Occupation Medicine and Hygiene

Cardiovascular disorders and exposure to chemical pollutants

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Keywords

Cardiovascular disorders • Occupational disease • Risk factors • Chemical hazards • Exposure

Summary

Introduction. *Exposure with some chemical can cause cardiovascular disorders. Occupational exposures with chemicals are modifiable risk factors for cardiovascular diseases. The Objective of this study was the determination of cardiovascular disorders in industries with occupational exposures.*
Materials and methods. *Study was a cross-sectional method and was done on workers of related industries. The study was done with a physical examination and checklist by getting health and illness history and clinical tests about the risk factors and cardiovascular disorders. According to exposures the population of the study was divided into 3 groups. Data were analyzed with SPSS 16, by considering $p < 0.05$ as significant.*
Results. *The frequency of unstable angina and stable angina were the most in group 1. The relative risk for unstable angina was 1.55 (1.46-1.61) in group 1 and for stable angina was 1.54 (1.47-1.62) in this group. The risk of thrombophlebitis was 8.48 (7.07-10.17) in group 2.*
Conclusions. *Workers in industry with chemical pollutants had cardiovascular disorders. The occupational exposures, especially chemical agents are effective on cardiovascular system.*

Introduction

Cardiovascular disorders have been the most causes of death in the world in recent decades. At least 52 percent of deaths were from noncommunicable diseases (NCDs). The most frequent NCDs were cardiovascular disorders (CVDs) near 37 percent [1].
CVDs are known disorders that more than 30 percent of people in the community are affected and many of them have its complications and disabilities. These disorders have many important risk factors; changeable and non changeable risks [2]. Some of the changeable risks are hyperlipidemias; high levels of low-density lipoprotein (LDL) and triglyceride (TG), smoking, nutrition, overweight and obesity, hypertension, environmental and occupational exposures [3, 4].
Occupations have many hazards for the cardiovascular system. These items could be modified. These hazards are chemical such as metals; Lead (Pb), Cadmium (Cd), Antimony(Sb), Arsenic (As), other chemicals, solvents, particulate matters and gases, physical and psychological stress [3, 4].
The lead could be caused hypertension with a direct effect on the vascular system and with an indirect effect with chronic renal disorder. Cadmium might be affected on blood pressure and hypertension, it is related to renal effects of Cadmium especially. Arsenic could be caused gangrene by vessel injuries. Arsenic and Antimony could be caused arrhythmias and electrocardiography disturbances. Carbon disulfide had effects on blood vessels. The noise could be as a stressor factor for high blood pressure.
Scientists demonstrated the occupational risk of ischemic heart disease, in this study was shown the effect of Lead as a toxic metal in the cardiovascular system [5]. In a prospective cohort study, researchers showed the effect of metal welding fume on cardiovascular disease [6].
Researchers studied the association between blood Lead and blood pressure [7]. Scientists researched the prevalence of major cardiovascular risk factors among oil and gas and energy company workers [8].
Researchers demonstrated the effect of exposure limits for oil-based metalworking fluids on cardiovascular mortality in a cohort of autoworkers [9].
There were some studies that worked on other occupational risks. Scientists showed diminished health status in firefighters [10].
Researchers worked on occupational noise and myocardial infarction [11]. One study showed the effect of low-dose ionizing radiation on cardiovascular diseases [12]. Other researchers studied and found the same results in this situation [13-16].
Researchers demonstrated the influence of the cardiomyocyte circadian clock on cardiac physiology and pathophysiology [17]. There were some studies about night-shift work and its effect on the cardiovascular system and causing disorders [18-20]. These studies emphasized on circadian rhythm disturbances that can cause physiological disruption in the circular system [21-23]. Kind of job and occupational risks, researched in other study health care workers, car industry and others, the result was important and specific [24, 25].
In some job, psychological stress was more important than other risks [26-29]. Preventive methods

for cardiovascular health were emphasized and introduced [30, 31]. The workers must be helped to the health system for having better health [32].
There were none modifiable risks such as age and gender [33]. We cannot work on. In the world, there were a lot of useful studies on cardiovascular health [34, 35]. The prevalence and incidence of CVDs were different in the world. In countries with low to middle income, cardiovascular disorders were more prevalent [36, 37].
Researchers had some studies about the occupational risk factors in some industries [38-41].
Objective of this study was the determination of cardiovascular disorders in industries with occupational exposures.

Methods

Study setting

Industries with exposure to chemical pollutants (municipality; city services and related jobs) in Mashhad; northeast of Iran.

Study design and target population

The study was a cross-sectional method, was done on workers who were employed in related industries, about cardiovascular disorders and risk factors. The data were taken from personnel with a physical examination and a filling checklist by getting health and illness history, study of risk factors for cardiovascular disorders. According to exposures the population of the study was divided into 3 groups.
According to this 3 groups were demonstrated in industries: group 1; workers at exposure to chemical pollutants (face worker) 988 person, male workers, 35.56 ys, group 2; other workers without exposures in the same industry specially sedentary works (nonexposure) 987 person, male workers, 34.25 ys, group 3; other workers with low level physical and chemical hazards at the same industry(nonface worker) 989 person, male workers, 36.54 ys.
The study populations were workers from the industries with exposure to chemicals. The author researched and followed by a physical examination in research time. Random sampling method was used to $\alpha = 0.05$, power = 80, P1 = 34% and P2 = 14%, study population were calculated 988 for each group (3 groups). About 2,964 in total were assessed.

The inclusion and exclusion criteria

Inclusion criteria were workers who worked in an industry with chemical pollutants, other workers without chemicals and other workers with low level, at least one year of work experience in the same work. The exclusion criteria were having cardiovascular disorders and related diseases before beginning this job.

Procedure

Participants were evaluated for risk factors for cardiovascular disorders: overweight and obesity (BMI 25 and more than 25), smoking (1 pack year and more), age (45s and more than 45s), diet (salty, high lipid, low fiber), stress (environmental and occupational), family history(cardiovascular disorders related disorders and death from them), hyper low density lipoprotein (LDL > 100 mg/dl), hyper triglyceride (TG > 200 mg/dl) and hypertension (systolic blood pressure 130 mmHg and more and diastolic blood pressure 80 mmHg and more).
In checklist design of the study; the checklist was checked with clinicians and specialists and also an experimental study was done with relation to 92.5%. The author interviewed by using a checklist and done tests in the clinical place with use of health issues in occupational health center.
Exposure assessment; for exposure assessment in this study physical hazards: noise and chemical hazards: toxic metal; lead, particulate matter, carbon monoxide, solvent had been assessed and the risk was calculated.
They had the same rotating shift work. Occupational exposures were measured and assessed. Sites 1 had metal exposures, particulate matter and carbon monoxide more than recommended exposure limits [42]. But it was less than the permissible exposure limits. The noise was measured with a sound level meter. Metal had been measured with occupation and toxicological standards. Environmental Lead and particulate matter had been measured with air sampling collected and filters dissolve with acids and the analytical methods with atomic absorption spectroscopy (AAS) were done. In clinical toxicology, blood samples had been examined for Lead, red blood cells were hemolyzed and blood ingested with acids then analyzed by atomic absorption spectroscopy and carboxihemoglobin had been examined after addition of acids then analyzed by atomic absorption spectroscopy. Air sample had been collected for measuring carbon monoxide analyzed with gas chromatography (GC) had been analyzed [42].

Statistical analysis

Data were analyzed with SPSS, statistical tests; kolmogorov smirnov test was used for assessment of quantitative variables normality then paramtric test; ANOVA test was done. Chi-2 or Exact test were used to compare qualitative variables and relative risks were measured according to confidence interval 95%. A p-value of less than 0.05 was measured for significant levels. Regression logistic was used for elimination of some related variables effects.

Etical consideration

In ethical consideration; this study was done with ethical attention and Helsinki declaration and participants' consent.

Results

General results

According to exposures, in this study, participants were divided into 3 groups. The mean age of the population was 35.62 ± 5.64 years old. The mean of work duration was 9.05 ± 4.60 years at the beginning of the study. The mean body mass index (BMI) was 25.56 ± 2.29 kg/m^2.

Special results

Result of mean exposure assessment in site 1: Lead in air was 0.03mg/m^3, (Blood Lead level was 25 mg/dL), particulate matter 2.5 was 0. 1 mg/m^3, carbon monoxide was 5 ppm (carboxihemoglobin was 3 percent). In site 2: none exposure and in site 3: noise was 75 dBA and particulate matter 2.5 in the air was 0.01 mg/m^3, carbon monoxide was 1 ppm, others were zero.

Table I shows the comparison between frequencies of cardiovascular disorders risks factors in three groups ($p < 0.05$). Hyper low-density lipoprotein (LDL > 100 mg/dl), hyper triglyceride (TG > 200 mg/dl), positive family history, rhythm disorders was the most in group 1 but had no significant differences. Smoking and overweight and obesity were the most in group 1and had significant differences ($p < 0.05$).

Table II demonstrates a comparison between frequencies of cardiovascular disorders in three groups ($p < 0.05$). Unstable angina and stable angina were the most in group 1 with significant differences. Myocardial infarction and varicose veins were the most in group 1, no significant differences ($p < 0.05$).

Table III shows the relative risks of cardiovascular disorders in three groups. The risk of thrombophlebitis was the most with 8.48 (7.07-10.17) in group 2 and 2.87 (2.62-3.14) in group 1. Hypertension had the most relative risk in group 1 with 2.14 (1.02-4.46). In three groups the relative risks were more than 1 but after the elimination of smoking and overweight affects the risk of hypertension was significantly in group 1 and in other groups relative risks were not significant.

Discussion

Also, according to study results, the number of workers

Tab. I. Comparison between frequencies of cardiovascular disorders risk factors in three groups ($p < 0.05$).

Groups / Risk factors	Group 1 N (%)	Group 2 N (%)	Group 3 N (%)	Chi-2 or Exact test	p-value
LDL > 100 mg/dl	226 (22.6)	44 (4.4)	29 (2.9)	0.451	0.798
TG > 200 mg/dl	443 (44.3)	83 (8.3)	171 (17.1)	4.963	0.084
Hypertension	540 (54.0)	101 (10.1)	198 (19.8)	5.8080	0.007
Positive Family history	3 (0. 3)	1 (0. 1)	1 (0. 1)	1.611	0.447
History of related disorder	2 (0. 2)	1 (0. 1)	1 (0. 1)	0.536	0.765
Smoking	76 (7.6)	11 (1.1)	1 (0.1)	29.55	< 0.001
Over weight	189 (18.9)	63 (6.3)	1 (0.1)	6.406	0.024

Tab. II. Comparison between frequencies of cardiovascular disorders in three groups ($p < 0.05$).

Groups / Disorders	Group 1 N (%)	Group 2 N (%)	Group 3 N (%)	Chi-2 or Exact test	p-value
Myocardial infarction	1 (0.1)	0	0	0.536	0.765
Unstable angina	5 (0.5)	1 (0.1)	1 (0.1)	2.691	0.03
Stable angina	13 (1.3)	1 (0.1)	3 (0.3)	7.061	0.004
Thrombophlebitis	1 (0.1)	2 (0.2)	0	7.422	0.119
Varicose veins	3 (0.3)	1 (0.1)	2 (0.2)	1.611	0.276
Rhythm disorders	2 (0. 2)	1 (0. 1)	1 (0. 1)	0.544	0.754
Chronic heart failure	1(0.1)	0	0	0.536	0.765

Tab. III. Relative risks with confidence intervals and after the elimination of overweight and smoking effects in three groups.

Diseases	Group 1 RR(CI)	Group 2 RR(CI)	Group 3 RR(CI)
Hypertension	2.14 (1.02-4.46)	1.00 (0.99-1.01)	1.02 (0.97-1.01)
Myocardial infarction	1.53 (1.46-1.61)	-	-
Unstable angina	1.54 (1.46-1.61)	1.13 (1.10-1.16)	1.30 (1.25-1.34)
Stable angina	1.54 (1.47-1.62)	1.14 (1.11-1.17)	1.30 (1.25-1.34)
Thrombophlebitis	2.87 (2.62-3.14)	8.48 (7.07-10.17)	
Varicose veins	1.53 (1.46-1.61)	1.13 (1.10-1.16)	1.30 (1.25-1.35)
Chronic heart failure	1.52 (1.45-1.60)	-	-

with cardiovascular disorders was the most in group 1 with 54 percent after 10 years. There was 19.8 percent in group 3 and 10.1 percent in group 2.

In this study, the number of workers with hypertension, unstable angina, and stable angina was the most in group 1 with significant level $p < 0.05$. Another study showed that ischemic heart disease in workers exposed to metal fumes and particles [5].

Another study had been found the results from exposure to metal welding fume related to cardiovascular disease [6]. In this study, we saw the most number of hypertension in group 1 that exposed to chemicals. In this study in site 1; Lead, particulate matter 2.5 and carbon monoxide were more than others. In another study demonstrated the metal effects on the incidence of hypertension too [7].

Oil and gas and energy company workers, oil-based metalworking fluids workers and in firefighters, studies showed the chemical effects on the cardiovascular system [8-10].

In this study after the elimination of smoking and overweight effects, there was some risk for cardiovascular disorders such as hypertension, unstable angina, and stable angina.

Group 2 with sedentary work was sensitive to thrombophlebitis disorders. In other studies, the risk of cardiovascular attacks and morbidity were demonstrated [5, 9].

Unfortunately in this study were not a psychological assessment that other studies found its effects on cardiovascular disorders [27, 28]. In this study, they had the same rotating shift work and the same nutritionally. Other studies showed the effect of night shift work and unsuitable nutrition on the cardiovascular system [22, 23].

The number of hyper low-density lipoprotein and hyper triglyceride were the most in group 1 that were not significant. It recommended that having a better nutrition and exercise program for workers. In other studies were recommended the preventive methods for health and wellbeing [30, 31]. Overweight and obese people were the most in group 1 and smoking too. There were two risk factors, after the elimination their effects we saw the risks of cardiovascular disorders too. In other studies, the researcher showed the effect of these risks [30, 31].

Physical risks had effective in cardiovascular system disorders in some studies were shown, according to scientific literature, not all physicals, but noise, coldness, and vibration were more prominent in this case [13-15]. In exposure to chemicals and physicals this fact was more prominent [14]. In this study the group 1 exposed to metal, particles and gas, group 2 had not physical and chemical and group 3 has a low level of both of them.

In this study, the author tries to isolate the three groups with special hazards, but workers in group 3 might be exposed to some physicals and chemicals, that these results might be related to occupational exposures. In this study, the author could not done the exact job analysis that other study with better isolation of groups can be more useful. The researcher did not complete an assessment about psychological stress, This item can be affected by cardiovascular system health.

According to this Study, researchers said that job analysis and determination of occupational risk factors for different industries, especially with metal agents and particulate matters exposure were necessary.

The author found that the work in the related industry had a risk of cardiovascular disorders. The chemical hazards in high exposure was more effective in the cardiovascular system.

Although the chemicals could be the most effective occupational hazards for cardiovascular disorders, especially heart attacks and angina, however other risks should not forget. Control of nonoccupational risk factors was necessary too.

Conclusions

Workers in industry with chemical pollutants had cardiovascular disorders. The occupational exposures, especially chemical agents are effective on cardiovascular system:

1. unstable angina and stable angina were more in exposure to chemicals than others;
2. thrombophlebitis was more in sedentary works than others;
3. author recommended control of chemical exposures for prevention of stable and unstable angina;
4. author recommended periodic exercises in sedentary works for prevention of thrombophlebitis

Preventive methods were useful and effective in this situation. Control of nonoccupational risk factors mustbe done too.

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Etical consideration

Compliance with ethical guidelines

In ethical consideration; this study was done with ethical attention and Helsinki declaration and participants' consent.

Conflict of interest statement

Author had not any personal financial interests.

Authors' contributions

SNA: researched and wrote the article.

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