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Original Research Article

Carbon Dioxide and Health

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Abstract: ***Background:*** Acute exposure to carbon dioxide could be caused diseases but in chronic exposure might be caused some mild to moderate symptoms and signs. Objective of this study was to determine the health effects of carbon dioxide in low to moderate concentration. ***Methods:*** The people who were employed in different industries were participated in this study. Groups were followed for brain and heart injury symptoms and signs. These groups were exposed to low concentrations of carbon dioxide; according to working sections, 4 groups were participated: working section A, working section B, working section C and working section D. Symptoms and signs were determined. Data were analyzed with SPSS 16.ANOVA, Chi-2, Exact test and relative risks with considering P<0.05 as significant level. ***Results:*** Working section D, had the most carbon dioxide concentration; 825.10±0.01 PPM. brain and heart injury symptoms and sign were determined. Loss of concentration, chest pain and headaches were the most in group D and relative risks were shown significant risks of carbon dioxide. Relative risks for loss of concentration was 2.25(1.34-3.77). Also relative risks for chest pain were 1.35(1.02-2.10). ***Conclusions:*** Carbon dioxide had health effects in low to moderate concentration and might be caused loss of concentration and chest pain.

Keywords: Carbon dioxide, Concentration, Occupational exposure.

INTRODUCTION

Acute exposure to carbon dioxide could be caused diseases but in chronic exposure might be caused some mild to moderate symptoms and signs. Occupational exposures with carbon dioxide could be controlled and occupational health centers in factories and industries tried to find the best way for decreasing this gas [1]. One of the most harmful occupational exposures was asphyxiant gases [1]. One of the known gases was carbon dioxide [1, 2].

The main etiology for many of disorders symptoms and signs in the environment and workplaces was chemical exposures [1]. But the air pollution was an important exposure in the environment and must be controlled. The health system tried to control it in all places [3, 4]. If it was more than standards, 2500 PPM, they had controlled [5-7]. But in recent years researchers showed symptoms and signs in lower concentrations [8, 9].

Exposure to high concentrations of this gas could be caused an acute poisoning with acute symptoms and signs such as; headache, nausea, loss of concentration, cardiac arrhythmia, chest pain, slowed reaction time, fatigue [10]. But in lower exposure, might be seen loss of decision making and chronic fatigue [11-14].

Satish U and coworkers studied about the psychological and neurological effects of carbon dioxide and they found that low-to-moderate CO2 concentrations could be affected on Human decision-making Performance [1]. Corsi RL and coworkers worked on carbon dioxide levels and effects on elementary schools [2]. Erdmann CA and coworker showed the effects of carbon dioxide on mucous membrane and lower respiratory building related symptoms [3].

Bloch-Salisbury E and coworkers demonstrated the acute changes in carbon dioxide levels alter the electroencephalogram without affecting cognitive function [4]. In another studies researchers worked on emergency management simulations and decision making [5, 6].

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Kaye J and coworkers studied about the acute carbon dioxide exposure in healthy adults [7].

Studies were performed on outdoor and indoor air pollution and were found that carbon dioxide was a pollutant of both spaces [8, 9].

Author had assessment about the Sick Building Syndrome Symptoms in employees, it had an important results about the exposure assessments.

Occupational healthcare worker worked on physical examinations and should be assessed the exposures too [11, 12]. There were some studies about the prevention of occupational and environmental diseases. Record NB and coworkers designed the community-wide cardiovascular disease prevention programs and health outcomes in a rural county and air pollution control [13]. In the workplaces must be paid attention to exposed workers [14].

Carbon dioxide one of the major atmospheric gas and had effects on environment [15]. Kleynhans EJ and coworkers showed the adaptation to elevated CO2 in different biodiversity contexts [15]. Song X and coworkers worked on health effects of pollution and demonstrated the short-term exposure to air pollution and its effect on cardiac arrhythmia [16].

Asphysiant gases had cardiovascular effects as the same as neurological ones [17, 18]. Cai Y and coworkers showed the associations of short-term and long-term exposure to ambient air pollutants on hypertension [19].

Lee WH and coworkers demonstrated the association between long-term exposure to air pollutants and prevalence of cardiovascular disease.(20)Other researches worked on other effects of air pollutants [21-23].

Health programs for workers were necessary and assessing and measuring the risk factors were important subject in this situation.

Objective of this study was to determine the health effects of carbon dioxide in low to moderate concentration.

METHODS

Study Setting; related industries.

Study design and Study population; it was a study with more than 2 years follow up. The people who were employed in different industries were participated in this study. Groups were followed for brain and heart injury symptoms and signs. These groups were exposed to low concentrations of carbon dioxide; according to working sections, 4 groups were participated: working section A, working section B, working section C and working section D. Symptoms and signs were determined.

Simple random sampling method was used with α= 0.05, power= 80, P1=25% and P2= 45%.

These groups were exposed to low to moderate concentration of carbon dioxide; according to working section the population was divided to four groups. Symptoms and signs were determined by using questionnaire and clinical examinations.

Symptoms and sign were heart and brain; headache, nausea, loss of concentration, cardiac arrhythmia, chest pain, loss of decision making, slowed reaction time, fatigue.

The Inclusion criteria were people who worked in different industries with at least 3 years work experience in the same work. The exclusion criteria were having the related diseases in heart and brain systems before beginning this job and having the positive family history of cardiovascular and neurological injuries and disorders.

Exposure assessment; all exposures assessed and calculated the risks. Other work exposures were kept in the standard levels. Carbon monoxide measured and calculated according to standards of occupational safety and health administration by using a gas sampling loop, injected into a gas chromatograph, and analyzed using a thermal conductivity detector. Each sample is collected by drawing a known volume of air into a five-layer gas sampling bag. Samples are collected in gas sampling bags and analyzed using a gas chromatograph (GC) [24].

The validity and reliability of questionnaire were checked with specialists' opinions and also with performing a pilot study with correlation coefficient 96%. The participants were examined by author using a questionnaire, physical exams.

For statistical analysis, data were analyzed with SPSS 16. Chi-2, Exact test, ANOVA, P value less than 0.05 was considered for significant levels and relative risks were calculated with confidence interval 95%.

Ethical consideration; the study was implemented with the consent that was obtained from all the participants.

RESULTS

The study participants were divided into 4 groups. Working section D, had the most carbon dioxide concentration; 825.10±0.01 PPM. Brain and heart injury symptoms and sign were determined. Loss of concentration, chest pain and headaches were the most in group D and relative risks were shown

significant risks of carbon dioxide. Relative risks for loss of concentration was 2.25(1.34-3.77). Also relative risks for chest pain were 1.35(1.02-2.10).

Table 1 showed the minimum, maximum and means of carbon dioxide concentration in four groups. Group D had the highest concentration and group A had the lowest concentration of carbon dioxide. There were significant differences between four groups.(P<0.05)

The highest number of symptoms and signs were in group D: headache, nausea, loss of concentration, cardiac arrhythmia, chest pain, loss of decision making, slowed reaction time, fatigue. The lowest number of symptoms and signs was from group A. There were significant differences. These items were demonstrated in Table 2 (P<0.05)

The relative risks for symptoms and signs were determined, group D had the highest risks. Relative risk in group D for loss of concentration was 2.25(1.34-3.77) and for fatigue was 2.22(1.77-6.37). Relative risk in group C and B for loss of concentration were 2.05(1.04-3.17), 1.25(1.34-2.27) and for fatigue were 2.20(1.12-2.40), 1.50(1.22-2.45). Table 3 shows the relative risks in different groups. By using the logistic regression, these were had significant differences.

Table 1: Means of Carbon dioxide concentration in PPM and comparison between working sections (P<0.05)

Group / Variable	working section A	working section B	working section C	working section D
Concentration Minimum	300.01±0.82	600.20±0.03	700.10±0.02	800.20±0.01
Concentration Maximum	550.20±0.02	650.50±0.05	750.02±0.01	850.01±0.02
Concentration Mean±SD	450.10±0.45	625.35±.04	725.06±0.01	825.10±0.01
P value	0.001			

Table 2: Frequencies of symptoms and signs and comparison between working sections (P<0.05)

Groups / Symptoms and signs	working section A N(%)	working section B N(%)	working section C N(%)	working section D N(%)	P value
Headache	7(0. 7)	10(1.0)	12(1.2)	15(1.5)	0.001
Nausea	1(0.1)	4(0.4)	5(0.5)	5(0.5)	0.04
Loss of concentration	5(0.5)	12(1.2)	15(1.5)	20(2.0)	0.001
Cardiac arrhythmia	1(0. 1)	3(0.3)	5(0. 5)	6(0.6)	0.04
Chest pain	5(0. 5)	8(0.8)	10(1.0)	15(1.5)	0.03
loss of decision making	2(0. 2)	6(0.6)	12(1.2)	16(1.6)	0.001
disrupted reaction time	3(0. 3)	5(0.5)	7(0. 7)	10(1.0)	0. 02
Fatigue	4(0. 4)	10(1.0)	14(1.4)	19(1.9)	0. 001

Table 3: Relative risk of symptoms and signs between working sections (P<0.05)

Groups / Symptoms and signs	working section A RR(CI)	working section B RR(CI)	working section C RR(CI)	working section D RR(CI)
Headache	1.05(1.01-2.14)	1.25(1.02-2.10)	1.30(1.01-3.10)	1.35(1.02-2.10)
Nausea	1.10(1.11-1.63)	1.20(1.04-1.53)	1.25(1.20-1.53)	1.30(1.10-1.43)
Loss of concentration	1.05(1.04-3.07)	1.25(1.34-2.27)	2.05(1.04-3.17)	2.25(1.34-3.77)
Cardiac arrhythmia	1.20(1.10-1.43)	1.30(1.30-1.65)	1.35(1.20-1.63)	1.51(1.01-2.32)
Chest pain	1.02(1.01-1.65)	1.12(1.02-1.65)	1.22(1.02-1.45)	1.35(1.20-1.63)
loss of decision making	1.08(1.02-1.55)	1.09(1.01-1.54)	1.20(1.02-1.53)	1.52(1.22-1.65)
disrupted reaction time	1.02(1.47-5.34)	1.12(1.57-6.47)	1.12(1.75-6.37)	1.28(1.12-1.53)
Fatigue	1.35(1.02-2.09)	1. 50(1.22-2.45)	2.20(1.12-2.40)	2.22(1.77-6.37)

DISCUSSION

According to our findings, Working section D, had the most carbon dioxide concentration; 825.10±0.01 PPM. Brain and heart injury symptoms and sign were determined. Loss of concentration, chest pain and headaches were the most in group D and relative risks were shown significant risks of carbon dioxide. Relative risks for loss of concentration was 2.25(1.34-3.77). Also relative risks for chest pain were 1.35(1.02-2.10).

According to the finding; group D had the highest number of symptoms and signs for cardiovascular and neurological systems: headache, nausea, loss of concentration, cardiac arrhythmia, chest pain, loss of decision making, slowed reaction time, fatigue. The lowest number of symptoms and signs was

from group A. Group A had the lowest concentration of carbon dioxide. There were significant differences.

The relative risks for symptoms and signs were calculated, group D had the highest relative risks. Relative risk in group C for loss of concentration was 2.05(1.04-3.17) and for fatigue was 2.20(1.12-2.40) there were significant. Relative risk in group B for loss of concentration was 1.25(1.34-2.27) and for fatigue was 1.50(1.22-2.45). There were significant too. By using the logistic regression, these were had significant differences. It mean symptoms and signs were not related to body mass index, age , other occupational exposure and environmental exposures.

Other studies showed the same as these results and demonstrated the special effects of carbon dioxide on heart, brain and psychological systems. (23,24). Carbon dioxide had effects on different part of the body, we thought it affected on all of them from heart to brain and mental system [20].

It seems that carbon dioxide that was emphasized on vital and non vital organ systems [2, 3]. These were more prominent on mental and psychological. In this study researcher showed that group D had the most frequency headache, nausea, loss of concentration, cardiac arrhythmia, chest pain, loss of decision making, slowed reaction time, fatigue. This group had the highest level of carbon dioxide. Other studies had demonstrated the harmful effects of asphyxiant gases [1, 2].

The highest numbers of people with loss of concentration, loss of decision making, fatigue, chest pain and headaches were the most in group D. The effects of this gas on blood pressure had been shown in other researches [1].

After deleting the effects of age, body mass index and other exposures the risk of diseases had significant difference. The risk of neurological symptoms and related diseases was demonstrated in other studies too [2, 3]. Neurological symptoms and mental disorders could be caused by exposure to carbon dioxide [2, 3]. This study showed the effects of low concentration of this gas on neurological symptoms and signs and mental or psychological symptoms such as loss of concentration and decision making.

The physician must not ignore this important item in occupational health system. Modifying the workplace specially from asphyxiant gases; simple or toxic was necessary and then employee could be worked very well [20, 21].

According to the results of this study, researcher thought that specific job analysis must be done for all workers and must be measured all of risk hazards in the work place. In other studies were worked on determination of risk factors by emphasized on gases in related industries [21, 22].

Frequency of symptoms and signs were important and were gathered by reliable and valid questionnaires. Some studies used questionnaires as the same as this study [21, 22].

Author found that the carbon dioxide was an important risk factor for cardiovascular and neurological disorders even in low to moderate concentrations. Low to moderate concentration in long time might be followed by neurological, mental such as loss of concentration, loss of decision making and cardiovascular symptoms such as arrhythmia and chest pain [2, 3].

Examination in occupational and environmental medicine had an important situation. Cardiovascular and neurological disorders could be prevented by periodic examinations and assessments of pollutants. The author of this article recommended to the occupational physicians and occupational health team, must be assessed the risk factors in the workplaces specially chemicals and asphysiant gases and tried to modified the workplaces, they should be examined personnel in periodic examinations and assessed the exposures.

Carbon dioxide exposure could be resulted from environmental exposures and air pollution, occupational health team might be paid attention.

CONCLUSIONS

Carbon dioxide had health effects in low to moderate concentration and might be caused loss of concentration, decision making, fatigue and chest pain.

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