neighboring the oldest and great steel factory in Iran at a 5 km distance from the south of the steel factory at an altitude of 1700 meters above sea level. Isfahan Steel Company produces more than 2 million tons of steel yearly.[12]

Ferydounshahr has a population of 11192 and is considered the control city. It is located in the center of the Iranian plateau, and due to its geographical location in the Zagros Mountains at 2530 meters above sea level, it is the highest city in Iran. This city has a pleasant climate and is free of air pollutants due to the lack of industrial factories around it.

This study was based on the data available in the electronic health file system of Iranian citizens (SIB system) in the statistical unit of Isfahan Province Health Center.

The inclusion criteria were the accessible data related to the electronic health file of citizens living in those two cities as permanent inhabitants, who registered and participated in the risk assessment program for cardiovascular accidents, and their data were convincing for completing the checklists.

The unmet criteria were health files belonging to those citizens who have stayed in the exposed and/or controlled cities as tribal migrants.

The exclusion criteria belonging to those CVD risk factors were incomplete either in the exposed or control cities.

According to the Iranian Minister of Health and Medical Education (Health Deputy) guideline for risk assessment regarding cardiovascular accidents in 2017, all over 30 years old population who stayed in rural and urban areas should call from their family physicians. In addition, they should undergo physical examinations and assessment of weight, height, blood pressure, testing blood sugar, blood cholesterol, and triglyceride, smoking habits, fruit, and vegetable consumption, and physical activity behaviors.[13] A body mass index of 25-30 and ≥ 30 was considered overweight and obese, respectively. The hypertensive cases were those who, in at least two consecutive measurements, had systolic and diastolic blood pressure ≥ 140/90 mm/g upon the standard circumstances. The DM patients or dyslipidemia cases were diagnosed as definite cases based on laboratory tests after at least 8 hours of fasting according to standard circumstances. In this way, the fasting blood sugar ≥ 126 mg/dL at two times was considered the definitive criterion for DM. Furthermore, total blood cholesterol ≥ 200 mg/dL and blood triglyceride ≥ 200 mg/dL were assumed definite cases of hypercholesterolemia and hypertriglyceridemia, respectively. The existence of at least one of them was considered hyperlipidemia.

According to the Iranian middle age health package, all above 30 years old should be visited by their family physicians before and after blood glucose, cholesterol, and triglyceride assessment, and their laboratory data should be interred into electronic health files. In continuity, the definite cases of those suffering from HTN, DM, hyperlipidemia, and cardiovascular accidents risks have been ordered to tackle a healthy lifestyle, and if they need, they would have to take prescribed medicine to control the blood glucose, cholesterol, and triglyceride in the safe range. The risk values of cardiovascular accidents were determined as less than 10%, 10-20%, 20-30%, and above 30%. According to evidence, the interval between two consecutive appointments for feature family physician visits relied on the value of cardiovascular accident risk in which the time of consecutive visits was scheduled for another year, 9 months later, 6 months later, and 3 months later, respectively.[14]

The data included the demographic status of the population such as gender, age groups, marital status, and literacy status, and data on cardiovascular risk factors were collected by census and entered into the checklist. The obtained data were entered into the Statistical Package for Social Sciences (SPSS. 24.0, SPSS Inc., Chicago, IL). Quantitative and qualitative data were reported as the mean ± standard deviation and frequency distribution (percentage), respectively. The chi-square test was used to compare the frequency distribution of demographic characteristics such as gender, age groups, marital status, literacy level, and some cardiovascular risk factors such as HTN, DM, hyperlipidemia, and obesity among people over 30 years old in the exposed and control cities. The Mann-Winey U test was employed to compare the inhabitants in the exposed and control cities regarding some health-related behaviors such as fruit and vegetable consumption and physical activity, and $P < 0.05$ was considered a significance threshold.

Results

A number of 10397 (59.53%) and 6747 (60.28%) over 30 years population (compared to the total population) were included in the exposed and the control cities in 2021, respectively. Using the Chi-square test, there was no statistically significant difference in terms of gender ($P = 0.47$), marital status ($P = 0.849$), and the composition of age groups in people over 30 years of age living in both cities ($P = 0.992$); however, the frequency of higher educated inhabitants (more than high school and university level) was significantly more ($P = 0.048$) in the control city than in the exposed city (63.33% vs. 49.55%), the details of which are presented in Table 1.

The numbers of people over 30 years of age who underwent a cardiovascular accident risk assessment program (compared to the total number of people over 30 years old) in the exposed and control cities were 6872 (66.1%), and 4710 (69.81%) respectively. Among people over the age of 30 who were assessed for their blood pressure, fasting blood sugar, blood lipids, and body mass index, and their data were accessible in their electronic health file, only the prevalence rate of hyperlipidemia was significantly higher in the residents of the exposed city than in the control city ($P = 0.001$). In addition, hyperlipidemia was found to be more prevalent in females than males ($P = 0.001$).

There was no statistically significant difference between the two genders in the other risk factors for cardiovascular accidents. Hence, the above 30 years old population in the exposed city significantly had more adequate consumption of vegetables and physical activity in comparison with the

control city ($P=0.017$, $P=0.001$, respectively, Table 2).

Discussion

Based on the results of the present study, except for the prevalence of hyperlipidemia, there were no significant differences between the residents of the two cities regarding HTN, DM, overweight, and obesity. Despite past published studies that emphasized the role of air pollution on the prevalence rate of coronary artery diseases (CADs),[4-7,15] in this study, there were no significant differences between the residents of the two exposed and the control cities. Although our findings are not in line with past published papers, it needs to pay attention to the following arguments:

Firstly, the prevalence rates of HTN, DM, hyperlipidemia, overweight, and obesity in the present study were less than (at least 50%) the mean of similar indices at the national level even among the above 30 years old who reside in the adjacent city to steel factory surprisingly[16] considering some healthy lifestyles; these lifestyle habits included the diet habit for vegetable consumption and physical activities which are significantly predominant between above 30 years old citizen of the exposed city.

Secondly, based on the findings from a previous study in a circle territory with a radius of 20 to 50 km around

Table 1. Demographic Characteristics of the Above 30 Years Old Population Who Stayed in the City Near a Steel Plant as the Exposed City and the Control City in 2021

Total Population		Exposed City n=17436 No. (%)	Control City n=11192 No. (%)	*P* Value
Gender of people over 30 years old	Male	5319 (51.16)	3340 (49.5)	0.47*
	Female	5078 (48.84)	3407 (50.5)	
Total number of people over 30 years (per the total population)		10397 (59.6%)	6747 (60.28)	
The frequency (percent) of age groups	30-39	3389 (36.67)	2083 (32.99)	0.992*
	40-49	2491 (26.19)	1667 (26.4)	
	50-59	1838 (14.52)	1209 (19.14)	
	60-69	964 (10.08)	725 (11.48)	
	70-79	484 (5.09)	405(6.41)	
	>80	249 (2.62)	226 (3.58)	
Marital status	Single	936 (%)	641 (9.5)	0.849*
	Married	8709 (83.76)	5612 (83.2)	
	Divorced	183 (1.76)	69 (1.02)	
	Widow	569 (5.47)	426 (6.27)	
Literacy level	Illiterate	964 (9.27)	740 (10.97)	0.048*
	Primary school	2312 (22.24)	858 (12.72)	
	Secondary school	1969 (18.94)	876 (12.98)	
	High school	3423 (32.92)	1976 (29.29)	
	University	1729 (16.63)	2297 (34.04)	

Note. *Chi-square test.

Table 2. The Frequency of HTN, DM, Hyperlipidemia, Overweight, and Obesity Among the Over Than 30 Years Old Populations Who Lived in the City Near a Steel Plant as the Exposed City and the Control City in 2021

		Exposed City			Control City			*P* Value
People over 30 who were evaluated for cardiovascular risk events	Male	3779 (54.99%)			1804 (38.3%)			0.074*
	Female	3093 (45.01%)			29.6 (61.7%)			
The number (%) of people who were evaluated for cardiovascular risk events (compared to the total number of people over 30 years old)		6872 (66.1%)			4710 (69.81%)			0.576*
Frequency (prevalence) of HTN		1411(20.53%)			779 (16.54%)			0.471*
Frequency (prevalence) of DM		709 (10.32%)			336 (7.13%)			0.447*
Frequency (prevalence) of hyperlipidemia		792 (11.53%)			21 (0.45%)			0.001*
Frequency (prevalence) of overweight and obesity		2237 (32.55%)			1275 (27.07%)			0.355*
Some behaviors		**Adequate**	**Partial adequate**	**Not adequate**	**Adequate**	**Partial adequate**	**Not adequate**	
Fruit consumption		81.53	18.12	0.35	79.99	19.73	0.28	0.719**
Vegetable consumption		80.47	19.06	0.47	66.41	33.07	0.52	0.017**
Physical activity		79.67	14.84	5.49	50	28.69	21.31	0.001**

Note. HTN: Hypertension; DM: Diabetes mellitus; *Chi-square test; **Mann-Winey U test.

the Isfahan Steel Company in rapeseed and safflower fields in this area, the concentrations of lead and cadmium in rapeseed and safflower extracts were less than the median level of standard that was approved by Food and Agriculture Organization/World Health Organization's Expert Committee on food additives.[17]

Third, following many strict regulations and qualified control on reducing or exit of hazardous gases from the Isfahan Steel Company, the 24-hour average concentration of PM in the entire study area was 92.5 μg/m^3 in 2016; this is higher than Iran's clean air standard but lower than the US Environmental Protection Agency (EPA) standard. Nonetheless, the annual average concentration of PM was 9.47 μg/m^3, which is lower than Iran's clean air standard and the EPA.[18] Consequently, they lead to minimizing the steel plant's air pollution accurately, and the findings from rapeseed and safflower extract in expanded territories around the steel plant may be confirmatory. This opinion may arise from to reversible nature of CADs following air pollution, in which recent studies declared that decreasing PM levels reduces CAD mortality for several years.[7]

Forth, considering the location of the exposed city to the steel plant and supposing the prevailing winds, the exposed city adjacent to the steel plant in this study is located in the southern part of the steel plant. Although the prevailing winds in this region are generally from the south (southwest) to the north (northeast),[18] the exposed city may stand with minimal air pollution on behalf of the steel plant. A similar finding is observed across US regions where CVDs were less prevalent with intense effects in Western regions than in Eastern regions.[7]

Fifth, it is necessary to pay attention to anxiety about exposure to suspected chemical or physical subjects regardless of their real dangers, as they induce negative effects on health status and can present diseases. For instance, annoyed citizens in industrial areas had a markedly chance of experiencing respiratory symptoms. Based on a study in an Industrial Area in Eastern Estonia, in addition to the direct effects of air pollution, up to 25% of residents in industrial areas were highly annoyed about air pollution.[19] The perception of air pollution may induce annoyance independent from the real air pollution in the environment. This phenomenon was demonstrated via mechanisms such as stress-induced inflammation and beliefs. The level of annoyance is dependent on social status and education status.[20] It is noteworthy that the frequency of the population over 30 years old who have studied at a higher level was more in the control city than in the exposed city.

In the present study, the prevalence of hyperlipidemia was significantly higher in the above 30 years old inhabitants who stayed in the exposed city compared to the control city. In 2021, Shun et al evaluated 959 residents aged above 35 years in the polluted areas of Taiwan. The assessments of CAD risk factors among the population showed a significant association between air pollution with higher odds ratios for abnormal total cholesterol levels and the risk of hyperlipidemia.[21] Similar findings were observed by Xu et al in 2021, in which industrial air pollution had significant effects on increasing the risks of hyperlipidemia.[22] Although the results of our study are consistent with the reports of those studies, according to the issues explained earlier, the more prevalence of hyperlipidemia in the exposed city should be criticized cautiously since neighboring to steel plant may not induce pure hyperlipemia without the occurrence of other CAD risk factors. It should be noted that the 10-year cardiovascular accident risk assessment program was implemented in the health delivery system recently, and the low number of above 30 years old population who underwent cardiovascular accident assessment in the exposed city may be a biased sample.

Furthermore, significantly higher frequencies of hyperlipidemia were observed in females than in males in both cities. A similar trend was found in a national survey in 2016 in which, for instance, more than 55% of women in contrast to about 45% of men had hypercholesterolemia.[16] However, cases who underwent a 10-year cardiovascular accident risk assessment were markedly women, and it is necessary to pay attention to selection bias between gender variables.[16] We surveyed based on electronic health files of the population who stayed in the exposed and the control cities that were completed in the past. Nevertheless, it suggests that future research would be designed as longitudinal studies with large sample sizes.

Limitations of the Study

Unfortunately, there was no facility to measure the PM level in the air across the exposed and the control city simultaneously during the present study. Further, we could not obtain reliable data about the prevalence rate of smoking in the exposed and the control cities.

Conclusion

Despite residence in a city located in the south of the steel plant, where the prevailing winds are generally from the south (southwest) to north (northeast), and following many strict regulations and qualified control on reducing or exit of hazardous gases from the steel plant, , yet adherence to some healthy lifestyle such as the diet habit for vegetable consumption and physical activities, which are significantly predominant among above 30-year-old citizens in the exposed city, the prevalence rate of CAD risk factors such as HTN, DM, overweight, and obesity did not significantly differ between the exposed and control cities, except for hyperlipidemia. Furthermore, the frequencies of hyperlipidemia were more prevalent only among women than men in both cities. There is a comprehensive study for an exact risk assessment of CADs following staying adjacent to a steel plant.

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Authors' Contribution

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Competing Interests

The authors have no conflict of interests associated with the material presented in this paper.

Ethical Approval

Ethical issues (including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, and the like) have been completely observed by the authors. This research was conducted based on the license of the Research Ethics Committee of Isfahan University of Medical Sciences with the code number: IR.MUI.MED.REC.1400.140.

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